IIEP research and studies programme

Improving the managerial effectiveness of higher education institutions

Management of innovation: a case study of the Birla Institute of Technology and Science Pilani, India

C.R. Mitra

International Institute for Educational Planning

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This monograph is part of the Institute's research on 'Improving the managerial effectiveness of higher education institutions', directed by Bikas C. Sanyal, IIEP

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by

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Foreword

An opportunity to write a case history of the transformation of BITS is both a matter of pride as well as a challenge. Pride lies in the fact that the author was intimately involved in the transformation which required 20 years of sustained commitment and effort. The challenge lies in the problem of condensing so much into a short report while at the same time conveying the feelings experienced years ago.

The author, having been a participant, has both a vantage point but also an intense partisanship, so that it is advantageous for the study to be written after such a long passage of time. The immediacy of the experience has now receded, giving way to thoughtful reflection and attempts to draw more general and objective conclusions.

The BITS experience is not a mere change, but truly an innovation; an outcome of a planned strategy to change purposefully both with or without additional physical inputs. The configuration and management of this gigantic task had to be distinctive and created for the particular context. This report is thus one on both institutional change and the respective management processes. There are few studies in the literature which describe the problems of transformation of a traditional institution in a developing country. Hence the story of the dramatic, far-reaching and successful educational innovation at BITS, Pilani, India, should fill a gap.

The changes at BITS have been so all-comprehensive and integrated that a case study must perforce focus on management of innovation rather than confine itself merely to describing managerial improvement. Management of innovation can be described as the art and science of

shaping a radically new achievement, and has invariably to be original and fit the context of the particular institution.

A report of this kind must cover many issues: it has to present hard facts, narrate the unfolding of the process and draw certain universal conclusions for use elsewhere. Thus the first chapters are purely narrative (the history, management and nature of changes introduced – Chapters 1-6), while Chapters 7-9 attempt a review and synthesis. Chapter 10 has a message for others regarding encouragement of innovative institutions. The Annexes present some of the statistical data and information in charts and tables.

Finally, I would like to take the opportunity here personally to thank Ms. Joyce E. Collins of the IIEP staff for her assistance in the preparation of the study.

C.R. Mitra

Preface

Over the last decade, as a result of financial stringency, combined with demands for expansion of enrolments and improved efficiency, higher educational institutions have been forced to reduce expenditure, seek new sources of funding and improve the utilization of existing resources. This has necessitated changes in the mechanisms, techniques and styles of institutional management. At the same time, higher education has had to cope with increased diversification and new types of students, including adult learners, so as to meet the changing needs of the labour market and foster closer links with industry as well as widen participation through the introduction of distance learning.

The implementation of innovation and change in institutional management, however, often faces obstacles and problems, including internal resistance, inadequate staffing or financial resources to make the change effective, or insufficient time devoted to preparing and planning for change.

It is against this background that in 1990 the IIEP launched a research programme on 'Improving the effectiveness of higher educational institutions' whose purpose was to increase understanding of the process of planning, introducing and implementing management changes in higher education institutions, in order to improve utilization of resources. The project aimed at identifying factors associated with success or failure, exploring ways of overcoming obstacles or problems, and suggesting methods to improve institutional management and increase

the responsiveness of higher education institutions to changing financial, economic and social pressures.

The research programme has several components, i.e. an information base, case studies and training materials and workshops. The case studies were a particularly important element since they were designed to identify the factors and strategies associated with successful innovation and change, and show the obstacles and problems to be overcome. This information was then subsequently used for the training materials and as a major input to the synthesis of the research programme.

Several types of innovation and change were pinpointed for particular study:

(i) Change in the organization of institutions:

- New forms of decision-making structures and information flows.
- The merger of separate institutions, departments or units.

(ii) Changes in financial management and resource allocation:

- Devolved budgeting.
- Resource generation.

(iii) Changes in educational delivery systems:

- From semester to trimester, from block to credit system, rationalization of curricula, double intakes.

(iv) Changes in staff management, including staff development and appraisal.

In total, 14 case-studies and one desk-study were carried out, three each in Africa, Asia and Latin America and five in developed countries.

The study published in this volume falls under category (i) and (ii) above and has contributed to an understanding of how institutions, given good management and continual innovation, may prosper in difficult environments.

The Birla Institute of Technology and Sciences (BITS), Pilani, India, is a wholly privately financed 'deemed' university. Few of this type of university exist in India and by their nature they must constantly innovate and modernize in order to compete. It was in a situation of stagnation and falling revenue in 1970 when a new leadership team began work and from then on instituted a series of cumulative reforms in academic structure, examinations, admissions and staff management, followed by changes in graduate programmes, research and consultancy, all subject to continual adjustment up to the present time. It must be mentioned here that the new Director was an Indian having experience of institutional management in one of the best technological universities in the United States of America.

The major conclusion of the study is that innovation automatically unfolds a whole range of necessary changes and strategy should determine how many elements can be tackled at one time. It is extremely rich in the number of lessons learned. Any developing country university feeling the burden of constraints of an unfavourable environment may profit from and be given fresh hope by this experience.

The overall results of the research programme will be published shortly in a synthesis of wide-ranging scope which covers the most important domains of university management.

Jacques Hallak
Director

Contents

Abbreviations

AICTE	All India Council for Technical education
ACB	Academic Counselling Board
BET	Birla Education Trust
BITS	Birla Institute of Technology and Science
CEERI	Central Electronics Engineering Institute
CGPA	College Grade Point Average
CSIR	Council of Scientific and Industrial Research
CTP	Certificate Training Programme
DCPL	Development Consultancy Private Limited
FICCI	Federation of Indian Chambers of Commerce and Industry
HBTI	Hartcourt Butler Technological Institute
IIT	Indian Institute of Technology
MIT	Massachussetts Institute of Technology
NCSM	National Council for Science Museum
NIBM	National Institute of Banking Management
NSS	National Service Scheme
PBI	Progressive Branching Index
PS	Practice School
R&C	Research and Consultancy
STD	Science and Technology Development
TIC	Technology Innovation Centre
UGC	University Grants Commission

Chapter 1
The background and the problems

1. The Indian university context

Indian higher education is characterized by a deadening uniformity, aversion to change and poor management, despite repeated government efforts to shake up the system. Much more far-reaching change has been achieved in the schools.

Complaints have been numerous in the literature. One author sums the situation up as follows:

> "A good deal of ineffective university performance can be attributed to unsound administration and unplanned growth. Bureaucracy decrees that communications have to take a set route with little interaction between constituent parts; there is overemphasis on procedures, paper work, rules; excessive concentration of financial power in the hands of administrators causes disputes even for petty amounts; delegation of authority is unclear and none may handle routine matters independently; staff are of poor quality, particularly the key administrators, there are no incentives for competence or job evaluation schemes (only seniority counts) and there are no methods to control or enforce discipline"[1].

1. Rao, V.S.P. University administration in India. University News, 19 March 1990.

The central funding body, the University Grants Commission (UGC) is trying to develop appropriate models and management patterns for universities, e.g. adherence to an academic calendar, a screening test for lecturers and for the first time a code to develop and evaluate teachers. 48 Academic Staff Colleges have started functioning and so far this is the only area of success.

The National Policy on Education 1986 aimed at radical reorganization through multipronged strategies but has failed to make much impact. The plan for autonomous departments has not been implemented except for two cases, and there are few signs of improvement in university management. Expansion also brought neglect of quality and research. Universities fail even to make admissions, conduct exams, declare results and award degrees on time[2]. Political will has been too weak to overcome the general inertia and suspicion of innovation.

Government policy and inputs are not the only forces which have been working for change. Ever since Independence many Indian universities have received assistance and increasingly borrowed various American concepts and practices in education. There have been notable examples of collaboration between Indian universities and counterparts in America. Many of the borrowed ideas relate to the semester system, modular courses, letter grades, integration of curricula, faculty structure, role perceptions of university research and consultancy, internal evaluation, and linkages with industry, etc. However, because of an inability to grasp the overall concept and due to neglect in developing adapted Indian techniques, the attempts to change have been largely thwarted. There has been no premium in taking risks and moving in directions of innovation.

It should also be mentioned that higher education in India, unlike the USA, is not one where industry has sponsored institutions with alternative curricula and educational features, nor has it ever made any attempt to spearhead educational transformation. Only two examples can be cited, e.g. institutes of science sponsored by the Tatas and by Birla industries. Also various industrial houses have come forward to partially

2. Saxena, R. Governance of Indian universities, Higher Education, Vol. 20, No. 1, July 1990.

bear the cost of prototype colleges and universities, e.g. the capitation colleges in engineering and medicine.

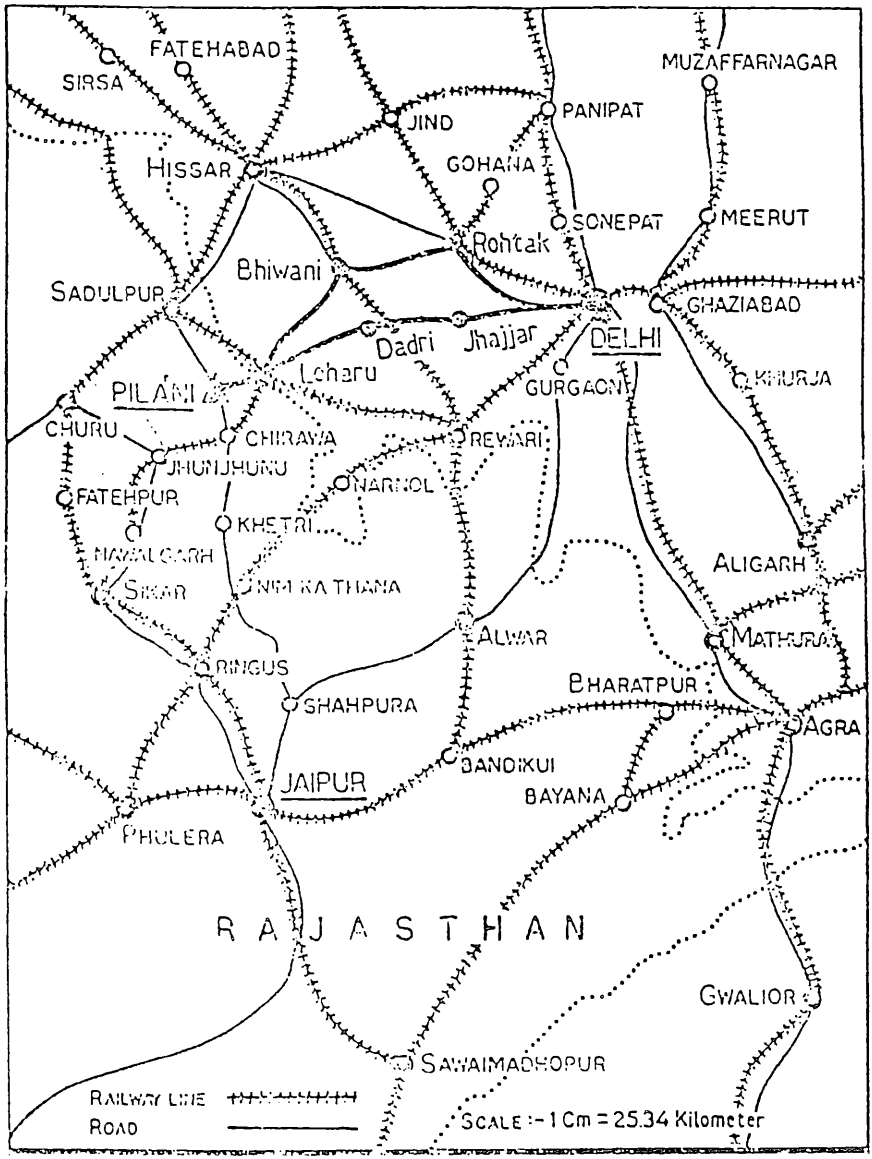
2. Genesis of the Birla Institute of Technology and Science (BITS)

It was in this very inauspicious context that Mr G.D. Birla announced in 1963 that he intended to launch a private Institute of Technology somewhere in India in collaboration with the Massachusetts Institute of Technology (MIT), USA and with foreign exchange support from the Ford Foundation, USA.

The institution that ultimately came into existence was formed from the merger of three colleges of engineering, sciences and liberal arts already existing in Pilani (see *Map 1*). These colleges were operated by the Birla Education Trust (BET) and were affiliated with Rajasthan University. Socially and culturally the setting was extremely conservative and the colleges had always been subject to patronizing controls. The new entity was called BITS and obtained a 'deemed university' status from the Government of India and the UGC in the year 1964. In governmental parlance it was not pronounced an IIT, which has a distinctive tag of 'institution of national importance' through Act of Parliament. As a 'deemed university', BITS was able to apply for resources to finance mainly non-recurrent expenditures and posts for a five-year period only from the UGC.

It may be mentioned in passing that MIT was already concurrently involved in the development of the Institute of Management, Calcutta and was associated with eight other American universities in IIT Kanpur. There was hardly any interaction between the MIT personnel located in these three places in India. The input at Pilani was one of the lowest in any American project.

Map 1. Location of BITS, Pilani



BITS came into existence with its statutes already prepared and approved by the government. The Ford project provided for four Americans stationed in Pilani, ability to purchase equipment and back volumes of journals which needed foreign exchange at a time when supply was very tight. The American visiting professors almost immediately introduced many structural changes in education and also in the curriculum. It was basically a one-sided transaction. In fact what was organized by the Americans on an unprepared ground was constantly unmade by the Indians in course of implementation. To give an example, an MS degree was created but was aborted even before the first batch came out. The most dramatic idea the Americans pushed was the concept of Practice School. In fact the idea was accepted at the administrative level in the first meeting of the Board of Governors and the Governing Body in 1964, but it could not be launched.

The Americans were not satisfied with the pace of modernization and development at Pilani. Both MIT and the Ford Foundation insisted on a change of leadership and in May 1969, the author took over as director. It should be noted that the author, while an 'insider' being Indian, was also an 'outsider' not having had any contact with BITS previously and also had many years working abroad, in particular at MIT.

At the time of his arrival, the situation was that BITS, during the first five years of its life, had been buffeted by all kinds of demands for which it was not prepared with adequate intellectual capacity, managerial flair and financial resources. It had arrived at a stalemate when the old was nominally buried but the new was unable to be born. It could only be concluded that the moment had arrived to begin the real encounter between the changeless and the changing. Neither the heritage of BITS nor the Indian higher education scene offered hospitality for painless innovation to germinate on the soils of Pilani. This situation is demonstrated in *Chart I.*

3. The problems

As noted in *Chart I*, the first task in 1969 was to make a realistic assessment of resources and constraints.

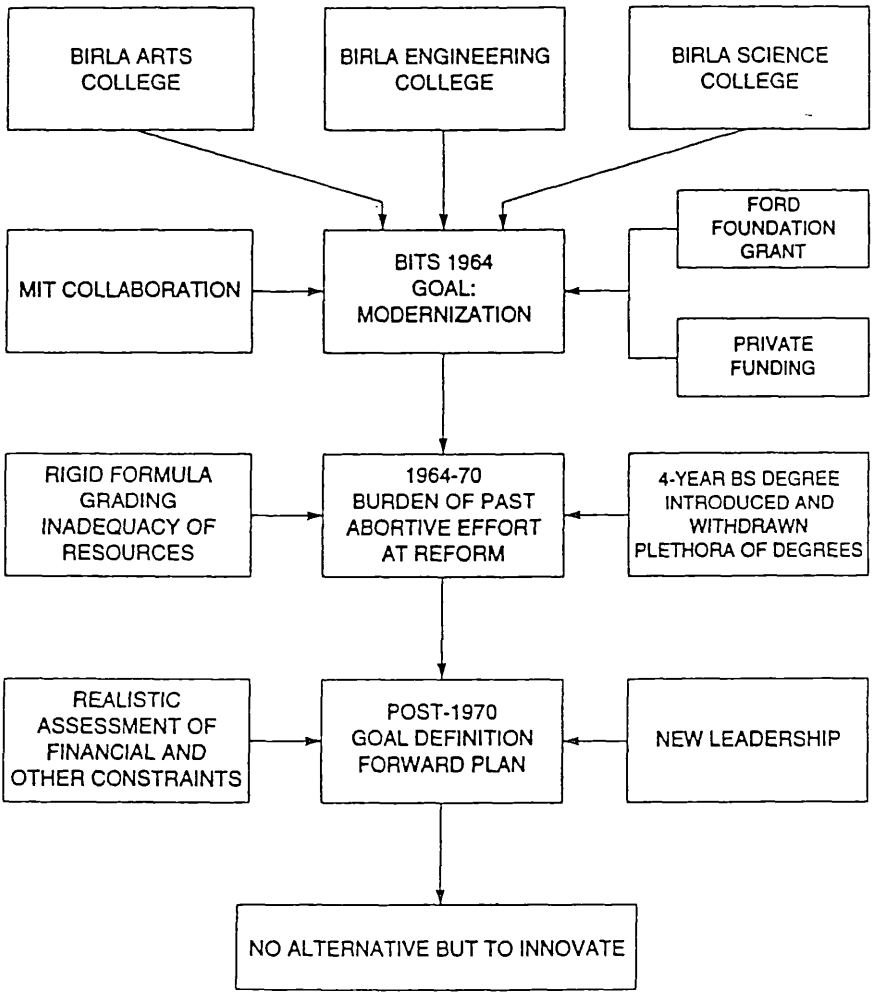


Chart 1. BITS and the situation in 1970.

(a) Financial

Until the formation of BITS, all schools and colleges at Pilani were financed by the Birlas who decided not to ask for grant-in-aid from the government. Funds were funnelled through the BET which was the controlling agency for the educational complex. Although BITS eventually became administratively independent of BET, the separation was so fuzzy that the facilities provided for the staff and the students of BITS were freely shared by BET without any payment. In fact, land, capital assets, buildings, were never fully demarcated between BITS and BET.

Soon after the formation of BITS, funds were no longer received through BET, but instead, ad hoc amounts, year by year, were secured through donations from Birla Industries. While the new university was based on deficit financing, there were no fixed pay-masters.

By 1970, it was evident that the supply of new money provided during the first five years of the institute had dried up, and the closure of the Science and Arts Faculties was contemplated.

(b) Administrative

The basic rules of governance of the new university were formulated by the central government. The structures of the General Body and the Board of Governors allowed a free hand to the Birlas. This paternalistic and conservative mode of life and behaviour continued and hampered the growth of a university ambience in a modern setting. The sponsors did not want to relax their grip. There was no evidence that they understood the full implications of what a modern university requires. The integration of the three erstwhile colleges remained incomplete.

(c) Faculty

Staff generally met the requirements of basically undergraduate colleges of an affiliating university. They were used to following orders and precedence. Salary scales were unattractive and hence recruitment of better quality personnel had not met with success. Any ideas of autonomy and responsibility left them somewhat confused. They remained intellectually isolated and had never been burdened by the tasks

of negotiating approval of grants for new educational requirements. The American presence was viewed more in personal terms rather than in terms of new educational vistas, and staff had not internalized change or fully supported reforms and the practice school.

(d) Students

It has always been a mixed bag, consisting of high talent and low motivation, and generally coming from rich and well-connected families in Northern India. They were treated somewhat like public school students. There simply was no leadership or ethos to inspire and demand intellectual excellence. Admission was not known to be strict but even so, the institute was unable to fill even engineering places by students with first division. Also acceptance by employers of graduates was not universal.

(e) Low impact of the MIT-FORD project

The project cost was $3.11 million and covered 1965 to 1977. It was not large enough to do more than try to operate through persuasion.

MIT as far as project funds were concerned was the senior partner and by convention took the decisions on choice of equipment, journals, American experts and type of training of Indian faculty. Emphasis in the beginning concentrated on the development of selected areas of excellence in spite of sub-critical size. Fundamental issues of transformation, idea absorption and idea implementation were not addressed. Therefore some reforms initiated by the Americans floundered very badly, while others were not even started. Further, it was established by 1969 that the rupee cost of processing the Ford dollars had become larger than the currency conversion rate. Many misgivings were expressed both by MIT and the Ford Foundation.

The above constituted a daunting list, and was clearly a challenge for any change-maker.

Chapter 2
The solution proposed

Given the situation that resistance to educational change was strongly entrenched as a whole in the country, and that five years of trying to implement foreign ideas at BITS had so far proved dysfunctional, as well as demoralizing to the staff, that BITS had a low image and an essentially static budget, it was obvious that something fundamental had to be done to stop the drift and the dismantling of the institute. Making minor changes would not be enough. The choice was between:

(i) Seeking new massive inputs of resources to replace the old and obsolete; or

(ii) Building an original system with present resources -- the path of innovation and risk.

The limitations of private resources and the desire for self-reliance impelled the institution to opt for (ii).

Intensive and participatory discussions were initiated. Since nothing similar existed elsewhere, the task was to identify the elements of a model which would be constantly evolved as the institution went ahead. A model was clearly required in order to have a reference point against which standards of performance could be checked. In addition, a model sets a vision and a goal. It helps in securing some coherence of approach in contrast to piecemeal response to events. Finally, a model helps in internalizing the whole process. This in fact proved to be the most vital element in this strategy.

1. The key features established for the model were:

(i) It must possess the stamp of originality, be adaptive, and self-corrective.

(ii) It must be goal-seeking.

(iii) The process would have to be backed up by institutional research to give information on refinement of the model and to supply valuable feed-back data.

(iv) It must work on a wavefront including simultaneously academic, financial and administrative matters.

(v) It must stress efficiency and invent original techniques which are locally created and constantly honed.

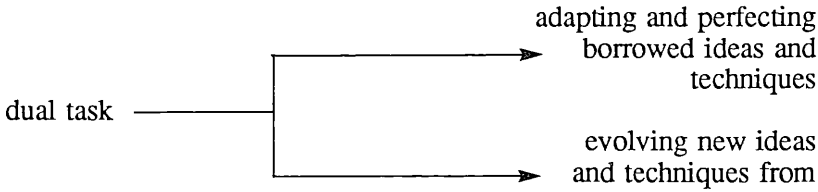
(vi) The model must be transparent so as to be widely comprehended.

(vii) It should generate a new cadre of self-assured and proven implementors.

The model and the policy for its management were studied, defined and put forward for discussion.

General characteristics of the Innovation Model adopted by BITS

An adaptive system capable of both
Renewal and discard, having a



constituting an ever-expanding chain reaction in a continuous process, one innovation leading to another

2. Characteristics of management techniques

Although management is to be concerned with constant innovation, it does not in any way mean adventurism but:

- a mixture of confrontation and accommodation
- pilot runs, caution, wisdom and patience
- controlled experiment
- providing in-built checks
- anticipating next innovation warranted by the chain-reaction of the previous innovation
- turning liabilities into assets
- techniques are implemented only if self-perfected and serving goals
- goals are defined through an internal process
- creation of a stake for all and generation of extreme commitment through:

  (i) a participatory process (allowing sufficient lead time for discussions);
  (ii) continuous education of all those who participate, in particular imparting the ideas that innovation does not always add to costs, and a price also has to be paid for refusal to innovate.

Comprehensive and intense discussions generated an atmosphere of intellectual ferment and eventually the self-reliant, self-regulatory and innovative model gained adherence. BITS had to be put on an independent footing.

The matter was taken up at the highest level with MIT and the Ford Foundation. Ultimately in 1970, the Ford project contract incorporated the following extraordinary clauses:

(a) MIT was made a junior partner in the relationship, pronouncing BITS as the ultimate arbiter on all administrative and financial decisions on the Ford dollar. This was the first American project in India where the initiative was passed to the Indian partner.

(b) The convention that the Ford dollar could be used only for American experts, American equipment and American back volumes was broken. A specific clause was added to the effect that BITS was free to go to other parts of the world for these items and still pay with Ford dollars.

A whole year was spent in sensitizing people and deciding what was possible in Pilani in the endeavour to translate valid and valuable foreign concepts into practice at Pilani. In this changed situation, some American professors participated enthusiastically, accepted local leadership and played a vital role.

Instead of asking for more inputs, and looking to big brothers and to the government for assistance, a self-reliant alternate path was boldly internalized.

A comprehensive document incorporating the Institute's new goals and a plan of action to realize them was brought out in the form of 'Forward Plan 1970', which document formed the basis for the subsequent development of BITS.

The major goals to be achieved with this new management model were:

(i) To complete the unfinished integration of the three colleges.

(ii) To salvage the science and humanities faculties.

(iii) To seek out and forge new linkages with the outside world, by:

All degree programmes irrespective of engineering, sciences and humanities being based on science and mathematics and thus admissions restricted to the Physics, Chemistry and Mathematics stream of the 10+2 school system.

The central thrust, particularly in humanities and social sciences, to remain founded on science and technology.

All degree programmes irrespective of the faculties in all the three tiers purposively oriented towards a perception of employment.

Symbiotic linkages with the world of work and employment to be established by:

- acknowledgement of an Information Society;
- incorporating practice school in the curricula;
- laying the foundations for research and consultancy;

(iv) To achieve the competitive edge in respect of quality of student input, placing of graduates, recruitment of faculty and bids for outside money.

(v) To achieve financial self-sufficiency by:

- Search for new resources outside budget;
- Internal and external resources to be fully integrated;
- High efficiency of all input-output relations;
- Tuition fees based on the concept of economic fees;
- The stress on efficiency was to aim at:
- Low cost per student and degree;
- Set staff-student ratios;
- High utilization factor of classrooms and laboratories;
- Low cost of processing Ford dollars.

(vi) To establish BITS' reputation as a world class institution, first at undergraduate level and then at Masters and Ph.D. levels.

The goals and stakes were set high: innovation and change had correspondingly to be at a high level, and as foreseen in the model, on an integrated wavefront.

Chapter 3
Implementation

A model that is evolving constantly as a part of a planned process, demands a strategy of implementation which is equally original and subject to constant amendment on receipt of feed-back information. Further, it must reject any technique copied from elsewhere which is not directly relevant to the purpose in hand.

Two types of strategy had to be recognized. One was for developmental activities and the other for operational stability. Since the needs are different, the methods are equally different. Further, every innovation must give rise to a new routinization to replace old habits of thoughts and action. Strategy, therefore, demands a clear perception and timing of the innovation-routinization cycles.

For the model to maintain a human face, strategy must address largely two categories of participants. The first is the newly converted whose fullest education has to be ensured. The second is the detractors who have to be won over or have to be fully neutralized.

Implementation had to include certain elements which are touched upon below:

(i) Information about the innovation must be constantly circulating and based on reasoned argument and publishable documentation.

(ii) The development must take place through achievable increments. It would be a mistake to aim for too high a goal with which the system cannot cope.

(iii) The benefits of the system must be made as widely available as possible. Vulnerable sections of the population should be given due consideration.

(iv) No piecemeal and ad hoc reforms should ever be attempted. There appears to be a critical number of reforms which should be tackled together. Thus, academic and non-academic or main-line and side-line activities should be tackled together.

(v) Often the simplest ideas appear to be the most difficult to implement only because people do not appreciate that all that is required is to discover a new method.

(vi) The leader should always take the people into his/her confidence and frankly describe the risk which has to be taken and the stakes involved. Quite clearly the reward system must liberate itself from the standard formula-ridden unimaginative system that has infested most Indian universities.

(vii) Intellectual isolation must be deliberately broken. The system must foster the process of checks and balances to ensure change through phases of stability.

(viii) As the model unfolds, it must create congruence of interest and advantage. For example, academic registration before the beginning of every semester is a must for the system design. The spin-off was that tuition fees were collected simultaneously, so that cash flow planning was ensured.

(ix) Induction into the competitiveness of the world of work and education has to be purposefully sustained. Competition with similar institutes to attract the best students, to place the graduates in employment or in graduate schools in the most selective universities in the world, recruitment of faculty and securing new funds to augment the task of a cost-effective education, became a central challenge of the institution's existence.

Since in India, the key requirement is imagined to be funds and more funds, achievement of financial self-sufficiency was critical. It had a dual objective, namely (i) to demonstrate that management of innovation is almost synonymous with management of all resources and (ii) participants must be given immediate proof of the concept that innovation can indeed take place without any extra money from the sponsors of the institute.

Since the model and method of implementation were original and took shape as the system unfolded, the creation of intellectual think-tanks and publication of forward plans and project reports were vital.

At the initiation of any reform – from the most simple and innocuous to the most complex and far reaching – a project report was always drawn up. Depending upon the subject at hand and the extent of transformation, the project almost invariably went through one or more stages of a concept paper, a detailed implementation scenario and a final implementation guide to put the idea on-stream, followed by a meticulous monitoring and feedback process.

While the emphasis was strongly on internalization, necessary interaction with the outside world was simultaneously maintained. In short, the task was to sensitize, educate and convert all those who would be affected by the change as well as all those who were outside to take the desired action. The most innovative step in this endeavour was to give a copy of the project paper to each of more than 2,000 students. In fact, the most fundamental changes took place without an element of surprise. The system always remained open, information was constantly shared and implementation was achieved through participants who were already trained to deal with the change.

A chronological list of the changes and innovations implemented is given in *Appendix 1*. The incremental or more radical nature of different change processes adopted is illustrated in Chapters 4, 5 and 6 which follow.

Chapter 4
The major changes in management, staff, financing and evaluation

1. The management and administrative structure

(a) Management

BITS is a society registered under the Societies Act. It has a Memorandum of Association, and Rules and Regulations drawn up by the Government of India, which are almost copies of the corresponding rules and regulations of the IITs. However, although these rules were drawn up by the Government, the sponsors were able to ensure freedom of operation.

All powers of the society are vested in the General Body and almost immediately transferred to the Board of Governors. The Chairman of the Board of Governors is also the Chairman of the General Body. He exercises all emergency powers, on the strength of which he acts and reports to the Board. As per convention, the Board and the General Body meet once a year.

G.D. Birla was life-time Chairman. After his death, his son K.K. Birla, was named Chairman by the General Body for a term of three years, which has since been extended.The Board and General Body have a provision for a Treasurer who so far has invariably been a member of the Birla family or one enjoying the confidence of the family. The powers and duties of the Treasurer are not at all defined in the rules.

In a Board consisting of eighteen members, six are ex-officio, three are nominees of the Government of India, three are nominees of the Birla Educational Trust (BET), three are selected by the General Body and

three are co-opted by the Board itself. Thus the overwhelming majority of members come with the approval of the Birlas.

The General Body consists of about 38 members. There are eight founding members, some 18 members nominated by the General Body itself, four alumni members and one member each nominated by the Government, UGC, University of Rajasthan, CSIR, AICTE, FICCI and the Director of the Institute. Here again the overwhelming majority of members are nominated by the Birlas.

The statutes provide for a Senate (the highest academic body), a Finance Committee, a Building Committee and an Examination Committee. The Senate is overwhelmingly an internal organization except for four experts from outside and also four student members. The Finance and the Building Committees are the responsibility of the sponsors. The Examination Committee is basically internal to BITS.

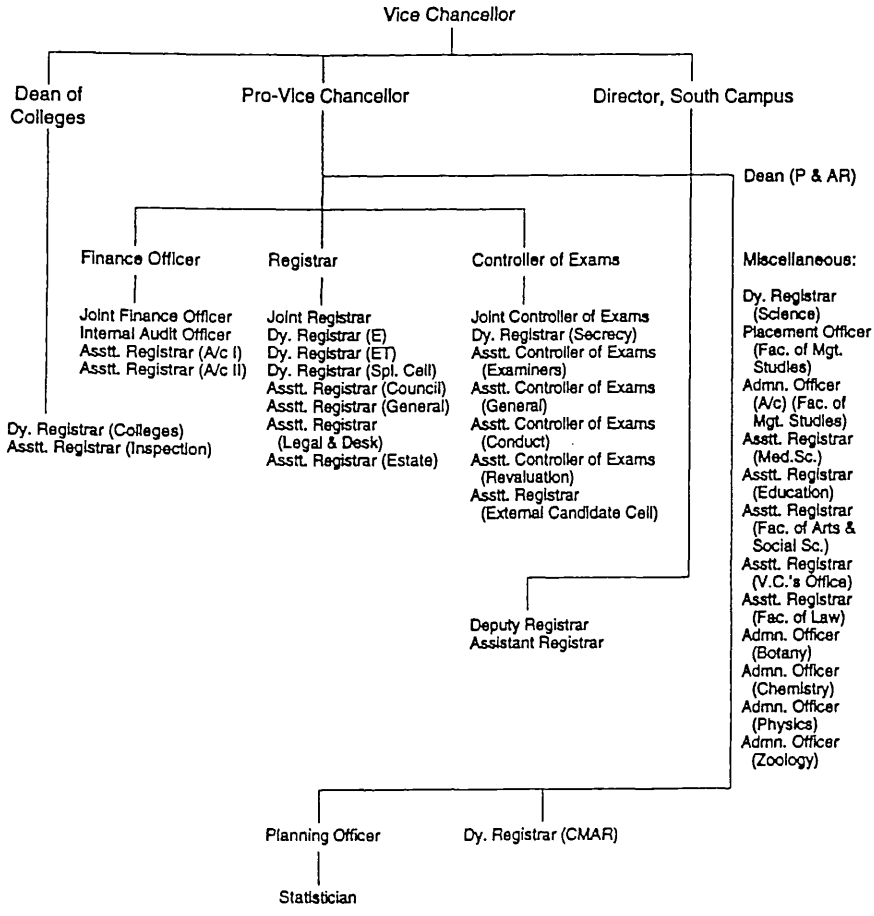
It should be understood there is nothing in the constituency and formation of these bodies which is fundamentally different from the IITs or similar deemed universities.

Since the appointment of staff and admission of students are de facto completely in the hands of the Institute, and generally the sponsors do not try to interfere, this management structure did not impede innovation despite being of the traditional kind.

(b) Administration

The prevailing pattern of university administration in India is that each institution is subdivided into largely autonomous faculties or departments while admissions and examinations, planning and administration are handled centrally (see *Chart 2*).

BITS having been founded on three separate colleges was also split administratively. Hence in 1974 a committee was formed to review the structure and recommend a new model consistent with the goals set in the Plan. After two years, agreement had been reached on a structure of 10 Divisions headed by a Dean and 11 units headed by a chef (see *Chart 3*).



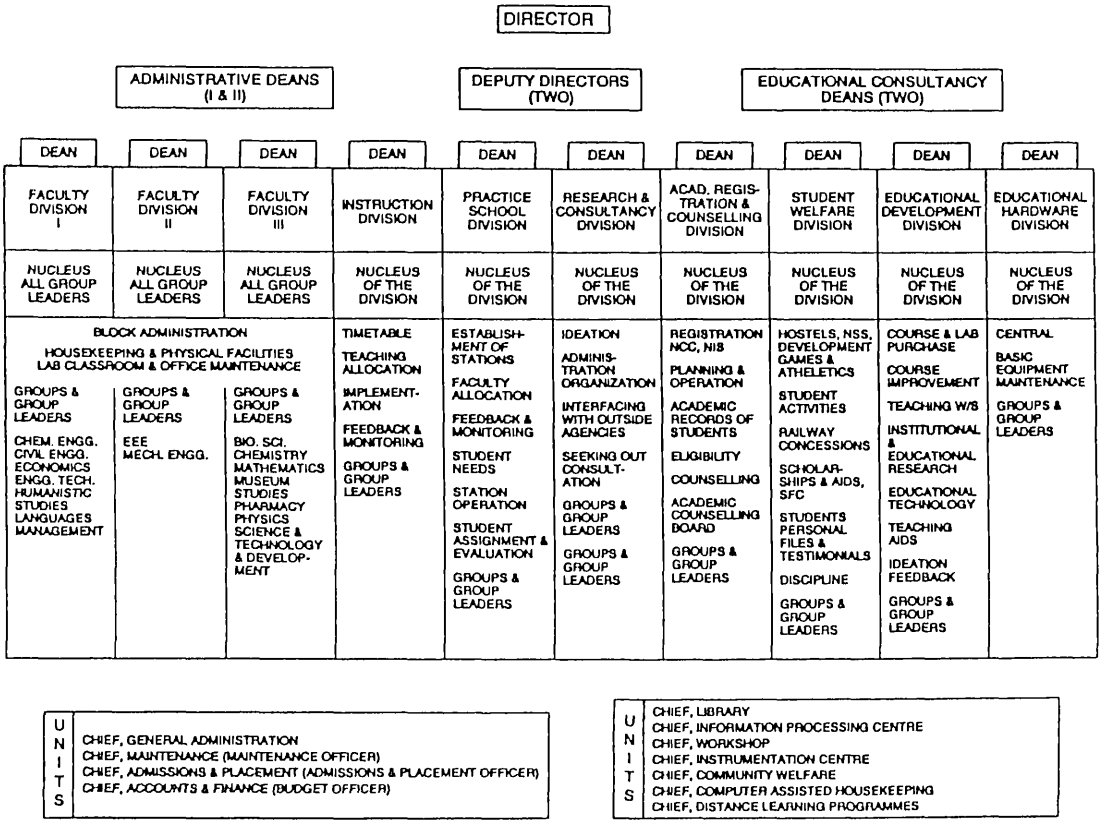
Explanations:

P & AR: Planning and Administration Reforms
CMAR: Co-ordination, Monitoring and Administration Reforms
E: Establishment
ET: Establishment Teaching

University News, Monday, October 2, 1989.

Chart 2. Organization structure of University of Delhi

Chart 3. Administrative structure



It was felt that only through a smaller group of coherent second level leadership, could professional attention be devoted towards achieving overall efficiency, cost effectiveness, and maximum return on investment. Besides these administrative operational and financial issues, the entire gamut of academic issues were similarly addressed. A new culture and perspective was carefully nurtured over years so that the relationship between any aspect of an academic matter could immediately be placed in the total perspective of the network of academic matters.

Each Division decides on basic policies and has an office with supporting clerical staff. This has a dual advantage: academic staff feel responsible to see that their decisions are carried out and have to integrate academic, administrative and financial matters. Thus administration is to a large degree decentralized though purchasing, accounts, maintenance, library, admissions and computerized information systems are centralized.

On comparing the two Charts, one may see that it is in the domain of administration, where the majority of educators are also administrators, that BITS differs from its counterpart institutions.

(c) Use of the computer

The computerization effort at BITS has to be seen as a response to educational and intellectual challenges. As a tool for the management of innovation it was required because the innovation process demanded scientific analysis, accurate entry of data and respect for deadlines. As a catalyst for continued innovation, the computer had to be used to release human beings from the burdens of manually operated data processing systems so as to prepare them to operate on the next plateau of educational development. Computerization at BITS, like all other reforms, was accomplished without additional manpower or funds.

The educational reforms were ambitious, complex and inter-dependent at the operational level and a far greater sophistication of information for decision-making was required. For this purpose an IBM 1130 which arrived in 1969 was pressed into service, (it may be recalled that PCs were not available at that time).

Tasks required software development which was locally done. Both students as well as the faculty played an enabling role. There was in any case no money to buy software packages or to hire an expert. The first

target was to computerize the entire students' records so that the database could supply instantaneous information about the individualized academic path followed by a student within the large degree of flexibility permitted to him. It is literally true that the academic reform could not have been implemented without this computerization.

In the subsequent evolution of the information system, other activities came under the ever increasing computerization process. Mention may be made of admissions, budget and finance monitoring, staff data, students co-curricular activities, inventories and agenda preparation for all statutory bodies of the institute.

At one point 85 persons were involved in computerization tasks which has now fallen to 41: 30 in the regular team, 20 giving 25 per cent of their time and six who formulate and introduce new software. Systems are becoming increasingly integrated, i.e., the staff database provides not only personal details, salary, leave, pension, medical reimbursements etc. but also gives inputs to the budget, and to reports for audits, and cost-benefit and resource utilization. Development work is still going on for the Distance Learning Programme, and budget monitoring. The computer as a tool has been much appreciated and utilized in the BITS innovation process.

2. Staff

In India, most promotions or increments are determined on the basis of mere length of service and number of papers published. Similarly, faculty development programmes tend to dislodge a staff member and send him for training to so-called prestigious institutions in India and abroad. It is unfortunately not realized that he is not a student but is a professional teacher and growth must take place within his own habitat. Thus this can lead to dysfunctionality when on return he can find himself powerless to change the system and apply what he has learnt. The Government, as source of the funding, can at the end only measure success in terms of expenditure and not in terms of how many faculty members have been trained to participate in institution building.

The BITS model recognized from the start that no innovation is possible without large scale participation of the faculty and the students. They must palpably see the right place for themselves in the system, and

obtain rewards through promotion and other recognitions and through gainful employment.

BITS inherited an entire stock of faculty who were earlier employed by the predecessor affiliated colleges. They had been recruited over a period of time to meet the limited requirements of undergraduate studies in an affiliated college. But the formation of BITS set in motion a search for identity in the new context of a university and this was crippled by the fact that staff qualifications did not match those in a mature university. The problem was tackled through the establishment of a new reward system, staff development and widening the recruitment area in harmony with the agenda of institutional development.

It was clear that a haphazard, once-in-a-while reward system would not work. Further, the ethos of Indian universities never recognizes flare and proven competence in educational innovation and academic administration.

BITS formulated a new set of criteria in 1970 according to which the faculty would compete for promotion. These rightly accepted length of service as well as the number of published papers, but other items were added such as participation in unconventional programmes like practice school, manning the new academic administrative process and participating in various co-curricular activities like looking after the hostels, counselling the students, etc. These aspects and the response of the faculty were analyzed each year and were the subject of review at least once every five years by an appointed committee.

This worked well on two occasions, but the third time union pressure was orchestrated in order to nullify the system. To partly mollify the feelings generated, a second review was made. The earlier decision remained unaltered, although certain additional promotions were given, and the results were accepted. It was found that in the realm of staff management in the context of change, it is necessary to adhere to the principles, openness and fairness while being willing to discuss and look at certain aspects once again.

Less success was experienced in the attempts to improve the quality of faculty by recruitment. Salary scales and allowances worked against it. BITS attempted to offer the same salary scales as government IITS but maintenance of parity related only to the basic salary. BITS never enjoyed the extra money that comes in the name of dearness allowance, house allowance etc. Thus an average BITS faculty would get 500

rupees per month less than the corresponding IIT faculty. The question of parity provoked considerable problems when national scales were raised, such as in 1973. Unfortunately UGC was unwilling to meet some part of the cost for this to be implemented at BITS, and at the same time, the sponsors of the institute expressed their inability to find the extra money. In these circumstances, the faculty and other staff were encouraged to work out an agreed consensus through which the new salary scale could be implemented within the given budget. The outcome of this exercise was to abolish some of the duplications which were taking place, as regards practice school, organization of teaching and examinations, academic registration and counselling etc. This was organized on an institution-wise level and substantially reduced the cost. Further reduction was achieved by freezing some non-teaching posts. This clearly was an example where local initiative and self-interest increased the overall health of the institution.

Recruitment procedures were made very flexible i.e. temporary appointment of qualified people where it appeared delay would result in losing them, contractual appointments and short-term Associate and Adjunct Faculty positions for outstanding persons from India and abroad. In the early years, BITS even paid the travel costs of prospective faculty from any part of the world. However, a survey of staff mobility showed that the institute had not been able to retain some faculty of promise and that the causes of their departure were usually monetary.

Thus innovation had to take place with faculty of a rather low-flying kind, and a staff development programme appeared to be the main answer to the problem of improving quality. The government provides for Summer Schools and Quality Improvement Programmes but BITS simply could not accept these opportunities as the only means of faculty development. The entire educational process at BITS – its administrative reorganization, off-campus programmes and multidisciplinary research activities make heavy demands on the existing faculty and it is not always practicable to spare faculty to attend these schemes which require extended absence from the institute. Also, since innovative approaches in BITS were moving on all fronts simultaneously, staff development had to be harmonized with institutional development. Fortunately the programme of innovation invariably stimulated faculty aspirations and their stake in the change.

BITS therefore had to work out a scheme suited to its own needs. A vigorous search for willing and potential faculty members is made from amongst fresh graduates in the 20-25 years age group. These young people are then given appointments as Teaching Assistants, Assistant Lecturers or even Lecturers depending on their academic qualifications, and it is also made possible for them to simultaneously work towards a higher degree of BITS. An individual programme is carefully worked out for each of these persons in terms of teaching activities, subject workshops and also 'Intensive Teaching Workshops'. The senior and experienced faculty shoulder the additional burden of this training process.

Intensive Teaching Workshops bring together new entrants and experienced faculty who are outstanding teachers in a forum where the new entrants give lectures on their subjects simulating their classroom. At the end of each lecture, the performance is discussed. The results have been encouraging and many successful teachers have emerged through this process. Subject Workshops train the young faculty in terms of the knowledge-component in various critical courses.

This summary would be incomplete without recording the positive role the faculty played. Even though they may have been purveyors of externally imposed educational ideas, they willingly gave up the external examination system, whereby they faced loss of income as examiners. Similarly, when the limits of resources were honestly presented to them, they accepted and worked for extraordinary changes, which have never been attempted by more high-flying faculties elsewhere.

The comparative table given as *Annex 2* is an eloquent commentary on the achievement of the faculty towards acquisition of higher degrees without costing any additional money to the institute. The table shows growth of proportion of faculty having Ph.Ds from 20 per cent to 74 per cent over 1964 to 1988 and a change in the workload from emphasis on teaching to teaching plus research, academic management and course development. The point has again to be emphasized that human beings involved in a process which is fair and rewarding, can achieve much more than others might imagine.

3. Financing and cost effectiveness

In India it has always been expected that the State should plan, implement and subsidize the education system. The situation is overwhelmingly so in the case of higher education. In respect of primary and secondary education and undergraduate college education, there is a large degree of private initiative but also with much of the financial aid coming from the State. There are examples where the private contribution is very high, i.e. capitation fee institutions, prestigious schools in urban situations and certain exclusive schools and colleges which charge high fees. Intensive discussion has taken place in India in the past decade on whether the practice of capitation fees is legally proper and whether the existence of expensive schools does not negate egalitarian norms.

At BITS, the approach towards fees has been two-fold, namely those who can pay must share a larger cost of the education of their children, and the university should provide and give a helping hand to those who need financial assistance. Thus BITS today is simultaneously the most accessible and open university inasmuch as there is no quota for the sponsors, yet it has the highest fees structure in the country. Nevertheless, the pressure for admission continues to be very heavy (of the order of 1:15). Thus a part of the cost of education has been distributed to the clients without resorting to the evils of a capitation fee.

Although BITS has what may be said to be high fees in the Indian context, and 50 per cent of the cost of operation comes from fees (the remainder is provided by UGC, sponsors and an endowment fund), at the same time the cost per student per year is certainly by far the lowest compared to similar institutions (See *Table 1*). This has been achieved through initiatives and innovations to achieve the goal set for financial self-sufficiency. It is a fact that from 1969-70, when the whole train of innovations was launched in BITS, there has been no additional budget provision for a single item of innovation.

Table 1. A comparison of unit cost and other parameters with IITs and IISc as of 1984

S NO.		IIT/B	IIT/D	IIT/K	IIT/Kh	IIT/M	IISc	BITS
1	Unit cost in Rs. per sutdent	26,711	23,609	39,413	24,967	29,876	50,778	7,093
2	Unit cost (Rs. in lakhs) per degree	26.11	16.67	31.96	13.84	33.28	28.54	3.18
3	No. of teaching staff (lectures upwards)	320	390	272	438	339	309	165*
4	Teaching/supporting/helping ratio	1 : 3 : 2	1 : 4 : 1	1 : 3 : 2	1 : 3 : 2	1 : 4 : 1	1 : 3 : 2	1: 1 : 1
5	No. of students	2 737	2 966	1 784	2 883	2 449	1 068	2 152
6	Teacher/student ratio	1 : 8	1 : 7	1 : 6	1 : 6	1 : 7	1 : 3	1 : 13
* BITS requires Ph.D. even for lecturer. Counting the junior teaching staff, the total is 204.								

The budgets between 1969-70 and 1989-90, after correcting for the official increase of 4 per cent in contingency expenses and salaries and additional dearness allowance, have remained static. During this period, approved budgets had to absorb the cost of an expensive series of innovations like: practice school course, accommodation for all 2,000 students and the cost of sending out faculty in continuous residence at nearly 90 stations; increase in the number of courses for half the students by almost a factor of 25 per cent; introduction of about 10 new degree programmes, and the offering of a dual degree which almost doubled the capacity of the technical departments. Changes to the administrative structure, together with modern hardware support again had to be achieved without recourse to additional finance. All this was done both by making economies and by taking initiatives which achieved almost 60 per cent contribution in cash or kind from collaborating industries in the various operations like practice school, M.E. Collaborative, and Off-Campus Ph.D.

Reductions in overhead expenditures had to be achieved by optimal utilization of all resources and funds. New norms and procedures for educational planning were evolved to achieve (i) a higher utilization factor for the existing space, (ii) greater time sharing of costly equipment, (iii) timely action on upkeep and maintenance of all facilities, (iv) one of the lowest servicing rupee cost for each Ford Foundation dollar made available, (v) 1:1:1 ratio for teaching and support staff. One example which can be given is that when the duration of first degree programmes became four years instead of five, BITS arranged to increase the intake by 25 per cent to keep the entire physical facilities occupied. No other university is known to have done it.

Another initiative was the creation of an endowment fund, the income from which now practically meets the remaining deficit in the budget. BITS is the only university in the country which has its own endowment fund and was the first to work out this concept in the field of higher education in India. The progress achieved by BITS towards self-sufficiency is shown in *Table 2*.

A final word must be said about the attitude of BITS towards sponsored research which must be understood against the backdrop of austerity. BITS is aware that engagement in research in new areas of national relevance and of vital interest to industry must be an important responsibility. But it has been shown that practically every sponsoring

organization in India financially exploits the university when it sponsors research. BITS has felt that the sponsored research must also pay for overhead costs and thus any research programmes are soundly costed to ensure that the institution will not incur liabilities which it would be hard pressed to fulfill.

Table 2. BITS' efforts towards self-sufficiency (as percentage of recurrent budget)

Year	Deficit	Dividend + Interest	All fees	Other revenue
1964-65	63.50	-	32.10	4.40
1965-66	69.50	-	28.30	2.20
1966-67	71.60	-	25.40	2.00
1967-68	75.40	-	22.40	2.20
1968-69	78.00	-	19.70	2.30
1969-70	79.80	-	17.70	2.50
1970-71	80.20	-	17.20	2.60
1971-72	69.65	11.75	15.90	2.70
1972-73	66.75	15.05	14.40	3.80
1973-74	53.81	27.49	15.00	3.70
1974-75	58.52	28.58	11.00	1.90
1975-76	62.36	25.14	10.80	1.70
1976-77	63.51	24.09	10.70	1.70
1977-78	62.68	25.52	10.10	1.70
1978-79	52.36	35.90	10.03	1.71
1979-80	39.80	42.89	15.11	2.20
1980-81	35.34	42.42	19.30	2.94
1981-82	31.92	44.12	20.77	3.19
1982-83	31.09	40.74	24.48	3.69
1983-84	15.50	41.92	37.36	5.22
1984-85	9.27	42.99	42.70	5.04
1985-86	6.58	37.83	49.42	6.17
1989-90	8.02	19.19	67.46	5.37

There are two aspects which should engage our attention on the cost of education. One is the type of norms used for educational

planning and their validity and the other is to discover methods of doing more with less. Norms have evolved on the assumptions of the traditional structure of administrative and departmental hegemony. They are thus not necessarily applicable in a dynamic situation. For instance, unit cost in terms of rupees per student per year makes no reference to the number of degrees and diversification of degrees that a multi-department university would be involved in. From the overall economic point of view, questions of diversification, reuse of waste and optimization of structure cannot be ignored. In the case of BITS, the cost per student per year is certainly the lowest for similar universities, but the cost per student per degree is surprisingly lower than many colleges teaching only three or four degrees.

4. Evaluation of institutional performances

Universities in India are created through Acts of legislation or through provisions in the existing Acts of Parliament. Since the overwhelming majority of universities are funded by Central or State Governments, it is to be expected that various agencies supported by these governments combine the distribution of funds with necessary assessment of performance. Indeed, agencies like UGC and AICTE even used distribution of funds as a means of introducing new academic reforms and new areas of studies, scholarship and research.

Non-government organizations like the Medical Council of India, Bar and Pharmacy Council, Management Association, etc. have been zealously trying to specify minimum requirements of physical and human resources before a new department in the disciplines in their purview may be started followed by a continuous monitoring of performance. Certain professional bodies like the Institution of Engineers (India), Indian Institute of Chemical Engineers, Indian Institution of Telecommunication Engineers, etc. have also shown concern and taken initiatives in updating standards in the various disciplines of engineering. These associations have further provided for memberships by examinations which have been equated as first degrees in engineering for entry into the profession of engineering.

Thus while some agencies have used release of funds as a method of demanding required performance and conforming to standards, only in the case of the Medical Council of India can one say that the whip-hand by withdrawal of recognition is available to punish defaulting departments or institutions. Another kind of watch-dog arrangement existing largely in the USA has not found favour in India so far, i.e. the self-imposed accreditation system, which in the USA not only assesses the performance of a department but also gives it a numerical rating, which may be used by any institution who chooses to do so. The Association of Indian Universities at least had one opportunity to move in the direction of voluntary accreditation, but did not do so.

Thus it can be seen that there is neither effective punishment, nor is public approbium generated for poor performance. On the other hand there has been no attempt to reward a department or an institution which takes the courage to innovate or implement effectively recommended reforms.

As far as BITS is concerned, it was realized that no system can live without assessing its own performance. When a system is sponsored or funded by an external agency, there will be the demand to be accountable. Moreover, when a system is launched as an innovative one or is catapulted into an innovative situation by choice or circumstances, performance evaluation is extraordinarily important. Any innovation carries risks. The planner must minimize the risk by advance planning, select appropriate strategies for implementation and seek to ensure constant feedback.

Evaluation of performance is not the same as its measurement. Measurement in the extreme circumstance is one that an investigator encounters in a physical experimentation. But in a social situation, for a complex system, the investigator does not always have the freedom to make precise measurements. Therefore, there is a tendency to oscillate between an impressionistic evaluation and precise measurements. The model must, therefore, be designed to accommodate this dichotomy.

Since at BITS the innovation process was continuous, it had by some means to be assessed at every stage. It was natural at the outset for BITS to proceed empirically on a systematic performance evaluation and measurement wherever feasible. In fact the tendency was to convert every routine and every developmental encounter into a feedback process.

For example, BITS welcomed and nurtured a series of mechanisms by which at least the major aspects of innovation were evaluated by implication by the world of work and the employment market. The very integrated and sustained interaction of BITS with a large number of industries for the operation of the Practice School, Internship, M.E. (Collaborative) etc. served as a ready-made mechanism, as was the continuous interaction with a whole train of foreign experts, that was made possible by the collaboration with M.I.T. and the Ford Foundation.

Also, through the mechanism of Adjunct, Visiting and Associate Faculty, BITS caused its ideas and operations to be subjected to intensive discussion and assessment by a large number of outside experts.

In addition, BITS actively sought a share of development funds from the UGC and was visited by a series of Visiting and Expert Committees – in fact 12 over a period of 10 years.

By introducing campus interviews (from zero in 1968 to 72 companies in 1988-89; see *Table 4*) by various companies which have sent experts to interview graduating students for employment, the Institute has been able to carefully record views not only on performance but on the nature of the curricula and effectiveness of the teaching process. The verdict of some of these assessments are available in various publications. Mention may be made of `What others have said about BITS', opinions expressed by conferences and other organizations, associations and distinguished visitors.

Last but not least, the very quality of input seeking admission to BITS every year and the acceptance of BITS products by foreign universities, particularly those in the USA, for higher studies are some tangible criteria among others of the measurement of its performance (see *Table 3*).

The Institute has actively nurtured investigative research into its own process of innovation and operation, particularly wherever it has tried to break new ground in the country like examination reform, effectiveness and relevance of subjects in the foundation years, practice school operations, quantification of the R&D system, etc. It is through this in-house research and the publication of its findings (*Appendix 2* is one example) that the Institute has been able to keep itself, sponsors, students and collaborating bodies, informed about its performance.

Chapter 5
Changes in educational structure, admissions, examinations and placement

1. Educational structure

The period of almost four decades since independence has been characterized by a ferment of schemes and projects dealing with reform and changes in the educational structure and the examination system. Integration has been a well received reform in the case of engineering education piloted by AICTE. However, the thrust on integration across science programmes has remained abortive in spite of the promised fund support from UGC. Even the new Master's degrees in science introduced by the IIT system have become moribund.

However, while the urge for reform in engineering and sciences has been at least fairly strong, it has been limited in respect of social sciences and the humanities.

One important reform, much supported for the agriculture universities and the IITs, always had a twin objective, namely to introduce the semester system and to modularize the content of courses. This approach was, on a limited scale, adopted by many postgraduate departments throughout the country. Not much remains of that thrust. Some departments have abandoned the semester system, and the spin-off benefit expected, namely, a wide range of flexibilities, did not materialize even in the IIT system.

While the declared goals for educational structural reform have been invariably spelt out in terms of educational objectives, there is little evidence to show that the planners had worried about the employment aspect. While one may argue as to whether the purpose of the educational system is to supply a ready-made product to fit into the employing organizations, it is no longer possible to plan the educational system by

maintaining separation between the world of study and the world of work.

It is significant to record that within a span of hardly five to seven years the entire Central Board school system has seen a sea change affecting duration, content, integration across subjects, method of evaluation and awarding division, introduction of new laboratory experiments and an almost fundamental conversion of the syllabi in mathematics, biology, chemistry and physics through which even at the school stage, modern mathematics, molecular biology, and quantum mechanics have been introduced. What is disturbing is to find that the university system which will now receive the products of such a new system, has not yet decided on the corresponding changes that should be made in terms of contents, duration and integration of knowledge, not to speak of interaction between the world of study and the world of work.

Structural reform of education in BITS was part of a comprehensive task. It required making a review of the role of BITS in the context of the total situation, recognizing that piecemeal reform can never take root and finally, being convinced that the inter-relationship of theory with practice cannot be ignored in the design of any viable system.

(a) Basic curriculum reform

Curriculum reform began in 1970 with the setting up of three different committees – one each for the Faculties of Engineering, Science and Humanities – to evolve the framework of a new academic structure for their respective degree programmes. However, after a few months, the committees were asked to interact with each other, when it was discovered that there was a lot of common ground between them. They had all recommended one form or another of a broad-based educational structure followed by specialization. On the basis of this overlap the three committees were merged into a single institute-wide core committee with a chairman, entrusted with the task of evolving an academic structure for all the first degree programmes of the institute.

The Core Committee deliberated for a period of nearly 18 months and presented a comprehensive report in June 1971, giving the detailed academic structure and corresponding operational plan. During these 18 months the committee interacted with faculty members from each department to discuss the finer points. A few teachers had very strong

reservations about the quantum of Mathematics to be introduced in the core. This was especially so in the areas where students did not have adequate training in Higher Mathematics. However, after exhaustive discussions the new framework was designed with a common background in Physics, Chemistry, Mathematics and English.

The Committee's main recommendations were:

(a) Proliferation of so-called service courses should be avoided, e.g. there were eight separate courses of statistics, each intended for a certain discipline.
(b) The concept of service courses should be replaced by a single core course which can be developed and taught more economically.
(c) As far as possible, students of every degree programme should be required to do a part or the whole of a package of core courses in each of the basic disciplines like Mathematics, Physics, Chemistry, Language skills, etc.

The results of this exercise were that total course offerings were reduced from 500 to about 200 per year, teaching of core courses was merged and consequently there was a reduction in classroom contact hours.

This essential and basic early reform which contributed to the goal of cost efficiency, permitted staff to have the time to devote to other goals like building up a specific BITS education model, increasing quality, improving links with industry, etc.

(b) Building up the BITS Education Model

BITS progressively restructured its educational programmes to make them interdisciplinary, flexible and marketable.

Curriculum reform at BITS was characterized by broad-based foundation training topped by opportunities for specialization in disciplines. All degree programmes (engineering, science, humanities) include foundation courses comprising mathematics, technical arts (graphics, workshop practice, computer techniques, report writing, etc.), core science courses (physics, chemistry, biology), engineering science courses (circuit theory, electronics, energy conversion, etc.). Discipline courses, certain advanced analysis and application oriented courses are

based on the foundation courses and the electives. Electives fulfil varied objectives like orientation towards higher studies, preparation for multidisciplinary professional challenges, provide the prerequisite requirement for special types of courses, etc.

It is important to appreciate the decision regarding normal input. BITS demanded from all its students including humanities, preparation in physics, chemistry and mathematics and also adequate English at (10 + 2) level. If a single character of input had not been prescribed, much of the curricular integration would not have been possible. Integration also tended to reduce cost. However, the system still permitted the flexibility of seeking admission for an input with higher or lesser preparation through its flexible admission process. Finally; it is to be noted that the integration achieved through curriculum reform made the introduction of the Practice School possible.

Unusual flexibilities allow many legitimate needs to be met. These are, for example, transfer, programme acceleration/deceleration, dual degree, admission in both semesters, admission with marginal deficiency, and admission with advanced standing. These features do not exist in any other Indian university, hence a brief description may be necessary.

Transfer is a process of horizontal movement of a student from one degree to another without completion of the first degree and with a renewed opportunity to complete the second choice of degree in minimum time. Acceleration is the possibility to complete a degree before the normal prescribed time. Deceleration does not only mean failure to keep pace but a planned arrangement to go slow. Dual degree is a scheme whereby a student works concurrently for two first degrees with marginal extra time. This is usually a combination of a degree in basic sciences with another in a professional area. Other flexibilities in admission allow more than one point of entry into the structure. This is based on use of a semester system, which provides for admission in both semesters, and involves the breaking up of each programme (each containing a prescribed load of courses – that begin and end in the semester) so as to make admission relatively independent of the academic year. It is the same underlying academic structure which permits a student to accelerate or decelerate his programme. Though the semester system was adopted right from the start in 1965, none of the special features cited above were present. The flexibility of semesters has made implementation of innovative ideas easier or perhaps the innovative ideas

have made the system flexible and adaptable to needs. The semester system is not unique to BITS – rather it is its successful utilization in the Indian context which is distinctive.

The structure also provides a package of courses as electives which are selected by the students themselves, and does not impose any restrictions other than appropriate prior academic preparation for each course. This has allowed each student to create his own preparation for career and life. Irrespective of whether his specialization is engineering or non-engineering, he may take courses in emerging areas like microprocessors, genetic engineering, or computer software, instrumentation or he can use these electives for the purpose of going in for more fundamental sciences or even taking a suitable combination towards the achievement of a degree.

Probably the most important design features in the BITS structural reform was to classify programmes in terms of the extent of mathematics and hard science components incorporated in the programme, to divide practice school and non-practice school streams (*discussed below*) and to provide for a planned dual degree between science and technical subjects.

It should be mentioned that the evolution of the academic structure used today (see *Chart 4*) required moving on all fronts simultaneously, i.e. parallel reforms of the examination system, linkage with industry, new attitudes towards research, an original approach to the faculty reward system, functional administration, modernization brought by effective use of computers, and mobilization and optimization of resources – in fact, a wavefront of simultaneous changes.

A few words on each level of the structure are necessary to show how it differs from what is offered elsewhere in India.

(c) Integrated first degrees

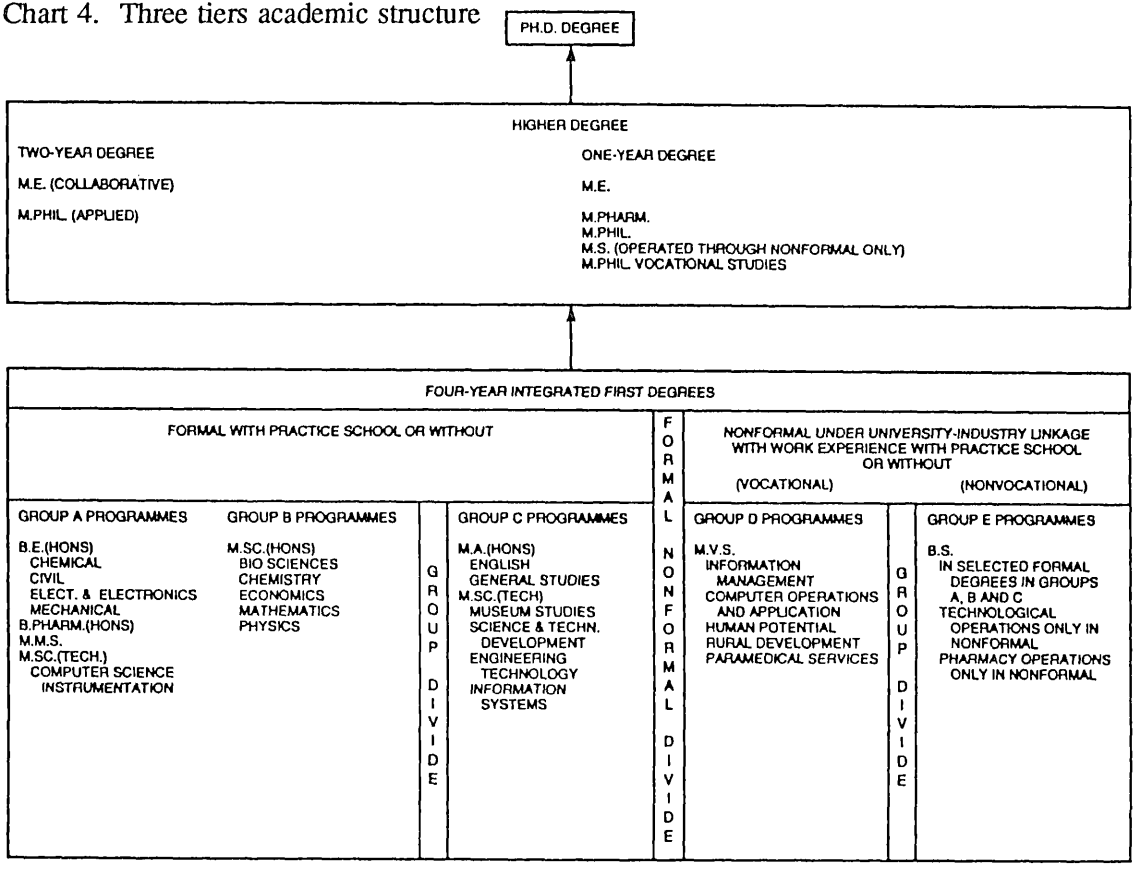
Unlike other technological universities, BITS offers degrees in both sciences and humanities. A sustained effort began in 1969, with the core curricula and modular concept, whereby curricula are designed according to a combination of various modules. These purposely incorporated components which made the graduate more acceptable to employers. There was some problem in regard to degrees in sciences and humanities, but the break-through occurred when most science and humanity students eventually appreciated the value of additional courses not done by

corresponding students in universities in India. In order to achieve the unprecedented integration of structure in 1973, 18 months of prior debate and discussion took place and several working documents were produced. Face to face discussion with both the faculty and students was continuously maintained.

The important features of the integrated first degrees are given below:

(i) All first degrees, irrespective of disciplines, have a uniform duration of four years after (10 + 2).
(ii) Prescribed input for all degrees is physics, chemistry, mathematics and adequate English at the (10 + 2) level.
(iii) All degrees offer an option of Practice School.
(iv) All degrees are divided in terms of formal and non-formal, formal in terms of Groups A and B together separated from C and non-formal in terms of vocational and non-vocational. The separation has been introduced to impart academic credibility to the system without compromising the basic tenets of the design, e.g. single character input, Practice School option, etc.
(v) The academic flexibilities provided in the structure operate within the framework of the various separations. They provide an opportunity for the rehabilitation of weak students in difficult programmes as well as offer restricted opening to deserving students of soft programmes to fulfil their academic ambition of studying certain hard science courses.
(vi) A dual degree option in which a student may simultaneously work towards two first degrees and complete both, normally, in five years after (10 + 2). This has been possible due to curriculum integration. The dual degree scheme has been immensely successful in getting the best students for science degrees.

Chart 4. Three tiers academic structure



The General Body of BITS had decided in 1964 that there should be a practice school programme, but hardly any progress had been made. The author himself is a product of MITs practice school programme and was responsible for attempting to implement it for the first time in India at HBTI, Kanpur. Here it had failed and at BITS it was unable to be born. After some reflection, it was seen that the practice school in India must have at least the following features:

(i) It has to encompass all disciplines and provide an extension of classroom learning in local industries. A team of students drawn from different disciplines must tackle real life problems which cannot be categorized under a discipline specialization.
(ii) The first degree structure must provide a suitable slot for the practice school so that all students drawn from different disciplines must first be given basic and adequate preparation in a core programme. Thus, the launching of the practice school and the creation of integrated first degrees are mutually reinforcing.
(iii) The practice school is an innovative linkage with industry (one of the goals of BITS) but it is also an expensive proposition requiring management of distant centres. Since BITS' sponsors could not give the money, most of the cost of off-campus education had to be obtained in kind from industry.

It will be appreciated that all these preparations had to be done prior to the formal launching of the practice school, and it took almost four years to start an experimental run.

It was at this stage that the student union demanded that the experiment be extended to include all students no matter for which degree they were studying. It is rare for students to demand more rigour in academic matters and conventionally practice school was always considered an option. However, the faculty were only slowly converted to the idea, since after all it was they who had to go to industrial sites and reside in the practice school station for some years. The sponsors supported it because it earned them a good reputation without having to find much in the way of money.

Students not opting for the Practice School stream and students in the dual degree scheme are required to do a one-semester whole time

thesis. Thus at any point of time something of the order of 100 theses are being simultaneously pursued, which is unusual for first degree level.

BITS mode ensured from the beginning that all degrees have a value and are given equal treatment academically. Further, no early specialization was permitted so that all students across the board had at least one-two years of common courses, taught through sections freely chosen by the students irrespective of the degree to which he is bound. Further, every student including that of M.A. (English) could and did go to the practice school. Out-of-pocket allowances were voluntarily given by industries to the student whether he was a student of arts or engineering. In other words, the first exposure of the practice school revealed to the students that they also had a place in economic activities. This attitude was ultimately translated into a more enlightened approach when industries came for campus interviews. Since electives were chosen by the student, he could mould a combination with an eye to future employment. The dramatic change in the area of computers is worthy of mention. Computer companies hired any student of BITS and not necessarily only those with degrees in computer science.

(d) Higher degrees

BITS did not have resources either from the sponsors or the government to subsidize Post Graduate Engineering and Ph.D. degrees. This level of education has no premium in the eyes of Indian industry as yet. As a result, the best products of the first degree will not undertake postgraduate degrees if they can find employment. Nevertheless the nation's planners have allocated a great deal of resources to this level, but unfortunately even in the best of IITs, the Ph.D. thesis is basically science-oriented rather than engineering based.

A decision was taken to suspend admissions until circumstances were more favourable. They were resumed from 1987 when BITS decided to make a major departure from the practice obtaining in the country in the following important ways:

(a) A Masters in Engineering was designed as a two-semester programme. No scholarship was offered. Those who wanted the course paid high fees.

(b) The pursuit of a Ph.D. even in the field of engineering did not ipso facto require a preparatory degree in engineering. Depending on the broad area, the candidate had to pass a qualifying examination to show he was up to the academic level required. In fact the largest number of Ph.D. candidates in the BITS system are found amongst the faculty and professionals at large who pursued an off-campus Ph.D.

(e) Non-formal degrees through distance learning

Many large and well-known universities in the country have been practising some form of *distance learning*. Correspondence courses and external candidates are some of the manifestations of the same. One feature is uniform, the universities' list of degree programmes remains a priori. It is really a change in the mode of delivery, and has never been used to develop new courses and new degree programmes.

BITS entered the distance learning area as an offshoot of the practice school and the M.E. (Collaborative) programmes. BITS first went to industry so as to make the curriculum at the first degree level relevant to the world of practice. The need was that of BITS and not of industry. But once this symbiotic relationship matured, industry turned to BITS to advise it on general manpower development problems. Out of this was born the M.E. (Collaborative) programmes. Somewhat later came the whole new distance delivery system. In M.E. (Collaborative) programmes the functional activity of an industry, say project engineering, was identified as a worthy pursuit for an academic degree. Thus, what was created never existed in the university nor in the industry. It was an imaginative synthesis.

Distance learning extended to all the three tiers of degree offerings, namely, first, second and Ph.D. Further it was able to sustain a degree programme in vocational areas. Here again target populations were identified and syllabi and degree programmes were built up from scratch in harmony with professional demands and reward systems.

2. Admissions

It is the usual practice for Indian universities, particularly the professional kind, to hold entrance examinations for admission. BITS

considered this issue from all aspects. It had to compete with the best in the country for the most talented students and its previous lack-lustre image was not sufficient to induce students to appear for an entrance test in different parts of India. Moreover, BITS simply was not able to hold such tests on a large scale. Therefore, it clung to its own admission process which was based on the school leaving performance of a candidate, despite being aware that the marking system differed from state to state.

During the initial years (1964 to 1970) admissions were made in the different faculties based on these marks; the experience was that while good students were available in the most popular programmes like Electrical and Electronics, and Mechanical Engineering, students available for programmes like Civil Engineering were not so good. In the case of science programmes it was very difficult to fill up places with first divisioners.

In 1973, when the Institute introduced Integrated programmes, it unified admission to all degree programmes and simultaneously introduced the concept of normalized percentage of marks. Normalization is a process by which the disparity that may exist between the absolute marks awarded to the candidates by the different examining bodies in the country is brought to the same scale of comparison.

Basically, it tries to place a candidate under review against the best candidate in the qualifying examination of the Board, in a system where the first rank student of one Board is equated with the first rank student in another Board of similar size. The method has been used for more than a decade and today BITS receives applications from about 10,000 students spread all over India. The process has the advantage that it enables a large number of bright students to know beforehand their chances of getting admission to BITS. For instance, while the first rank students of such a big examining body as the Central Board are not assured of a place in IITs, in BITS, they not only get the degree programme of their choice but also 100 per cent scholarship. BITS was thus able to get rank holders from various Boards and national talent scholarship holders.

Other features of the admission process unique to BITS are:

(i) A candidate can apply for all 18 first degree programmes through one application form. He has only to pay for the cost of the

application form and the Bulletin and of course does not need to undertake any travel, coaching classes for entrance examinations, etc. This aspect of BITS admission is much appreciated by students and more so by their parents.

(ii) The admission process is wholly computerized with no quota for sponsors.

(iii) Admission offers are sent to candidates at their addresses, once again, saving the candidates considerable expenditure and travel time, etc.

(iv) Second semester admissions, see *Table 3*.

Criteria for admission are flexible and allow for:

(i) Admission with marginal deficiency

While the academic preparation required for admission to each degree has been clearly spelt out, there is a provision whereby brilliant students whose prior preparation has been marginally deficient in terms of stated courses/subjects may also be admitted with the condition that they are required to do additional courses over and above those prescribed for a student with normal preparation, e.g. students from rural areas who were bright, but had poor English. (Incidentally, the national statistics show that entrance examinations tend to favour students from urban areas).

(ii) Admission with advanced standing

When a candidate for any programme in the three tiers of education of the Institute comes with a preparation beyond the minimum requirement, the courses the candidate has already done are reviewed and credits given if they are equal to the BITS courses.

So far, all places for all programmes including Economics, Biology etc. have been filled with students of very high calibre (see *Table 3*) while IITs have never been able to fill up their science places. As a matter of fact, many of the IITs have closed down their five-year Integrated Science programmes because of lack of response through their entrance examination.

Table 3. Admissions: quality of student input

Year of Admission	Percentage of marks in the Qualifying subjects (Generally PCM)		
	Max.		Min.
1964-65	90.0		42.0
1965-66	93.0		41.5
1966-67	93.7		38.2
1967-68	91.2		52.0
1969-70	92.7		51.6
1970-71	96.7		45.0
1971-72	92.3		56.2
	Semester	Normalized agg. percentage Highest %	Lowest %
1972-73	I Sem.	94.30	65.22
	II Sem.	88.16	65.22
1973-74	I Sem.	100.00	70.97
	II. Sem.	94.41	70.97
1974-75	I Sem.	97.83	73.00
	II Sem.	97.83	80.11
1975-76	I Sem.	97.00	78.61
	II Sem.	96.14	79.76
1976-77	I Sem.	99.73	78.50
	II Sem.	92.30	69.63
1977-78	I Sem.	100.00	79.11
	II Sem.	97.19	82.84
1978-79	I Sem.	100.00	60.88
	II Sem.	99.05	79.83
1979-80	I Sem.	100.00	69.46
	II Sem.	99.87	84.24
1980-81	I Sem.	100.00	78.72
	II Sem.	(No admissions made)	
1981-82	I Sem.	100.00	81.10
	II Sem.	97.18	85.80
1983-84	I Sem.	100.00	84.33
	II Sem.	100.00	86.69
1984-85	I Sem.	99.88	85.60
	II Sem.	98.67	85.60
1985-86	I Sem.	100.00	85.05
1986-87	I Sem.	100.00	88.63
1987-88	I Sem.	100.00	88.11
1988-89	I Sem.	100.00	88.86

An independent entrance examination would involve the cost of more than Rs.15.00 lakhs which does not of course include the private cost of candidates and their parents for going to the centres of examination. In the case of IITs most of this cost is subsidized by the Government. If BITS were to attempt to set an entrance exam and recover all these costs from the candidates then it would put itself at a great disadvantage vis-à-vis its IIT competitors. In order to ensure that all places are filled, a waiting list is operated, as well as admission in both semesters. The second semester admission is only meant for those vacancies which occur due to withdrawal of students well after the beginning of the first semester and is not meant to achieve what a waiting list is supposed to achieve.

3. The educational ethos and examinations

The 18 months of introspection initiated in the 1969 debate came to the conclusion that new ideas had to be adopted in an original way. Fortunately the open discussion initiated amongst students and faculty saved the day when all agreed to detailed working papers which synthesized American ideas with the Indian heritage and idioms of thoughts and expression. Thus were born a unique set of documents, primarily the academic regulations, the coursewise timetable and mandatory handout for each course before the beginning of each class in every semester. The academic regulations clearly record the obligations and privileges of the students as well as of the faculty. The old concepts of rigid rules relating to class attendance, number of examinations, closed book examination, and rigid formulation of courses were all discarded. The timetable ensures that what the academic regulations grant is not denied in actual implementation. Further, it is a starting premises that what is imparted is a course, and not a class. Worn out ideas like post-graduate courses being distinct from under-graduate ones were discarded. The course-wise hand-out states the coverage of the syllabus in terms of textbooks and other details. The weights allotted to the various components of evaluation are explained, information is given on the policy of make-up examinations for those who miss the main examination, and finally the course hand-outs touch upon the grading policy that the teacher is supposed to follow.

The existing examination system has been pronounced as the greatest ill of Indian education by experts like the Radhakrishnan and Kothari Commissions. Persistent criticism is made of its lack of credibility and fears are expressed that it suffers from bouts of mass copying. It is a moot question whether this is an educational or a social issue. Major fund giving organizations like the UGC, have provided generous funds for departments and universities to introduce lasting changes. Similar changes were also attempted in the school system. Unfortunately there is no systematic study of the outcome of this massive and costly effort, but it is known that many places where various kinds of reforms were introduced whether as an experimental measure or on a permanent basis, gave them up and went back to their old system. Particular mention may be made of reversion from the semester system to the annual system, and giving up letter grades for marks. Quite often when letter grades were awarded, they were permanently tagged to percentage marks. It is also reported that outside the Agricultural Universities and IITs, internal evaluation has been attacked by the students, by the lay public and most surprisingly by the teachers themselves.

It must be remembered that when the UGC revised the salary scales of teachers, one of the arguments for upgrading was that there would be no more opportunities to earn through the external examination system. The new salary scales were awarded but the external examination system together with fees continues.

The BITS approach was to adopt techniques already established elsewhere and also devise others for new situations like Practice School evaluations, develop a strong self-monitoring mechanism and tackle the whole network of issues rather than one problem at a time.

The reforms carried out in this domain have been the following:

(i) Continuous internal evaluation, relative grading and qualitative letter grades for courses and overall assessment on which the division level is based. The Institute conducts continuous assessment throughout the semester by set and surprise oral exams, short duration examinations, home assignments, project work, a three-hour comprehensive examination at the end of each semester, etc.

(ii) The lowest grade E is a pass grade, and students are required to maintain a minimum academic standard, otherwise they are brought

before the Academic Counselling Board. A report of NC (not cleared) is awarded if a student does not apply himself to the course and requires the same course to be taken again.

(iii) There is provision to make up for a missed test, for withdrawal from a course, and for repetition of a course to improve the grade.

(iv) In off-campus Practice School courses, new variables are included. Personality traits are evaluated by new instruments of testing students located in different stations across the country requiring the setting up of monitoring, feedback and normalizing procedures.

(v) The system is self-monitoring and provides for continuous checks and balances so that a student or any concerned faculty member can make an approach to the instructor-in-charge, failing which, an appeal can be made to the Examination Committee. The Examination Committee functions both through in-camera discussion and open interaction to maintain the highest degree of credibility of the system.

(vi) Certain cumulative minimum performance indicators must always be maintained. Whenever a student fails to maintain this standard and is unable to improve, in spite of being given a reasonable opportunity, he is required to leave the Institute or seek a transfer to a less exacting course of study.

(vii) In a continuous system which requires frequent evaluation, it is neither practical nor educationally necessary to demand a minimum percentage of attendance before the student is permitted to sit an exam or a particular component. Thus, in that sense, there is no required attendance.

(viii) Simultaneous implementation of reforms for existing and new students.

Interviews by employers are held on campus and at various practice school centres in both semesters and the number of industries interested has continued to grow (see *Table 4*).

Table 4. Campus interviews and job offers

Year	No. of industries visiting	No. of students interviewed	Job offers
1964-71	No systematic campus interviews existed		
1971-72	14	200	26
1972-73	16	230	25
1973-74	19	257	32
1974-75	22	230	43
1975-76	28	240	70
1976-77	26	200	76
1977-78	36	200	110
1978-79	35	210	103
1979-80	47	220	158
1980-81	52	270	217
1981-82	57	300	260
1982-83	61	350	261
1983-84	58	300	191
1984-85	63	300	232
1985-86	64	320	236
1986-87	67	300	221
1987-88	66	320	225
1988-89	72	320	243

4. Degrees and employment

The Radhakrishnan Commission, reinforced by the Kothari Commission, suggested that one important reform would be to delink jobs from degrees. The specific benefits have not been spelt out, but the implied assumption is that this would relieve the pressure for entry into the higher education system. However, the professions depend on certain well-defined prior training in science, engineering, medicine, technology and much of that which was previously done outside the university system, has now been taken over by the university system. Reference can be made to engineering, management, accounting, mining, etc.

The BITS response to this issue is not through delinking but through the process of improving the employability of a degree holder. The

result has been that even for a non-professional degree awarded by BITS, there is a very strong demand from employers and BITS is the only university in the country where industries send their representatives to the campus for interviewing not only engineering graduates but non-engineering graduates as well.

For additional feedback, the Admissions and Placement Office follows up graduates employed. Information is periodically gathered from them through a carefully prepared proforma about their present status and whether they need any help. Quite often, because of BITS' contacts with the industrial world and research organizations, enquiries are made about suitable candidates for employment.

In other words, through the curricula, course content and demands of students, it was sought to create a new product even for disciplines like Basic Sciences, Social Sciences and Languages. The detailed definition of such a programme was facilitated by continuous interaction with prospective employers through the Institute's massive practice school arrangement. The half-way house of practice school stations became the eyes and ears of the Institute, to achieve a better understanding of the professional world. It also afforded an opportunity to both the university and industry to look at the issues of training and employment as interrelated factors. BITS was able to identify new areas for which no other universities in India have so far organized degree programmes, i.e. Science Technology Development, Engineering Technology, Science and Technology Museums, etc.

There is another way in which the marketability of the product is improved through the efforts of the students themselves. The options available are utilized by them when nearer graduation in such a manner that they may choose a combination of courses and projects within and outside the campus which have a great market value. It has been found that Indian industry is generally looking for a more broad-based person rather than a spoon-fed person with too premature a specialization.

Chapter 6
Changes in research and links with industry

1. Research

That any university should be engaged in the pursuit of research and consultancy is not disputed. However, the question that has been avoided is the degree to which a poor country can invest money in this when the results do not clearly justify the expenditure. India can boast of the third largest university system and the third largest R&D system, but in 45 years of independence, when impressive industrial and social development has taken place, relatively little new technology and know-how has come from these systems.

BITS during the era of the three colleges, carried out some traditional research, mainly in botany, zoology and chemistry to obtain the corresponding Ph.D. degree of the affiliating university. There was hardly any research in any other discipline. Consultancy was largely confined to routine analysis for clients who did not have access to the expensive instruments which the institute possessed. As described earlier, a series of goals to be carried out by BITS was set in 1970. The first priority was to make the university a world-class undergraduate school, and only in the second phase was the graduate school to be reformed. The continuation of research was ensured by providing time for this in the integrated first degrees. Students in any discipline could name a project and work on it. Ph.D.s in any discipline were encouraged because the main clients were faculty members and professionals in industry. In addition, the institute has successfully negotiated research contracts through the Research and Consultancy Division (established in 1976). The routine tasks of the R&C Division include looking after the

overall research interests of the institute such as Ph.D. admission, identification and support of worthwhile research projects, allotment of topics to students at all levels (Ph.D., two-year higher degree and the first degree), organization of seminars etc. Thus the administrative structure of the institute incorporates an efficient system which can plan and effectively execute a suitable and worthwhile research policy.

Research grants have to provide for properly costed overheads and so far most contracts have been in the area of institutional transformation where BITS has acquired considerable know-how. Clients have been both government and private industry:

Some success has also been achieved in other research areas like solar energy, science and society and computer science. In these areas major research or consultancy projects have been sponsored by outside agencies. For example, the Department of Science and Technology, Government of India sponsored a project on a solar pump for Rs.500,000 over one year which was extended for another year for an additional Rs.300,000 and also a project on solar concentrators for about Rs.200,000 over 18 months. These projects were advertised in the national press by the Government of India. BITS applied along with other institutions - national as well as state. A team of faculty members of different disciplines was formed with a co-ordinator to plan the projects. The Institute did not have many published research papers or patents in the field of solar energy in support of its application. What it did have was an interdisciplinary team, a policy of relevant research integrated with teaching, a strong and innovative educational programme and the Practice School link with industry.

In addition, some major projects have been sponsored in the field of computer science by the Department of Electronics, and a project on credit plan preparation was sponsored by the United Commercial Bank.

2. Links with industry

Right after Independence in 1947, the Scientific Manpower Committee recommended 'practical training schemes', and the Kothari Commission (1966) went on to emphasize the need for co-operation between university-industry, suggesting internships (as in the case of medical education). These recommendations were subsequently re-confirmed by the Ministry of Education (1970). However the ideas

did not take off and as recently as 1980, the Nayudamma Committee once again recommended efforts to implement linkages between University and Industry.

Although sponsored by an industrial house, BITS was never formally linked to Birla industries and BITS graduates hardly ever sought employment in Birla industries. When the panel of industries in India was persuaded to include BITS along with IITs as a place for campus interviews, only non-Birla private industries participated systematically. In addition, there is nothing in the constituency of the various bodies of BITS to provide for representation from industry. The one exception is a representative from FICCI in the General Body consisting of 38 members.

After BET withdrew as a sponsor G.D. Birla provided the difference for the deficit on a year by year basis through ad hoc donations from different industries of which he was the Chairman of the Board of Directors. By the year 1982 BITS became de facto financially self-sufficient because of increasing fees and all-round optimization of resources. During K.K. Birla's regime no further money was sought or received.

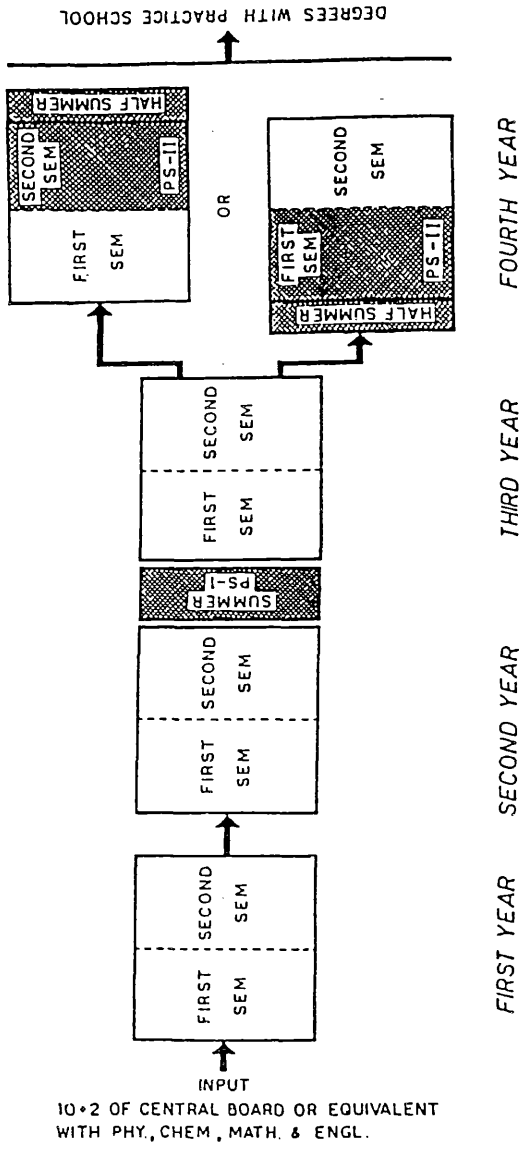
Thus the various links that BITS has evolved with industry derive from the goals and ethos of the institution and not from any pressure from Birla Industries. These links are as follows:

(a) Practice School

BITS developed its own version of Practice Schools in order not only to establish links with Industry but also as a device to improve all-round education. It was necessary to universalize the image so that the academic credibility of the Practice School would become an All India matter. For this purpose collaboration was sought not only from Birla industries but also from other industries and most prominently from the public sector. In fact out of a total of about 70 industries, there are only four or five Birla industries, and the overwhelming majority are government industries.

Practice School (PS) operates at the first degree level (see *Chart 5*). Today, during any academic year, this programme accommodates over 1,000 students, 75 faculty and around 90 professional organizations spread across the length and breadth of the country.

Chart 5. Flow chart of first degree programme showing PS components



Through the PS programme (which has a total duration of 7½months in a degree period of four years), the first degree students of engineering, sciences and humanities get on-the-job training by working on actual projects, under the supervision of BITS faculty in residence in professional organizations (Practice School stations), such as public and private sector industries, banks, consultancy units, national and CSIR laboratories, publishing houses, etc. They are evaluated on a continuous basis by the resident BITS faculty in consultation with professional experts from the host organizations, and are awarded a grade which is included in the CGPA. (College Grade Point Average).

It is not true that industry does not co-operate; BITS' experience shows that industry will pay for a reasonable part of the cost and also become a partner in a process where new horizons continuously open up which the two partners may jointly exploit to their mutual benefit. Today, every student of BITS gets a stipend awarded by industry during the period of Practice school training. The amount of money is the same whether it is engineering, sciences, social sciences or traditional arts. Some industries have come forward with the proposal that they would like to pay an honorarium to the faculty resident in the industry. This was indeed a major breakthrough, and now 60 per cent of the inputs (in cash and kind) towards the Practice school come from participating industries.

(b) Linkages at the postgraduate level

For quite some time, concern has been expressed at the national level about the health of the Master of Engineering degrees. To begin with, it has been observed that it is difficult to attract the best undergraduate students to postgraduate programmes. Furthermore, even those who join, in spite of the 100 per cent scholarships, more often than not, fail to complete the programme (the drop-out at the institute, over the period 1962-71, was of the order of 40 per cent against the national average of 60 per cent over the same period). The originally conceived national goal of achieving a high standard of education cannot be carried out. What is more, even after students are trained, they do not come up to the expectations of the employers, thus in turn creating a manpower mismatch problem.

It is within this context of the state of postgraduate education and with the advice of the feedback continuously received from major employer groups in the country and also from the Institute's PS stations, that BITS launched M.E. (Collab.) M. Phil.(Applied) and off-campus Ph.D. programmes in 1979/80.

M.E.(Collab.) Programmes: These two-year, full-time programmes constitute the superstructure of the PS programme, thus linking post-graduate engineering education with industry. The educational objectives of M.E. (Collab.) programmes, implemented entirely in the industrial setting, are two-fold, namely, (i) programmes develop future national manpower in a well-defined functional subject-area, and (ii) such a programme provides an opportunity for in-house training of the staff of industries participating in the programme.

BITS operates such M.E.(Collab.) programmes in multifaceted and functional disciplines at its off-campus centres: 'Project Engineering' at Calcutta and 'Industrial Production' at Nagda. It is gratifying to note that major industries in the country have invited BITS to start more programmes of this nature. Every collaborating industry has not only sponsored their talented employees (who must meet the admissions criteria) but has offered scholarships in the open competition for students drawn from the entire country. Industry has further provided all the facilities and the time and involvement of its senior scientists, engineers and professionals in the conduct of these courses.

M.Phil.(Applied) is operated on the same pattern as M.E. (Collaborative). It differs in content since it is capable of accommodating the whole range of competence and accomplishment that persons in industry achieve after 10 to 15 years of service. Off-campus Ph.D.s are mainly to provide opportunities for people from industries to pursue Ph.D.s in their places of work in areas which are of intense interest to industry.

(c) The Technology Innovation Centre (TIC)

The TIC, created in 1984, provides a means for scientists/engineers/entrepreneurs to come to the campus for their own developmental projects which can also involve students and utilization of BITS facilities. This scheme is conceptually a reversal of the Practice School process.

It is clearly the Practice School operation that helped the Institute perceive what should be done to continuously improve acceptance of graduates by the employment market, and what further reforms could be initiated at a higher level.

(d) Distance learning programmes

Addressing the issue of general manpower development problems of industry, BITS in 1987 introduced vocational and non-vocational degree programmes through a distance learning system. Target populations were identified and syllabi and degree programmes were built up in harmony with professional demands. An in-house training scheme of the premier R&D organization in the country was converted into pursuit of a higher degree in S&T. This confirmed that there was a practical necessity to transform in-house training programmes conducted by major industrial houses into higher levels of educational pursuits.

Chapter 7
The obstacles encountered

It would of course not be surprising, given the number of changes and reforms embarked upon over the period 1970 to 1989, to find that BITS experienced some set-backs. As pointed out, the context and resources available were not such as to favour an innovatory institution. BITS still faces these obstacles in achieving the basic goals it set for itself in 1970, and after having made so many years of effort, there are signs of system exhaustion. It would therefore be useful to look at the failures and relapses and the reasons for them according to the goal set.

1. BITS to become an institution of international repute, and eventually serve as a model for change within the country

Although BITS has demonstrated that despite a traditional environment, innovations can be introduced and made to work in a higher educational institution, it has not been able to serve as an exemplary influence. Its experience has been published in a national journal and in book form but it would seem that the main obstacle here has been the lack of support by external bodies and hence little impact on the national scene.

BITS is a deemed university under Clause 3(2) of the UGC Act. Such a university is supposed to be created and nurtured to innovate in ways that state universities are unable to do. Neither the sponsors nor the UGC fully recognized the extraordinary innovations implemented by the Institute, and neither came forward to back the next phase that the Institute delineated. In particular:

(i) The sponsors took a restricted view which did not go beyond the patronage that is usual in what is known as good schools.
(ii) Birla industry never joined in the campus interviews, in which most major industrial houses participate.
(iii) The budget of the Institute has remained static since 1982. It has not reflected either the vision or the format that is associated with unprecedented innovation. In the beginning, from 1970, the practice was to release the entire allocation to the Institute so that if something was saved through modern methods and techniques of management, the money did not go back to the sponsors, but instead was available to BITS to plough back into innovations. It should be mentioned that the Institute itself earns revenue from its Co-operative Stores, Guest House, etc.

In addition, the external members on the Board of Governors, General Body and the Senate of the Institute ultimately decided to play the role of benign observers.

A few of the important unusual degree programmes as well as educational delivery systems were worked out with the positive encouragement and financial support of other agencies. However, these agencies did not maintain their involvement, which was disappointing particularly because the initial acceptance by students as well as employers was high. The list below shows the programmes which lacked follow-up:

(i) NCSM towards Museum Studies Degree;

(ii) CSIR towards ME degree in Science and Technology;

(iii) DCPL and NIBM towards ME (collaborative) degrees in project engineering and industrial planning;

(iv) UGC towards M.Sc. degree in molecular and analytical biology;

(v) AICTE towards practice school and other spin-off activities.

Perhaps this goal may yet be achieved to some extent since the Government of India recently pronounced BITS as the only university

having successfully carried out *bold innovations at minimum unit cost* and agreed to participate in a scheme to augment the endowment over seven years. This will help to put the Institute on a sound financial footing so that it can go forward with some of its latest plans.

2. In order to achieve an international reputation, BITS was to develop both graduate studies and research and consultancy

It has already been noted earlier that industry tends to be satisfied with first degree level graduates and that external agencies did not continue their financial support to some of the higher degree courses. Thus the context proved a major obstacle to meeting this goal. Some of the programmes which failed were:

- Unassigned admission introduced in 1971 and withdrawn in 1978.
- Post-graduate diploma in museum studies had to be converted into a M.Sc.(Tech.) two-year degree.
- All two-year M.Sc.(Tech.) in museum studies, science and technology development, computer science, instrumentation, had to be converted to first degrees after a trial run of siphoning.
- All two-year ME/M.Pharm./M.Phil. degrees failed to reach viability and were converted to one-year degrees.
- Telescoping into Ph.D. or higher degree from any first degree.
- The foreign language requirement for Ph.D. was dropped.
- Distance learning Programmes which can reach out to professionals and evolve new curricula and courses of studies, have not been sufficiently exploited.

(a) Consultancy

Having carried out consultancies with paid overheads for the Ministry of Education and several firms, the Institute has not been able to widen its clientele. One particular type of consultancy eagerly sought after by industry is a conversion of in-house training into a structured educational programme. All major industries, private as well as in the public sector, spend a lot of time on the induction of fresh university

graduates and the updating of their own personnel. Programming and proper monitoring and measurement of the outcome of these training programmes, on which industry invests time and money, has remained unsatisfactory, and the opportunity revealed has not yet been fully grasped by the Institute or by universities.

(b) Research

The educational structure provides imaginative slots for faculty and students to do broad investigations on any worthy topic. In fact, a large number of these project courses contribute towards know-how generation, self-reliance and software support for the total computerization of the system. A similar success has eluded the Institute in respect of open-ended laboratory exercises and other endeavours which require thinking rather than copying.

3. A management model that is open, participative and favours innovation

While the model purposefully incorporated a continuous feedback information system, the Institute has not always been able to act with dispatch, process the information and get to the heart of the matter. Prompt reaction to problems depends on having multi-level leaders of change within BITS, but their formation has been slow, despite structures and processes to encourage this. The Faculty Review and Reward Process was launched in 1970 in order to send out a message to the faculty that those who join in the different and unique innovative tasks of BITS could be promoted even if no posts are available. It is a thorough exercise on which the final verdict is given by a formally appointed committee. Unfortunately, recently the Institute has not acted on the recommendations made which has had repercussions on motivation to participate in change.

4. Development of a polyglot and unique culture of innovation for the BITS campus

A great deal of progress has been made in this regard. It is important to record that no academic reforms instituted at BITS had to be scrapped under threat from any quarter. If any reform was withdrawn or amended, it was invariably done as part of a rational process, because of feed-back obtained from students, teachers, employers and others. For example, there was one major students' strike at the beginning of changes to the academic structure, where grievances were stated in academic terms. The Institute insisted that if the students wanted, they could go back to the old system, but the academic reforms were not subject to negotiation as they had been finalized through a consensus. Ultimately the students dropped their demand. They came to realize that the offering of common courses, sharing of common facilities such as library, hostel, cafeteria, etc. was more advantageous, as was the upgrading of BITS, the practice school and greater employment possibilities. However certain facets of academic life seen in foreign universities could not be accepted by them, e.g. student instructors, which were introduced in 1978 but under pressure withdrawn in 1985, and student counselling.

An all-India institution with a residential campus should in principle develop a polyglot culture and there should be no separation between the academic and what is not purely academic. Further, it is important that the residents of the campus participate fully in community life. Although much has been done in this direction, unfortunately, life on campus has remained untouched by the dynamism and modernization which has been built into the educational programmes.

Chapter 8
Evaluation of BITS experience

The whole of this report has demonstrated how successive wavefronts of change moved forward and touched every aspect of the work of a formerly traditional Indian higher educational institution. *Chart 6* is an attempt to illustrate the experience. It can be seen that academic structure, exams admission procedures and staff management were all tackled right from the beginning and that academic structure was the object of continuous reform up to 1981. Certain innovations needed a long lead time, e.g. the practice school required four years to obtain complete coverage and integration of the academic structure necessitated 18 months of reflection and planning. It was due to the need for preparatory work that changes to the administrative structure could take place only later in 1976. As regards developing programmes at the higher level (Masters and Ph.D.), the graph demonstrates the attempts made every two-five years or so to launch out in this direction. Research and consultancy required the longest lead times of all and evidently had to wait for the qualifications of the staff to be improved through in-service programmes and study.

Appendix 2 presents the main indicators of achievement over the period 1968 to 1988. The number of different courses given has risen from 250 to 510, the number of types of degrees from 27 to 58, the quality of student intake as measured by marks obtained in the school leaving exam has risen from a minimum of 42 per cent to 88 per cent, and the percentage of Ph.D.s in the teaching staff from 20 per cent to 60 per cent.

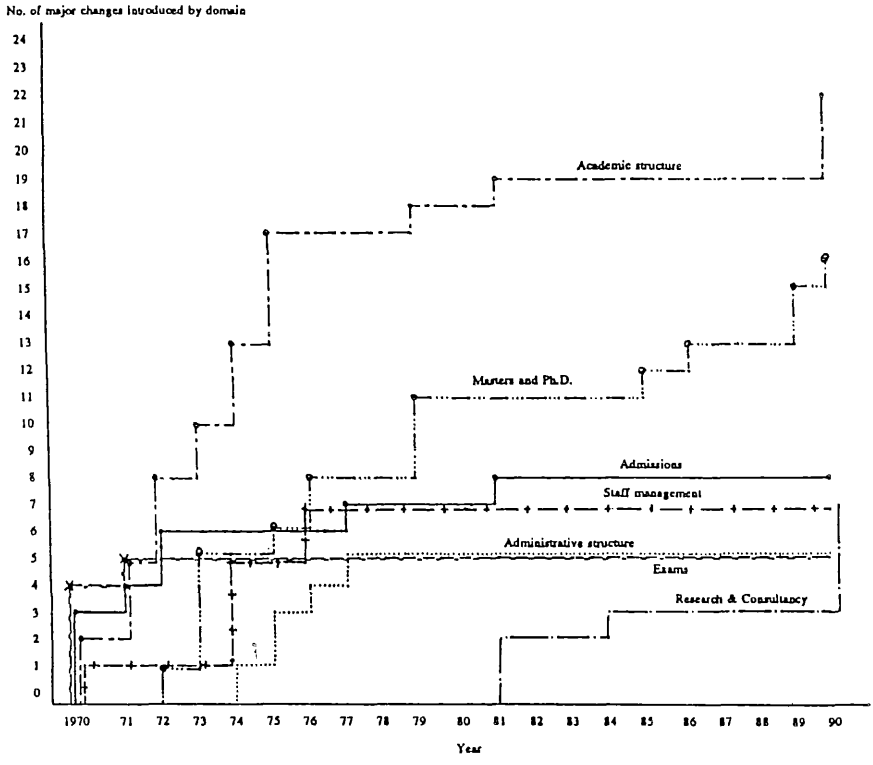


Chart 6. Wavefronts of change at BITS

At the same time unit costs per graduate, as shown earlier, are much lower than those in any IIT. That this was carried out at no extra cost to the sponsors of BITS must be credited to the successful design of the management model, which enabled savings to be made through the design of original methods and techniques to ensure:

- Cost effectiveness
- Computerization – in-house generated software
- Institutional research
- New administrative structure
- Diversification and recycling
- Standardization of all input
- Evaluation of university performance

The highlights of the model which was evolved over the first six-seven years are its academic and administrative integration. These are recapitulated below:

(a) Academic Integration brought about:

- A three-tier structure and imaginative use of modular concept of courses. The structural integration of the first degree programmes is quite original in conception, and allows maximum academic flexibilities at minimum cost. *It is the core of the system.*
- Requirements like Practice School and research projects etc., cut across the Institute without distinction of the discipline in which a student obtains his degree.
- Similarly, faculty teach courses which take them out of the narrow self-defined specialization.
- Reduction in number of marginally different courses and better focus on the remainder consistent with a uniform input of Physics, Chemistry, Mathematics with adequate English and with graduates' ability to find gainful employment.
- A minimum number of components to yield the maximum number of systems options.

(b) Administrative Integration has been ensured by:

- The basic administrative component is not the traditional department but the Divisions and Units headed by Divisional Deans and Unit Chiefs.
- The key persons in the hierarchy of administration are educational administrators who are invariably teachers and who have to integrate education, administration and financial management in a systems concept.
- A management information system, storage and retrieval of base data, interrelationship between data, etc., have been instituted and have generated new techniques. Complete computerization has taken place in practically every domain of the Institute – academic, administrative, etc., through goal-specific in-house software generation.

One way of evaluating the achievements of this management model is to show how far BITS now differs from most Indian universities.

Vital differences between BITS and most Indian universities

(i) Financial and administrative features

- BITS is the only university in India which is self-financing.
- Continuous educational innovation in spite of the lowest operating cost.
- Tuition fees are based on the concept of an economic fee even at the postgraduate level.
- Discipline oriented departments no longer form administrative units, instead divisions and functional units are integrated across the Institute.
- Both a financial and an administrative role is vested in faculty members as academic administrators.
- A goal seeking system has been designed based on the Institute's own plan formulated in 1970.

(ii) Admission matters

- Admission based on 10+2 results and not on entrance examination.
- All input in every first degree is from the Physics, Chemistry and Mathematics streams of the 10+2 schooling.
- Flexibility of admission, i.e. in second semester, with advanced standing, or with marginal deficiency.
- Admission to all higher degrees and the Ph.D. programme is specially designed to meet the legitimate aspirations of the professional world.

(iii) Educational characteristics

- Science and Technology have pride of place in every programme.
- A common foundation at first degree level of all students bound for degrees in Engineering Science, Technology, Humanities or Social Sciences.
- Flexibility in the educational structure.
- A package of electives enables all first degree students to determine their own orientation and careers.
- Practice School is participated in by all first degree students. Under supervision of BITS teachers, they transfer to Practice School stations for the pursuit of learning in an industrial setting for a stipulated period of stay. What was created at BITS is a unique adaptation of the original MIT idea but took the model of medical education, as exemplified by internship and residence as its main features. Even MIT has pronounced it to be original and recommended it as an appropriate model for the Third World.
- Some higher degree programmes are entirely run at Practice School stations.
- Handsome financial assistance is given to both first degree students and higher degree students by Industry.
- Open-ended analytically oriented projects are taken up by 25 per cent of the students every year. Another 15 per cent of students take up such projects voluntarily outside their

semester load. Projects are open to all students irrespective of the ultimate degrees for which they are enrolled.

- Completely new degrees in quantitative economics, biological sciences, science and technology development, museum studies, management, engineering technology, general studies, have been programmed.
- Off-campus Ph.D. extends a challenge to professionals to obtain a Ph.D. in their own settings, on their own problems derived from professional practice. Similarly ME (Collaborative) and M.Phil. (Applied) are offered. This feature of the distance learning programme of BITS is absolutely original. It was designed to meet the genuine need for growth of practising professionals. Its fundamental approach is to upgrade existing professionals rather than merely release new graduates in a traditional way on to the employment market.
- Additionally, vocational degrees taught through the distance learning scheme meet an important need in Indian education.

(iv) Graduate acceptance

- Campus interviews for all graduating students are held by 70 industries in both semesters.
- Graduate Schools of American universities accept BITS graduates on the same basis as they do for IIT graduates.

(v) Foreign collaboration

In the matter of foreign collaboration, BITS approach was unique, based on the concept of equality between partners. As early as 1970, the contract with the Ford Foundation incorporated this.

(vi) Self-evaluation

A university which is so different from the traditional mould and is always on the curve of innovation and change, has to design its own voluntary methods of continuous monitoring of performance, obtain feedback to make mid-stream corrections, discover new ways of

mobilization of resources and constantly keep the system on a goal-seeking path.

The ultimate arbiters of the success of BITS may be said to be its clients, i.e. the students and industry. As far as the students are concerned, it can be said that once a momentum had been gained, it tended to generate further change and demands for reform came from the most unexpected quarter, i.e. the students union, which asked for practice school, open book examination and for more difficult subjects in the curricula. Although students went on strike several times, they were never willing when final decisions were made, to trade the new system for the old.

As to industry, it now gives a high preference to practice school graduates and in the area of non-engineering subjects almost always gives first preference to BITS graduates. Thus students and graduates know that they have made a good choice by investing time and money at BITS.

Chapter 9
Conclusions and lessons learned

This report has so far unfolded the innovative process at BITS and its particular management techniques. What was accomplished was the outcome of an intuitive and empirical process constantly altered and perfected. After 20 years of sustained involvement, it is now possible to draw certain generalized conclusions from the experience. But first of all, a few comments should be made about innovation and its management in knowledge-intensive institutions in the developing world.

Management of innovation is not a job for amateurs, it is a professional task and a serious business. It is time that planners, administrators and fund-givers should insist that projects attempting to introduce educational innovations must include the development of needed professional skills. The wealth of information and expertise amassed by BITS and other institutions having undergone sustained involvement in educational innovation is one source that can be consulted to guide actions and decisions elsewhere. Much can also be learnt from the management of research and development and of technology transfer and diffusion in traditional societies.

Good management goes hand in hand with successful innovation, as the following generalizations derived from this developing country experience show:

(i) Mere change is usually not enough. It has to be an innovation.

(ii) The doctrine of one innovation at a time is invalid, since innovation automatically unfolds a gamut of changes. Strategy should determine how many elements of change can be

tackled at one time. This will depend on the management's ability to cope within the given circumstances.

(iii) Management has to be shaped to suit the historical unfolding of an educational enterprise. Its task is to devise the new strategies and techniques necessary to close the gap between ideation and fruition. The design of strategies and their unfolding requires a large number of experimentations. Of course, there will be a continuous and constant recourse to design and planning, but it would be wise to conduct pilot runs to make decisions about the correctness of the direction being followed.

(iv) Management of an academic institution, even in the traditional system, cannot be left in the hands of non-academic people.

(v) Uncertainty about the outcome has to be lived with. The pragmatic approach is to convert uncertainty into risk and then minimize it as far as possible.

(vi) Successful innovation must be followed by a new routinization to replace the old, with judicious control of the innovation-routinization cycles. A new attitude towards time becomes critical. Both the timing of an event and the time taken for the completion of a job have to be intuitively understood and planned.

(vii) Much has been said about the cost of change and innovation as if an orderly change or innovation is invariably expensive. In this context, two questions are conveniently ignored, namely, what would be the cost of retention of traditional methods and, is the innovation necessarily expensive? In the earliest stages of innovation at BITS, it was found that money was never a critical factor. In fact soft money tends to make the system flabby and non-enterprising.

(viii) Finally, it is obvious that self-reliance is the key factor. But self-reliance is different from self-sufficiency. The history of BITS will show that until 1969, it was quite self-sufficient, living in isolation and acting on events. Self-reliance is the foundation on which the innovation model was based.

To go a little deeper into the lessons which have been learned from this particular experience, ranging from decisions to adopt certain new

ideas to their implementation in the various institutional domains, the following particular advice can be given:

(a) Foreign collaboration and ideas

Foreign collaboration is meant to quicken the process of transformation. Far too often Indian universities have used it as a crutch and a status symbol, and to acquire equipment only. There is no desire to adapt the know-how, develop a synthesis and establish a two-way traffic of ideas and concepts. This state of affairs is harmful to both donors and receivers. BITS, MIT and the Ford Foundation tried to do things in a different and more effective way.

Placed in the driver's seat, in 1970 BITS was obliged to go deeper into the American concepts which appeared at first sight to be useful. It was manifestly clear that a mere copying of concepts and techniques of application would lead to frustration, and that they would have to undergo fundamental alterations in emphasis and manifestation. For example, the practice school begun in chemical engineering was freely adopted for all other disciplines, and internal evaluation leading to qualitative letter grades incorporated many of the Indian habits. The role of the American experts was not confined to their subject specializations, but expanded to involvement in total educational development also.

Readers should be reminded that more massive foreign collaboration from the USA was given to selected Indian universities (prominent examples are IIT Kanpur, IIM, Ahmedabad and Calcutta, many agricultural universities), yet in the field of planned structural change in education, these institutions have not been able to go as far as BITS. Thus, the American influence can be pronounced at best as necessary but not sufficient.

(b) Commonality and originality of institutional management

There cannot be a unique formula by which myriads of management functions in thousands of institutions can be tackled. There are, however, certain basic tasks which should be carried out:

- Goal definition and re-definition
- Environment design

- Strategy formulation
- Planning and execution
- Performance evaluation and forecasting
- Control of the process and operation

The above management tasks are formulated in terms of stand-alone goals, but any real system has to respond to the associated tasks also. It is evident that educational changes require concurrent administrative changes, infrastructural arrangements in harmony with the changes, rewards for success and commitment and at least withdrawal of favour for failures and lackadaisical attitudes.

Originality in the management processes comes from the vision and intuition used in the prior design of an organization or an agenda of approach.

BITS wisely decided in 1969 to invest in an original management technique to usher in fundamental changes. However, since additional physical inputs were simply not available, it was clearly making a virtue out of a necessity.

(c) Improving staff quality for management and teaching

Commitment and a sense of mission are important for the key staff in the institution. This can be engendered by the model which should offer a vision and a stake for each person involved. It should obligatorily include those who are most affected and most vulnerable and be made plain that there are benefits and a place for each provided they participate in the process.

In this respect, a special public relations post is useful to keep information circulating both to staff of the institution and to outsiders to assist where possible in the diffusion of successful innovation.

Staff development should take place on recruitment, prior to implementation of a change and as an on-going process of improving qualifications. To make faculty development a truly acceptable process, an institution must relate it to the mission stated and be sure to reward the faculty in accordance with previously declared methods.

(d) Goal definition and re-definition

Both for the updating of the system as well as for the introduction of a revolutionary thrust into a system, it is important that individual institutions should define their goals, decide on the techniques to be used for reaching the goals and propose what attitudes they will adopt towards constraints which are simultaneously social, economical and political. BITS had to overcome a great deal of wishful thinking and was required to define its goals in much more realistic terms than would have been necessary if the burden of the past coupled with inadequate resources in the present, had not been combined with a challenge to develop the Institute into one which could compete with the best in all respects.

There are choices between goals, but it was also found that to achieve a goal, there might be a need to make mid-course corrections, to delay, or sometimes the earlier goal would have to be replaced by an alternative.

(e) Educational goals

These were the primary goals of BITS. Goals of curricula were enunciated by working backwards from the role of the graduate in the job market.

The above approach was applied to all existing degree programmes as well as to the new degree programmes which were introduced, followed by total academic restructuring and implementation of the Practice School for all disciplines. This was the first watershed from which BITS has never looked back.

The next recognizable watershed was to bring the corresponding reform to the graduate school and the Ph.D. programme.

When these two watersheds had been achieved for the purpose of making the curricula of BITS relevant and marketable, reverse input from industries prepared BITS to go into the third watershed, i.e. the unique Distance Learning courses and educational consultancy.

The precise relationship between educational goals, the particular educational structure and the mode of evaluation for examination must be spelt out. Quite often the objectives of an examination system are not clearly understood.

(f) Education-industry linkages

Industry linkage is necessary to create a symbiotic relation between theory and practice. Practice School is one such manifestation. The fact that in BITS case, it spearheaded other reforms proves the validity of this concept. Some form or other of this basic concept is required to reduce the significance of the so-called scholarship which is based on book learning.

As in the first degree of engineering, practice and inputs from sister disciplines and other modern skills are equally required for the first degrees in sciences and humanities. The employment pattern of BITS graduates in these disciplines proves the point.

(g) Importance of the use of distance learning programmes in an innovative institution

Distance learning activities in Indian universities have been basically an extrapolation of correspondence courses. They are considered suitable for people who did not make the grade or were left out by the formal system. They augment the earnings of the university through additional examination fees. However, an authentic distance learning system should not mean that it is only for intellectually inferior students. It is simply a system which must reach out to that population which is placed in circumstances that do not permit them to go through the formal system. New courses of studies and new degrees can find an authentic expression only when distance learning is available to the professional activities of a modernizing society.

(h) Control and evaluation

In this domain, BITS took account of certain obvious things which do not appear to be a universalized experience in higher educational institutions:

(i) Purpose quantification is extremely vital for understanding how the innovative process is working. This had to be carried out rapidly and instantaneous corrections made. Feedback has another important purpose. Innovation never stops at one place. On the

principle of change begetting change, a certain degree of sovereignty in the innovation process is discernable. New opportunities quietly unfolded, and the management has immediately to seize this opportunity to increase the network of innovation. It was through such opportunities that timely starting of integrated first degrees, practice school and distance learning was achieved. The responses in each case were instantaneous and favourable.

(ii) Measurement hinges on quality of the data and its validity. Hence a full perception of the nature of data and methods of treatment is critical for the task.

(iii) The use of the computer for handling this data is vital.

(iv) In innovative circumstances, the process is continuously and empirically evolved. Thus performance measurement has to be equally empirically evolved in harmony with the unfolding of the process.

(v) Performance measurement is not a passive activity, it demands management skill to create a framework through which desired data can surface.

(vi) The detailed internal evaluation of a system teaching unique courses and adopting unusual evaluation techniques must explicitly describe all its operations to the persons involved. It is through such openness that credibility can be achieved.

(vii) As to day to day control, this requires systematic updating of Academic Regulations. This meticulously prepared document has proved to be a key document in the allotment of teaching load to the teachers, operation of the courses and evaluation of the performance of the students. These regulations serve both as an important feedback on the total educational involvement of the Institute and also make the system absolutely transparent so that flexibilities and discretionary clauses are morally binding on the part of all who encounter the system.

Chapter 10
What others can do

The success of a wavefront of educational innovations resulting in institutional transformation as achieved by BITS, has implications for its beneficiaries and society at large. Unless institutional mechanisms for building awareness, exchanging information, structured learning channels and rewards systems to consciously encourage and nurture innovations are established the chances are that such innovations will remain only an event rather than a cumulative process in history. The BITS experience of two decades provides evidence of the danger that lack of support from outside the system can make the institution an isolated instance. This case history of BITS must end by addressing all concerned as to what they may do to foster innovative institutions:

(i) Beneficiaries of the innovation have an extra responsibility to become active supporters. They must join in publicizing the innovation to the lay public and in neutralizing opponents.

(ii) Planners and administrators in the government often admire innovation but hardly go beyond that. They must learn to differentiate between institutions and positively support the innovative. The various possibilities of distance learning, non-profit and for-profit (corporate college) institutions and new kind of linkages between the institutions and employing world have to be explored.

(iii) Research institutions and individual researchers should recognize higher education as a discipline of study and further that innovation and institutional transformation are rare phenomena which need to

be documented with all care and attention and made available in print for the benefit of all.

(iv) International organizations like the IIEP, UNESCO can act as effective agents to universalize success stories of innovation in multiple forms in different developing countries throughout the world. They may take the lead in formulating structured mechanisms for the education and training of practising leaders of higher education. Intensive workshops for the heads of higher education institutes may well be the first step in creating a systematic knowledge base and case studies of innovations. Formulation of appropriate teaching materials could be another. Creating a new cadre of personnel for higher education institutions through training at appropriate levels may be a worthy objective for organizations like the IIEP.

(v) The third world must look inward for experiences and learn from each other. There is a rich experience in higher education already available within the third world provided it curbs its tendency to look at the developed world as the source of every idea. The BITS case history has amply shown how foreign ideas required an original adaptation.

In the above context the problem of the third world basically has been that it is more obsessed with the techniques and tools and possession of buildings and equipment rather than the work it has to do in dealing with the ideas and knowledge which is continuously being transferred from the advanced countries. Only when the goals are set can the power of ideas be visualized and techniques internally and harmoniously generated. Ultimate success depends on how effectively the transfer of knowledge and its free adaptation in our own culture is handled.

Appendices

Appendix 1
Chronological list of implementation of innovations

1970

- Qualitative letter grades
- CGPA (College Grade Point Average)
- New admission procedure
- Admission with advanced standing
- Semesterwise registration process
- Transcript
- Academic Review Board
- New book-keeping of academic records
- Faculty review
- Annual progress reports, self-assessment

1971

- Controlled experiment to offer Science Programmes to weak Engineering students
- Foundation courses for all programmes
- Analytical course content in the non-analytical programmes
- Abolition of 300 marginally different courses
- Flexibility through free electives
- Unassigned admission for a limited number
- Campus interviews
- Academic records partially computerized

1972

- Second semester admission
- Syllabi of 76 foundation courses
- Branching Procedure
- Progressive Branching Index (PBI)
- Branching list, Admissions merit list both computerized
- Unassigned admissions for all
- Normalization of Board marks
- M.Sc.Bio Sciences
- Coursewise timetable

1973

- First PS at PG level
- First PS for B.E. for limited numbers
- Five-year integrated programme
- M.Sc.(Tech.) Computer Science, Instrumentation and Museum Studies
- Siphoning of the first degree students into M.Sc.(Tech.) Computer Science

1974

- Academic Regulations to include:

  - Course-load, a student decision
  - Repetition of D-grade under certain conditions
  - New grade to replace the old one on repetition in the computation of CGPA. New academic flexibilities incorporating:
  - Admission of M.Sc.(Hons.) to M.E.
  - Any B.E.(Hons.) to any M.E.
  - Dual degree scheme

- PS extended for Science, Economics and Management
- Student invitees for Senate
- Meritorius students involved in teaching courses
- Subsidizing textbook writing for developing new courses
- Adjunct faculty scheme

- Associate faculty scheme

1975

- Academic Regulations amended as follows:

  - E grade in place of F grade
  - All grades acceptable
  - Optional free electives
  - Academic Counselling Board (ACB) for monitoring student performance

- Student membership in ACB
- Student membership in Discipline Committee
- Telescoping
- Prerequisites for all courses firmed up
- PS as an option for all students
- Flexible admission requirements to encourage professionals to do postgraduate or Ph.D.
- Doctoral admissions centralized
- PS linkage with NSS
- PS student profile computerized 1976
- Administrative restructuring
- Siphoning into M.Sc.(Tech.) programmes
- New M.Pharm., M.Sc.(Tech.), STD and M.E. programmes revised
- First intensive teaching workshop
- Disciplinewise gold medals replaced by single award system for integrated programme
- Students as Registration Advisors

1977

- Student membership in the Senate
- Return to Assigned admissions

1979

- Preparatory year for the 10 + 2 input
- Achievement test after admission to determine the level of preparation
- More Engineering Science and Analysis and Application-Oriented Courses introduced in all first degree programmes
- M.A. (Econ.) to M.Sc.(Econ.)
- M.Sc.(Tech.) programmes as integrated first degree programmes
- ABC grouping of all first degree programmes
- Dual degree universalized
- M.E. (Collaborative)
- Discontinuance of PS from 1st year of higher degree programmes
- M.Phil. (2 years)
- Admission to single-discipline M.E. discontinued

1981

- New four-year integrated programmes
- Integration of Academic Regulations for all the three tiers
- Engineering Diploma holders admitted to M.Sc.(Tech.) programmes under C group through advanced standing admission
- New programme of M.Sc.(Tech.) in Engineering Technology
- Increased intake for first degree programmes
- M.Phil. (New scheme) one-year
- First all-India University Youth Academic Week (APOGEE)
- BITS Consultants
- Genetic Engineering Laboratory

1984

- Courses in emerging areas
- Courses in Development Processes
- Technology Innovation Centre (TIC)
- Certificate Training Programme (CTP)

1985

- M.Phil.(Applied) 2-year
- BITS introduces M.Phil.(Applied) programme

1986

- Ph.D. Aspirants Scheme introduced

1987

- M.V.S. degrees started
- New M.E./M.Pharm./M.Phil. programmes started

1988

- B.S. degrees revived
- M.S. degrees revived
- Title Fellow of the Institute (Honoris Causa) instituted
- M.Sc.(Tech.) Information System degree started
- M.Phil.(Vocational Studies) degree initiate

1989

- CSIR training scheme for group B scientists converted into an academic programme (M.S. in S & T)
- Flexible semesters came into operation
- M.E. (Microelectronics) started, to be conducted jointly with CEERI, Pilani
- M.S. (Software Systems) introduced
- M.S. (Pharmacy Operations) introduced
- M.S. (Technological Operations) introduced
- Conduct of first degree thesis at off-campus centres introduced
- Collaboration with Uniformed Services, and University of Health Sciences, Bethesda, USA

1990

- Collaboration with NPL, Delhi
- M.S. (Physical Sciences) started
- Associate students under the Distance Learning scheme linked up with manpower training programmes in industries
- B.S. (Industrial Management) introduced
- First level diploma in computer applications introduced
- M.E. programmes revitalized
- Practice School operation extended to the USA
- Consumer Electronics Centre
- Centre for Software Development
- Collaboration with Motorola, USA in the areas of computer communication, microprocessors, digital signal processing
- Centre for Research on Educational Innovation and Institutional Development inaugurated

Appendix 2. Record of achievements of BITS 1963-1989

Serial number	Item	1963-1964	1964-1965	1973-1974
1.	No. of teacher (budget)	188	232	250
2.	Senior/Junior teaching ratios (actual)	0.34/1.00	0.44/1.00	07.78/1.00
3.	Percentage of Ph. D in teaching staff (actual)	NA	20.00% (approx.)	47.9%
4.	Teaching/support/help staff ratios (budget)	1.6/1.0/1.3	1.4/1.0/1.2	0.58/1.0/1.1
5.	Average workload on teaching staff			
(a)	teaching	18 hrs/week	18 hrs/week	12.5 hrs/week
(b)	examinations	none (external on payment)	none (external on payment)	7.5 hrs/week (internal evaluation)
(c)	research and consultancy	marginal	marginal	marginal
(d)	academic management	none	none	5 hrs/week
(e)	course development	none	none	none
6.	University-industry linkage	none	none	(12 students) (1 organization) (1 faculty) for PS-II
7.	Ph. D diversifications	In sciences only marginally in arts	In sciences only marginally in arts	First time Ph. D in engineering

Appendix 2. (continued)

Serial number	Item	1985-1986	1987-1988	1988-1989
1.	No. of teachers (budget)	267	289	289
2.	Senior/Junior teaching ratios (acutal)	1.25/1.00	0.76/1.00	NA
3.	Percentage of Ph. D in teaching staff (actual)	52.2% + 10.00% working for Ph. D	60% + 14% working for Ph. D	NA
4.	Teaching/support/help staff ratios (budget)	1.0/1.0/0.87	1.0/0.87/0.82	1.0/0.87/0.82
5.	Average workload on teaching staff			
(a)	teaching	12.5 hrs/week (89% of faculty teaching more than two disciplines)		
(b)	examinations	7.5 hrs/week (internal evaluation)	same as for 1985-1986	same as for 1985-1986
(c)	research and consultancy	8 hrs/week		
(d)	academic management	15 hrs/week		
(e)	course development	18 hrs/week (35% of faculty have produced textbooks)		
6.	University-industry linkage	(335 students) [PS-II] (40 organizations) [M.E. Collab] (35 faculty) [M.E. Phil] (Applied) for [Ph. D] [Off-campus] (550 students) (60 organizations) (55 faculty)	(390 students) [PS-II] (50 organizations) [M.E. Collab] (40 faculty) [M.E. Phil] [Applied] for [Ph. D] [Off-campus] (550 students) [M.V.S.] (60 organizations) (55 faculty)	(440 students) [PS-II] (50 organizat.) [M.E. Collab] (45 faculty) [M.E. Phil] for [Ph. D] [Off-campus] (550 students) [M.V.S.] (60 organizat.) [B.S.] (55 faculty) [M.S.]
7.	Ph. D diversifications	In all disciplines	anyone anywhere	anyone anywhere

Appendix 2. (continued)

Serial number	Item	1963-1964	1964-1965	1973-1974
8.	No. of degree programmes	27	27	48
9.	No. of courses	250 (equiv.)	250 (equiv.)	395
10.	Input quality of student (first degree)	NA	40% to 90% of marks	70.9% to 100% (normalized
11.	Intake/applications (first degree)	Underfilled	Underfilled	1/12
12.	Staff/student (actual)	1/11	1/9.7	1/10.5
13.	Unit cost per student (budget)	Rs. 1029	Rs. 1917	Rs. 4074
14.	Unit cost per degree Laks (budget)	0.71	1.25	1.76
15.	U.G/P.G/(actual) (budget)	NA NA	9.06/1.00 3.40/1.00	4.67/1.00 2.33/1.00

Appendix 2. (continued)

Serial number	Item	1985-1986	1987-1988	1988-1989
8.	No. of degree programmes	48	55	58
9.	No. of courses	430	500	510
10.	Input quality of student (first degree)	85.05% to 100% (normalized)	88.11% to 100% (normalized)	NA
11.	Intake/applications (first degree)	1/10	1/9	NA
12.	Staff/student (actual)	1/10.8	1/11.66	NA
13.	Unit cost per student (budget)	Rs. 8373	Rs. 10014	Rs. 9388
14.	Unit cost per degree Laks (budget)	4.20	4.60	4.57
15.	U.G/P.G/(actual) (budget)	1.67/100 1.14/1.00	1.67/1.00 0.95/1.00	NA 0.95/1.00

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The book

The BITS experience is not a mere change, but truly an innovation; an outcome of a planned strategy of institutional reform both with or without additional physical inputs. The design and management of this gigantic task had to be distinctive and created for the particular context. This report thus described both institutional change and the respective management processes covering the entire spectrum of university functions i.e. academic structure, examinations, admissions, staff management, research and consultancy. Strong centralized management backed up by computerized information systems played a significant role. The literature provides few examples of the striking transformation of a traditional institution in a developing country and hence the lessons learned will be of wide interest. The study forms part of an IIEP research programme directed by Bikas C. Sanyal.

The author

C.R. Mitra has had a long and distinguished career in higher education. Trained as a chemical engineer in India and the USA, he worked in both countries on the development of the chemical industry and on teaching, research and designing new educational institutions. He was President of a college for ten years and of a multidisciplinary university for twenty years. He has published several books and articles on education, science and technology. He now acts as consultant to a number of international and national institutions.