A Study
on
The Nature of Work and Placement of Postgraduate Alumni of the Indian Institute of Technology, Bombay

Project sponsored by
Department of Science & Technology, Government of India

Principal Investigator :
Prof. S. P. Sukhatme
Department of Mechanical Engineering
Indian Institute of Technology, Bombay

November 1990

With best compliments from

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INDIA

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CONTENTS

ABSTRACT

Of the 700 students who pass out with various degrees from IIT Bombay every year, nearly half obtain the degrees of M.Tech. (about 250) or Ph.D. (about 70). This report is based on a study of the professional careers of these alumni after leaving the Institute. It is probably the first of its kind in the field of technical education in India. The analysis in the report is done on the basis of data supplied by the alumni themselves in their replies to a questionnaire. Some of the important findings are as follows:

Based on their current addresses, alumni have been classified into three broad categories - those who are settled in India, those settled abroad, and those who have been abroad but have returned to settle in India. The category settled abroad constitutes the brain drain. For M.Tech. alumni, this number is found to be 13.4 percent, while for Ph.D. alumni, it is seen to be only 9.8 percent.

Amongst M.Tech. alumni, the largest number (about 35 percent) list their current professional status as 'Executive/ Manager'. The next largest number (about 30 percent) list themselves as 'Industrialist/Entrepreneur' or as 'Self-employed Consultant'. Thus a very significant number are running their own business. On the other hand, amongst Ph.D. alumni, about 60 percent list their status as either 'Research Scientist/Engineer' or 'Academic Researcher/Teacher', thereby reflecting the strong influence of the Ph.D. degree on the professional status.

An analysis of the sector of work indicates that for M.Tech. alumni, the majority (over 60 percent) work in the private sector, with the remainder divided amongst educatinal institutions, the public sector and government service. However, in so far as Ph.D. alumni are concerned, the largest number (over 40 percent) work in educational institutions with the next largest number (about 30 percent) in the private sector.

The mean annual income for salaried M.Tech. alumni in India who passed in the time span 1973 to 1977 is Rs73,467. It is Rs65,466 for those who passed from 1978 to 1982, and Rs49,137 for those who passed from 1983 to 1987. A break-up in terms of the sector of work shows that incomes for those working in the private sector are the most. They are followed by alumni working for the government or in the public sector. Alumni working in educational institutions have the lowest incomes. The differentials in incomes between the various sectors are also seen to increase with the passage of time. Comparing the annual incomes of M.Tech. and Ph.D. alumni in India, one sees that in every sector of work (excepting the 'educational institution' sector), Ph.D. alumni who have passed in a particular time span have higher incomes than M.Tech. alumni who have passed in the same time span. In the 'educational institution' sector, the incomes of the two sets of alumni are more or less the same.

An analysis of the major duty being done by M.Tech. alumni shows that the largest number (about 50 percent) are engaged in teaching/R&D/design. In the case of Ph.D. alumni, the number of such alumni is even larger (about 75 percent). It is clear therefore that the majority of M.Tech. and Ph.D. alumni continue to work essentially in the area of their specialization rather than drifting towards management.

Data on M.Tech. alumni who are having their own business indicates that over 90 percent of them started the business on their own. The average annual turnover of the companies being run by them is Rs26 lakhs and the average number of employees is 19. In 90 percent of the cases, the nature of the business being conducted is either 'Production/Manufacturing' or 'Consultancy/ Project Planning/Execution'. Data on Ph.D. alumni who are running their own business is very similar in content.

The responding alumni have also given a feedback on the usefulness and relevance of the educational programme undergone by them at IIT Bombay. While there is a general appreciation of the M.Tech. and Ph.D. programmes in an overall sense, a number of

constructive suggestions have also been made. Of these, the one made most often is the need for having a more practical and industry-oriented bias both in the course work and the thesis work.

The overall picture emerging from the study is of a young and vigorous set of alumni, the vast majority of whom are contributing fruitfully to the industrial development of our country.

Chapter 1

INTRODUCTION

1.1 Postgraduate Programme at IIT Bombay

The Indian Institutes of Technology were set up with the objective of providing highly qualified scientific and technical manpower to meet the country's industrial needs. It was envisaged that they would lay more or less equal emphasis on undergraduate and postgraduate education and that the number of students passing out with postgraduate and undergraduate degrees would be approximately equal. It was particularly envisaged that the postgraduate degree holders would eventually play an important role in research and development establishments and in industry, and help in achieving self-reliance in many sectors.

In keeping with these objectives, the present student population of approximately 2500 at IIT Bombay consists of an equal number of undergraduate and postgraduate students. The degree/diploma output of the Institute for five recent years is given in Table 1.1.

It will be seen that the average annual output is about 700. Of this, approximately 300 students obtain B.Tech./M.Sc. degrees, while the remainder obtain M.Tech./M.Des. degrees, the Ph.D. degree and the postgraduate diploma (D.I.I.T.).

On an average, about 250 students obtain their M.Tech. degrees each year in a number of engineering disciplines and also in a number of inter-disciplinary areas. At the moment, the following M.Tech. specializations are offered at IIT Bombay:

By Departments:

1. Mechanical Engineering
2. Electrical Engineering
3. Civil Engineering
4. Chemical Engineering
5. Computer Science & Engineering
6. Aeronautical Engineering
7. Metallurgical Engineering

By Interdisciplinary Groups/Centres:

1. Industrial Engineering & Operations Research
2. Environmental Science & Engineering
3. Materials Science
4. Energy Systems Engineering
5. Systems & Control Engineering
6. Corrosion Science & Engineering
7. Industrial Management
8. Reliability Engineering

Ph.D. programmes are also offered in all the above mentioned departments and interdisciplinary groups. In addition, Ph.D. programmes are also offered in the science departments (Physics, Chemistry, Mathematics, and Earth Sciences) and in the Humanities & Social Sciences Department. In all, about 60 to 70 students obtain their Ph.D. degrees each year.

It is thus evident that the output of postgraduate students may be considered to be very satisfactory both in terms of numbers and in terms of the diversity of specializations offered. It is also worth noting that the engineering component of the M.Tech. and Ph.D. output of the IITs forms a significant part of the national output. Data on the out-turn of M.Tech./M.E. degrees for all institutions in the country indicate that the IITs contribute about 35 percent

Table 1.1 Degree/Diploma Output of IIT Bombay for the Years 1983 to 1987

Degree	1983	1984	1985*	1986	1987
B.Tech.	253	289	433	214	243
M.Sc.	66	71	71	66	80
D.I.I.T.	14	3	7	3	6
M.Tech.	251	253	223	219	290
M.Des.	22	12	12	-	41
Ph.D.	65	71	56	51	67
	671	699	802	553	727

* The large B.Tech. output in 1985 is because of the simultaneous passing out of the first batch of the new 4 year stream and the last batch of the 5 year stream.

Table 1.2 Doctorates in Engineering and Technology in India for the Period 1978-81

Ph.D. output	Year			Total
	1978-79	1979-80	1980-81	
IITs	140	145	130	415
All other Universities and Institutes	134	176	139	449
Total	274	321	269	864

Source: 'Science and Technology Doctorates', Special Survey Report, Department of Science and Technology, 1985.

of the total. Table 1.2 gives figures for the Ph.D. output in engineering and technology in the IITs and in all other Universities and Institutes in the country over a three year period. It is seen that in the case of Ph.Ds., the IITs have contributed 48.0 percent to the total output.

1.2 Need for the Present Study and its Objectives

It is strange but true that there are no follow-up studies available on alumni who have passed out with postgraduate qualifications from Indian universities and from the IITs. This observation is particularly significant in the context of the large financial investment which the nation makes in this sector, particularly for scientific and technical education. The type of questions which need to asked about IIT postgraduate alumni are: After passing out, how many stay on in India? And how many settle down abroad? What is the magnitude of the brain drain? What is the nature of work done by them? How many stay in the profession as practising engineers, research engineers/scientists, academic researchers and teachers? And how many drift eventually to the area of management? For those who are employed, how many are in the public sector? And how many in the private sector? What is their salary structure and how does it compare between different sectors? A very important question whose answer would be of interest is : How many of the postgraduate alumni are industrialists or entrepreneurs? In which areas have they established their businesses? In an overall sense, a follow- up study on IIT alumni would seek to find out if IIT postgraduates are contributing significantly to the national scene by leading the way, and by being inventive and innovative. Detailed answers to the above questions and others of a related nature would help to put the role of an IIT postgraduate programme in its proper national perspective. They would also set into motion some fresh thinking on the appropriateness of the postgraduate curriculum and provide ideas for new courses and directions.

The present study is thus unique and probably the first of its kind in India. It has been undertaken keeping all the above aspects in mind. The following broad objectives have been identified:

1. To analyze and obtain career profiles of postgraduate alumni of IIT Bombay.

2. To quantify the extent of the brain drain of the postgraduate alumni. (This information combined with data obtained earlier on undergraduate alumni would yield a picture for the IIT as a whole).

3. To obtain feedback on the curriculum undergone by the alumni with a view to judging its appropriateness and the need for modifications.

1.3 Some Related Studies

(i) A related study on the magnitude and nature of the brain drain of graduates of IIT Bombay has just been completed.[+] The set of alumni selected for the study were B.Tech. graduates who passed out in the five year period from 1973 to 1977. The objectives of the study were to quantify the extent of the brain drain, to understand the process of the brain drain and to obtain a broad profile of the IIT Bombay graduate a few years after he had graduated. These objectives have been achieved. For the first time, a fairly reliable estimate of the magnitude of the brain drain is now

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+ S.P. Sukhatme and I. Mahadevan, 'Pilot Study on Magnitude and Nature of the Brain Drain of Graduates of the Indian Institute of Technology, Bombay', Report submitted to the Department of Science and Technology, November, 1987.

S.P. Sukhatme and I. Mahadevan, 'Brain Drain and the IIT Graduate, Part I - Magnitude of the Brain Drain, Part II - Understanding the Brain Drain Process', Economic and Political Weekly, pp.1285-1293, 1988.

available. It is estimated that 31 percent of the alumni passing out with B.Tech. degrees have settled abroad, while 69 percent are living in India. Out of those abroad, an analysis of the countries shows that 82.6 percent are in the US/Canada. Apart from this, a number of other useful results regarding the process of the brain drain and the nature of work being done by IIT graduates have been obtained.

(ii) An interesting study on the placement of M.I.T. alumni[+] revealed that at least one in five of M.I.T.'s engineering graduates is found in some kind of managerial role. As they advance in their careers, the ratio approaches one in two. Since it is reasonable to assume that the alumni of the other major engineering schools in United States have followed approximately the same career patterns as those of M.I.T., technological education has obviously been an important source of administrative talent for American industry. The study makes abundantly clear the fact that the flow of engineering graduates into management has been substantial and steadily increasing in volume. The majority reach executive rank because there was a definite demand for managerial personnel with their particular skills. This finding throws light on the importance of further studies in order to obtain feedback from alumni regarding planning of technological curricula.

(iii) The Asian Institute of Technology[++] at Bangkok conducted a tracer study of alumni who passed out from 1961 through 1984. The results of the study support the view that AIT serves Asia since the majority of the respondents work in their home country and many of those living outside of their country are staying in other parts of Asia. Only 3.5 percent are employed in developed countries like U.S.A. and some European countries. The study further shows that most of

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+ J.B. Rae, 'Engineering Education as Preparation of Management - A Study of M.I.T. Alumni', The Business History Review, Vol.29, pp.64-72, 1955.

++'Tracer Study - 1961 to 1984 Alumni'. Report of the Development Office, Asian Institute of Technology, Bangkok, 1986.

AIT's alumni are doing research and development, management and production, construction and design work and that their biggest employers are the government and private sectors and to a lesser extent educational institutions. The findings also show that as the alumni grow older, they occupy senior management positions. This is more true with the doctoral degree holders for the data show that more of them work at the senior management level.

1.4 Population Under Consideration in Present Study

After discussions with the Department of Science and Technology, it was decided to conduct the present study for alumni of IIT Bombay who obtained their M.Tech. and Ph.D. degrees over the fifteen year period from 1973 to 1987[+] . The break-up of students who obtained these degrees over the above time span is given in Tables 1.3 - 1.6. Table 1.3 gives the classification of M.Tech. alumni by their department/inter-disciplinary programmes. The alumni are classified in three groups: (i) Full-time students receiving an Institute Scholarship, (ii) Sponsored students (including Q.I.P.), and (iii) Departmental staff. It will be seen that of the total number of 2842, most alumni belong to the group of full-time students receiving the Institute scholarship. The study has been restricted to this group of 2584 alumni. This is because most of the sponsored students belong to the Quality Improvement Programme and it was felt that their career profiles were reasonably well known.

The yearwise break-up of M.Tech. alumni presented in Table 1.4 shows that the M.Tech. output has steadily increased from about 130 in 1973-77 to about 250 in 1983-87. This is mainly due to the introduction of the programme in Computer Science and Engineering in the late seventies and the starting

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+The study on B.Tech. alumni was conducted for the five year period 1973 to 1977. There is thus an overlap of five years in the two studies. This would permit comparisons between the alumni of the three degree programmes,viz. B.Tech., M.Tech. and Ph.D.

Table 1.3 Departmentwise Classification of M.Tech. Alumni of IIT Bombay (1973-1987)

Department/Inter-disciplinary programme	Full-time students with Institute Scholarship	Sponsored (including Q.I.P.)	Deptl. staff	Total
Aeronautical Engg.	85	19	3	107
Chemical Engg.	317	3	1	321
Civil Engg.	426	45	3	474
Computer Sci. & Engg.	200	47	1	248
Electrical Engg.	509	46	4	559
Mechanical Engg.	472	51	8	531
Metallurgical Engg.	240	4	0	244
	2249	215	20	2484
I.E. & O.R.	63	1	0	64
Industrial Management	41	5	0	46
Materials Science	65	4	0	69
Environmental Sc.&Engg.	63	2	1	66
Systems & Control Engg.	44	6	0	50
Energy Systems Engg.	26	1	0	27
Corrosion Sci.& Engg.	23	1	0	24
Reliability Engg.	10	2	0	12
	335	22	1	358
Total	2584	237	21	2842

Table 1.4 Yearwise Classification of M.Tech. Alumni of IIT Bombay

Year	Full-time students with Institute scholarship	Sponsored (including Q.I.P.)	Deptl. staff	Total
1973	127	11	7	145
1974	149	11	1	161
1975	85	11	1	97
1976	123	9	1	133
1977	99	9	2	110
	583	51	12	646
1978	183	8	2	193
1979	147	15	1	163
1980	194	22	4	220
1981	183	14	0	197
1982	185	6	1	192
	892	65	8	965
1983	232	17	0	249
1984	237	12	0	249
1985	186	35	1	222
1986	195	26	0	221
1987	259	31	0	290
	1109	121	1	1231
	2584	237	21	2842

Table 1.5 Departmentwise Classification of Ph.D. Alumni of IIT Bombay (1973-1987)

Department/Inter-disciplinary programme	Full-time research scholars and project staff	Sponsored (including QIP/FIP external, foreign)	Deptl. staff	Total
Aeronautical Engg.	14	6	5	25
Chemical Engg.	53	12	8	73
Civil Engg.	40	55	11	106
Computer Sci. & Engg.	2	1	1	4
Electrical Engg.	38	31	16	85
Mechanical Engg.	19	38	17	74
Metallurgical Engg.	22	14	10	46
	188	157	68	413
Physics	48	5	10	63
Chemistry	155	9	11	175
Mathematics	97	9	5	111
Earth Science	28	2	0	30
	328	25	26	379
Humanities & Soc.Sci.	30	2	1	33
	30	2	1	33
Interdisciplinary	3	2	2	7
	3	2	2	7
Total	549	186	97	832

Table 1.6 Yearwise Classification of Ph.D. Alumni of IIT Bombay

Year	Full-time research scholars and project staff	Sponsored (including QIP/FIP, external, foreign)	Deptl. staff	Total
1973	18	0	11	29
1974	25	6	6	37
1975	29	5	4	38
1976	38	11	9	58
1977	39	14	12	65
	149	36	42	227
1978	41	8	7	56
1979	27	9	9	45
1980	35	8	7	50
1981	47	14	12	73
1982	46	18	5	69
	196	57	40	293
1983	47	23	6	76
1984	42	17	3	62
1985	38	15	3	56
1986	41	14	1	56
1987	36	24	2	62
	204	93	15	312
	549	186	97	832

of a number of interdisciplinary programmes.

Table 1.5 gives the classification of Ph.D. alumni by their department/interdisciplinary programme. Here the alumni are again classified in three groups: (i) Full-time research scholars receiving an Institute scholarship and project staff, (ii) Sponsored students including those under Q.I.P./F.I.P., external registrations and foreign students, and (iii) Departmental staff. It will be seen that of the total number of 832, the largest number, viz. 549, belong to the first group. However, the number of students under the other two groups is not small as is the case in Table 1.3. This statement is particularly true for the engineering departments. The study has been restricted to the first group of Ph.D. alumni mainly because the career profiles of those in the other two groups are well known. It should also be noted in the population under study, 328 (59.7 percent) are from the science departments, and 188 (34.2 percent) are from the engineering departments. A very small number of 33 (6.0 percent) are from the Humanities and Social Sciences and the interdisciplinary programmes.

The yearwise break-up of Ph.D. alumni given in Table 1.6 shows that if one excludes the first three years (1973-1975), the average Ph.D. output has been around 60. Of this, about 40 belong to the first group which is being studied.

Chapter 2

METHODOLOGY

2.1 Phases of Work

The present study has been broadly conducted in four phases:

In the first phase, a fairly systematic effort was made to locate the current addresses of as many alumni as possible who were part of the population under consideration. At the time of leaving the Institute, most students leave behind an address for correspondence. Individual letters were sent to each alumnus at this address requesting him (or a relative who might open the letter) to give the current address. In addition, the alumnus was also requested to give the current addresses of other alumni which might be available with him. A reply paid post card was enclosed for the purpose. Further a systematic effort was made to obtain addresses from faculty members of our Institute. Through all these efforts which lasted nearly six months, 1477 addresses out of the population of 2584 were obtained for the M.Tech. alumni, while 470 addresses out of the population of 549 were obtained for the Ph.D. alumni[+]. These constitute 57.2 and 85.6 percent respectively of the populations under consideration. Both these percentages can be considered to be very satisfactory in relation to the population sizes involved.

In the second phase, a draft questionnaire was prepared keeping all the objectives of the study in mind. The draft questionnaire was shown to a few faculty members and alumni for their comments and suggestions. Based on these inputs, the questionnaire was refined and finalized. The questionnaire (alongwith the covering letter) is given in Appendix I.

+ Some of these addresses were also obtained in the third phase when the 'filled-up' questionnaires were received.

The questionnaire was posted over a period of about two months to the addresses obtained under the first phase. This constituted the third phase of the study. Return stamped envelopes were sent for the convenience of all respondents located in India. After about one month, a reminder was sent to all those who had not responded to the questionnaire. Personal letters were also sent to a few alumni to seek their help in obtaining replies. Replies were received over a six month period till the end of 1989. Replies received until December 31, 1989 were considered in the analysis.

In the fourth and final phase, the information received in the replies was first stored in the form of data base files using dBASE III-PLUS on an IBM - compatible PC. The information was organized in suitable files each having a number of fields. Responses given to some of the questions in the form of comments were stored as memos. The stored information was then analyzed and compiled in the form of suitable tables for incorporation in this report.

2.2 The Questionnaire

The questionnaire (Appendix I) was designed keeping the broad objectives of the study in mind. The questions were structured in the following order:

Personal information (Questions 1-7)
Academic career and training (Questions 8,9)
Job profile (Question 10)
Current work (Questions 11-16)
Feedback on IIT/B programme (Question 17)
Background information (Question 18)
General (Questions 19-21)

Most of the questions were objective in nature excepting for a few (Questions 13; 17a,c,d,e; 21) which required a comment.

It was estimated that the questionnaire would take about 20 minutes to answer. Alumni were assured that their replies would be kept confidential and used only for the purpose of the study. They were also assured that complete anonymity of individual respondents as well as that of their organizations would be maintained.

2.3 Replies Received

The total number of replies received to the questionnaire was 974 for M.Tech. and 295 for Ph.D. 23 alumni obtained both their M.Tech. and Ph.D. from the Institute during the period 1973-87. Their responses have been analyzed under both the degree programmes.

The distribution of the yearwise and departmentwise replies received from M.Tech. alumni is given in Tables 2.1 and 2.2. The corresponding data for Ph.D. alumni is given in Tables 2.3 and 2.4. Tables 2.1 and 2.3 show that the percentage response over 3 spans of five years (1973-77, 1978-82 and 1983-87) is very close to the overall response both for M.Tech. and Ph.D. alumni. Similarly Tables 2.2 and 2.4 show that the departmentwise response generally varies between 30 and 45 percent+ for M.Tech. alumni and between 45 and 60 percent for Ph.D. alumni. The above comments indicate that alumni of all years and all departments are reasonably well represented in the responses received.

The overall response rate of 37.7 percent for M.Tech. alumni and 53.7 percent for Ph.D. alumni is also very good considering the size of the population involved in each case. In each case the number of responses is clearly large enough to draw reasonable inferences regarding the population as a whole.

+ The high percentage from Mechanical Engineering alumni can be attributed to the fact that many of them are personally known to the author of this report.

Table 2.1 Distribution of Replies Received from M.Tech. Alumni - Yearwise

Year of obtaining degree	Replies received	Number obtaining degree	% response
1973-77	226	583	38.8
1978-82	323	892	36.2
1983-87	425	1109	38.3
Total	974	2584	37.7

Table 2.2 Distribution of Replies Received from M.Tech. Alumni - Departmentwise

Department/Inter-disciplinary Programme	Replies received	Number obtaining degree	% response
Aeronautical Engg.	35	85	41.2
Chemical Engg.	109	317	34.4
Civil Engg.	168	426	39.4
Computer Science & Engg.	51	200	25.5
Electrical Engg.	157	509	30.8
Mechanical Engg.	262	472	55.5
Metallurgical Engg.	74	240	30.8
Interdisciplinary	118	335	35.2
Total	974	2584	37.7

Table 2.3 Distribution of Replies Received from Ph.D. Alumni - Yearwise

Year of obtaining degree	Replies received	Number obtaining degree	% response
1973-77	84	149	56.4
1978-82	101	196	51.5
1983-87	110	204	53.9
Total	295	549	53.7

Table 2.4 Distribution of Replies Received from Ph.D. Alumni - Departmentwise

Department/Inter-disciplinary Programme	Replies received	Number obtaining degree	% response
Aeronautical Engg.	5	14	35.7
Chemical Engg.	34	53	64.2
Civil Engg.	17	40	42.5
Computer Science & Engg.	1	2	50.0
Electrical Engg.	23	38	60.5
Mechanical Engg.	13	19	68.4
Metallurgical Engg.	13	22	59.1
Physics	25	48	52.1
Chemistry	76	155	49.0
Mathematics	49	97	50.5
Earth Science	21	28	75.0
Humanities & Social Sci.	16	30	53.3
Interdisciplinary	2	3	66.7
Total	295	549	53.7

Chapter 3

CAREER PROFILE OF THE IIT BOMBAY POSTGRADUATE

3.1 Categorization of Alumni

In a manner similar to that adopted for the earlier study of B.Tech. alumni, all respondents in the present study have been classified in three broad categories.

Category X : Alumni who have been essentially working in India since they obtained their M.Tech./Ph.D. degree from IIT Bombay. (This includes those who have been abroad for short-term training, those who have been sent abroad by their organization for training/ assignment and those who have been abroad just for visits.)

Category Y : Alumni who are currently living abroad more or less on a permanent basis.

Category Z : Alumni who have been abroad for more than one year and who have returned to settle and work in India.

The categorywise break-up of the 974 replies received from M.Tech. alumni is given in Table 3.1, while the corresponding break-up of the 295 replies received from Ph.D. alumni is given in Table 3.2. In the sub-sections which follow, these replies will be analyzed in terms of (i) the personal and background information of the alumni, (ii) their present location, (iii) their academic career and professional training, and (iv) the nature of the work which they are doing. The order followed will be to consider the data for M.Tech. alumni and the data for Ph.D. alumni, and then to make comparisons between the results for the two sets of alumni and the results obtained in the earlier study on B.Tech. alumni.

Table 3.1 Categorywise Break-up of Replies Received from M.Tech. Alumni

Category	Year of obtaining degree			Total
	1973-77	1978-82	1983-87	
X	186	256	364	806
Y	26	47	54	127
Z	14	20	7	41
	226	323	425	974

Table 3.2 Categorywise Break-up of Replies Received from Ph.D. Alumni

Category	Year of obtaining degree			Total
	1973-77	1978-82	1983-87	
X	75	75	83	233
Y	5	14	15	34
Z	4	12	12	28
	84	101	110	295

3.2 Personal and Background Information

3.2.1 M.Tech. Alumni

Of the 974 respondents, 963 (98.9 percent) are male and 11 (1.1 percent) are female. Thus the present study is concerned with a predominantly male population.

The age distribution of the respondents is shown in Table 3.3. It is seen that almost all the alumni who passed from 1973 to 1977 are in the age group of 35 to 45, those who passed from 1978 to 1982 are in the age group of 30 to 40, while those who passed recently from 1983 to 1987 are predominantly in the age group of 25 to 35. From the reply to Question 7, it is seen that 97.3 percent of the 1973-77 batch, 91.6 percent of the 1978-82 batch and 55.3 percent of the 1983-87 batch are married.

As part of the background information, respondents were requested to indicate the location where they did their schooling, the level of education of their parents and the occupation of their parents (Question 18). The responses are given in Tables 3.4 to 3.7.

Table 3.4 shows the location where respondents underwent most of their schooling. They were asked to select one amongst four options - village, town, city and metropolitan city. It is seen that in an overall sense 56.27 percent went to school in a city or metropolitan city, while a smaller but significant percentage of 38.51 had their schooling in a village or mofussil town. The categorywise break-up indicates the interesting fact that the corresponding figures for categories Y and Z were 70.08 and 68.30 percent respectively for the 'city/metropolitan city' location and 23.62 and 19.51 percent respectively for the 'village/town' location.

Table 3.5 indicates the level of education of the parents of M.Tech. alumni. It is seen that 60.37 percent of the fathers

Table 3.3 Age Distribution of M.Tech. Alumni as on 31.12.1989 (Question 3)

Age	Year of obtaining degree		
	1973-77	1978-82	1983-87
20-25	0	0	5
25-30	0	1	297
30-35	0	192	119
35-40	144	123	3
40-45	78	4	0
> 45	3	1	0
Not answered	1	2	1
	226	323	425

Table 3.4 Location of Schooling - M.Tech. Alumni (Question 18a)

Category		Location of schooling					Total
		Village	Town	City	Metropolitan city	Not clear/ Not answered	
X		110	227	275	156	38	806
	%	13.65	28.16	34.12	19.35	4.71	100.00
Y		11	19	47	42	8	127
	%	8.66	14.96	37.01	33.07	6.30	100.00
Z		1	7	14	14	5	41
	%	2.44	17.07	34.15	34.15	12.20	100.00
Total		122	253	336	212	51	974
	%	12.53	25.98	34.50	21.77	5.24	100.00

Table 3.5 Education of Parents of M.Tech. Alumni (Question 18b)

Category	Father					Mother					Total
	Post-graduate	Graduate	High school	Lower	N.A.	Post-graduate	Graduate	High school	Lower	N.A.	
X	152	318	212	109	15	40	132	324	283	27	806
%	18.89	39.45	26.30	13.52	1.86	4.96	16.38	40.20	35.11	3.35	100.00
Y	33	56	30	7	1	10	27	52	36	2	127
%	25.98	44.09	23.62	5.51	0.79	7.87	21.26	40.94	28.35	1.57	100.00
Z	15	14	5	7	0	2	9	19	9	2	41
%	36.59	34.15	12.20	17.07	0	4.88	21.95	46.34	21.95	4.88	100.00
Total	200	388	247	123	16	52	168	395	328	31	974
%	20.53	39.84	25.36	12.63	1.64	5.34	17.25	40.55	33.68	3.18	100.00

Table 3.6 Occupation of Father - M.Tech. Alumni (Question 18c)

Category	Occupation									Total
	a	b	c	d	e	f	g	h	j	
X	73	96	20	64	23	246	77	102	105	806
%	9.06	11.91	2.48	7.94	2.85	30.52	9.55	12.66	13.03	100.00
Y	6	15	3	22	3	39	8	20	11	127
%	4.72	11.81	2.36	17.32	2.36	30.71	6.30	15.75	8.66	100.00
Z	3	4	0	3	4	13	5	4	5	41
%	7.32	9.76	0	7.32	9.76	31.71	12.20	9.76	12.20	100.00
Total	82	115	23	89	30	298	90	126	121	974
%	8.42	11.81	2.36	9.14	3.08	30.60	9.24	12.94	12.42	100.00

Code: a) Agriculture
b) Business
c) Medical
d) Engineering
e) Law practice
f) Public/Govt. service
g) Private service
h) Teaching/Research
j) Other

Table 3.7 Occupation of Mother - M.Tech. Alumni (Question 18c)

Category		Occupation										Total
		a	b	c	d	e	f	g	h	i	j	
X		19	5	3	0	0	20	3	49	617	90	806
	%	2.36	0.62	0.37	0	0	2.48	0.37	6.08	76.55	11.17	100.00
Y		0	0	1	1	0	6	0	8	100	11	127
	%	0	0	0.79	0.79	0	4.72	0	6.30	78.74	8.66	100.00
Z		0	0	0	0	0	1	0	3	32	5	41
	%	0	0	0	0	0	2.44	0	7.32	78.05	12.20	100.00
Total		9	5	4	1	0	27	3	60	749	106	974
	%	1.95	0.51	0.41	0.10	0	2.77	0.31	6.16	76.90	10.88	100.00

Code: a) Agriculture
b) Business
c) Medical
d) Engineering
e) Law practice
f) Public/Govt. service
g) Private service
h) Teaching/Research
i) Housewife
j) Other

are graduates or postgraduates, while 37.99 percent have a high school or lower education level. In contrast, only 22.59 percent of the mothers are graduates or postgraduates, while 74.23 percent have a high school or lower education level. The categorywise break-up indicates that parents of alumni in categories Y and Z have a better level of education. In the case of fathers, about 70 percent are graduates or postgraduates, while in the case of mothers about 27 percent are graduates or postgraduates.

Thus the figures seem to bear out the fact that the tendency to go abroad is enhanced if one's schooling is done in an urban atmosphere and if one's parents are graduates or postgraduates.

The occupation of fathers is given in Table 3.6. It is seen that the largest number (30.60 percent) are in public or government service. An approximately equal number (around 12 percent) are in teaching/research and in business, while a slightly smaller number (around 9 percent) are in private service, in engineering and in agriculture. A very small number are in the medical profession and in the legal profession. As far as the occupation of mothers is concerned, Table 3.7 shows that the overwhelming number (76.90 percent) are housewives. The next highest number (which is only 6.16 percent) are in teaching/research. There are a negligible number in all the other professions. In both Tables 3.6 and 3.7, the categorywise break-ups do not reveal any significant differences from the overall values.

3.2.2 Ph.D. Alumni

Out of the 295 replies received, 272 (92.2 percent) are males and 23 (7.8 percent) are females. Thus like the M.Tech. alumni, the study of Ph.D. alumni is concerned with an essentially male population.

The age distribution of the respondents is given in Table 3.8. It is seen that alumni who passed from 1973 to 1977 are essentially in the age group of 40 to 45, those who passed from 1978 to 1982 are in the age group of 35 to 40, while those who passed from 1983 to 1987 are primarily in the age group of 30 to 35. From the reply to Question 7, it is seen that 98.8 percent of the 1973-77 batch, 96.0 percent of the 1978-82 batch and 82.7 percent of the 1983-87 batch are married.

The responses of Ph.D. alumni to Question 18 are given in Tables 3.9 to 3.12.

Table 3.9 which gives the location of schooling shows that in an overall sense 44.75 percent went to school in a city/metropolitan city, while a larger number, viz. 49.16 percent had their schooling in a village/town.

Table 3.10 gives information on the level of education of the parent. It is seen that 41.35 percent of the fathers are either graduates or postgraduates, while 54.92 percent have a higher school or lower education. In the case of mothers, only 11.53 percent are graduates or postgraduates, while 81.69 percent have a high school or lower level of education.

The occupation of fathers of Ph.D. alumni is given in Table 3.11. It is seen that the largest number of 28.47 percent are in public/government service. Surprisingly, the next highest number (16.27 percent) are in agriculture, while an approximately equal number (around 10 percent) are in teaching/research, in business and in private service. As far as the occupation of mothers is concerned, Table 3.12 shows that the largest number (78.98 percent) are housewives. There are a negligible number in all the other professions.

In Tables 3.9 to 3.12, percentages have also been presented on a categorywise basis. However, the numbers involved in categories Y and Z are small and it does not seem

Table 3.8 Age Distribution of Ph.D. Alumni as on 31.12.1989 (Question 3)

Age	Year of obtaining degree		
	1973-77	1978-82	1983-87
25-30	0	0	4
30-35	0	5	67
35-40	9	65	37
40-45	54	28	2
45-50	19	3	0
>50	2	0	0
	84	101	110

Table 3.9 Location of Schooling - Ph.D. Alumni (Question 18a)

Category	Location of schooling					Total
	Village	Town	City	Metropolitan city	Not clear/ Not answered	
X	41	75	70	35	12	233
%	17.60	32.19	30.04	15.02	5.15	100.00
Y	7	9	10	3	5	34
%	20.59	26.47	29.41	8.82	14.71	100.00
Z	5	8	11	3	1	28
%	17.86	28.57	39.29	10.71	3.57	100.00
Total	53	92	91	41	18	295
%	17.97	31.19	30.85	13.90	6.10	100.00

Table 3.10 Education of Parents of Ph.D. Alumni (Question 18b)

Category	Father					Mother					Total
	Post-graduate	Graduate	High school	Lower	N.A.	Post-graduate	Graduate	High school	Lower	N.A.	
X	37	57	77	55	7	10	15	69	125	14	233
%	15.88	24.46	33.05	23.61	3.00	4.29	6.44	29.61	53.65	6.01	100.00
Y	7	9	10	5	3	3	3	13	11	4	34
%	20.59	26.47	29.41	14.71	8.82	8.82	8.82	38.24	32.35	11.76	100.00
Z	4	8	13	2	1	0	3	6	17	2	28
%	14.29	28.57	46.43	7.14	3.57	-	10.71	21.43	60.71	7.14	100.00
Total	48	74	100	62	11	13	21	88	153	20	295
%	16.27	25.08	33.90	21.02	3.73	4.41	7.12	29.83	51.86	6.78	100.00

Table 3.11 Occupation of Father - Ph.D. Alumni (Question 18c)

Category	Occupation									Total
	a	b	c	d	e	f	g	h	j	
X	39	27	6	10	2	61	24	28	36	233
%	16.74	11.59	2.58	4.29	0.86	26.18	10.30	12.02	15.45	100.00
Y	5	3	2	0	0	14	1	4	5	34
%	14.71	8.82	5.88	-	-	41.18	2.94	11.76	14.71	100.00
Z	4	2	0	0	0	9	1	3	9	28
%	14.29	7.14	-	-	-	32.14	3.57	10.71	32.14	100.00
Total	48	32	8	10	2	84	26	35	50	295
%	16.27	10.85	2.71	3.39	0.68	28.47	8.81	11.86	16.95	100.00

Code: a) Agriculture
b) Business
c) Medical
d) Engineering
e) Law practice
f) Public/Govt. service
g) Private service
h) Teaching/Research
j) Other

Table 3.12 Occupation of Mother - Ph.D. Alumni (Question 18c)

Category		Occupation										Total
		a	b	c	d	e	f	g	h	i	j	
X		10	0	0	0	0	2	1	7	184	29	233
	%	4.29	-	-	-	-	0.86	0.43	3.00	78.97	12.45	100.00
Y		0	0	2	0	0	0	0	2	23	7	34
	%	-	-	5.88	-	-	-	-	5.88	67.65	20.59	100.00
Z		0	0	0	0	0	0	0	0	26	2	28
	%	-	-	-	-	-	-	-	-	92.85	7.15	100.00
Total		0	0	2	0	0	2	1	9	233	38	295
	%	3.39	-	0.68	-	-	0.68	0.34	3.05	78.98	12.88	100.00

Code: a) Agriculture
b) Business
c) Medical
d) Engineering
e) Law practice
f) Public/Govt. service
g) Private service
h) Teaching/Research
i) Housewife
j) Other

reasonable to compare the percentages for these categories with those obtained on an overall basis.

3.2.3 Comparisons

It is of interest to make some comparisons between the personal and background data of M.Tech. and Ph.D. alumni and comparable data available for undergraduate students of the B.Tech. programme [+], most of whom enter through the Joint Entrance Examination (JEE).

Table 3.13 is a comparison of the location of schooling. (The specific question asked to B.Tech. students is 'normal place of residence' which may be considered to be equivalent to 'location of schooling'.)

Table 3.14 is a presentation of data on the father's occupation. (The specific question asked to B.Tech. students is 'father's/guardian's occupation' which may be considered in most cases to mean 'father's occupation'.)

Table 3.15 is a comparison of the educational background of the parents. They are divided into three groups - neither parent being a graduate, one parent being a graduate and both parents being graduates.

An inspection of the three tables shows that there are some striking differences and some similarities between the data for B.Tech., M.Tech. and Ph.D. alumni. In the case of B.Tech.

+ The data has been taken from 'Factual Data and Statistical Analysis, Joint Entrance Examination 1987', Indian Institute of Technology, Bombay and represents candidates from the region coming under the jurisdiction of IIT Bombay who have qualified for admission to the B.Tech. programme. Since a majority of these candidates join IIT Bombay and eventually complete their B.Tech. requirements, it would be quite appropriate to treat this data as representative of B.Tech. alumni of IIT Bombay.

Table 3.13 Comparison of Location of Schooling of Undergraduate and Postgraduate Alumni

	Location of schooling (%)			
	Village	Town	City/ Metropolitan city	Not clear/ Not answered
B.Tech.	2.83	11.55	85.62	0.00
M.Tech.	12.53	25.98	56.27	5.24
Ph.D.	17.97	31.19	44.75	6.10

Table 3.14 Comparison of Father's Occupation for Undergraduate and Postgraduate Alumni

	Occupation								
	a	b	c	d	e	f	g	h	j
B.Tech.	1.09	9.15	2.83	12.20	0.44	35.95	17.21	12.20	8.93
M.Tech.	8.42	11.81	2.36	9.14	3.08	30.60	9.24	12.94	12.42
Ph.D.	16.27	10.85	2.71	3.39	0.68	28.47	8.81	11.86	16.95

Code: a) Agriculture
b) Business
c) Medical
d) Engineering
e) Law practice
f) Public/Govt. service
g) Private service
h) Teaching/Research
j) Other

Table 3.15 Comparison of Parents' Educational Background for Undergraduate and Postgraduate Alumni

	Neither parent graduate %	One parent graduate %	Both parents graduates %	No data %
B.Tech.	15.69	31.81	52.51	0.00
M.Tech.	35.83	39.22	21.87	3.08
Ph.D.	52.88	30.51	11.19	5.42

alumni, 85.62 percent have a schooling background from a city/ metropolitan city and 52.51 percent have both parents as graduates. The corresponding percentages for M.Tech. alumni are 56.27 and 21.87, and for Ph.D. alumni only 44.75 and 11.19. The reasons for these differences are not far to seek. They are : (i) Admission to the B.Tech. programme is through a highly competitive entrance examination. Coaching facilities for this examination are available more readily in the cities. The coaching also requires a fair investment of money. (ii) Although education at an IIT is highly subsidized, tuition fees and hostel rent being negligible, the cost of living in a hostel is significant. This deters many parents from sending their children for the B.Tech. programme. However in the postgraduate programme, every student gets a scholarship towards his living expenses and his education is thus fully subsidized.

In all groups of alumni, the highest percentage (ranging from 28.47 to 35.95) list their father's occupation as government/public service. A significant number are also in teaching/research. This is a reflection of the importance which the salaried middle class attaches to an education. In all groups, there are a negligible number of alumni whose fathers have a background in medicine or law. On the other hand, a significant number of fathers have a background in engineering. The importance of a role model' is thus seen to some extent.

3.3 Location of Alumni

3.3.1 M.Tech. Alumni

As stated in Section 2.1, a total of 1477 current addresses were obtained. The data was analyzed in terms of alumni staying in India and alumni staying abroad. The results are presented in Tables 3.16 and 3.17.

Table 3.16 is a 'disciplinewise' break-up, while Table 3.17 is an 'yearwise' break-up of alumni with respect to their present location. The important result emerging from the two tables is that 85.3 percent of the M.Tech. alumni who passed from 1973 to 1987 are in India, while 14.7 percent are abroad. These percentages are based on the population under study, viz. 2584. In order to obtain percentage estimates of alumni in India and abroad based on the total M.Tech. output of 2842 (refer Table 1.3), we will assume that the alumni not included in the study are all in India. This is a very good assumption, since these alumni were mostly teachers from engineering colleges sponsored under the Quality Improvement Programme of the Government of India. Thus the percentage of M.Tech. alumni abroad (category Y) is (2584/2842) x 14.7 = 13.4 percent. This is the overall magnitude of the brain drain. The remaining alumni, viz. 86.6 percent are in India (categories X and Z).

Using the data on the replies received (Table 3.1), it is possible to estimate that the percentage who went abroad but returned, i.e. category Z = (41/127) x 13.4 = 4.3 percent. Thus the break-up of M.Tech. alumni based on the total output is as follows:

Category X : 82.3%
Category Y : 13.4%
Category Z : 4.3%

Table 3.16 Disciplinewise Location of Postgraduates (M.Tech.) of IIT Bombay (1973-1987)

Department/Inter-disciplinary programme	Number of alumni	Addresses known		Percentage of alumni		Percentage of addresses known
		In India	Abroad	In India	Abroad	
Aeronautical Engineering	85	55	14	79.7	20.3	81.2
Chemical Engineering	317	136	24	85.0	15.0	50.5
Civil Engineering	426	217	23	90.4	9.6	56.3
Computer Science & Engg.	200	61	24	71.8	28.2	42.5
Electrical Engineering	509	205	64	76.2	23.8	52.8
Mechanical Engineering	472	319	32	90.9	9.1	74.4
Metallurgical Engineering	240	108	11	90.8	9.2	49.6
	2249	1101	192	85.2	14.8	57.5
I.E. & O.R.	63	29	5	85.3	14.7	54.0
Ind. Management	41	19	1	95.0	5.0	48.8
Materials Science	65	24	5	82.8	17.2	44.6
Env. Sci. & Engg.	63	35	4	89.7	10.3	61.9
Systems & Control Engg.	44	19	3	86.4	13.6	50.0
Energy Systems Engg.	26	16	5	76.2	23.8	80.8
Corrosion Sci. & Engg.	23	11	2	84.6	15.4	56.5
Reliability Engineering	10	6	0	100.0	0.0	60.0
	335	159	25	86.4	13.6	54.9
Total	2584	1260	217	85.3	14.7	57.2

Table 3.17 Yearwise Location of Postgraduates (M.Tech.) of IIT BombaY(1973-1987)

Year	Number of alumni	Addresses known		Percentage of alumni		Percentage of addresses known
		In India	Abroad	In India	Abroad	
1973	127	51	6	89.5	10.5	44.9
1974	149	64	8	88.9	11.1	48.3
1975	85	50	9	84.7	15.3	69.4
1976	123	60	11	84.5	15.5	57.7
1977	99	46	8	85.2	14.8	54.5
	583	271	42	86.6	13.4	53.7
1978	183	82	20	80.4	19.6	55.7
1979	147	77	22	77.8	22.2	67.3
1980	194	93	12	88.6	11.4	54.1
1981	183	75	13	85.2	14.8	48.1
1982	185	81	18	81.8	18.2	53.5
	892	408	85	82.8	17.2	55.3
1983	232	125	14	89.9	10.1	59.9
1984	237	119	26	82.1	17.9	61.2
1985	186	100	17	85.5	14.5	62.9
1986	195	107	13	89.2	10.8	61.5
1987	259	130	20	86.7	13.3	57.9
	1109	581	90	86.6	13.4	60.5
Total	2584	1260	217	85.3	14.7	57.2

In other words, 86.6 percent have settled down in India and only 13.4 percent (constituting the brain drain) have settled abroad.

It may perhaps be argued that the above estimate of the brain drain is a little on the high side because it includes alumni who have passed as recently as 1987 and are studying abroad. Some of these alumni will eventually return. While this is true, it is also true that some more alumni will go abroad either for studying or for taking up a job after working for a few years in India. The two flows may in fact balance out so that the percentage in category Y will remain essentially unchanged.

The disciplinewise break-up in Table 3.16 indicates some significant trends in the brain drain. The highest brain drain is in Computer Science and Engineering (28.2 percent) followed by Electrical Engineering (23.8 percent), Aeronautical Engineering (20.3 percent) and Chemical Engineering (15.0 percent). The lowest percentages (around 9 percent) are in Mechanical Engineering, Civil Engineering and Metallurgical Engineering. In the case of the interdisciplinary programmes, too much significance cannot be attached to the magnitude of the brain drain in each programme because of the smaller numbers involved and the consequent possibility of larger errors. It is worthwhile only to examine the magnitude of the brain drain for all the interdisciplinary programmes considered together. This percentage (13.6 percent) is almost the same as the figure of 14.7 percent for the population under study.

The yearwise break-up shown in Table 3.17 is best examined on a five yearly basis in three groups. The figures indicate that the magnitude of the brain drain of M.Tech. alumni increased slightly from 13.4 percent+ in the time span

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+ The percentages based on total M.Tech. output are 12.1, 15.9 and 12.1 respectively.

1973 to 1977 to 17.2 percent in the time span 1978 to 1982. It came down again to 13.4 percent in the next time span of 1983 to 1987. The variation is small and it seems that the magnitude of the brain drain of M.Tech. alumni has not changed much over the years.

Since the addresses of all alumni in the population under study could not be obtained, it is necessary to show that the addresses available represent a reasonable large random sub-set from which results valid for the population under study can be inferred. This has been done as follows:

A random sample of 100 alumni was generated from the population under study using RNSRI, an IMSL subroutine. The number of addresses known in this sample was noted. This procedure was repeated 100 times. The average number of addresses in these 100 random samples was found to be 56.7 with a standard deviation of only 4.0. The mean value of 56.7 is in close agreement with value of 57.2 percent obtained from all the known addresses. This good agreement coupled with the relatively low value of the standard deviation indicates that an adequate number of addresses has been obtained.

3.3.2 Ph.D. Alumni

The total number of current addresses obtained were 470. These addresses were analyzed on the basis of alumni staying in India and alumni staying abroad. The analysis is presented on a disciplinewise basis in Table 3.18 and an yearwise basis in Table 3.19.

The important result emerging from both Table 3.18 and 3.19 is that 85.3 percent of the Ph.D. alumni who passed from 1973 to 1987 are in India, while 14.7 percent are abroad. These percentages are based on the population under study, viz. 549. If one considers the total Ph.D. output of 832 (refer Table 1.4) and assumes that alumni not included in the study

Table 3.18 Disciplinewise Location of Postgraduates (Ph.D.) of IIT Bombay (1973-1987)

Department/Inter-disciplinary programme	Number of alumni	Addresses known		Percentage of alumni		Percentage of addresses known
		In India	Abroad	In India	Abroad	
Aeronautical Engineering	14	12	2	85.7	14.3	100.0
Chemical Engineering	53	45	2	95.7	4.3	88.7
Civil Engineering	40	32	3	91.4	8.6	87.5
Computer Science & Engg.	2	2	0	100.0	0.0	100.0
Electrical Engineering	38	24	8	75.0	25.0	84.2
Mechanical Engineering	19	13	4	76.5	23.5	89.5
Metallurgical Engineering	22	18	4	81.8	18.2	100.0
	188	146	23	86.4	13.6	89.9
Physics	48	35	12	74.5	25.5	97.9
Chemistry	155	98	21	82.4	17.6	76.8
Mathematics	97	68	8	89.5	10.5	78.4
Earth Science	28	26	1	96.3	3.7	96.4
	328	227	42	84.4	15.6	82.0
Humanities and Soc.Sci.	30	26	3	89.7	10.3	96.7
Interdisciplinary	3	2	1	66.7	33.3	100.0
Total	549	401	69	85.3	14.7	85.6

Table 3.19 Yearwise Location of Postgraduates (Ph.D.) of IIT Bombay (1973-1987)

Year	Number of Alumni	Addresses known		Percentage of Alumni		Percentage of addresses known
		In India	Abroad	In India	Abroad	
1973	18	13	0	100.00	0.0	72.2
1974	25	17	3	85.0	15.0	80.0
1975	29	21	5	80.0	19.2	89.7
1976	38	33	1	97.1	2.9	89.5
1977	39	31	2	93.9	6.1	84.6
	149	115	11	91.3	08.7	84.6
1978	41	27	7	79.4	20.6	82.9
1979	27	16	4	80.0	20.0	74.1
1980	35	22	6	78.6	21.4	80.0
1981	47	33	7	82.5	17.5	85.1
1982	46	32	9	78.0	22.0	89.1
	196	130	33	79.8	20.2	83.2
1983	47	33	6	84.6	15.4	83.0
1984	42	28	7	80.0	20.0	83.3
1985	38	28	6	82.4	17.6	89.5
1986	41	36	2	94.7	5.3	92.7
1987	36	31	4	88.6	11.4	97.2
	204	156	25	86.2	13.8	88.7
Total	549	401	69	85.3	14.7	85.6

are all in India[+] (excepting foreign students numbering 9), then the percentage of Ph.D. alumni settled abroad (category Y) = 14.7 x (549/823) = 9.8 percent. This is the overall magnitude of the brain drain. The remaining alumni, viz. 90.2 percent would come under categories X and Z.

Using the data on the replies received from Ph.D. alumni (Table 3.2), it is possible to estimate the percentage in category Z to be (28/34) x 9.8 = 8.1 percent.

Thus the break-up of Ph.D. alumni based on the total output is as follows:

Category X : 82.1%
Category Y : 9.8%
Category Z : 8.1%

In other words, 90.2 percent have settled down in India and only 9.8 percent (consisting the brain drain) have settled abroad.

The disciplinewise break-up in Table 3.18 indicates that the brain drain from the engineering departments is 13.6 percent, while from the science departments it is 15.6 percent. These percentages based on the population under study are not very different. However, the percentages based on the total output come out to be 6.2 and 13.5 percent respectively. The percentage of the brain drain for the engineering departments is now seen to be much less than that for the science departments.

+ Unlike M.Tech. alumni, the number of Ph.D. alumni under the 'sponsored' or 'departmental staff' grouping is large, particularly in the engineering departments. For this reason, a sample study of the present location of each Ph.D. alumnus under these two groupings was done for one department, viz. Mechanical Engineering. It was found that of the 55 (= 38 + 17) such alumni in Mechanical Engineering, after deleting 2 foreign students, only 2 persons have migrated abroad.

The yearwise break-up shown in Table 3.19 may be examined on a five yearly basis. It shows that the magnitude of the brain drain over the three time spans is 8.7, 20.2 and 13.8 percent respectively. The corresponding percentages based on the total Ph.D. output come out to be 5.7, 13.5 and 9.0 percent respectively. Thus there appears to have been an increase in the brain drain for the time period 1978-1982 and a subsequent decrease.

Once again the validity of the results has been checked following the same procedure as for the M.Tech. alumni. In this case, the average number of addresses in 100 random samples was found to be 85.2 with a standard deviation of 2.6. The mean value of 85.2 is in close agreement with the value of 85.6 obtained from all the known addresses. This good agreement coupled with the low value of the standard deviation indicates that an adequate number of addresses has been obtained.

3.3.3 Comparisons

We will conclude Section 3.2 by making comparisons on the location of postgraduate alumni and corresponding data obtained in our earlier study on B.Tech. alumni.

Table 3.20 gives a comparison of the alumni in each category on a percentage basis. It is seen that the brain drain is highest amongst B.Tech. alumni (30.8 percent), somewhat less with M.Tech. alumni (13.4 percent) and still less with Ph.D. alumni (9.8 percent). It is also seen that the ratio of those who go abroad and return to stay in India to those who go abroad is lowest amongst B.Tech. alumni (21.8 percent) and highest amongst Ph.D. alumni (45.3 percent). The value for M.Tech. alumni (24.3 percent) lies in between.

The principal reason for the fact that the highest brain drain occurs amongst B.Tech. alumni is their slightly better

academic performance and ability. The strong urban bias in which most of them have grown up also influences their decision to settle abroad. However in the case of all alumni it is to be noted that the vast majority (69.2 percent for B.Tech., 86.6 percent for M.Tech. and 90.2 percent for Ph.D.) settle down in India. This fact is often overlooked, the popular perception being that most IITians settle abroad. The above percentages are also shown in Fig.3.1.

3.3.4 Overall Brain Drain

Based on the estimates of the brain drain given in Table 3.20 for B.Tech., M.Tech. and Ph.D. alumni, it is now possible to make a good estimate of the overall brain drain from IIT Bombay occuring currently. This is done in Table 3.21 by making a reasonable assumption regarding the brain drain of M.Sc. alumni and neglecting the small output of D.I.I.T. and M.Des. alumni. We see that in a typical year, 21.4 percent of the alumni who pass out are likely to settle down abroad. This estimate is likely to hold true to a reasonable extent for all the IITs since the backgrounds and abilities of students studying at the IITs and the outputs of B.Tech., M.Tech. and Ph.D. alumni from the Institutes are very similar.

Table 3.20 Comparison of Categorywise Location of Alumni

	Category			Ratio(Z/Y+Z) (%)
	X(%)	Y(%)	Z(%)	
B.Tech.	60.6	30.8	8.6	21.8
M.Tech.	82.3	13.4	4.3	24.3
Ph.D.	82.1	9.8	8.1	45.3

Note: 1. Data for B.Tech. alumni is for 1973 to 1977.

2. Data for M.Tech. and Ph.D. alumni is for 1973 to 1987.

Table 3.21 Estimate of Current Brain Drain from IIT Bombay on an Overall Basis

Degree	Typical current output	Estimate of current brain drain (%)	Number in category Y
B.Tech.	250	30.8	77
M.Sc.	80	25.0	20
M.Tech	250	13.4	34
Ph.D.	60	9.8	6

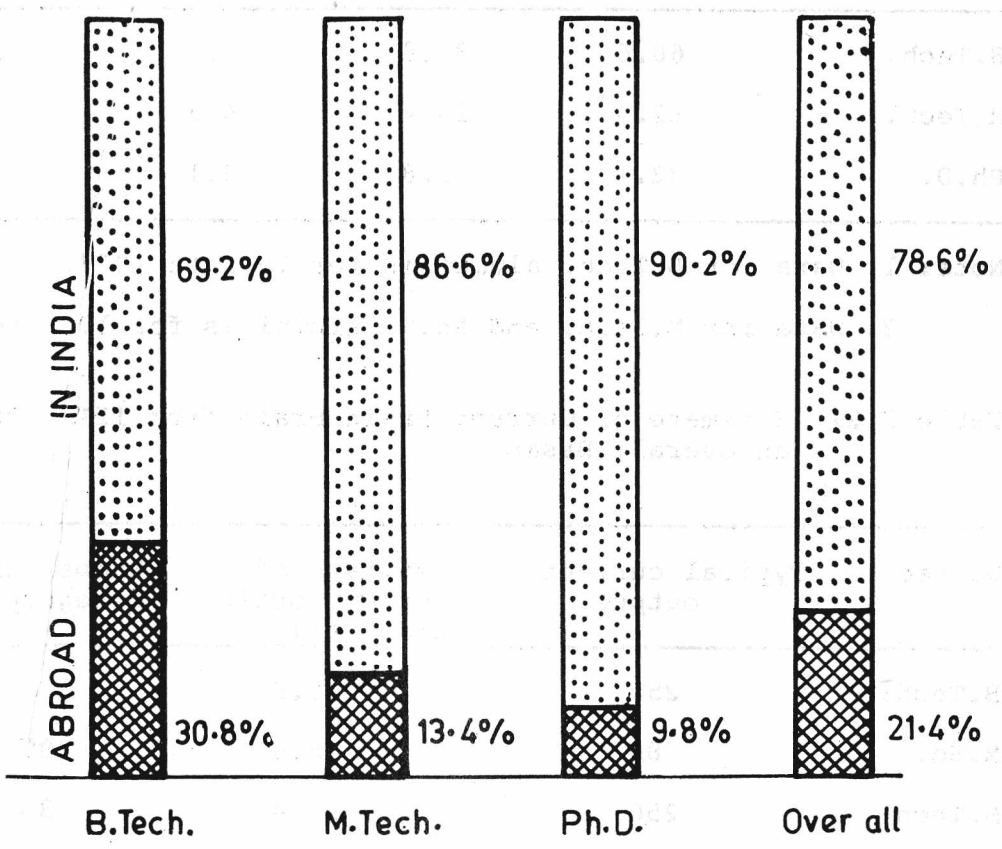
Brain drain on an overall basis for all alumni

= (137/640) x 100 = 21.4%

Note: 1. D.I.I.T. and M.Des. output is excluded because it is small.

2. It is assumed that the percentage of 30.8 obtained for B.Tech. alumni who passed from 1973 to 1977 is valid for making a current estimate. Sample surveys conducted on recent batches indicate that there are significant fluctuations from one year to the next, but that the average value is still between 30 and 35 percent.

3. Brain drain for M.Sc. alumni is assumed to be 25 percent



FIG·3·1 LOCATION OF ALUMNI OF I.I.T. BOMBAY

3.4 Academic Career and Professional Training

3.4.1 M.Tech. Alumni

Tables 3.22 to 3.25 present results regarding the academic career and professional training of M.Tech. alumni. These are based on the answers given to Questions 8 and 9. Table 3.22 indicates whether the alumni obtained their Bachelor's degree (B.Tech. or equivalent) from an IIT or from some other University. Table 3.23 gives data regarding the further studies undertaken after the M.Tech. degree, while Table 3.24 indicates whether there was any gap between obtaining the Bachelor's degree and starting studies for the M.Tech. programme at IIT Bombay. Finally Table 3.25 indicates the nature of professional training (if any) undergone by alumni after leaving the Institute.

The data in Table 3.22 show that a reasonable number of the M.Tech. alumni (18.28 percent) have obtained their B.Tech. degree from an IIT. The categorywise breakup shows that the percentage is a little higher for categories Y and Z. The above percentages disprove the statement often heard that very few B.Tech. graduates of an IIT continue on for an M.Tech. at an IIT.

Table 3.23 shows that an overwhelming majority of the alumni, viz. 81.31 percent (about 4 out of 5) do not undergo any further studies after obtaining their M.Tech. degree. Of the 18.69 percent who do undergo some studies, 5.13 percent do a Ph.D. in India and 3.70 percent do a Ph.D. abroad. Only 4.93 percent go in for a postgraduate degree or diploma in management. Categorywise, of those who have settled abroad or been abroad, a relatively high percentage (about 21 percent) do their Ph.Ds. Consequently the percentage of those who do not undergo any further studies in these categories declines to about 60 percent. It should be noted that 37 alumni out of 792 who have been included under 'No

Table 3.22 University/Institute at which M.Tech. Alumni Obtained their B.Tech./B.E. Degree (Question 8)

Category	At an IIT	At some other University	Not clear/ Not answered	Total
X	135	666	5	806
%	16.75	82.63	0.62	100.00
Y	30	90	7	127
%	23.62	70.87	5.51	100.00
Z	13	27	1	41
%	31.71	65.85	2.44	100.00
Total	178	783	13	974
%	18.28	80.30	1.33	100.00

Table 3.23 Studies after M.Tech. (Question 8)

Category	Ph.D. in India	Ph.D. Abroad	P.G. Degree/ Diploma in Management	P.G. Degree/ Diploma in Engineering	No Further Studies	Others	Total
X	46	0	40	10	695	15	806
%	5.71	0.00	4.96	1.24	86.23	1.86	100.00
Y	4	27	6	17	72	1	127
%	3.15	21.26	4.72	13.39	56.69	0.79	100.00
Z	0	9	2	5	25	0	41
%	0.00	21.95	4.88	12.20	60.98	0.00	100.00
Total	50	36	48	32	792	16	974
%	5.13	3.70	4.93	3.29	81.31	1.64	100.00

Table 3.24 Gap Between B.Tech./B.E. and M.Tech. Degree (Question 8)

Category	Gap		Total
	Yes	No	
X	218	588	806
%	27.05	72.95	100.00
Y	24	103	127
%	18.90	81.10	100.00
Z	14	27	41
%	34.15	65.85	100.00
Total	256	718	974
%	26.28	73.72	100.00

Table 3.25 Professional Training - M.Tech. Alumni (Question 9)

Category	Short duration		Long duration		Total
	Yes	No	Yes	No	
X	205	601	95	711	806
%	25.43	74.57	11.79	88.21	100.00
Y	19	108	10	117	127
%	14.96	85.04	7.87	92.13	100.00
Z	6	35	6	35	41
%	14.63	85.37	14.63	85.37	100.00
Total	230	744	111	863	974
%	23.61	76.39	11.40	88.60	100.00

further studies' in Table 3.23 are in fact undergoing further studies but have not completed them. When they complete their studies, the number of alumni in the 'No further studies' column will reduce to 755, which is equivalent to a percentage of 77.52. Correspondingly the number of alumni who undergo further studies will increase to 22.48 percent.

The figures presented in Table 3.24 indicate the interesting fact that 26.28 percent of the alumni had a gap between the completion of their Bachelor's degree and the start of their Master's programme. In most cases (85 percent) the gap was either of one year or of two years duration. Approximately 80 percent of those who had a gap worked on a job during this period. They either left the job or took leave in order to obtain the M.Tech. degree. It is difficult to determine the exact number of alumni who joined the M.Tech. programme after a gap because of their inability to get a job. However it is clear that this percentage is quite small.

Alumni were requested to indicate the type of professional training undergone by them after obtaining their degrees. A break-up in terms of 'short duration' training (less than 6 months) and 'long duration' training (more than 6 months) is given in Table 3.25. It indicates the somewhat disturbing fact that only 23.61 percent (about 1 in 4) have undergone 1 or more stints of short duration and that only 11.40 percent (about 1 in 9) have undergone training of long duration. Industries somehow do not seem to find the time to release personnel for training of any kind even though most of them probably recognize the need for continuing education programmes in order to assimilate new technologies and prevent obsolescence.

3.4.2 Ph.D. Alumni

Tables 3.26 to 3.28 present results regarding the academic career and professional training of Ph.D. alumni.

Table 3.26 University/Institute at which Ph.D. Alumni Obtained their B.Tech./M.Sc. Degree (Question 8)

Category	At an IIT	At some other University	Not clear/ Not answered	Total
X	61	172	0	233
%	26.18	73.82	0.00	100.00
Y	7	24	3	34
%	20.59	70.59	8.82	100.00
Z	7	21	0	28
%	25.00	75.00	0.00	100.00
Total	75	217	3	295
%	25.42	73.56	1.02	100.00

Table 3.27 Gap Between M.Tech./M.Sc. and Ph.D. Degree (Question 8)

Category	Gap		Total
	Yes	No	
X	91	142	233
%	39.06	60.94	100.00
Y	12	22	34
%	35.29	64.71	100.00
Z	10	18	28
%	35.71	64.29	100.00
Total	113	182	295
%	38.31	61.69	100.00

Table 3.28 Professional Training - Ph.D. Alumni (Question 9)

Category	Short duration		Long duration		Total
	Yes	No	Yes	No	
X	44	189	28	205	233
%	18.88	81.12	12.02	87.98	100.00
Y	4	30	12	22	34
%	11.76	88.24	35.29	64.71	100.00
Z	4	24	14	14	28
%	14.29	85.71	50.00	50.00	100.00
Total	52	243	54	241	295
%	17.63	82.37	18.31	81.69	100.00

The data in Table 3.26 shows that like the M.Tech. alumni, a reasonable number of Ph.D. alumni (25.42 percent) have obtained their B.Tech. or M.Sc. degree from an IIT. From their academic career, it is also seen that hardly any alumni undergo further studies after their Ph.D. degree. This is to be expected.

The figures in Table 3.27 show that 38.31 percent of the alumni had a gap between the completion of their Master's degree and the start of their Ph.D. programme. In most cases (about 60 percent) the gap was either of one or of two years duration.

The break-up of data on professional training given in Table 3.28 indicates that only about 1 in 5 alumni have undergone training of a short duration or of a long duration. The long duration training of Ph.D. alumni is generally in the form of a post-doctoral fellowship.

3.4.3 Comparisons

It is worthwhile to conclude Section 3.4 by comparing data on further studies undertaken by M.Tech. alumni with studies undertaken by B.Tech. alumni. This is done in Table 3.29. It is seen that in the case of B.Tech. alumni, only 35.9 percent do not study further, whereas in the case of M.Tech. alumni, 81.31 percent do not pursue further studies. For both alumni, a significant percentage go on to do a Ph.D. However with B.Tech. alumni, most of the Ph.Ds. are obtained abroad. It is also interesting to note that with B.Tech. alumni, a large number (28.7 percent) obtain a degree or diploma in management. The corresponding percentage for M.Tech. alumni is only 4.93.

Table 3.29 Comparison of Further Studies Undertaken by B.Tech. and M.Tech. Alumni

	Ph.D. in India	Ph.D. Abroad	P.G. Degree/ Diploma in Management	P.G. Degree/ Diploma in Engineering	No Further Studies	Others	Total
B.Tech.	1.0	11.2	28.7	17.6	35.9	5.6	100.00
M.Tech.	5.13	3.70	4.93	3.29	81.31	1.64	100.00

3.5 Nature of Work

3.5.1 M.Tech. Alumni

We now turn our attention to an important aspect, viz. the nature of work being done by alumni. Aspects such as the current professional status, the sector of work, the annual income, the major duty, etc. will be examined. In case of alumni who are running their own business, the turnover, number of employees and the nature of the business will be analyzed.

Table 3.30 presents data on the current professional status (CPS) of M.Tech. alumni (Question 12). Regardless of whether they were employed or running their own business, they were requested to list their CPS under one of the following:

a. Practising engineer
b. Research scientist/Engineer
c. Executive/Manager
d. Industrialist/Entrepreneur
e. Academic researcher/Teacher
f. Consultant (self employed)
g. Consultant (employee)
h. Other

Since the CPS also depends significantly on the number of years which have elapsed after obtaining the degree, the data in Table 3.30 is split not only categorywise but also yearwise into three spans of five years. In an overall sense, the largest number of alumni, viz. 21.97 percent, list their CPS as 'Executive/Manager'. They are closely followed by 'Research scientist/Engineer' (20.53 percent) and 'Practising engineer' (16.74 percent). Those listing themselves as 'Industrialist/ Entrepreneur' and 'Consultant (self-employed)' are running their own business. There are 147 alumni in this group and they constitute (9.24 + 5.85) = 15.09 percent of the total.

Table 3.30 Current Professional Status - M.Tech. Alumni (Question 12)

Category	Year of passing	a	b	c	d	e	f	g	h	Total
X	73-77	12	19	70	47	16	13	8	1	186
	78-82	39	45	79	22	21	14	30	6	256
	83-87	85	108	43	16	33	19	45	15	364
	Sub-total	136	172	192	85	70	46	83	22	806
	%	16.87	21.34	23.82	10.55	8.68	5.71	10.30	2.73	100.00
Y	73-77	7	7	4	1	4	1	2	0	26
	78-82	8	11	5	0	7	3	8	5	47
	83-87	8	5	1	1	6	2	6	25	54
	Sub-total	23	23	10	2	17	6	16	30	127
	%	18.11	18.11	7.87	1.57	13.39	4.72	12.60	23.62	100.00
Z	73-77	2	0	5	2	1	2	2	0	14
	78-82	2	4	5	0	6	1	2	0	20
	83-87	0	1	2	1	0	2	1	0	7
	Sub-total	4	5	12	3	7	5	5	0	41
	%	9.76	12.20	29.27	7.32	17.07	12.20	12.20	0	100.00
Total		163	200	214	90	94	57	104	52	974
%		16.74	20.53	21.97	9.24	9.65	5.85	10.68	5.34	100.00

Code: a. Practising engineer
b. Research scientist/Engineer
c. Executive/Manager
d. Industrialist/Entrepreneur
e. Academic researcher/Teacher
f. Consultant (Self-employed)
g. Consultant (employee)
h. Other

This is a significant fact. However the categorywise break-up indicates that amongst those settled abroad (category Y), this percentage is relatively small and is only (1.57 + 4.72) = 6.29 percent.

It is worth noting that in column h of the table, the number of alumni in categories X and Y in the time span 1983-87 is high. These alumni are mostly students pursuing studies after their M.Tech. After completion of their studies, they will eventually redistribute themselves into the other types.

The following percentages of CPS are obtained, if one considers only the data for alumni who passed out from 1973 to 1977:

a. Practising engineer	9.29%
b. Research scientist/Engineer	11.50%
c. Executive/Manager	34.96%
d. Industrialist/Entrepreneur	22.12%
e. Academic researcher/Teacher	9.29%
f. Consultant (self-employed)	7.08%
g. Consultant (employee)	5.31%
h. Other	0.44%

This percentage profile is substantially different from the overall percentage profile for all alumni. It indicates a large increase in alumni listing their CPS as 'Executive/ Manager' and in those running their own business. It is likely that this profile is a 'final' profile more representative of the professional status which M.Tech. alumni eventually tend to acquire.

In Table 3.31, alumni are classified by the sector in which they are working (Question 11). It is seen that the majority (61.60 percent) are working in the private sector. An approximately equal but smaller number are working in

Table 3.31 Sector of Work - M.Tech. Alumni (Question 11)

Category	Year of passing	Government	Public sector	Private sector	Educational Institutions	Other	Total
X	73-77	11	26	133	14	2	186
	78-82	18	27	180	29	2	256
	83-87	59	69	187	42+	7	364
	Sub-total	88	122	500	85	11	806
	%	10.92	15.14	62.03	10.55	1.36	100.00
Y	73-77	2	1	18	4	1	26
	78-82	1	1	33	12	0	47
	83-87	1	0	22	30+	1	54
	Sub-total	4	2	73	46	2	127
	%	3.15	1.57	57.48	36.22	1.57	100.00
Z	73-77	0	2	11	1	0	14
	78-82	1	3	10	6	0	20
	83-87	1	0	6	0	0	7
	Sub-total	2	5	27	7	0	41
	%	4.88	12.20	65.85	17.07	0.00	100.00
Total		94	129	600	138	13	974
%		9.65	13.24	61.60	14.17	1.33	100.00

+ The relatively large number of alumni of the 1983-87 group listed as working in educational institutions are in many cases studying for a higher degree.

educational institutions[+] (14.17 percent) and in the public sector (13.24 percent). A still smaller number (9.65 percent) are in Government service. In both categories X and Y, the number of alumni working in educational institutions in the time span 1983-87 is slightly high because they are studying for a higher degree. These numbers will eventually reduce and redistribute themselves into the other sectors.

The following percentages are obtained if one considers only the data for alumni for the years 1973 to 1977:

Government	5.75%
Public sector	12.83%
Private sector	71.68%
Educational Institutions	8.41%
Other	1.33%

The above percentages show that with the passage of time there is a clear increase in the number working in the private sector with a corresponding decrease in the number of alumni in government service and in educational institutions. The shift to the private sector is because of the better salaries and 'perks' offered to salaried employees as they become senior and also because of the fact that many alumni start their own enterprises after serving for a few years.

In the private sector, the following are some of the companies having a large number of alumni working for them: Tata Consultancy Services, Larsen & Toubro, Tata Electric Companies, Tata Consulting Engineers, Crompton Greaves, Tata Exports, Thermax (India), Telco, Tata Unisys, Bajaj Auto, Philips India, Godrej & Boyce.

In the public sector, the largest employers of M.Tech. alumni are ONGC, Hindustan Aeronautics Ltd., Indian Telephone

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+ The term 'educational institutions' includes both government and private institutions.

Industries and Indian Oil Corporation, while in the Government, a significant number of alumni are working in the Department of Space, Department of Atomic Energy and in various Laboratories of CSIR.

The annual income of alumni is reported in Tables 3.32 to 3.37 (Question 11). In all the tables, data for alumni in categories X and Z are combined together. This is because the data on incomes did not show any real difference between the two categories and because the number of respondents in category Z is small. It is to be noted that in all the income tables, alumni who have listed their CPS as 'Industrialist/ Entrepreneur' or 'Self-employed Consultant' are not included. For annual income, most alumni have reported their basic pay and allownces. However some seem to have stated only their basic pay. This accounts for the low minimum values in the income ranges in some cases.

Tables 3.32 to 3.34 give the incomes of alumni in categories X and Z who have passed in the three time spans of 1973 to 1977, 1978 to 1982, and 1983 to 1987.+ A further sub-division is made in terms of the sector of work. Tables 3.35 to 3.37 present the same data with a sub-division being made in terms of the further studies undergone by the alumni. An examination of the tables shows some interesting trends. Firstly as is to be expected, mean incomes of alumni as a whole who passed from 1973 to 1977 (Rs73,467) are higher than those who passed from 1978 to 1982 (Rs65,466). In turn, the incomes of these alumni are higher than those who passed from 1983 to 1987 (Rs49,137). This statement is also true when alumni are considered by the sector of work or by the further studies which they have undergone. Secondly, it is seen that the

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+ Data on income of alumni in category Y are not presented because the numbers involved in five year time spans with sub-divisions by sector of work are small and variations in income are large. Consequently averages are not meaningful. Also data from many countries with different standards of living are involved.

Table 3.32 Annual Income of M.Tech. Alumni in Categories X and Z who Passed from 1973-1977 - Classification by Sector of Work (Question 11)

	Government	Public sector	Private sector	Educational Institutions	Other	Total
Number reporting income	11	27	76	15	1	130
Income range (Rs)	44,400 to 75,000	40,000 to 84,000	32,000 to 200,000	36,000 to 100,000	80,000 to 80,000	32,000 to 200,000
Mean annual income (Rs)	64,362	62,082	82,121	56,339	80,000	73,467

Note: 1. Alumni who have listed their CPS as 'Industrialist/Entrepreneur/Self-employed Consultant' are not included.

2. Most alumni have reported basic pay and allowances. However some seem to have reported only their basic pay.

Table 3.33 Annual Income of M.Tech. Alumni in Categories X and Z who Passed from 1978-1982 - Classification by Sector of Work (Question 11)

	Government	Public sector	Private sector	Educational Institutions	Other	Total
Number reporting income	19	30	147	34	1	231
Income range (Rs)	34,000 to 85,000	37,000 to 85,000	30,000 to 170,000	28,800 to 75,000	62,500 to 62,500	28,800 to 170,000
Mean annual income (Rs)	55,876	59,630	71,573	49,659	62,500	65,466

Note: 1. Alumni who have listed their CPS as 'Industrialist/Entrepreneur/Self-employed Consultant' are not included.

2. Most alumni have reported basic pay and allowances. However some seem to have reported only their basic pay.

Table 3.34 Annual Income of M.Tech. Alumni in Categories X and Z who Passed from 1983-1987 - Classification by Sector of Work (Question 11)

	Government	Public sector	Private sector	Educational Institutions	Other	Total
Number reporting income	56	64	153	38	4	315
Income range (Rs)	25,800 to 62,000	30,636 to 72,000	28,800 to 96,000	28,200 to 54,360	38,000 to 50,000	25,800 to 96,000
Mean annual income (Rs)	43,907	45,976	54,576	40,760	44,500	49,137

Note: 1. Alumni who have listed their CPS as 'Industrialist/Entrepreneur/Self-employed Consultant' are not included.

2. Most alumni have reported basic pay and allowances. However some seem to have reported only their basic pay.

Table 3.35 Annual Income of M.Tech. Alumni in Categories X and Z who Passed from 1973-1977 - Classification by Studies After M.Tech. Degree (Question 11)

	No further studies	Ph.D. in India or abroad	P.G. Diploma/ Degree in Management	P.G. Diploma/ Other Degree in Engineering		Total
Number reporting income	93	16	13	2	6	130
Income range (Rs)	32,000 to 180,000	50,000 to 100,000	42,000 to 200,000	66,000 to 72,000	44,000 to 100,000	32,000 to 200,000
Mean annual income (Rs)	72,814	72,625	80,769	63,333	71,500	73,467

Note: 1. Alumni who have listed their CPS as 'Industrialist/Entrepreneur/Self-employed Consultant' are not included.

2. Most alumni have reported basic pay and allowances. However some seem to have reported only their basic pay.

3. Number of alumni under 'P.G. Diploma/Degree in Engineering' and 'Other' are very small. Consequently the income range and mean income values may not be meaningful.

Table 3.36 Annual Income of M.Tech. Alumni in Categories X and Z who Passed from 1978-1982 - Classification by Studies After M.Tech. Degree (Question 11)

	No further studies	Ph.D. in India or abroad	P.G. Diploma/ Degree in Management	P.G. Diploma/ Other Degree in Engineering		Total
Number reporting income	190	18	14	5	4	231
Income range (Rs)	28,000 to 170,000	34,000 to 120,000	42,000 to 150,000	54,000 to 100,000	46,500 to 70,000	28,800 to 170,000
Mean annual income (Rs)	65,396	60,300	72,822	73,200	56,625	65,466

Note: 1. Alumni who have listed their CPS as 'Industrialist/Entrepreneur/Self-employed Consultant' are not included.

2. Most alumni have reported basic pay and allowances. However some seem to have reported only their basic pay.

3. Number of alumni under 'P.G. Diploma/Degree in Engineering' and 'Other' are very small. Consequently the income range and mean income values may not be meaningful.

Table 3.37 Annual Income of M.Tech. Alumni in Categories X and Z who Passed from 1983-1987 - Classification by Studies After M.Tech. Degree (Question 11)

	No further studies	Ph.D. in India or abroad	P.G. Diploma/ Degree in Management	P.G. Diploma/ Other Degree in Engineering		Total
Number reporting income	291	13	6	3	2	315
Income range (Rs)	25,800 to 96,000	28,800 to 80,000	44,000 to 90,000	60,000 to 85,000	55,000 to 58,000	25,800 to 96,000
Mean annual income (Rs)	48,559	49,184	63,333	71,667	56,500	49,137

Note: 1. Alumni who have listed their CPS as 'Industrialist/Entrepreneur/Self-employed Consultant' are not included.

2. Most alumni have reported basic pay and allowances. However some seem to have reported only their basic pay.

3. Number of alumni under 'P.G. Diploma/Degree in Engineering' and 'Other' are very small. Consequently the income range and mean income values may not be meaningful.

incomes for those in the private sector are the most. They are followed by alumni working for the government or in the public sector. Alumni working in educational institutions have the lowest average incomes. The differentials are also seen to increase with the passage of time. It is to be noted also that the private sector (and to some extent the public sector also) offers many perquisites and subsidies which are not reflected in the data on annual incomes presented in the tables. Thus the actual differences are in fact even more marked. Finally the subdivision by further studies shows that it is beneficial to obtain a postgraduate degree or diploma in management. The annual incomes of such alumni are about Rs7,000 to Rs14,000 more than the average for all alumni taken together. In contrast, the extra time and effort spent in studying for a Ph.D. does not seem to help an M.Tech. much from a financial standpoint. The annual incomes of such alumni are about the same as the average for all alumni taken together.

Table 3.38 gives details regarding the number of jobs held (Question 10). It is seen that the percentage of alumni who have stayed on one job (no job change) is highest (47.76 percent) for the junior most group who passed from 1983 to 1987. It decreases to 30.03 percent for the 1978-82 group and further to 22.12 percent for the 1973 to 1977 group. This is to be expected. The percentage profile seen for the 1973-77 group may be considered to be a 'final' profile for M.Tech. alumni. It indicates that about half the alumni will hold either one or two jobs during their career, while the other half will hold more than two jobs.

Table 3.39 presents data on whether alumni are working in the same field of work in which they were trained at IIT Bombay (Question 13). A large number of (61.40 percent) indicate that they are in fact working in the same field. This is a satisfying percentage indicating to some extent the relevance

Table 3.38 Number of Jobs Held - M.Tech. Alumni (Question 10)

Year of passing		Number of jobs					Total
		1	2	3	> 3	Nil/N.A.	
1973-77	Number of alumni	50	68	46	55	7	226
	%	22.12	30.09	20.35	24.34	3.10	100.00
1978-82	Number of alumni	97	90	77	55	4	323
	%	30.03	27.86	23.84	17.03	1.24	100.00
1983-87	Number of alumni	203	127	56	28	11	425
	%	47.76	29.88	13.18	6.59	2.59	100.00

Table 3.39 Current Field of Work Vis-a-Vis Field of Training at IIT Bombay - M.Tech. Alumni (Question 13)

Category	Same field	Different field	Partly same field	N.A.	Total
X	486	239	36	45	806
Y	84	39	3	1	127
Z	28	11	2	0	41
Total	598	289	41	46	974
%	61.40	29.67	4.21	4.72	100.00

of the education received. In order to obtain an idea of the specific work being done, respondents were requested to describe their present field of work. Approximately 900 alumni gave brief descriptions. Out of these, about 100 representative samples are reproduced in Appendix II. A perusal of the samples is revealing. It shows the remarkable diversity of the work being done by alumni. It also shows that a very large number of them are in research, design and development. This fact is corroborated by the answers given to Question 14.

Table 3.40 is an important table indicating the major duty/duties performed by an alumnus in his present work (Question 14). The duty ranked as number one is tabulated in Table 3.40. For the purpose of analyzing the data, it is convenient to club some of the similar duties (having overlaps with each other) together. Thus one may consider alumni listing teaching, research and development, or design (a,b or c) as their major duty under one group. Similarly alumni listing their major duty as production, maintenance/trouble shooting, or construction/erection/commissioning (d,e or f) may be considered under one broad group. Alumni listing their work as consultancy or EDP/computers (g or h) may be considered under the next group and finally alumni listing their major duty as some aspect of management (i to n) may be considered under one broad group. It is seen that in all categories (X, Y or Z), the largest number of alumni come under the first group, viz. teaching, research and development, or design. The overall percentage of alumni who list one of the above as their major duty is 50.62 percent. The percentage of alumni in other three groups is much smaller and ranges from 13.14 to 15.30 percent. It appears therefore that a large number of M.Tech. alumni continue to work in engineering and technology rather than drifting gradually towards management.

We now turn our attention to data on alumni running their own business, i.e. those who have given their CPS as

Table 3.40 Major Duty in Present Work - M.Tech. Alumni (Question 14)

Category		a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	Total
X		72	141	171	58	36	24	77	50	38	33	3	1	8	48	46	806
	Sub-total		384			118			127				131			46	806
	%		47.64			14.64			15.76				16.25			5.71	100.0
Y		9	55	20	1	4	2	5	13	4	1	0	1	2	4	6	127
	Sub-total		84			7			18				12			6	127
	%		66.14			5.51			14.17				9.45			4.72	100.0
Z		6	6	13	1	0	2	2	2	1	3	0	0	0	1	4	41
	Sub-total		25			3			4				5			4	41
	%		60.98			7.32			9.76				12.20			9.76	100.0
Total			493			128			149				148			56	974
%			50.62			13.14			15.30				15.20			5.75	100.0

Code:

a. Teaching
b. Research and development
c. Design
d. Production
e. Maintenance/Trouble shooting
f. Construction/Erection/Commissioning
g. Consultancy
h. EDP/Computer
i. Project planning
j. Marketing
k. Finance
l. Personnel management
m. Industrial management
n. General management
o. Any other

Industrialist/Entrepreneur/Self-employed consultant. It has already been noted that these alumni constitute a significant percentage. An important question which arises is whether the alumnus started a new business or whether he joined an existing business (Question 16). Data in Table 3.41 clearly show that in more than 90 percent of the cases, M.Tech. alumni started the business on their own.

Data on turnover and the number of employees are presented in Table 3.42. It indicates that the companies being run range from small 'one man' shows to fairly large organizations with hundreds of employees. The average annual turnover of the companies is Rs26 lakhs and the average number of employees is 19.

It is of interest also to study the nature of the business being conducted. Three groupings 'Production/ Manufacturing', 'Consultancy/Project Planning/Execution', and 'Marketing/Trading' have been used. The data in Table 3.43 show that as befits technical persons an approximately equal percentage (around 45) are engaged in the first two types of business activity, with only a few being engaged in the third type of activity.

3.5.2 Ph.D. Alumni

Table 3.44 presents data on the current professional status (CPS) of Ph.D. alumni. As with the M.Tech. alumni, the data is split not only categorywise but also yearwise into three spans of five years. In an overall sense, it is seen that the largest number of alumni (36.95 percent) list their CPS as 'Research scientist/Engineer'. They are closely followed by 'Academic researcher/Teacher' who constitute 35.59 percent of the total. The strong influence of the Ph.D. degree on the professional status is thus clearly seen. A much smaller percentage (13.22 percent) list their CPS as 'Executive/ Manager'. Similarly the percentage of those

Table 3.41 Data on M.Tech. Alumni Who are Running their Own Business (Question 16)

Category	Business started with own initiative	Joined/Running an existing business	Not clear/ Not answered	Total
X	120	6	5	131
Y	8	0	0	8
Z	8	0	0	8
Total	136	6	5	147
%	92.52	4.08	3.40	100.00

Table 3.42 Turnover and Number of Employees of M.Tech. Alumni in Categories X and Z Running their Own Business (Question 16)

	1973-77	1978-82	1983-87	Total
Average turnover (Rs in lakhs)	32	24	14	26
Range of turnover (Rs in lakhs)	1 to 200	1 to 170	1 to 100	1 to 200
Average number of employees	28	15	8	19
Range of employees	2 to 400	1 to 75	1 to 70	1 to 400

Table 3.43 Nature of Business - M.Tech. Alumni (Question 16)

Category	Production/Manufacturing	Consultancy/Project planning/Execution	Marketing/Trading	Not clear/ Not answered	Total
X	63	56	10	2	131
Y	2	6	0	0	8
Z	0	6	1	1	8
Total	65	68	11	3	147
%	44.22	46.26	7.48	2.04	100.00

Table 3.44 Current Professional Status - Ph.D. Alumni (Question 12)

Category	Year of passing	a	b	c	d	e	f	g	h	Total
X	73-77	4	23	16	5	22	1	4	0	75
	78-82	1	23	12	4	31	2	2	0	75
	83-87	3	34	7	7	25	4	1	2	83
	Sub-total	8	80	35	16	78	7	7	2	233
	%	3.43	34.33	15.02	6.87	33.48	3.0	3.00	0.86	100.00
Y	73-77	0	3	0	0	2	0	0	0	5
	78-82	0	3	2	0	9	0	0	0	14
	83-87	0	10	0	0	5	0	0	0	15
	Sub-total	0	16	2	0	16	0	0	0	34
	%	0.00	47.06	5.88	0.00	47.06	0.00	0.00	0.00	100.00
Z	73-77	0	2	0	1	1	0	0	0	4
	78-82	0	5	1	0	6	0	0	0	12
	83-87	0	6	1	0	4	0	1	0	12
	Sub-total	0	13	2	1	11	0	1	0	28
	%	0.00	46.43	7.14	3.57	39.29	0.00	3.57	0.00	100.00
Total		8	109	39	17	105	7	8	2	295
%		2.71	36.95	13.22	5.76	35.59	2.37	2.71	0.68	100.00

Code: a. Practising engineer
b. Research scientist/Engineer
c. Executive/Manager
d. Industrialist/Entrepreneur
e. Academic researcher/Teacher
f. Consultant (Self-employed)
g. Consultant (employee)
h. Other

running their own business is small (5.76 + 2.37 = 9.13 percent) but not negligible.

The following percentages are obtained if one considers only the data for alumni who passed out from 1973 to 1977:

a. Practising engineer	4.76%
b. Research scientist/Engineer	33.33%
c. Executive/Manager	19.05%
d. Industrialist/Entrepreneur	7.14%
e. Academic researcher/Teacher	29.76%
f. Consultant (self-employed)	1.19%
g. Consultant (employee)	4.76%
h. Other	0.00%

This percentage profile is not very different from the overall percentage profile for all Ph.D. alumni.

In Table 3.45, Ph.D. alumni are classified by the sector in which they are working. Keeping in mind the data of the previous table, it is not surprising that the largest number (41.36 percent) are working in educational institutions. The next largest number (31.53 percent) are working in the private sector, while a small number are in Government service (17.63 percent) and in the public sector (8.14 percent).+ A perusal of the companies/organizations in which alumni are working indicates that in the public sector, the ONGC is one of the largest employers, while in the Government, a significant number are working in the Department of Space and in various laboratories of CSIR. In educational institutions, the largest number are in IIT Bombay itself working either as faculty members or on the staff of the various research centres in the Institute. A significant number are also working in the other IITs.

+ An analysis of the data for the 1973-1977 set of alumni does not show any significant differences from the percentages obtained for all alumni.

Table 3.45 Sector of Work - Ph.D. Alumni (Question 11)

Category	Year of passing	Government	Public sector	Private sector	Educational Institutions	Other	Total
X	73-77	15	7	27	26	0	75
	78-82	9	7	22	37	0	75
	83-87	16	9	30	26	2	83
	Sub-total	40	23	79	89	2	233
	%	17.17	9.87	33.91	38.20	0.86	100.00
Y	73-77	2	0	0	3	0	5
	78-82	1	0	4	9	0	14
	83-87	1	1	3	9	1	15
	Sub-total	4	1	7	21	1	34
	%	11.76	2.94	20.59	61.76	2.94	100.00
Z	73-77	1	0	1	2	0	4
	78-82	3	0	3	5	1	12
	83-87	4	0	3	5	0	12
	Sub-total	8	0	7	12	1	28
	%	28.57	0.00	25.00	42.86	3.57	100.00
Total		52	24	93	122	4	295
%		17.63	8.14	31.53	41.36	1.36	100.00

The annual income of Ph.D. alumni is reported in Tables 3.46 to 3.48. In these tables, data for alumni in categories X and Z are combined together. Data for alumni in category Y are not presented for the same reasons given earlier for M.Tech. alumni. The three tables are for the three time spans, 1973 to 1977, 1978 to 1982, and 1983 to 1987 with a sub-division being made in terms of the sector of work. The tables show some clear trends. Firstly as is to be expected, mean incomes as a whole and in all sectors of work increase with seniority. Thus the mean incomes of alumni as a whole who passed from 1973 to 1977 is Rs77,248. It is Rs60,946 for those who passed from 1978 to 1982, and is Rs52,219 for those who passed from 1983 to 1987. A more important trend seen from Tables 3.46 to 3.48 is that mean incomes of alumni in the private sector are the most. They are followed by alumni working in the public sector and the Government. Alumni working in educational institutions have the lowest mean incomes.

Table 3.49 classifies alumni by the number of jobs held. It is seen that approximately 30 percent have held only one job (no job change), while about the same number have held two jobs. The remaining have held three or more jobs.

Table 3.50 presents data on whether alumni are working in the same field in which they were trained or in a different field. A high percentage of alumni (65.76 percent) indicate that their current field of work is similar to the field in which they were trained. As in the case of M.Tech. alumni, brief descriptions of the specific work being done by some Ph.D. alumni are given in Appendix II. They indicate that the work being done is of a varied nature with emphasis on teaching, research and development.

Table 3.51 lists the major duty performed by the alumnus in his present work. It is seen that the largest number of alumni (76.61 percent) list their major duty in the first group

Table 3.46 Annual Income of Ph.D. Alumni in Categories X and Z Who Passed from 1973-1977 - Classification by Sector of Work (Question 11)

	Government	Public sector	Private sector	Educational institutions	Other	Total
Number reporting income	15	6	21	25	0	67
Income range (Rs)	50,000 to 84,000	56,000 to 100,000	50,000 to 200,000	20,840 to 100,000	-	20,840 to 200,000
Mean annual income (Rs)	71,223	71,833	105,286	58,610	-	77,248

Note: 1. Alumni who have listed their CPS as 'Industrialist/Entrepreneur/Self-employed Consultant' are not included.

2. Most alumni have reported basic pay and allowances. However some seem to have reported only their basic pay.

Table 3.47 Annual Income of Ph.D. Alumni in Categories X and Z Who Passed from 1978-1982 - Classification by Sector of Work (Question 11)

	Government	Public sector	Private sector	Educational institutions	Other	Total
Number reporting income	12	7	18	41	0	78
Income range (Rs)	50,000 to 72,000	55,000 to 84,000	59,000 to 125,000	17,760 to 75,000	-	17,760 to 125,000
Mean annual income (Rs)	57,653	65,714	87,667	49,365	-	60,946

Note: 1. Alumni who have listed their CPS as 'Industrialist/Entrepreneur/Self-employed Consultant' are not included.

2. Most alumni have reported basic pay and allowances. However some seem to have reported only their basic pay.

Table 3.48 Annual Income of Ph.D. Alumni in Categories X and Z Who Passed from 1983-1987 - Classification by Sector of Work (Question 11)

	Government	Public sector	Private sector	Educational institutions	Other	Total
Number reporting income	20	8	22	29	1	80
Income range (Rs)	34,000 to 80,000	48,000 to 70,000	35,000 to 92,680	25,200 to 72,000	50,000 to 50,000	25,200 to 92,680
Mean annual income (Rs)	49,258	61,625	62,245	44,136	50,000	52,219

Note: 1. Alumni who have listed their CPS as 'Industrialist/Entrepreneur/Self-employed Consultant' are not included.

2. Most alumni have reported basic pay and allowances. However some seem to have reported only their basic pay.

Table 3.49 Number of Jobs Held - Ph.D. Alumni (Question 10)

Year of passing		Number of jobs					Total
		1	2	3	>3	Nil/N.A.	
1973-77	Number of alumni	25	29	14	14	2	84
	%	29.76	34.52	16.67	16.67	2.38	100.00
1978-82	Number of alumni	31	25	23	20	2	101
	%	30.69	24.75	22.77	19.80	1.98	100.00
1983-87	Number of alumni	35	41	21	7	6	110
	%	31.82	37.27	19.09	6.36	5.45	100.00

Table 3.50 Current Field of Work Vis-a-Vis Field of Training at IIT Bombay - Ph.D. Alumni (Question 13)

Category	Same field	Different field	Partly same field	N.A.	Total
X	148	64	12	9	233
Y	26	4	2	2	34
Z	20	5	3	0	28
Total	194	73	17	11	295
%	65.76	24.75	5.76	3.73	100.00

Table 3.51 Major Duty in Present Work - Ph.D. Alumni (Question 14)

Category		a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	Total
X		68	91	12	10	5	3	7	5	7	3	2	0	0	6	14	233
	Sub-total	171			18			12		18						14	233
	%	73.39			7.73			5.15		7.73						6.01	100.0
Y		10	19	0	1	0	0	0	1	0	0	0	0	0	0	3	34
	Sub-total	29			1			1		0						3	34
	%	85.29			2.94			2.94		0.00						8.82	100.0
Z		6	19	1	0	0	0	0	0	0	1	0	0	0	0	1	28
	Sub-total	26			0			0		1						1	28
	%	92.86			0.00			0.00		3.57						3.57	100.0
Total		226			19			13		19						18	295
%		76.61			6.44			4.41		6.44						6.10	100.0

Code:
a. Teaching
b. Research and development
c. Design
d. Production
e. Maintenance/Trouble shooting
f. Construction/Erection/Commissioning
g. Consultancy
h. EDP/Computer
i. Project planning
j. Marketing
k. Finance
l. Personnel management
m. Industrial management
n. General management
o. Any other

which includes teaching, research and development. This is in consonance with the data on current professional status given in Table 3.44.

Finally we present data in Tables 3.52 to 3.54 on Ph.D. alumni running their own business. Table 3.52 shows that in most cases (87.50 percent) alumni started the business with their own initiative. Data on turnover show an average turnover of Rs122 lakhs and the average number of employees to be 19 (Table 3.53). The range indicates that the companies being run are small 'one man' firms to large organizations. The nature of the business is given in Table 3.54. It shows that the largest number (58.33 percent) are in 'Production/ Manufacturing', while the next largest number (29.17 percent) are engaged in 'Consultancy/Project planning/Execution'. A negligible number are in 'Marketing/Trading'.

3.5.3 Comparisons

Once again it is of interest to compare the data on M.Tech. and Ph.D. alumni with earlier data obtained on B.Tech. alumni. Table 3.55 shows a comparison of the current professional status. Since the B.Tech. study was made for the batches which passed out from 1973 to 1977, the comparison is restricted to these batches. The table shows similarities in the data for B.Tech. and M.Tech. alumni. For both of them, the largest number classify themselves as 'Executive/Manager' (38.5 percent for B.Tech. and 34.96 percent for M.Tech.). The next largest number are alumni running their own business (22.5 percent for B.Tech. and 29.20 percent for M.Tech.). In contrast as far as Ph.D. alumni are concerned, the largest number (33.33 percent) classify their status as 'Research scientist/Engineer'. The next largest number (29.76 percent) are alumni whose status is 'Academic researcher/Teacher'.

A comparison of the sector of work is given in Table 3.56. Here again the data for B.Tech. and M.Tech. alumni are

Table 3.52 Data on Ph.D. Alumni Who are Running their Own Business (Question 16)

Category	Business started with own initiative	Joined/Running an existing business	Not clear/ Not answered	Total
X	21	2	0	23
Y	0	0	0	0
Z	0	0	1	1
Total	21	2	1	24
%	87.50	8.33	4.17	100.00

Table 3.53 Turnover and Number of Employees of Ph.D. Alumni in Categories X and Z Running their Own Business (Question 16)

	1973-77	1978-82	1983-87	Total
Average turnover (Rs in lakhs)	361	15	36	122
Range of turnover (Rs in lakhs)	5 to 650	10 to 30	1 to 200	1 to 650
Average number of employees	40	11	13	19
Range of employees	6 to 70	4 to 22	2 to 30	2 to 70

Table 3.54 Nature of Business - Ph.D. Alumni (Question 16)

Category	Production/Manufacturing	Consultancy/Project planning/Execution	Marketing/Trading	Not clear/ Not answered	Total
X	14	7	1	1	23
Y	0	0	0	0	0
Z	0	0	0	1	1
Total	14	7	1	2	24
%	58.33	29.17	4.17	8.33	100.00

Table 3.55 Comparison of Current Professional Status of Undergraduate and Postgraduate Alumni (1973-1977)

	a	b	c	d + f	e	g	h
B.Tech.	20.7	4.6	38.5	22.5	4.8	7.0	1.9
M.Tech.	9.29	11.50	34.96	29.20	9.29	5.31	0.44
Ph.D.	4.76	33.33	19.05	8.33	29.76	4.76	0.00

Code: a. Practicing engineer
b. Research scientist/Engineer
c. Executive/Manager
d. Industrialist/Entrepreneur
e. Academic researcher/Teacher
f. Consultant (self-employed)
g. Consultant (employee)
h. Other

Table 3.56 Comparison of Sector of Work for Undergraduate and Postgraduate Alumni (1973-1977)

	Public sector Educational institutions Government service	Private sector	Other
B.Tech.	15.3	83.2	1.5
M.Tech.	26.99	71.68	1.33
Ph.D.	66.67	33.33	0.00

somewhat similar with most of them (83.2 and 71.68 percent respectively) working in the private sector. However in the case of Ph.D. alumni, the number working in the private sector is only 33.33 percent.

Comparing the annual incomes of M.Tech. and Ph.D. alumni settled in India (Table 3.57), one sees that in each time span and in almost every sector of work, Ph.D. alumni have incomes higher than M.Tech. alumni.+ The difference increases if one considers only the incomes of Ph.D. alumni who passed from the engineering departments. This is a more fair comparison since most M.Tech. alumni are engineers. These data are also presented in Table 3.57. In the case of annual incomes, only an approximate comparison with the earlier data on B.Tech. alumni is possible since those data were obtained more than two years ago. For B.Tech. alumni who passed from 1973 to 1977, the annual income for categories X and Z was reported to be about Rs58,000. Allowing for an increase of 20 percent for obtaining the present income, one gets a value of Rs69,600. Thus it appears that the mean annual income of M.Tech. alumni who passed during the same period is slightly better, being about Rs4,000 more.

As far as the major duty in the present work is concerned, both M.Tech. and Ph.D. alumni list teaching/R&D/ design as their main activity. Thus the majority continue to work essentially in the area of their specialization. This is quite unlike what has been observed for B.Tech. alumni, a large number of whom (particularly in categories X and Z) list their major duty as some aspect of management.

+ The only exception is the 'educational institution' sector in which the incomes of both sets of alumni are about the same for the time span 1978-82. Because of this fact and the fact that a large percentage of Ph.D. alumni are working in educational institutions, the mean annual income for Ph.D. alumni considering all sectors of work is lower than that for M.Tech. alumni for the time span 1978-82.

Table 3.57 Comparison of Annual Incomes of M.Tech. Alumni and Ph.D. Alumni - Categories X and Z

Year of passing		Sector of Work				All sectors
		Government	Public sector	Private sector	Educational institutions	
1973-77	M.Tech.	64,362	62,082	82,121	56,339	73,467
	Ph.D. (All depts.)	71,223	71,833	105,286	58,610	77,248
	Ph.D. (Engg. depts.)	75,960	78,333	109,333	60,186	83,237
1978-82	M.Tech.	55,876	59,630	71,573	49,659	65,466
	Ph.D. (All depts.)	57,653	65,714	87,667	49,365	60,946
	Ph.D. (Engg. depts.)	58,806	66,000	101,374	56,307	70,440
1983-87	M.Tech.	43,907	45,976	54,576	40,760	49,137
	Ph.D. (All depts.)	49,258	61,625	62,245	44,136	52,219
	Ph.D. (Engg. depts.)	48,880	65,000	79,136	50,099	60,034

3.6 Concluding Remarks

It would be worthwhile to conclude with some remarks of a general nature regarding our M.Tech. and Ph.D. alumni.

The data presented in this chapter show that the vast majority settle down in India and that whatever be the measure used for judging them, they are clearly very successful by Indian standards. They are also contributing significantly in a professional sense to the developmnet of the country. The indicators used for judgement may be income, professional status, duties performed, involvement with entrepreneurship, etc. The implications of this positive assessment are important because it is well known that the investments made by the nation in educating students at the IITs are higher than in the other universities. The results of this study show that this investment in the postgraduate programmes has been a very worthwhile one. In the long run, it probably pays for itself many times over.

An interesting question which arises as a consequence of this study is as follows: What about the other IITs? Are these results likely to be applicable to them also? In order to answer these questions, one needs to examine the nature of the student population entering the IITs. It is generally known that in most departments, students of more or less equal calibre enter the IITs. It is also known that the overall approach and level of teaching and research is similar in the five institutes. Thus one can tentatively say that the findings of this study are likely to apply in large measure to all the IITs. Given the overall output of the IITs, this statement implies that the present findings are broadly applicable to 35 percent of the nation's M.Tech. output and 50 percent of the Ph.D. output in engineering and technology.

Finally it may be useful to mention that similar studies need to be conducted at various universities in the country which offer M.Tech. and Ph.D. programmes in engineering and technology. Such studies would help in judging the efficacy of the programmes and viewing them in their proper perspective.

Chapter 4

FEEDBACK ON THE IIT BOMBAY PROGRAMME

As stated in Section 2.2, a part of the questionnaire was devoted to obtaining some feedback from the alumni regarding the programme of studies which they underwent at IIT Bombay. The replies obtained were varied and interesting, and are analyzed in the sections which follow.

4.1 M.Tech. Alumni

Alumni were asked in Question 17b if they got the field of specialization of their choice when they joined the M.Tech. programme. The replies are given in Table 4.1 which indicates that most respondents (nearly 90 percent) got the specialization which they wanted.

They were then asked to comment on whether the relative weightage given to course work, seminars and the thesis in the IITB programme was satisfactory. Most alumni chose not to answer tne question of weightage by a 'Satisfactory' or 'Not satisfactory' reply. Only about 30 percent (Table 4.2) chose this form of reply+ and out of these, the vast majority thought that the weightage given to various aspects in the programme was satisfactory.

When asked about the extent to which their level of expectations were met, only 40.35 percent said that their expectations were fully met (Table 4.3). A larger number (54.52 percent) said that their expectations were only partially met. A very small number (1.33 percent) felt that their expectations were not met at all. An analysis of the yearwise break-up of the

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+ The most plausible reason for this low level of response is that the choice 'Satisfactory/Not satisfactory' was not specifically indicated on the questionnaire.

results presented in Table 4.3 indicates the interesting fact that the percentage of alumni whose expectations were fully met decreased from 50.88 to 40.56 to 34.59 over the three time spans 1973-77, 1978-82 and 1983-87. Correspondingly the percentage of those whose expectations were only partially met increased over the same time spans. This trend may be partly due to the fact that after a few years have elapsed, one usually tends to retain the pleasant memories of one's stay at the Institute and forgets some of the minor problems which arose. On the other hand, this trend may also be a consequence of the general dissatisfaction with the decrease in duration of the M.Tech. programme from two to one and a half years.

Apart from the data presented in Tables 4.1 to 4.3, respondents were also requested to comment on the M.Tech. programme and to suggest any modifications in the light of their experience after leaving the Institute. Quite a few alumni made some very significant observations and comments. These are listed in the paragraphs which follow. Typical comments of alumni are also reproduced.

1. Many respondents felt that the basic M.Tech. curriculum was balanced and the structure should remain unchanged. They felt that the M.Tech. programme had given them confidence to tackle diverse problems.

> "The course has built up confidence to work on any assignment independently. It may be field work, project work or maintenance work."
>
> "Today I find it possible, with great confidence and courage, even to dictate on my subject to my clients, competitors and related researchers. This is due to the comprehensive training I had at IITB."
>
> "The stay at IITB expanded our horizons. It imparted new vision to look at various aspects of technology."

2. A majority of the respondents felt that the M.Tech. programme was too theoretical and that it was necessary to make it more relevant to the needs of Indian industry.

"Course work, seminars and thesis are alright. However, the much required exposure to the outside industry is lacking. When I finished my M.Tech. and joined industry it was like studying everything from scratch."

"The M.Tech. programme would have been more satisfying and complete if more emphasis was laid on exposing the students to more practical design/field problems".

"Courses do have the correct name, but not the right contents. I feel worried about the almost zero level of practical knowledge/methods taught at IITB. When I joined my job on the shop floor, I could not handle any machine, I had to start from the beginning as I had no experience during B.Tech. or M.Tech. But the analytical thinking developed in IIT helped."

3. Many respondents felt that the thesis was an important component of the M.Tech. programme and that it should be based on industrially relevant problems.

"I enjoyed the thesis work the most, because it forced me to reach for answers rather than getting ready made theoretical solutions."

"The project work/dissertations should exclusively be those suggested and financed by industries. They should involve economic considerations i.e. results should benefit the industry economically. Theoretical projects should not be encouraged."

"Experimental dissertations should be more oriented towards industry for which financial assistance from the industry can be sought."

"I think M.Tech. projects should not only be sponsored by industry, the work should be carried out in industry itself."

4. Even though the course work was generally considered to be useful, alumni felt that courses should emphasize applications and should include examples from industries. This would be possible if the faculty had more interaction with industry.

"I feel that some industrial projects should be included in the courses, so that one can enter industry with more confidence."

"I found a gap between theoretical education in the class room and actual engineering practice. I suggest that practising engineers be invited to enlighten students about the practical aspects of engineering education."

"The courses conducted by IITB are no doubt good. But it will be more useful if they are more practically oriented."

5. Some respondents felt that IIT must take the initiative to liaise with industry. Also students must be taught the significance and applicability of what they are learning.

"Too much theoretical knowledge is not required in industry. Institutes like IITB should approach industry for more research and development work to design indigenous machines/ products."

"Physical significance should be stressed while teaching abstract subjects".

"One of the things that seemed to be missing in overall curriculum or execution of courses was to present the need of learning what we learn. This would make the programme more effective in terms of using the knowledge in industry or in the field of employment in general."

6. Some alumni suggested practical training or job training in industry to make the curriculum more relevant.

"In addition to course work, seminars, etc., industrial (on job) training may be offered to students to make them aware of problems encountered in industries and also learn a few skills. I suggest a good liaison between the Institute and the industries."

"More emphasis should be given to hands-on-experience in the industry which will automatically generate the practical way of thinking and adapting to the requirements of the organization."

7. A number of respondents suggested a need for strengthening hardware and laboratory facilities in the Institute.

"I think IITB and in general all academic institutes in India are too theoretical. Our students are generally good in theory and modelling, but are poor in experimentation and hardware. Most of the research programmes need good hardware capabilities."

"I feel instead of seminars, practical demonstrations of unit processes should be arranged in a multipurpose pilot plant where much initiative should be taken by the students."

8. A few respondents stressed the need to emphasize communication skills and felt that more importance should be given to the presentation of seminars.

The following are some additional comments of an interesting nature made by M.Tech. alumni:

> "The history and development (evolution) of scientific ideas is completely neglected, making for incomplete education."
>
> "I feel that whatever is taught in IIT is of very little use in the outside environment, i.e. the industries have not geared upto the new things and they are not in a position to accept bright young IITians. However I have no suggestions regarding how this can be incorporated in IIT courses."
>
> "There will always be a mismatch between academic orientation and industry expectation. Quite often industries employ engineers for quite routine jobs. Graduate engineers will just have to look for technically challenging jobs. No curriculum can train one for every possible job. On the other hand, students who have concentrated on their studies will quite easily be able to adapt to an industry situation."

4.2 Ph.D. Alumni

Tables 4.4 to 4.6 for Ph.D. alumni have the same data as Tables 4.1 to 4.3 for M.Tech. alumni. Surprisingly inspite of the wide diversity of Ph.D. alumni and their different backgrounds, the answers in Tables 4.4 to 4.6 are very similar to those in Tables 4.1 to 4.3.

When asked as to whether they got the field of specialization of their choice, about 90 percent (Table 4.4) said that they did. As far as the relative weightage for various aspects of the programme was concerned, most alumni (Table 4.5) who chose to answer with a 'Satisfactory/Not satisfactory' type of reply thought that the relative weightage was satisfactory. Finally when asked about the extent of which their level of expectations were met, 49.83 percent said that their expectations were fully met, while 45.76 percent said that their expectations were partially met. As with the M.Tech. alumni, an analysis of the yearwise break-up shows that the percentage of alumni whose

expectations were fully met decreased from 59.52 to 51.49 to 40.91 over the three time spans of five years each from 1973 to 1987.

Respondents were also requested to comment on the Ph.D. programme and to suggest modifications. A summary of the main comments is given below:

1. Most respondents were satisfied with the Ph.D. programme.

> "The programme has been quite useful in preparing one for systematic data collection from research work and its presentation."
>
> "IITB offered me an excellent healthy approach to study and mental discipline. The latter helped me a lot to solve various problems that I encounter almost everyday right from magnet-making to silver polishing."
>
> "IITB exposed me to seminars, conferences in fields not directly related to mine. I feel this has given me a global view of my own discipline and a general love of science."
>
> "I learnt a new subject in detail and could attend various credit courses to update my knowledge. I learnt to think for myself and live in the company of professionals. I would not have got such an opportunity anywhere else."
>
> "At IITB, I met people from all corners of the country and found the environment truly secular and non-parochial. I saw hardworking professors with erudition. I saw individuality and independence of expression - above all, a trouble free environment."
>
> "I am fully satisfied with what I learnt. The stay at IIT actually pivoted my career and honed my mental outlook."

2. Many of the respondents felt there was a need to make the Ph.D. programme more relevant to the needs of the Indian industry.

> "More emphasis on practical aspects of engineering problem solving is desirable. It is also necessary to impart motivation to the students to put technology to use for solving problems facing the country."

"The student should be made aware of the industry related to his field of specialization during the programme."

"Dissertation thesis should be industry oriented."

"Apart from ongoing programmes, some courses in the respective branches should include case studies of the existing industrial units. The cases should cover all possible technical details, history of the concern and various problems incurred."

"Industrially oriented courses should be introduced whenever possible. The projects selected at doctorate level should be more applied research oriented."

"Teaching and practical training should have more emphasis on industrial applications. Industry oriented research should be encouraged."

"Minimum 6 months industrial experience after submission of thesis would give much benefit."

"Course work, seminar and dissertations are necessary. But all of these need modification. The topics/subjects must be related to industrial problems. Presently they are too theoretical to find any application in Indian industry."

"There should be some weightage to industrial training and the whole environment should be more oriented towards Indian conditions/problems and appropriate solutions to them."

"There is very little interaction between IITs and the industries. More and more sponsored projects are necessary to make the IIT education more effective."

3. Some respondents felt that the course work needed to be strengthened.

"More research level courses should be offered. Research programme is presently adhoc and needs to be streamlined."

"The standards of courses and lectures are not maintained in the sense that the latest state-of-the-art technology is not taught. The courses are still at the basic level. One expects that the postgraduates from IITs will be uptodate in knowledge. For this there is a necessity of the lecturer updating himself continuously which is not the case."

"Course work should be made more rigorous."

"Most of the courses are conducted at the basic level. Courses should be applied, field oriented. Quality of courses in terms of knowledge must be improved."

"I think the present formal requirements are satisfactory. However a good postgraduate programme should offer a wide choice of courses/seminars that a Ph.D. student can sit through informally. The present available choice is poor."

"Course work at Ph.D. level lacks vigour and creativity."

"A course on research methodology/evaluation of research projects can be included in the course work for Ph.D."

4. Some suggested that a broader range of courses should be offered and efforts should be made to provide some interdisciplinary courses. To increase awareness of ongoing research, some respondents suggested an increased emphasis on presentation of seminars at various stages of the Ph.D.

"The inter-group interaction in each of the departments has to be enhanced by way of asking the research students and faculty to give seminars on general topics of current interest. The intensity of discussion within a research group and between the groups should be enhanced."

"I feel seminars on selected topics, preferably from the subjects forming part of the doctoral thesis at various stages would go a long way in helping the doctoral aspirant to judge the progress of his work and get opinions from others."

5. Comments specific to departments:

Chemistry: Five respondents felt the need for improved instrumentation, reduced bureaucracy and courses on instrumentation techniques.

Physics: Four respondents complained about lack of adequate infrastructural facility.

Table 4.1 Did You Get the Field of Specialization of Your Choice? M.Tech. Alumni. (Question 17b)

Category	Yes	No	Not answered	Total
X	701	90	15	806
%	86.97	11.17	1.86	100.00
Y	113	12	2	127
%	88.98	9.45	1.57	100.00
Z	40	1	0	41
%	97.56	2.44	0.00	100.00
Total	854	103	17	974
%	87.68	10.57	1.75	100.00

Table 4.2 Relative Weightage of M.Tech. Programme (Question 17c)

Category	Satisfactory	Not satis-factory	Not answered	Total
X	227	9	570	806
%	28.16	1.12	70.72	100.00
Y	30	1	96	127
%	23.62	0.79	75.59	100.00
Z	12	2	27	41
%	29.27	4.88	65.85	100.00
Total	269	12	693	974
%	27.62	1.23	71.15	100.00

Table 4.3 Level of Expectations Met at IITB - M.Tech. Alumni (Question 17d)

Year of passing		Fully	Partially	Not at all	Not answered	Total
1973-77	Number	115	98	3	10	226
	%	50.88	43.36	1.33	4.42	100.00
1978-82	Number	131	173	3	16	323
	%	40.56	53.56	0.93	4.95	100.00
1983-87	Number	147	260	7	11	425
	%	34.59	61.18	1.65	2.59	100.00
Total	Number	393	531	13	37	974
	%	40.35	54.52	1.33	3.80	100.00

Table 4.4 Did You Get the Field of Specialization of Your Choice? Ph.D. Alumni (Question 17b)

Category	Yes	No	Not answered	Total
X	212	14	7	233
%	90.99	6.01	3.00	100.00
Y	32	0	2	34
%	94.12	0.00	5.88	100.00
Z	26	1	1	28
%	92.86	3.57	3.57	100.00
Total	270	15	10	295
%	91.53	5.08	3.39	100.00

Table 4.5 Relative Weightage of Ph.D. Programme (Question 17c)

Category	Satisfactory	Not satisfactory	Not answered	Total
X	67	1	165	233
%	28.76	0.43	70.82	100.00
Y	10	1	23	34
%	29.41	2.94	67.65	100.00
Z	8	0	20	28
%	28.57	0.00	71.43	100.00
Total	85	2	208	295
%	28.81	0.68	70.51	100.00

Table 4.6 Level of Expectations Met at IITB - Ph.D. Alumni (Question 17d)

Year of passing		Fully	Partially	Not at all	Not answered	Total
1973-77	Number	50	32	0	2	84
	%	59.52	38.10	0.00	2.38	100.00
1978-82	Number	52	45	0	4	101
	%	51.49	44.55	0.00	3.96	100.00
1983-87	Number	45	58	2	5	110
	%	40.91	52.73	1.82	4.55	100.00
Total	Number	147	135	2	11	295
	%	49.83	45.76	0.68	3.73	100.00

Chapter 5

CHAPTERWISE SUMMARY

Chapters 1 & 2: Introduction and Methodology

i. The average annual output of IIT Bombay (in terms of students obtaining various degrees) is at present about 700. Out of this, nearly half obtain the postgraduate degrees of M.Tech. and Ph.D.

ii. The present study is concerned with these postgraduate alumni. It has been undertaken with the following objectives in mind:

a. To analyze and obtain career profiles of postgraduate alumni of IIT Bombay.

b. To quantify the extent of the brain drain of the post-graduate alumni.

c. To obtain feedback on the curriculum undergone by the alumni with a view to judging its appropriateness and the need for modifications.

iii. The study has been conducted for alumni who obtained their M.Tech. and Ph.D. degrees from IIT Bombay over the fifteen year period from 1973 to 1987. It has been restricted to those who were full-time students receiving an Institute scholarship or those working as project staff. These number 2584 in the case of M.Tech. and 549 in the case of Ph.D. alumni. Sponsored students (e.g. QIP) and departmental staff have not been included in the study. Of the 549 Ph.D. alumni, 188 are from the engineering departments, 328 from the science departments, 30 from the H&SS department and 3 from the interdisciplinary programmes.

iv. A comprehensive effort was first made to locate the current address of as many alumni as possible. As a result, 1477 addresses constituting 57.2 percent of the population under consideration were obtained for the M.Tech. alumni, and 470 addresses constituting 85.6 percent of the population under

consideration were obtained for the Ph.D. alumni. Both these percentages can be considered to be very satisfactory in relation to the population sizes involved.

v. A questionnaire was designed keeping the broad objectives of the study in mind and posted to alumni whose addresses had been obtained.

vi. The total number of replies received to the questionnaire was 974 for M.Tech. and 295 for Ph.D. This is equivalent to an overall response rate of 37.7 percent for M.Tech. and 53.7 percent for Ph.D. alumni and is clearly large enough to draw reasonable inferences regarding the population as a whole. The distribution of the yearwise and departmentwise replies received from both M.Tech. and Ph.D. alumni indicate that alumni of all years and all departments are well represented in the responses received.

Chapter 3 Career Profile of the IIT Bombay Postgraduate

Categorization of Alumni:

i. The postgraduate alumni forming part of the study have been divided in three broad categories:

Category X : Alumni who have been essentially working in India after obtaining their M.Tech./Ph.D. degree.

Category Y : Alumni who are currently living abroad more or less on a permanent basis.

Caterory Z : Alumni who have been abroad for more than one year and who have returned to settle and work in India.

ii. The break-up of replies received from M.Tech. alumni is as folows: Category X - 806; Category Y - 127 and Category Z - 41. Total = 974.

iii. The break-up of replies received from Ph.D. alumni is as follows: Category X - 233; Category Y - 34 and Category Z - 28. Total = 295.

Personal and Background Information:

iv. Alumni were asked to indicate where they had done most of their schooling - in a village, a town, a city or a metropolitan city. 56.27 percent of the M.Tech. alumni indicated that they did most of their schooling in a city or metropolitan city. For Ph.D. alumni, the corresponding percentage was only 44.75. In contrast, data available on B.Tech. alumni from other sources indicate that 85.62 percent have a schooling background from a city or metropolitan city.

v. Similarly data on the educational background of parents shows that for M.Tech. alumni, 21.87 percent have both parents as graduates, while the corresponding percentage for Ph.D. alumni is only 11.19. In contrast, data available on B.Tech. alumni indicate that 52.51 percent have both parents graduates.

vi. For both M.Tech. and Ph.D. alumni, the highest percentage list their father's occupation as government/public service.

Location of Alumni:

vii. Based on an analysis of the current address list and the replies received, the categorywise break-up of M.Tech. alumni is as follows:

Category X - 82.3 percent
Category Y - 13.4 percent
Category Z - 4.3 percent

Thus 86.6 percent of the M.Tech. alumni have settled down in India and only 13.4 percent (constituting the brain drain) have settled abroad. A disciplinewise break-up indicates that the

highest brain drain is in Computer Science and Engineering followed by Electrical Engineering. An yearwise analysis shows that the brain drain of M.Tech. alumni was 12.1 percent for the time span 1973 to 1977. It increased slightly to 15.9 percent for the time span 1978 to 1982 and came down again to 12.1 percent for the period 1983 to 1987. From these small variations in percentages, it appears that the magnitude of the brain drain of M.Tech. alumni has not changed much over the years.

viii. The categorywise break-up of Ph.D. alumni is as follows:

Category X - 82.1 percent
Category Y - 9.8 percent
Category Z - 8.1 percent

Thus 90.2 percent of the Ph.D. alumni have settled down in India and only 9.8 percent (constituting the brain drain) have settled abroad. A disciplinewise break-up indicates that the brain drain from the engineering departments is 6.2 percent, while that from the science departments is 13.5 percent. An yearwise analysis shows that the brain drain of Ph.D. alumni was 5.7, 13.5 and 9.0 percent for the three time spans 1973-1977, 1978-1982 and 1983-1987. Thus there appears to have been an increase in the brain drain for the time period 1978-1982 and a subsequent decrease.

ix. Using corresponding data obtained in an earlier study on B.Tech. alumni, it is seen that the brain drain is highest amongst B.Tech. alumni (30.8 percent), somewhat less with M.Tech. alumni (13.4 percent) and still less with Ph.D. alumni (9.8 percent). The principal reason for the fact that the highest brain drain occurs amongst B.Tech. alumni is their better academic performance and ability. The strong urban bias in which most of them have grown up also influences their decision to settle abroad.

x. Based on the above estimates of the brain drain of B.Tech., M.Tech. and Ph.D. alumni (who constitute the bulk of the output every year from IIT Bombay), it is possible to make a good estimate of the overall brain drain. This comes out to be 21.4

percent. Thus in a typical year, 21.4 percent of the alumni who pass out of IIT Bombay are likely to settle down abroad, and 78.6 percent (approximately 4 out of 5) are likely to stay in India.

Academic Career and Professional Training:

xi. Data on the academic career of M.Tech. alumni prior to their Master's degree indicate that 18.28 percent obtained their B.Tech. degree from an IIT. Similarly for Ph.D. alumni, 25.42 percent obtained their B.Tech./M.Sc. degree from an IIT. These percentages show that a reasonable number of B.Tech./M.Sc. graduates of an IIT continue on for an M.Tech. or Ph.D. at an IIT.

xii. Data on the studies undertaken by M.Tech. alumni after obtaining the M.Tech. degree show that 81.31 percent do not undergo any further studies. Of the 18.69 percent who do undergo further studies, 5.13 percent do a Ph.D. in India, 3.70 percent do a Ph.D. abroad and only 4.93 percent go in for a postgraduate degree or diploma in management.

In contrast, the earlier study on B.Tech. alumni had shown that only 35.9 percent do not undergo any further studies, 1.0 percent do a Ph.D. in India, 11.2 percent do a Ph.D. abroad and a very substantial number (28.7 percent) obtain a postgraduate degree or diploma in management.

xiii. Alumni were requested to indicate the type of professional training undergone by them after obtaining their M.Tech. or Ph.D. degree. A break-up in terms of 'short duration' training (less than 6 months) and 'long duration' training (more than 6 months) indicates the somewhat disturbing fact that only 23.61 percent of M.Tech. alumni have undergone 1 or more stints of short duration and that only 11.40 percent have undergone training of long duration. For Ph.D. alumni only about 1 in 5 alumni have undergone training of a long or short duration.

Nature of Work:

xiv. Amongst M.Tech. alumni who passed out from 1973 to 1977, the largest number (34.96 percent) list their current professional status (CPS) as 'Executive/Manager'. The next largest number listing themselves as 'Industrialist/Entrepreneur' or 'Consultant (self-employed)' are running their own business and constitute 29.20 percent of the total. This is a very significant fact.

xv. Amongst Ph.D. alumni who passed out from 1973 to 1977, the largest number (33.33 percent) list themselves as 'Research scientist/Engineer'. They are closely followed by 'Academic researcher/Teacher' who constitute 29.76 percent of the total. The strong influence of the Ph.D. degree on the professional status is thus clearly seen. The percentage of those running their own business is small (9.13 percent), but not negligible.

xvi. A comparison of earlier data on the professional status of B.Tech. alumni with the above mentioned data on M.Tech. alumni shows that there are considerable similarities. With the B.Tech. alumni too, the largest number of alumni (38.5 percent) list themselves as 'Executive/Manager' with the next largest number (22.5 percent) running their own business.

xvii. An analysis of the sector of work of M.Tech. alumni indicates that the majority (61.60 percent) work in the private sector. A small number are working in educational institutions (14.17 percent), in the public sector (13.24 percent) and in Government service (9.65 percent). The data also show that with the passage of time, there is an increase in the number working in the private sector.

xviii. In so far as Ph.D. alumni are concerned, the data show that the largest number (41.36 percent) are working in educational institutions with the next largest number (31.53

percent) working in the private sector. These percentages do not change much if one considers only the senior set of alumni who passed out from 1973 to 1977.

xix. A comparison with the data on B.Tech. alumni shows marked similarities between the B.Tech. and M.Tech. data in so far as the sector of work is concerned.

xx. The mean annual income for salaried M.Tech. alumni in India (categories X and Z) who passed in the time span from 1973 to 1977 is Rs 73,467. It is Rs 65,466 for those who passed from 1978 to 1982, and Rs 49,137 for those who passed from 1983 to 1987. A further break-up in terms of the sector of work shows that incomes for those working in the private sector are the most. They are followed by alumni working for the government or in the public sector. Alumni working in educational institutions have the lowest incomes. The differentials in incomes between the various sectors are also seen to increase with the passage of time.

xxi. For salaried Ph.D. alumni in India (categories X and Z), the mean annual incomes for the three time spans are Rs 77,248 (1973-77), Rs 60,946 (1978-82), and Rs 52,219 (1983-87) respectively. In terms of the sector of work, the trends observed are similar to those described above for M.Tech. alumni.

xxii. Comparing the annual incomes of salaried M.Tech. and Ph.D. alumni in India, one sees that in each time span and in every sector of work (excepting the 'educational institution' sector), Ph.D. alumni have incomes higher than M.Tech. alumni. As far as B.Tech. alumni are concerned, an approximate comparison of incomes with M.Tech. alumni shows that M.Tech. alumni have slightly higher incomes.

xxiii. An analysis of the major duty in the present work being done by M.Tech. alumni shows that the largest number (50.62 percent) are engaged in teaching/R&D/design. The remaining are

almost equally engaged in production/maintenance/trouble shooting/construction/erection/commissioning (13.14 percent), in consultancy/EDP/computer (15.30 percent) or in some aspect of management like marketing, finance, etc. (15.20 percent).

xxiv. As far as Ph.D. alumni are concerned, an even larger number (76.61 percent) are engaged in activities like teaching/ R&D/design, with correspondingly smaller numbers in all the other activities.

xxv. It appears therefore that the majority of M.Tech. and Ph.D. alumni continue to work essentially in the area of their specialization rather than drifting towards management. This is quite unlike what has been observed for B.Tech. alumni, a large number of whom (particularly in categories X and Z) list their major duty as some aspect of management.

xxvi. Data on M.Tech. alumni who are running their own business indicates that over 90 percent of them started the business on their own. The average annual turnover of the companies being run is Rs 26 lakhs and the average number of employees is 19. In most cases, the nature of the business being conducted is either 'Production/Manufacturing' or 'Consultancy/Project Planning/ Execution'. Only a few are engaged in running businesses involving 'Marketing/Trading'.

xxvii. In case of Ph.D. alumni running their own business, the data show that nearly 90 percent of them started their own business. The average annual turnover is Rs 122 lakhs and the average number of employees is 19. The nature of business being run is similar to that observed for M.Tech. alumni.

Chapter 4 Feedback on the IIT Bombay Programme

i. When asked about the extent to which their level of expectations were met, 40.35 percent of the M.Tech. alumni said that their expectations were fully met. A slightly larger number

(54.52 percent) said that their expectations were only partially met. A very small number (1.33 percent) felt that their expectations were not met at all.

ii. Respondents were also asked to comment on the M.Tech. programme and to suggest modifications in the light of their experiences. Many respondents felt that the basic M.Tech. curriculum was balanced in terms of course work, seminars and the thesis, and that the programme had given them confidence to tackle diverse problems. However they also felt that it was necessary to make the programme more relevant to the needs of Indian industry. This could be done by ensuring that the thesis topics were based on industrially relevant problems and by emphasizing applications and examples from industries in the course work.

iii. 49.83 percent of the Ph.D. alumni felt that their expectations were fully met while completing the Ph.D. programme, while 45.76 percent felt that their expectations were partially met. A small negligible percentage felt that their expectations were not met all all.

iv. Like M.Tech. alumni, many of the Ph.D. alumni also felt that the Ph.D. programme should be made more relevant to the needs of Indian industry.

Appendix I QUESTIONNAIRE AND COVERING LETTER

I.1 Covering Letter

Mechanical Engineering Department
Indian Institute of Technology
Powai, Bombay, 400076, India

April 15, 1989

Dear Alumnus,

This letter and the enclosed questionnaire are being sent to you as part of a study being conducted at the Indian Institute of Technology, Bombay on the Location, Nature and Work and Placement of its Postgraduate Alumni. As you are probably aware, IIT Bombay was established in 1958. During the thirty years of its existence, about 4000 students have obtained their M.Tech. degrees and more than 1000 have obtained their Ph.D. degrees. These constitute a significant fraction of the national output. It appears appropriate therefore, to take stock. Hence the present study, which is sponsored by the Department of Science and Technology, Government of India.

One of the objectives of the study is to find out where our postgraduate (M.Tech./Ph.D.) alumni are presently located and what they are doing. Among other things, we are also interested in knowing the nature and the type of work being done by our alumni, the position occupied, and the training or studies undergone before and after leaving IIT Bombay. We are also keen on obtaining some feedback from our alumni regarding the relevance of the curriculum which they had undergone here.

We believe that the results of the study would enable us to view the role of an IIT in its proper perspective and be of great value to the Institute in planning its future postgraduate activities. In order to keep the numbers involved within bounds, the present study includes only regular unsponsored students who obtained their Ph.D/M.Tech. degrees during the fifteen year period from 1973 to 1987. This itself involves about 600 Ph.D. and 2500 M.Tech. alumni. You are an alumnus of the above period and hence this letter. It is needless to state that your reply would be kept confidential and the information supplied by you used only for the purpose of this study. Complete anonymity of all individual respondents as well as that of their organization will be maintained in our research report.

We estimate that the questionnaire will not take more than 20 minutes of your time. Your response will be extremely valuable. Please do spare the time. Any comments or suggestions on the study would be most welcome.

With best wishes,

Yours sincerely,

Sukhatme

(S.P. Sukhatme)
Mechanical Engg. Dept.

I.2 Questionnaire

NATURE OF WORK AND PLACEMENT OF POSTGRADUATE ALUMNI OF THE INDIAN INSTITUTE OF TECHNOLOGY, BOMBAY (1973-1987)

1. Name :

2. Year of obtaining postgraduate degree from IIT/B:

   Department/Interdisciplinary programme :

3. Date of Birth:

4. Address for correspondence:

5. Telephone - Office :

   Residence :

6. Sex : Male/Female

7. Marital Status : Married/single

8. Academic Career

   Please give particulars of all degrees/diplomas obtained commencing with graduate degree. (Include IIT/B degrees)

Sr.No.	College/Institution	University	Examination/ Degree/Diploma	Year From	Year To	Field of specialization

9. Professional/Practical Training

Have you undergone any professional/practical training? Yes/No
If yes, please give the details.

Sr.No.	Institution/Organization	Duration	Year	Field/Specialization

10. Job Profile

Please give particulars of jobs held in chronological order. (Starting from the first job)

Sr.No.	Name and place of the employing organization	Designation	Date of joining	Date of leaving	Remarks, if any

11. Current Job

(a) Type of employing organization : Government/Public Sector/Private Sector/ Educational Institution/Other (specify)

(b) Gross annual salary with perquisites:

12. Which of the following predominantly fits your current professional status? (Tick only one)

a. Practising engineer	( )	e. Academic researcher/Teacher	( )
b. Research scientist/Engineer	( )	f. Consultant (Self-employed)	( )
c. Executive/Manager	( )	g. Consultant (employee)	( )
d. Industrialist/Entrepreneur	( )	h. Other (specify)	( )

13. Are you working in the same field for which you were trained at IIT/B? Yes/No
Please describe your present field of work.

14. Which of the following would you consider to be your major duty/duties in your present job? (Check one or more, rank if more than one).

		Rank			Rank
a. Teaching	( )	----	h. EDP/Computer	( )	----
b. Research and development	( )	----	i. Project planning	( )	----
c. Design	( )	----	j. Marketing	( )	----
d. Production	( )	----	k. Finance	( )	----
e. Maintenance/Trouble shooting	( )	----	l. Personnel management	( )	----
f. Construction/Erection/ Commissioning			m. Industrial management	( )	----
			n. General management	( )	----
g. Consultancy	( )	----	o. Any other (specify)	( )	----

15. Are you a member of any professional societies? Please list.

16. In question 12 have you listed your status as Industrialist/Entrepreneur/Self-employed consultant? If so,

    a. Name of the company/consultancy firm :

    b. Year of establishing the business : d. Number of employees :

    c. Annual turnover : Rs e. Nature of business :

17. Feedback on IIT/B Programme

    a. Reasons for joining IIT/B for postgraduate studies.

    b. Did you get the field of specialization of your choice? Yes/No

    c. The IIT/B programme consists of course work, seminars and a dissertation/thesis. Based on your experience after leaving IIT, please give your assessment on these aspects of the programme. Is their relative weightage satisfactory? Also please suggest any modifications (including new courses).

    d. Level of expectations met at IIT/B : Fully/Partially/Not at all
    Please elaborate.

    e. IIT/B organizes a number of short term training courses throughout the year as part of its Continuing Education Programme. In which specific areas would you like such courses to be run?

18. Background Information (Tick one)

a. Please indicate the location where you have done most of your schooling: Village/Town/City/Metropolitan City

b. Education of par ents	Father	Mother
Postgraduate	( )	( )
Graduate	( )	( )
High School	( )	( )
Lower	( )	( )

c. Parents occupation (when you joined IIT/B)		
Agriculture	( )	( )
Business	( )	( )
Medical	( )	( )
Engineering	( )	( )
Law Practice	( )	( )
Public/Govt. Service	( )	( )
Private Service	( )	( )
Teaching/Research	( )	( )
Housewife		( )
Others (specify)	( )	( )

19. Please give your consent for inclusion of your address and telephone number in the directory under preparation. Yes/No
Would you like to receive a copy? Yes/No

20. If possible, please give the name, current address, year of passing and department of some other alumni (M.Tech. or Ph.D.) to whom this questionnaire could be sent.

21. Any other comments.

Appendix II

DESCRIPTION OF FIELD OF WORK

In Question 13, alumni were requested to describe their present field of work. Representative samples of these descriptions are given below in the form of direct quotes. These give a good idea of the wide-ranging and interesting nature of the work being done by alumni.

II.1 Comments of M.Tech. Alumni

Aeronautical Engineering:

"I teach courses in Aerospace Propulsion along with other subjects like CFD, Simulation and Optimisation, etc."

"Stress analysis of structural components of aircraft. Earlier worked on helicoper structural components and HDB."

"As a group leader of product evaluation group in R&D of 2-3 wheeler industry, job involves field and lab. testing of components and vehicles."

"Working in the field of (1) High angles of attack aerodynamics, (2) After body flow management, (3) Design of strain gauge balances, (4) Helicopter aerodynamics."

"Aerodynamics and stability and control aspects of aircraft design."

"I am working in the flight control group. I was involved in designing the PCS architecture of LCA. Now I am involved in designing the actuator for LCA and other activities like computer generated imagery, ECM/EMI."

Chemical Engineering:

"I am running a paper pulp moulding unit to make egg trays, apple trays. I am a machinery supplier for making egg trays, apple trays, and render detailed engineering consultancy services."

"Manufacturing heat exchangers."

"Incharge of glass manufacture, control of composition of glass. Incharge of glass melting furnace, its control and efficiency. Also training of local manpower."

"Process development and design, project planning, implementation and commissioning - in polymerization and organic process industry."

"Manager (Tech. services) Polyethylene Plant. My experience covers design, engineering, production and now technical services. The basic knowledge has been the backbone."

"Proprietor of company manufacturing metering/dosing pumps."

"Manufacture of air pollution control equipments."

"Presently dealing in the field of energy conservation and graphics software."

"Process design of heat transfer equipment, waste heat boilers, deaerators. Commissioning/trouble shotting of above equipment."

"During my M.Tech. project, I designed, erected and commissioned/tested a vertical shaft kiln to produce rice husk cement. Based on the same technology, I have since successfully commissioned 5 mini cement plants in Maharashtra. Presently, I am working on mechanised brick plants."

"Optimization and control of polymerization processes."

"Computer applications in chemical engineering - simulation, design, control of chemical processes."

"Energy management in steel plant, i.e. controlling of fuels, utilities, and power distribution among the various departments of steel plant, by making optimum balance of fuels, utilities and power respectively."

"Membrane science, development of new membranes and new applications for membrane based separation technology."

Civil Engineering:

"Consulting engineer in the field of foundation engineering."

"Manufacturing construction chemicals."

"I am a consulting engineer in the field of Structural Engineering. I design buildings, factories, bridges, etc."

"At present I am planning and designing canals, canal structures, etc. I am combining both hydraulics and structures in my job."

"I am working as executive engineer in the irrigation department of the Govt. of Maharashtra."

"Developing computer software for structural engineering applications. Carrying out structural design for RCC/steel."

"Design of RCC and structural steel buildings, factories, sheds. Design of underground and overhead water tanks, cable joint pits. Design of transmission line towers."

"I got M.Tech. in Civil Engineering with specialization in geotechnical engineering. But presently my work is not restricted to geotech engineering. I also do other civil engineering works like RCC designs."

"I teach and do consultancy in the field (i.e. soil testing and foundation design) in which I was trained at IITB."

"All works related to civil engineering renewal and maintenance of railway lines, buildings, etc."

"Remote sensing applications in water resources study."

Computer Science and Engineering:

"Development of software in the areas of graphics, animation, computer aided instruction, systems software."

"CAD/CAM and MIS related s/w development."

"Design and development of computer peripherals. Design, consultancy for CAD/CAM. Execution of turnkey projects."

"Software systems design and development. Areas: Database systems, communications, CASE tools development."

"Development of CAD tools for VLSI design."

"I was trained for system software but am working in a data processing environment."

Electrical Engineering:

"Development of coherent transmitter for precision coherent monopulse radar."

"I am heading the work in thick-film hybrid microcircuit fabrication."

"Ultrasonic imaging and image processing."

"Design of electronic instruments."

"I do VLSI design of electronic circuits."

"At present manufacturing electrical stampings for small transformers, submersible pumps, scooter magneto stampings, F.H.P. motors, etc."

"I am heading a team responsible for the entire installation of satellite communication equipment for domestic network in the entire southern zone including Andaman and Lakshadweep Islands."

"At present I develop microwave devices and components for high power solid state applications. Fully familiar with microwave/monolithic integrated circuit technology."

"Development of microprocessor based products in the field of testing (automatic test equipments)."

"General area is digital signal processing. Multidimensional and speech signal processing. Adaptive and iterative algorithms."

"Designing hardware for microprocessor based systems, and software development."

"I graduated as a communication engineer from IITB. Now I am working as R&D engineer developing telecom switching products."

"Design and manufacture of instrument and other special types of transformers."

"Designing new tools for design of VLSI chips and designing VLSI chips."

"Development of circuits for TV/radio/telephones using Philips ICs. These circuit concepts are offered to manufacturers free of cost."

"I am involved in the design and development of electro magnetic launchers. Electromechanics would describe the area quite aptly."

Mechanical Engineering:

"Design and development of special purpose machines, import substitution, proving trials after prototype manufacture."

"Design and engineering of thermal systems."

"HVAC (heating, ventilation and air conditioning) projects execution."

"Overall responsibility of production and quality of 400 tons/ month cast iron foundry along with complete administration of foundry."

"I do technical marketing for air conditioners and water coolers. Also coordination activity between production, marketing and service."

"Engine design and development (I.C. Engines)."

"Design of boilers for sugar factories. Work also involves estimation and project activities. Also dealing with design and development of bubbling and circofluid fluidised bed boilers."

"Development of packaging machinery and gold chain manufacturing machines."

"Operation of thermal power plant (500 MW unit)."

"Design and development of air cooled heat exchangers such as oil cooler, inter cooler, after cooler, industrial and automotive radiators, and water cooled heat exchangers."

"Mechanical design of metal forming machine tools."

"I am concerned with the process design of various heat transfer equipments."

"Experimental and theoretical stress analysis. Development of computer software for stress analysis. Design of pressure vessels, heat exchangers, etc."

"I am engaged in manufacturing different ferrite products."

"Design, supply and commissioning of our brand 'Perfect Drip Irrigation Systems'. Manufacturing of drip irrigation equipments, pesticide spraying equipment."

"1. Establishing production lines of new products. 2. Procurement of capital equipment, like CNC machines, assembly equipment, etc."

"My present field of work includes manufacturing and marketing of cold roll formed sections and systems."

"Machine tool design, tooling and fixture design, CAD/CAM."

"Manufacturing bright steel bars. Looking after sales, purchase, production, administration, etc."

"Maintenance of thermal power station. Planning and execution of preventive, day-to-day and break down maintenance of machinery."

"Design and development of mechanical components and systems for new xerographic equipments."

"Process engineering for manufacturing of pressed parts and printed circuit boards."

"Design of special purpose machines, tooling and development work."

"Design and development of automotive suspension, steering and brakes."

"The present field of work predominantly consists of project monitoring and execution, cost monitoring, vendor development."

"Design and development of automated laboratory systems. Current project involves extensive use of robots and other computer-controlled machinery, integrated through a mainframe computer."

"My present work is dealing with repair and maintenance of high pressure hydraulic machines used in oil exploration work."

"I look after engine development and design of 2 stroke and 4 stroke motorcycles."

Metallurgical Engineering:

"Carry out research work on the development of materials for nuclear applications and their characterization for their mechanical behaviour."

"Since I had my basic training in the powder metallurgy field at IIT I am presently giving consultancy for the manufacturing of reduced grade iron powder and also marketing the same along with a few other products."

"Sales of carbon, alloy, stainless and tool steels."

"Production of welded stainless steel tubes."

"My field of specialization was in reaction sintering of silicon nitride. The present work is concerned with alternate automotive materials like FRP and ceramic type materials. In addition knowledge of conventional materials used for vehicle manufacturing is required."

"Manufacturing copper based alloy castings."

"My work involves possibility of developing new grades of steel, by appropriate alloy design, and also lending technical support to the foundry division as and when required."

"Presently I am working in the field of ancillary development of automobile components."

"Research on deformation behaviour of some nuclear structural materials."

"I am working in an invest ment casting foundry as a metallurgist. I am looking after laboratory, melting and heat treatment. Castings are mainly of various grades of steel."

"I am doing business in production of pressed parts from sheet metal."

II.2 Comments of Ph.D. Alumni

Aeronautical Engineering:

"Teaching and research in aerodynamics."

"Teaching and research in the area of control engineering."

Chemical Engineering:

"The present field of work involves the design, manufacture, erection and commissioning of specialized equipment for chemical, mineral and metallurgical processes. They are all tailor made to replace old equipment with a view to reduce labour, save energy, control pollution, improve performance and quality of product."

"General management and project planning for modernization and expansion of a sugar unit."

"My specialization at IITB was in the field of organic process industries and reaction kinetics and catalysis. I am using my knowledge for various design and consultancy assignments."

"Process engineering for chemical, petrochemical and fertilizer plants."

Chemistry:

"Manufacturing pharmaceutical products (Ayurvedic)."

"Marine pollution studies."

"Phytochemistry/synthetic chemistry/cancer chemotherapeutics."

"Macromolecular structure determination using x-ray crystallographic methods."

"Teaching and doing research on coordination compounds of dithioligands."

"Physical chemistry of surfactants."

"I am working presently in the field of asymmetric synthesis. This is one of the active branches of organic chemistry."

"I am working on the discovery of novel pesticides."

Civil Engineering:

"Computer and structural engineering applications, FEM, statics and dynamics of different kinds of structures, etc."

"Remote sensing applications to various subdisciplines of geology."

Earth Science:

"Mineralogy and microstructure of cement, refractories, concrete and other related raw materials for quality control and product development/improvement."

"I am working on problems of Himalayan geology, i.e. trying to solve some of the age and stratigraphic controversies in Himalayas."

"Exploration for oil and natural gas."

Electrical Engineering:

"Control system applications to aircraft."

"Digital signal processing."

"Solution of electromagnetic field problems using finite element method."

"Research and development in LSI/VLSI device technology. Improvement in process and specs of ICs. The reliability and failure analysis of ICs."

"Taking up projects in electronic engineering areas with emphasis on power semiconductor devices."

Environmental Science:

"Consultancy work in the area of water supply, sewerage, air and water pollution control, environment impact assessment studies."

Humanities & Social Sciences:

"Teaching and research in sociology with specialization in population studies."

"Training, research and consultancy in the area of human resources management for the entire banking industry in India."

"Trying to build a macroeconometric model for the Indian economy."

Mathematics:

"I have been engaged in development, research in aeronautical field with special emphasis on flight mechanics and control of aircraft."

"Software preparation for oil reservoir engineering studies; reservoir simulation."

"Doing and conducting research in the broad field of numerical analysis."

"I obtained Ph.D. in mathematics. But presently I am working in pattern recognition, digital image processing and application of expert system to remote sensing and geographic information system development."

"Teaching, research in the field of wave propagation and fluid flow."

"Development of mathematical models and corresponding software for oil exploration and exploitation."

"In addition to research in the area of spectral approximation (IITB), I also work in the area of operator equations."

Mechanical Engineering:

"Research and development in machine tools and testing machines."

"Industrial Engineering and Operations Research, manufacturing management and policy, manpower planning, environmental management, project management."

"We are developing, manufacturing and marketing solar energy equipments for domestic and industrial applications."

"Work involves development of a general purpose fluid dynamics software with a team of engineers for application to a wide variety of industrial problems. Also consultancy work."

"Automation and mechanisation including robotics/CAD, CAM."

"Design and engineering of fluidised bed boilers and other flurosolid systems, from marketing to commissioning including all detail engineering and development."

Metallurgical Engineering:

"Started career in refractory applications and corrosion protection. Presently running an organisation handling turnkey projects to the tune of Rs.10 crores."

"Teaching physical metallurgy, powder metallurgy, mechanical metallurgy, engineering materials, x-ray diffraction, etc. Research in the field of diffusion, sintering, composites, high temperature deformation."

"Corrosion problems in SAIL steel plants."

"Development and production of tungsten carbide products. Process control, quality control, raw materials planning and manpower control. Technical services to marketing staff."

"Advanced research on high temperature materials."

Physics:

"Teaching - Materials science. Research - Electronic materials."

"Particle physics and field theory."

"Experimental study of oxide superconductors; hyperfine interactions; teaching and laboratory development programme for M.Tech./B.Tech. students."

"Working on thin films and materials for magneto-optical recording technology which is used for high density data storage."

"Dynamical systems, phase transitions and bifurcations, space groups."

"X-ray protein crystallography."

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Finally I would like to thank all our alumni who have responded carefully and constructively to the questionnaire. It has been a pleasure corresponding with many of them.

Suhas P. Sukhatme

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