DESIGN OF AN INSTITUTE INDUSTRY INTERFACE WITH PARTICULAR REFERENCE TO POLYTECHNIC EDUCATION IN INDIA

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UNDER THE SUPERVISION OF

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CERTIFICATE

This is to certify that the thesis entitled **"Design of an Institute Industry Interface with particular reference to Polytechnic Education in India"** and submitted by Shakti Singh, ID No. 87PHXF005 for award of Ph.D. degree of the Birla Institute of Technology and Science, Pilani, embodies original work done by him under my supervision.

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CHAPTER-ONE

INTRODUCTION

1.1 Linking Education – Workbench : A Long-felt Educational Need

Industry-Institute linkages, central to integrating education and industrial production processes, are designed and administered at higher levels of education [25]. They may be used for economic development and social transformation, must necessarily be introspective and play their own critical role in student training and employment. Their particular importance at the polytechnic level can not be over emphasized because, among other things they define the employment value of the students of the traditional technician-training system to an industrialised and modernised economy. It is this aspect that has led many to think about the polytechnic-industry linkages [15] Many methods of reforms over the traditional technical education system have been implemented and practised to make the technician's education more meaningful and relevant. But the results are far from the expectations of the planners. One of the major steps to reverse this unsatisfactory situation is to adopt for implementation the co-operative education system at the polytechnic level. In the recent decades, India has made commendable efforts in the growth of the industrial sector. To cope with the demands for technical manpower of the industry, technical education has also made phenomenal growth. However, the growth in these two important sectors has been parallel and independent without linkages between the two. Consequently, a considerable degree of distrust on the support expected from each other has crept in. They, quite often, blame each other for various consequential ills. Whatever may be the drawbacks in the present system of technician's education, "The most important and urgent reform needed in education is to transform it, to endeavour to relate it to life, needs and aspirations of the people and, thereby, make it a powerful instrument of social, economic and cultural transformation necessary for realisation of national goals. For this purpose, the education should be developed so as to increase productivity, achieve social and national integration, accelerate the process of modernisation and cultivate social, moral and spiritual values" [10].

In the wide spectrum of technical manpower required by the industry, the technicians play a crucial role acting as a liaison between the engineers, technologists or managers at one hand and the skilled crafstmen at the shop floor level on the other. In order to produce the right type of technician by polytechnic, the education, the learning experience, is to be provided to the students at two places, namely, the polytechnic and Industry. Conceptually, a close relationship and spirit of partnership should exist between the polytechnics and Industries [13]. A close relationship means harnessing the resources of industry to those of polytechnics and integrating the act of learning with the content of action to impart optimum education.

The collaboration between higher technological institutions and the industry has different dimensions compared to the polytechnic-industry collaboration. In the former instance, the industry looks up mainly to supply and supplement their research and development requirements. As far as the polytechnics are concerned, the industry looks for properly trained manpower to meet the operational requirements. Naturally, the type and depth of collaboration of industries with these two types of educational institutions vary depending on the objectives and expectations [37].

The polytechnic-industry collaboration would centre around training the right type of the technicians for the industries. In this effort, the polytechnics and industry need to co-operate in identifying the manpower requirements, type and nature of training. While the industries can extend training facilities to students and teachers from polytechnics, the polytechnics on their part can make the curriculum more relevant, run specialised courses, conduct refresher courses etc. This linking of education to industry results in a change in the learning processes learning through working on real life problems, learning by practice, learning not only the subjects but also decision-making and learning to exist, live and grow in real life situation [31].

It is against the above frame of reference that section 1.2 presents the various methods of linking the work-bench with polytechnic education system.

1.2 Educational Methods for Linking Workbench-Institute with reference to Polytechnic Education

Many forms of co-operative education have developed and operated all over the world. The following could be cited readily. These models are based on application of concepts of use of education at various levels and, therefore, present different degrees of approximation of co-operative education.

1.2.1 Practical In-plant Training of Students

The practical inplant training is to co-relate theory and practice, and through this training the students are exposed to the industrial environment, in respect of : worker's psychology, factory discipline, production, quality control, coordination, etc., and the various constraints of time and cost situation. The proper supervision and follow-up by the teachers to ensure that the students receive the appropriate practical training during the period of training is missing in the present system, and this tells the pedagogic limitation of training.

1.2.2 Apprenticeship Training

The apprentice training is a course of training in any industry or establishment in persuance of a contract of apprenticeship and under-prescribed terms and conditions, which may be different for different categories of apprentices. In this method of training, the complete professional education is by apprenticeship with formal education system having almost no responsibility in the context.

For the preparation of the professions there are always two dimensions viz. theory and practice. Under the apprenticeship system the accent fell on the practice, often of mechanical kind, this by itself then tells the pedagogic limitations of training.

1.2.3 Sandwich Programmes

Sandwich programmes provide a mode of professional education in which 'off-campus' training interwoven between campus based study periods is part of the overall extended period of study. These programmes do not imply a one-to-one correspondence of theory to every practical instance, but it is a study which is illustrated by the applications of fundamental principles within the student's practical training in industry. Thus, here, industrial personnel fulfil the role of day-to-day instructors, while teachers visit the industry of training on few occasions [16].

1.2.4 Vocational Training

The vocational training directs to develop the particular skill and related knowledge required for a specific occupation or group of occupations. There is, as yet, no efforts to develop a comprehensive philosophy of vocational education which relates the manpower training to the needs of economic development and also social development. In the total vocational education structure, the main burden of vocational training is required to be taken by the employers, through on-the-job training. Unless it is integrated closely with the vocational education provided by the institutes, it's total effectiveness inclusive of needs of transferable skills can not be felt and this tells the pedagogic limitation of training.

1.2.5 Industrial Consultancy and Research

The industrial consultancy and research acts as a link between the industry and institute and seeks to promote effective utilization of the facilities and competence available at institute by the industry. Industry may also support other research and development projects undertaken by the institutes. The industrial consultancy services by technical insitutions result, among other things, in :

i) acquaintance by teachers of field problems ;

ii) acquisition by teachers of competence and confidence in solving these problems ;

iii) motivation to teachers to improve professional knowledge and skill.

Consultancy to industry causes teachers to remain in a constant state of development. Consultancy services by technical institutes also enable them to generate resources which can be used for institute development including faculty development. National Policy on Education 1986 states : "Institutes will be encourged to generate resources using their capacities to provide services to the community and industry. They will be equipped with upto date learning resources, library and computer facilities 6.15 (ii)" [23]. Thus industrial consultancy helps in interacting the institute faculty with the industrial experts.

1.2.6 Continuing Education of Industrial Personnel

Continuing education programmes provide effective means of sustaining professional development for those in industry by enabling them to acquire new knowledge and skills for meeting responsibilities. They have become an essential resource for developing professional skills and preventing technical obsolescence. They call for acquiring new knowledge and skills by working technicians and engineers, and towards this organise seminars, workshops and training course for the concerned personnel in industry. Conducting of these courses is a pedagogic challenge to technical planners and it also requires them to remain abreast of current field practices and ultimately results in more practical-oriented curricular experiences being offered by them to students at diploma and undergraduate levels.

1.2.7 The Industrial Exposure of Faculty

The industrial exposure of the faculty helps in teaching a more realistic and meaningful information and gives an industrial orientation to teaching. Such training results in :

i) giving teachers exposure to field environment and to the present state of art at the work bench.

ii) making teachers familiar with materials and processes used and products manufactured in concerned industries.

iii) exposing teachers to the operation of specialized plant and equipment which educational institutions do not have.

iv) Providing teachers an opportunity to observe people on the workbench, their work habits and factory discipline.

v) enabling teachers to observe the size and scale of operations in the field.

vi) creating among teachers appreciation of co-ordinated effort in an industrial setting of various persons at different levels.

vii) making teachers aware of the job responsibilities of teachnicians and engineers in industry.

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1.2.8 Practice School

Practice school establishes closer interaction between the academic and the industrial world. The practice shcool requires the students of engineering, science and humanities to practise their profession during the educational years. Unlike the sandwich programme, in the practice school system of education, the students and teachers drawn from different disciplines, involve themselves in inter-disciplinary mission, and goal-oriented real-life problem-solving, making improvements and serving immediate needs pertaining to production, design and development, planning, and ultimately, social action. Besides, it increases the job performance and proficiency, improves the employability, develops the interpersonal relationship, brings the institute near the industry and vice-versa and ultimately the student is able to see the relevance of his learning in the institute with the job in the field and inculcates a greater sense of responsibility and pride of his efforts, independence, judgement and development of maturity. The Practice School pattern of education demands greater academic effort from students, time for which is judiciously covered by making use of vacations, thereby keeping the overall study period more or less equal to the normal [36].

1.3 Issues involved in the Study

Thus, as can be seen, the reform of industry-institution linkage is a multifaceted concept involving teachers, students, employers, and industry. This, in turn, presents many issues of its organisation with reference to questions of curriculum modernisation for rapidly changing technology at the work place, training of teachers, R and D linkages, prior preparation of students, preparedness of employer in participating in linkages, inputs from industry, etc., and, therefore, particularly in respect of role of these constituents in this co-operating endeavour.

1.3.1 Role of Institute

i) No proper mechanism for revision of curriculum exists in institutions with the advancement of technology in the world of work. The institute can develop such mechanism which up-dates the curriculum with the new emerging areas and advancement in technology by creating links with industries.

ii) Various faculty development programmes existing are not effective due to in-adequate number of faculty, needed even as per curriculum.

iii) Persons with right aptitude for various faculty positions are not attracted due to the absence of promotional avenues, social and financial status, and higher learning outlets.

iv) Industries and R and D Institute's developing technologies, have no links with the polytechnic, for the technician-training requirements of industry to facilitate technology diffusion at the work-place; resulting in polytechnic having no locus-stand in R and D user chain.

v) Exchange of faculty between institute and industry is not existing at present as polytechnic faculty is not able to cope with the knowledge and skill requirements of the industry. Consequently, Industries are unable to spare their experts to the institute to facilitate faculty training in technology of industrial interest.

vi) Students' intake in the polytechnics is hetrogenous in nature, i.e., students come with varied preparations, like matric, 10+2, certificate from Industrial Training Institute and Junior Technical Schools, etc., in turn having different levels of knowledge and skills and there is no provision in the institutes to admit them according to their prior preparation levels.

vii) There is no mechanism to take the feedback from the passed-out students due to which the effectiveness of the transfer of learning in the world of work is not known to the institute.

viii) At present the creative problem-solving attitude is lacking in curricular design study.

ix) The environmental changes are taking place very abruptly due to fast developments in science and technology which, in turn, affects the modes of living. A new situation has been created for which all institutions have to respond appropriately and positively.

x) The education imparted by polytechnics is less relevant in national context. This is amplified by the observations made by the academic circles that the polytechnics are becoming nothing more than certifying agencies. Examinations tend to become a mere formality and a routine rather than an academic affair [22].

1.3.2 Role of Industry

i) The development of the country depends largely upon the industrial growth in respect of its production in general and emerging areas of technology in particular. As per the national policy, the manpower requirement in a middle level management, i.e., of technician level is to be met by the polytechnic education. The industries after taking the manpower from the polytechnic, further impart a training to the trained technicians of the polytechnic for the suitability of their world of work. Obviously, this implies that there is a gap between the polytechnic and industry. In order to save the time and money of the industry for retraining of technicians, they can have some system for industry-institute interaction to overcome the problems arising out of the advancement of science and technology.

ii) The highly-skilled technicians in the world of work do not have provision to take technical education of a higher level to assume higher responsibilities and it obstructs occupation mobility in the industry. A group of industries in the vicinity of polytechnic can interact with the institute to develop curricula according to needs.

iii) With the advancement of the technology, the needs of the humanity vary to achieve betterment of their economic life which directly depends upon the quality of the products available in the market, which have direct linkages with the man-power involved in the production of those products. The industry by its participation in linkages with institution can play a role to overcome this problem.

iv) The exchange of experts from the world of work and the faculty of the institute is almost non-existent, resulting in non-utilisation of the expertise available on both sides. The industry can impress upon the policy-makers at the national/state level to have such linkages.

v) Presently, technicians coming out from the technical institutions are job-seekers rather than problem-solvers of the industry. The current industrial sickness in small-scale industries, particularly in India, is due to the lack of well-qualified and adequate entrepreneurial manpower. Therefore, the industry can also associate itself with the educational institutions to have the manpower of their requirement.

1.3.3 Role of Teacher

i) Teachers cannot interact with the world of work directly as there is no institutional support to undertake such activities at the polytechnic level which discourages the creative and innovative attitude of the teachers. The teachers need to select such projects for the students which can associate them with industries to solve the problems of world of work.

ii) With the rapid advancement in science and technology the curriculum updating is most essential to have symbiotic relationship between education and technological advancements. Interface centres should be created and strengthened by the teachers in consultation with the institute and industry to have access to the latest technological and relevant data.

iii) The traditional lecture method is still continuing as instruction imparting medium, which has the lower communication capabilities than the other instructional methods like learning by doing, seeing is believing, audio-visual methods etc. The teachers can develop as per curriculum such instructional media which can communicate knowledge and skill required for the world of work.

iv) The technicians qualified from the polytechnic are incapable of taking entrepreneurial activities, i.e., self-employment, and are lacking in confidence, proficiency and communicating abilities for meaningful participation in the changing environment of the world of work. In this context the teacher needs to respond to following challenges :

- Train the student to acquire skills and the necessary cognitive, affective and psychomotor abilities.
- Revise and up-date curriculum, develop appropriate instructional resources, design and implement instructional delivery systems for education-work linkages.
- Monitor and evaluate the entire instructional process to ensure its relevance.
- Teach open-ended problems related to world of work.
- Co-ordinate theory with practice to relate technical knowledge with work in industry and to elaborate the complementary

functions of technical institutes and industry.

- Identify those factors which influence the choice of innovations for industry-institute interaction and understand the strategies devised for implementing the innovation and the benefits expected.

1.3.4 Role of Student

i) Students do not make the full use of the resources available in the institute as they believe in passing the course and not in acquiring the knowledge and skill during their course of study in the polytechnic. This ultimately deprives them of confidence and experience needed by the world of work, in turn mismatching them with the job situation. Students, therefore, need to meet following issues:

- Development of ability for experimenting and confirming the basic science laws and for creative applications to the society, so as to develop problem-solving skills.
- Acquiring skill of various operations in the workshops and developing models for productive jobs.

- To develop habits of participation in group, activities for supporting the academic career.

ii) The students lack in communication skill, in knowledge of latest developments in science and technology of their respective disciplines; resulting in lack of expression in knowledge and skills for the profession. To remove this lacuna, students should take active part in seminars, workshops, quiz, group-discussions, report writing, etc. conducted in collaboration with peer groups.

iii) The students lack in entrepreneurial skills and most of the students are job-seekers in Government/Public/Private sectors resulting in unemployment. The student can play the following roles :

- Collecting problems from nearby industries and develop engineering or technological models for their solutions.

- Taking projects of public or industrial utility rather than academic interest.

1.3.5 Role of Professional Expert

In the present technician education setup, the experience and expertise acquired by the experts of world of work is not communicated through the educational process to the students resulting in not updating the knowledge of students and faculty in the field of science and technology. The industrial experts can play following role to respond to this problem :

- Deliver the èxpert lectures to students and act as a resource person by involving in activities like participation in seminars, group-discussions, home projects, case studies, detailed project report preparation, and implementing site visits, etc.
- Participate in curriculum development.
- Demonstrate the system application in the field of their expertise.
- Prepare the books related to their experience in the world of work.
- Act as an immediate supervisor during the practical training of the students in the world of work.
- Exhibit the industrial fairs for the exposure of students, and guide students in these fairs, so as to explain what the industry expects from them as technicians and vice-versa.

1.4 Problem Statement : Objectives of Study

Indeed, it is these issues and the subsequent demands they make on various constituents of polytechnic-industry linkages that any educational mechanism must answer to research methods for modernising technician-education system for industrial economy.

The thesis essentially addresses itself to this question by specifically researching following three educational objectives :

i) To study the present state of the art vis-a-vis polytechnic-industry interaction.

ii) To diagnose and identify the factors responsible for lack or otherwise interaction betweeen industry and polytechnics.

iii) To develop a system that will facilitate interaction between industries and polytechnics with the ultimate objective of ensuring production of manpower which matches the job requirement.

1.5 Scheme of Chapterisation

Chapter two provides an overview of the existing literature on history and growth of technical education in India, with a special emphasis on training, its achievements and deficiencies involved in the process of transfer of learning in the polytechnic education. This establishes the need for Polytechnic-Industry interface.

Chapter three presents the salient features of the co-operative education and its growth. This also highlights the problem-solving method, its programme implementation and choice of industrial exposure and problem-solving method-a model for teaching-learning process. This also includes a detailed discussion on various relevant educational pedagogies in the international and national context.

Chapter four concentrates on planning and design of an experiment for polytechnic-industry interface through industrial exposure and problem-solving method.

Chapter five presents the conduct of the experiment.

Chapter six provides the analysis of the results.

Chapter seven offers a design of polytechnic-industry linkage and educational model, based on results of chapters five and six.

The thesis concludes with chapter eight.

CHAPTER-TWO

TECHNICAL EDUCATION IN POLYTECHNIC : INSTITUTION-INDUSTRY LINKAGE NEED-IDENTIFICATION FOR IMPROVED EDUCATIONAL QUALITY

2.1 Present Status

Today, a polytechnic in India represents a technical institution at the middle level which conducts full-time diploma courses in Civil, Mechanical and Electrical Engineering etc. The duration of the courses is 3 years and maximum educational requirement for admission is matric or secondary school certificate with Physics, Chemistry and Mathematics as the main subjects. All the polytechnics except two or three institutions that are under the control of Universities are affiliated to their respective State Boards of Technical Education. The State Boards prescribe the Diploma courses to be conducted by their Polytechnics, inspect the institutions to ensure maintenance of adequate instructional facilities, conduct examination and award diplomas. More than half of our polytechnics are administered and maintained by State Governments and the rest are managed by private agencies with regular grants-in-aid from respective state governments. For development of all institutions to required standards, Central Government provides financial assistance under the five year plans. Much of the development effort in technical institutions, particularly, Government institutions, gets frustrated because of rigorous procedures, controls and constraints and is, often, inconsistent with academic development [14].

During 1987, there were about 483 institutions, conducting diploma courses in about 136 disciplines with a total admission capacity of about 70,169 students per year; the total outturn from these institutions was of the order of about 46,672 per year. Out of these 483 polytechnics, 48 polytechnics are exclusively for girls and provide a wide range of courses.

Three patterns of courses have so for been evolved for technician education and they are :

i) Three year full time/part time courses after 10+ (Matric)

ii) Two year full time courses after 10+ and 12+ and

iii) Sandwich courses of 3 1/2 or 4 years duration after 10+.

All these schemes have been approved by All India Council for Technical Education and are under implementation in the polytechnics. The main pattern, however, is 3 years diploma courses which account for 94% of the total sanctioned intake in polytechnics (excluding girls polytechnics). The admission pattern, however, varies from state to state, depending upon the structure and stages of secondary education in the concerned state [26].

The state and subject wise distribution of polytechnics is given in [28]. It may be observed that 74% of the students in polytechnics (excluding the girls polytechnics) are at present distributed only in three major fields of engineering viz; Civil 29%, Electrical 21%, Mechanical 24%, and these three courses are conducted by all the states. The next two main disciplines are Pharmacy and Electronics wherein the percentage is 4.56% and 3.1%, respectively. The rest, about 19%, trained in 131 disciplines mentioned in [28]. Their percentage is very small as these are specialised courses, conducted by few state polytechnics, depending upon the industrial needs of the states.

The statewise comparative statement in respect of disciplines, population per polytechnic, population against one technician and out turn per lac population (Appendix 1) reveals that Tamil Nadu has the maximum number of disciplines 42, followed by Gujrat 34, Uttar Pradesh 32, Delhi 21, and so on and the states of Manipur, Meghalaya, Nagaland and Mizoram have the minimum of 3 disciplines each, namely, Civil, Electrical, Mechanical. The average population representation per polytechnic and per technician is minimum for Chandigarh, Andeman Nicobar, Goa and so on; and the maximum for Bihar, Rajastahan, Orissa, Madhya Pradesh, Andhra Pradesh and so on. Similarly, the outturn per lac population is the highest for Chandigarh, Goa, Delhi, Pondichery, Gujrat, Karnatka, and Kerala and minimum for Jammu & Kashmir, Bihar, Tripura, Rajasthan, Himachal Pradesh and so on .

From this analysis, it is concluded that the states like Gujrat, Tamil Nadu, Maharashtra, Karnatka, Kerala, Goa, Chandigarh and Delhi are more industrialised and economically better off than the other states like Jammu and Kashmir, Bihar, Tripura, Rajasthan, Himachal Pradesh, etc.

2.2 History and Growth of Technical Education in India

2.2.1 Development under the British Rule

The origin of Polytechnic Education in India is lost in the dim past of the country. The very first steps taken by the British East India Company for Education in India in 1813 provided for the introduction and promotion of a knowledge of science among the inhabitants of the British territories in India. Between 1830 and 1850, four Engineering schools were started as institutions attached to Engineering Colleges at Madras, Calcutta, Poona and Roorkee to train "upper and lower subordinates" (Overseers, and Draughtsmen) for the Public Works Department, Local funds, Municipalities etc. of the then provincial Government.

The famous Wood's Despatch of 1854 which envisaged an "enlarged system of education to be pursued in India", prompted the then Governor General of India, Lord Dalhousie to recommend to the Court of Directors the establishment of an engineering class at each Presidency. The reply from the Court of Directors was most encouraging in their despatch [38] dated the 2nd May, 1855, addressed to the Governor-

General in Council; they stated that: "We have, as you are aware, taken a warm interest in the establishment and progress of Thomson College of Engineering at Roorkee and have recently sanctioned the establishment of the similar institutions at Madras and Bombay. We accordingly authorise you to frame a scheme for a college of Civil Engineering, submitting the same for our final sanction".

However, the Thomson Engineering College, Roorkee, which was a direct out come of manpower needs for irrigation and for other engineering schemes undertaken by the Government, and was placed on a permanent footing in 1849, continued to serve as a model for future expansion of technical or engineering education in India. The Wood's despatch of 1854 contains the following significant observations about this Institution : "The success of the Thomson College of Civil Engineering at Roorkee has shown that (i) for the purpose of training up persons capable of carrying out the great works (which are in progress under the Government throughout India), and (ii) to qualify the natives of India for the exercise of a profession (which, now that the system of railways and public works is being rapidly extended, will offer an opening for a very large number of persons), it is expedient that similar places for practical institutions in Civil Engineering should be established in other parts of India".

The next important step in the development of technical education in India was the appointment of the Indian Universities Commission by Lord Curzon in 1902 under the Chairmanship of Dr. T. Raleigh. The report of the commission, which was submitted on the day of 9th June, 1902, made the following recommendations regarding the engineering or the technical education in India :

i) "As the colleges of Engineering train a large number of students for lower branches of profession and a small number only for the highest branches, of which the above university takes cognizance, we do not think it desirable that the University should itself undertake Institution in Engineering" [7].

ii) Physics, Chemistry, Mathematics courses should be provided in the colleges of engineering.

iii) In the Mining and Electrical engineering the training should be practical throughout.

The resolution on Indian Educational policy issued by the Council on 11th march, 1904, advocated a new approach to the development of technical education in India. It states that a fresh effort should be made towards the development of Indian industries, and specially those in which native capital may be invested. As a step towards providing men, qualified to take a leading part in the improvement of Indian Industries, the Government of India decided to give assistance in the form of scholarships to the selected students to enable them to pursue a course of technical education in Europe or America. They hoped that the technical shools in India may in time produce a regular supply of young men qualified to take advantage of such facilities and would also be beneficial to the Indian trade.

A decade later in 1913, we find greater enthusiasm for the development of technical education in India. Existing educational institutions had been overhauled and equipped for new courses. Scholarships tenable in Europe and America had been established. Tata family and His Highness the Maharaja of Mysore established an Indian Institute of Science at Banglore and the same was thrown open to public in 1911. The establishment of a technological institute at Cawnpore (Kanpur, presently) had been sanctioned. Industrial schools had been opened in several provinces. Altogether, the number of technical and industrial schools had risen since 1904 from 88 to 218 and number of pupils from 5,072 to 10,535.

The system of technical scholarships tenable abroad is still on trial. The problem of Indian scholars going abroad for study/training and not returning to India for employment, finds reference in the Educational Policy Resolution of 1913, and is valid even today. Termed as "Brain Drain" [12], there is still no remedy.

One also notices from the Government policy that educational institutions should in no case trade on commercial lines, yet in certain case instructions in industrial schools were to be supplemented by practical training in workshops, where application of new processes needed to be demonstrated.

During 1917-19, Sadler Commission of Calcutta University emphasised that within the sphere of technical education, practical training was most important. Practical training being costly and as it demands elaborate equipment, they recommended that "no course of study should be defined until there is responsible assurance that the necessary provision of teaching and equipment is forthcoming".

The close co-operation between industry and technical education advocated in the two preceding documents, viz. the Indian Educational Policy Resolution of 1913 and the report [27] of the Calcutta University Commission (1917-19), was also emphasised by the report on vocational education in India by A. Abbot (Formerly Chief Inspector of Technical Schools, Board of Education, England) and S.H. Wood (Director of Intelligence, Board of Education, England), submitted to the Government of India on 10th June, 1937. It stated that Industry and Commerce must co-operate with educational organisations of the Vocational Education provided, it is appropriate and adequately organised. Co-operation of this kind does not yet exist in India. The

Abbot-Wood Report, therefore, recommended that every province should make a survey of the educational needs of its industries and commerce and on the basis of that, prepare an educational frame work into which vocational schools and courses of instruction can be fitted. He also recommended that each subject in the vocational school should have its origin in the non-vocational school. Vocational education is not a matter for the school alone, since it is specific and not a general preparation for employment [33].

The report of the Technical Education Committee of the Central Advisory Board of Education, 1943 (which was adopted by the Board at its tenth meeting in January, 1944) described the primary functions of the technical education as that of satisfying the need of industry and commerce for: (a) skilled craftsmen, (b) intelligent foremen and executives, and (c) research workers. The Committee, therefore, recommended the provision of the following courses for technical instruction and training of workers of different categories from the managerial to the operative class [35] :

i) A two year full-time course in trade (Junior Technical or industrial) schools for those who are likely to enter industry immediately afterwards, and to become skilled artisans. Pupils will be admitted to this course after 8 + at the age of about 14.

ii) A six year full time course in Technical High Schools for those who aim at reaching ultimately, the supervisory or managerial grades or becoming research workers, and the selected pupils will be admitted after Primary stage at the age of about 11.

iii) A three year full-time Diploma Course to which students will be admitted after passing the final examination of Technical High school or an equivalent examination.

iv) A two year full-time Advanced Diploma Course in Senior Technical institutions, for those who have obtained the first Diploma.

v) A three year part-time Certificate Course for those already in employment. Here again the normal conditon for entry will be a Technical High School Leaving Certificate or its equivalent.

vi) A two year part time Advanced Certificate course for those who have obtained the first Certificate.

vii) Courses of all kinds and all standards in individual arts, crafts and other subjects related to industry and commerce for which there may be a sufficient demand.

In the field of technical education the report on post-war Educational Development in India (Sargent Report after the name of Sir John Sargent, then the Educational Adviser to the Government of India) which was published in 1944, reiterated the recommendations of the Technical Education Committee 1943 and maintained that any scheme for the development of technical institution as an integral part of the national system must have a two-fold character. It must form a link between education and industry and at the same time receive separate consideration in the form of mental training which is especially suited to certain types of intelligence irrespective of their future occupations. Regarding the nature of institutions for imparting technical education, the Sargent Report was strongly in favour of polytechnics as against monotechnics because more courses can be run under one roof.

The Committee under the Chairmanship of Mr. N.R. Sarkar in 1946 studied the development of higher technical institutions in India and came to the conclusion that the existing facilities were quite inadequate, both in quantity as well as quality, to meet the country's requirements for high grade technologists during the post-war period. The Committee made the following recommendations [30].

i) Not less than four higher technical Institutes one in the North, one in the East near Calcutta, one in the South and one in the West near Bombay will be necessary to satisfy the post-war requirements.

ii) To satisfy immediate needs for Engineers in general and for those with specialised training in Hydraulics in particular, the engineering nucleus or the Northern Insitutution should be set up without delay.

iii) To ensure proper planning of buildings, equipment and courses of study, the Principals and Heads of Main Departments of these institutions should be appointed and the services of an Architect with experience in the planning of technical institutions secured at a sufficiently early stage. The Sarkar Committee, however, emphasised the need of conducting a survey and thorough examination of the existing facilities before taking a final decision regarding the organisation and structure of higher technical education in the country as a whole.

2.2.2 Development During the Post-Independence Period

When India became independent in 1947, the Government of India recognised the importance of the technical manpower for the economic development of the country and decided to expand facilities for technical education and training in a big way. According to the Radhakrishan Commission report of 1949, improvement and co-ordination of the standards of polytechnic education became important and urgent. The report also emphasised the need for the new types of engineering and technical institutions in India and advocated that India needed more engineering schools to produce not merely men skilled in technology, but also sound, well integrated individuals and citizens. The Committee also advocated closer contact between engineering, arts, science and social studies and made the following recommendations [32] :

i) The number of Engineering schools of different grades should be increased, particularly, for training of foremen, craftsmen, draftsmen, overseers, etc.

ii) The first year or more of each course should, in general, be common to all branches of engineering.

iii) The training should be such that it makes the students self-reliant and competent to take initiative to start small scale industries.

The All India Council for Technical Education (A.I.C.T.E.) with the assistance of its Board of studies in Engineering and Metallurgy, Chemical Engineering & Technology, Textile technology and other fields reviewed the State polytechnic education in 1948 in the country and initiated a comprehensive programme for the reorganisation and development of polytechnics. The programme included revision of the syllabus and curriculum of courses and maintenance of uniform facilities for conducting the courses and adoption of uniform schemes of examinations for all polytechnics. The Board also specified the accommodation needed for class rooms, laboratories, workshops etc. in a polytechnic for different courses, lists of laboratories and workshop equipment and teaching and other staff required to conduct the courses. The Regional Committees of A.I.C.T.E. sent visiting committee of experts to inspect each polytechnic and to prepare a scheme for its improvements. On the basis of the recommendations of the Regional Committees, the Central Government gave grants-in-aid to the institutions to re-organise their courses and improve instructional facilities. Polytechnic set-up since 1950 onwards followed the standards laid down by the A.I.C.T.E.

The working group on Technical Education and Vocational Training appointed in Feb, 1959 under the Chairmanship of Prof. M.S. Thacker, made an intensive study of the existing facilities for technical education and training in India, and made far reaching recommendations for the qualitative as well as quantitative improvement of technical education and training facilities. The working group laid emphasis on link between the technical education and the industry, technical courses from school levels, curricular courses, importance of scientific courses and the use of tools and instruments [34]. It further recommended that :

i) The engineering colleges as well as the polytechnics should be located near the industrial areas as far as possible, so that the part-time teachers from the industries will be helpful to the institutions.

ii) The number of scholarships and loans in the engineering colleges and polytechnics should substantially be increased. Facilities for technical education by way of sandwich courses, part-time and short-term courses, correspondence courses, day-release schemes, etc., should be provided. Special training courses for the teachers in technical subjects should be organised by setting up the technical training colleges. In order to have qualitative improvements, the teacher-pupil ratio should be 1:15 at diploma and 1:10 at degree level.

While assesing the future requirements of industrial development, Kothari Commission (1964-66) found that the growing numbers of technical personnel will specially be required in Metallurgy, Chemical Engineering, Fuel Technology, Production Engineering, etc., and the courses in Civil, Electrical and Mechanical Engineering need to be diversified to produce the required technical personnel and stressed practical training in industries.

During 1968 the document on National Policy on Education published by the Government of India emphasised that there should be a continuous review of the agricultural, industrial and other technical manpower needs of the country and efforts should continuously be made to maintain a proper balance between the output of the educational institutions and employment opportunities. One such innovation is the introduction of sandwich courses (also called co-operative courses) under which a student spends specified periods alternately in an educational institution and in industry [11].

However, there was wide-spread criticism of the system of polytechnic education prevailing in the country. A.I.C.T.E. constituted a special committee for reorganisation and development of polytechnic education under the Chairmanship of Prof. G.R. Damodaren which submitted the report [6] on 28th Feb, 1971 and made following recommendations :

i) The polytechnic education should be co-ordinated with the state of Industrial and commercial development and the economic resources of the country as a whole.

ii) Quality and not the quantity should be improved.

iii) No need of new polytechnics to be established during the next five years.

iv) The preparation of the realistic estimates of the demand for technicians for the fifth and subsequent plans, region-wise and by specialities, and the type of technicians' functions in industry, in commerce services and in public utilities so that appropriate programmes of educational development could be formulated and included in the fifth five year plan.

Under the Apprentices (Amendment) Act 1973 which came into force on 1st December, 1974, four Boards of Apprenticeship Training were setup at Kanpur, Calcutta, Bombay and Madras to look after the training programme in each region. The Boards were also to organise supervisory development programmes, workshops and seminars with a view to improve the quality of training imparted to the apprentices [2].

In 1976-77, Direct Central Assistance scheme was introduced in selected Polytechnics to bring about qualitative improvements in the standard of Technical Education in the country [1].

The scheme of "Community Polytechnics' initiated in 1978 has given a practical turn to the development of energy sources in rural areas and technology for the rural masses. About thirty-five Community Polytechnics spread over all the four regions of the country are serving as focal points to promote the transfer of technology to rural community and are thus instrumental in brining about social transformation of our rural areas [8]. The scheme of Entrepreneurship Development was introduced in the middle of the 6th plan in one form or other in technical education system. During the same plan diversification of the courses took place to match the specialised job requirements. In 1986 National Policy on Education emphasised the need for manpower planning, technical-teacher education and training, continuing education and distance learning, and training for new technologies such as microprocessors, environmental engineering, laser technology, water resources management, computerisation, entrepreneurship development, woman education and for technological innovations.

2.3 Polytechnic Education : A Logistical Description

The progress of the establishment of Technical Institutions in India till the beginning of the century was very slow. Till 1900, the Technical Institutions functioning in the country were, at Roorkee (Estt. 1846), Bengal (Estt. 1856), Patna and Dacca (Estt. 1876) and Poona (Estt. 1894). With the advent of the 20th Century, the College of Engineering and Technology, Jadavpur (1906), Indian Institute of Science, Bangalore (1911) and Engineering college, Banaras Hindu University (1919) were established. At the time of outbreak of second world war in 1939, India had only 11 Engineering Colleges with an annual intake of 1200 students. During the period of war, the requirement of engineering personnnel rose suddenly, and the duration of engineering courses was reduced to 2 years only to make up for the needs of engineering personnel.

As already mentioned, after the second world war, the Government of India appointed an Expert Committee in 1945 under the Chairmanship of Sri N.R. Sarkar to look into the needs of postwar industries etc. On the basis of surveys conducted by the Sarkar Committee for higher technical education, All India Council for Technical Education was established in 1945 to make arrangements to provide facilities for advanced technical education. It also recommended the establishment of four higher Institutions of Technology in the four regions of the country. In accordance with these recommendations Indian Institute of

Technoloyg, Kharagpur was established in 1951. Subsequently Indian Instiute of Technology at Bombay in 1957, Madras in 1959 and Kanpur in 1960 were established. Indian Instistute of Technology, Delhi was established* in 1961. These institutions received considerable technical assistance from foreign countries namely, U.S.S.R, West Germany, U.S.A. and U.K. and are providing excellent facilities for degree, post-degree and reserach in the field of engineering and technology.

The establishment of Regional Engineering Colleges in each State, managed by the Central and State Governments, during the Second and Third Five-Year plans for training of engineering personnel is a land mark in the field of technical education for emotional integration of the people of various states in the country.

After the independence great strides have been made in the field of technical education. As against 38 engineering colleges and technological institutions conducting degree courses in engineering and technology and 53 polytechnics conducting diploma courses in 1947, 156 engineering colleges and technological institutions and 483 polytechnics were functioning in the country during 1987. The progress of development in the field of technical education during the

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* Currently, work is in progress to establish yet another I.I.T. in Assam.

Five-Year plans in respect of growth of polytechnics, growth of trained technicians and diversification of courses is given in Table 2.3.1.

Table 2.3.1

The Progress of Technical Education (Polytechnic) in Five Year Plans

Plan	Year of reference	No. of Institutions	Actual Students	Out-turn	No. of Disciplins
1947-48	1947	53	3670	1440	3
First five year plan 1951-1956	1952	89	6216	2626	Not availble (N/A)
Second five year plan 1956-1961	1956	109	10318	4103	N/A
Third five year plan 1961-1966	1961	195	27701	10349	N/A
Extended to 1968 (Annual plan	1968	280	46712	23183	55
Fourth five year plan 1969-1974	1969	280	27056	21921	N/A
Fifth five year plan 1975-1980	1978	280	324	50000	N/A
Sixth five year plan 1981-1986	1981	350	60000	40000	73
Seventh five year plan	1987	483	70160	46672	136

However, acute un-employment problem faced by the graduate engineers and diploma holders in 1968 resulted in reduction of intake to technical institutions on a selective basis and the figures given thus indicate the reduced levels. Otherwise, targets of admissions for the Third Five- Year Plan were 50,000 for diploma and 25,000 for degree institutions. Unemployment of engineering and diploma holders represented only a temporary set-back, in as much as many schemes of industrial developments during the Five Year Plan did not fully materialise. The industrial growth of the country, however, picked up and now it is hoped that the unemployment of technically qualified people will gradually decrease consequent upon rapid industrial growth of the country [4].

The working group on Technical Education, 1978 recommended restructuring of courses in technical institutions so as to ensure meaningful interaction and collaboration with industry. The scheme of 'Community Polytechnics' initiated in 1978 has given a practical shape to the idea of transfering technology to the rural areas and establishing the links of polytechnics with the community. In the subsequent plans more stress has been laid on the entrepreneurial skill development among the polytechnic graduates and the industry-institute (polytechnic) interaction.

The growth of the institutions, trained personnel and diversifications of courses have been represented graphically in fig.2.3(1), 2.3(2) and 2.3(3).

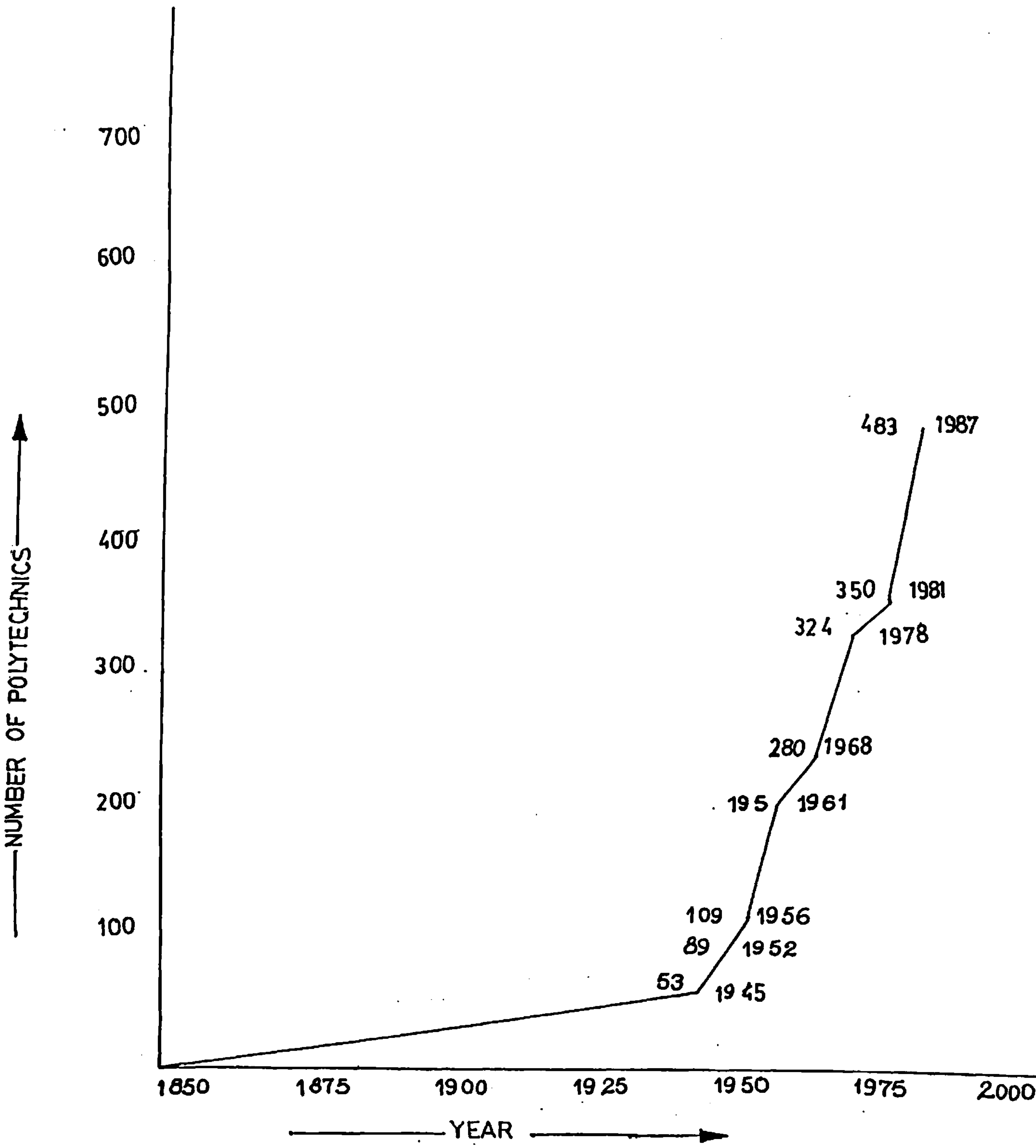

FIG:2.3(1) GROWTH OF POLYTECHNICS

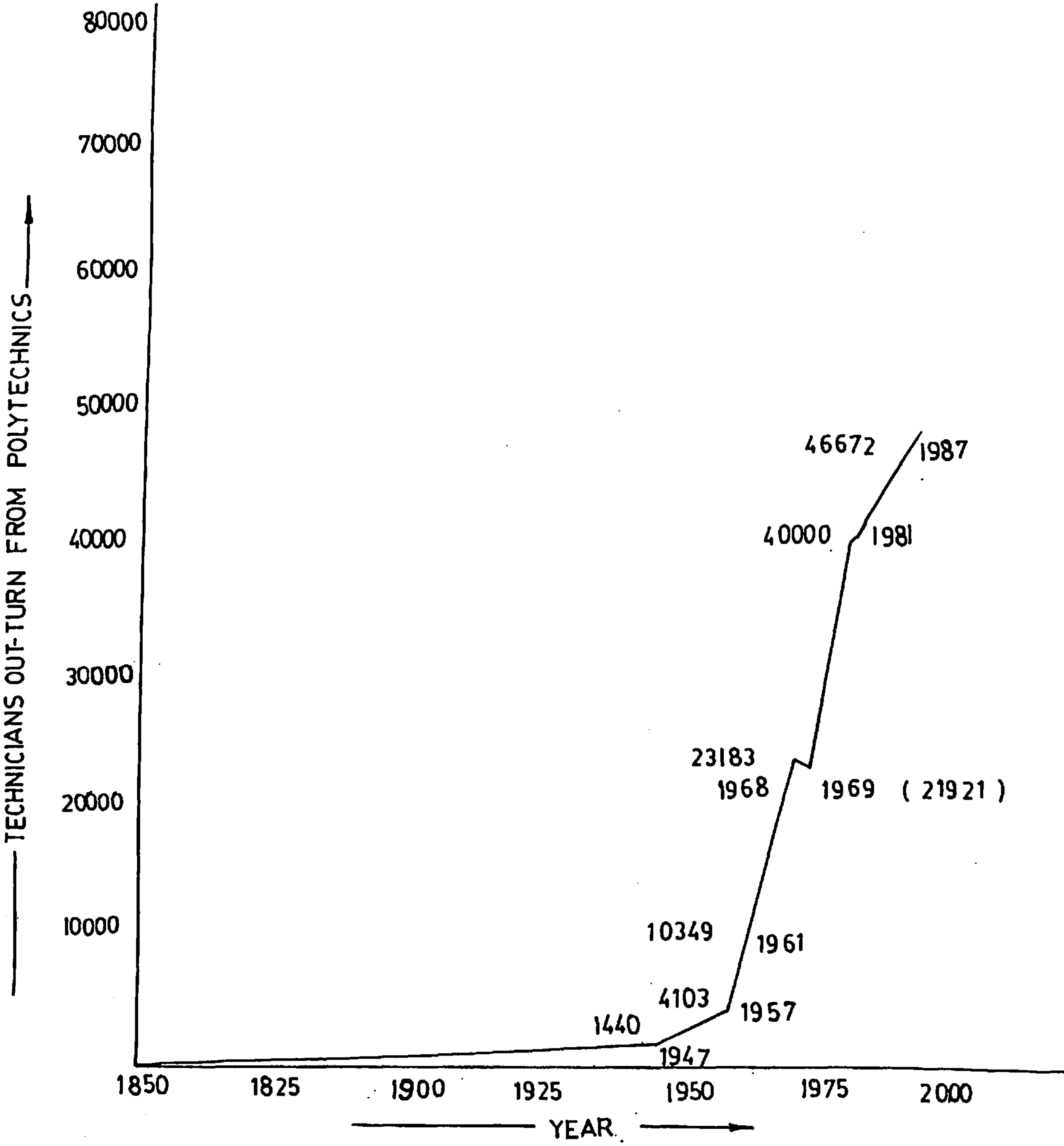

FIG: 2·3(2)· GROWTH OF TRAINED TECHNICIANS

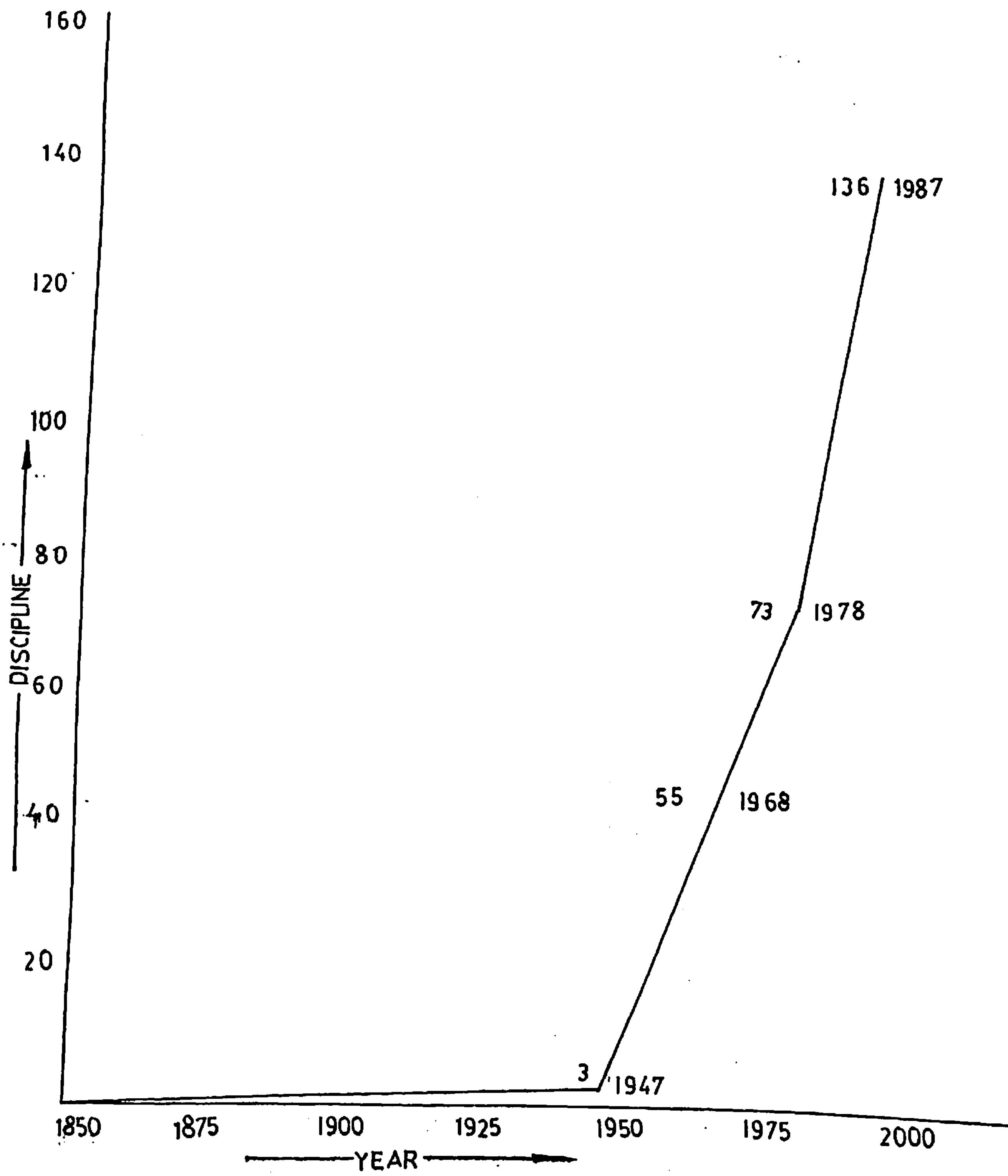

FIG 2.3(3) DIVERSIFICATION OF COURSES

In order to keep pace with the technological development all over the world, the content, syllabi, the schemes of examinations etc. for the degree and diploma examinations are being constantly reviewed by the Central Government (through All India Council for Technical Education) and efforts are being made to modernise not only the equipment, content of the engineering/technical institutions but also to update the faculty members. Thus, various schemes of faculty development, e.g., Quality Improvement Programmes, etc., have been initiated by the Government of India during the current Five-Year Plan Programme.

The programmes of faculty development include long term training, short term in-service training and training in industry. Four Technical Teachers' Training Institutes (T.T.T.I) at Chandigarh, Bhopal, Calcutta and Madras cater to the needs of training of teachers from polytechnics, development of curriculum for diploma courses and preparation of instructional material distributed to polytechnics for adoption or adaption. On the governing body of T.T.T.Is there are eminent Industrialists who encourage the Industry-Institution collaboration. In the beginning, when long term teachers' training was introduced, one year was exclusively earmarked for undergoing industrial training in different industries which bridged the gaps of the industry and institution to some extent.

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A synopsis of the development in the field of Technical Education particularly when the problem presently researched working to education work linkage would be incomplete if a mention is not made of the following :

2.3.1 **Practical Training Scheme**

In 1947, the Government of India set up a Committee for suggesting different measures to promote Technical Education in India. The Committee was also to give its recommendations for the Institute-Industry interaction. The committee recommended bridging up of the gap between the act of learning and context of action. The Central Government while accepting the ' Manpower Committee' recommendations, initiated in 1949-50 a practical training scheme to encourage fresh graduates (stipend Rs. 150/-) and diploma holders (Stipend Rs. 100/-) to undergo practical training in industry for up to two years. In 1953-54 this scheme was revised for many reasons like lack of interest on the part of institutions in securing suitable training places, delay in disbursement of stipends, large drop out from the training programmes, inadequate co-operation from industry, etc. Then the Central Government decided to assume direct responsibility for administering the scheme through its four regional offices. The scheme made some progress under the new arrangement but as the years passed, the regional offices found it increasingly difficult to manage various aspects of the scheme in addition to their responsibilities for the development of Technical Education. The Government, again in 1968, decided to set up regional boards of Apprenticeship training to administer the scheme. Each Board included representatives of both the industry and technical institutions to ensure close co-ordination between education & practical training.

2.3.2 Apprenticeship Training Act

The Apprenticeship Training Act, 1961 which covered the training of apprentices in various trades (ITI level) has been amended by the Apprentices (Amendment) Act, 1973 to cover the training of Graduates and Technicians (Diploma holders) in Engineering and Technology. It is now a statutory obligation on the part of every employer covered under the Act to train a prescribed number of Graduates and Diploma Holders in Engineering/Technology. The employers covered under the Act include State and Central Government Departments, Public Sector undertakings and Industries in the Private Sector. The above Act now covers 71 subjects/fields in Engineering/Technology which include most of the courses taught at the Engineering Colleges/Polytechnics.

2.3.3 Sandwich Courses

Even as the improvements in practical training and Apprenticeship Act were taking shape, a feeling was gaining ground, in later part of 1960, that though post-institution apprenticeship was important, a sandwich course should be instituted to bring about a more fruitful integration of institution and industry for theory and practice in the total educational process. In 1970-71, the special committee on re-organisation and development of Polytechnic education appointed by the Government of India, and later in 1978, the working group on Technical Education, emphasised close interaction for effective instructional processes, designing and conducting co-operative and sandwich programmes, industrial training of teachers and mutual consultancy for solving each other's problems etc. Out of above 483 polytechnics* in the country conducting engineering diploma courses, at present 46 offer courses on sandwich pattern. The number of students enrolled in sandwich courses is about 4% of the total number of students undergoing engineering diploma courses. Sandwich courses generally conducted in India do not have active involvement of Industries in the design and development of curriculum, course structure, course implementation, students' evaluation and students' placement. Also teachers are not actively involved during the industrial training of the sandwich programmes.

2.3.4 National Policy of Education (N.P.E) 1986

To cope with the rapidly changing technological needs of the world of work technical education system must respond to this changing environment by continuously evaluating

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* 1987 Statistics [28].

courses and programmes, updating curricula, introducing new courses, modernising resources and facilities and providing for a close interaction between the world of technical education and the world of work. Thus, for interaction of the institues with the industry, N.P.E. 1986 has made following recommendations [24] :

i) Render consultancy services to industries to improve the quality of products and services and improve productivity.

ii) Undertake R and D activities to advance the frontiers of knowledge and solve problems of Industries.

iii) Partcipate in designing, developing and implementing formal and non-formal educational programmes suiting technical manpower development needs of various target groups.

iv) Information services : Technical institutions, through the proposed industrial liaison cells, should provide information to industries in areas of interest to them, like: availability in the institutions of specialized machines and equipment, manpower development courses being offered, R and D assistances available, library services and assistnce that the institutions can render to the industry for recruitment of technical graduates and diploma holders, etc. The cell will, in turn, obtain feed-back about the performance of engineers and technicians who have graduated from the institutes, to help identify strengths and weaknesses of courses for future improvements.

2.3.5 Sharing of Experiences and Expertise

Lectures by professionals in the world of work on selected topics to students and by technical teachers to industrial personnel will help in sharing resources and information and bridge the gap between industry and institutions. Professionals from the world of work should be involved also in students evaluation and curriculum development. This will help teachers keep themselves in regular contact with professionals in a variety of aspects including class room teaching, students' evaluation, curriculum development etc.

2.3.6 Industrial Training of Teachers

Most of the teachers join the teaching profession just after passing out from college. They lack a clear understanding of industrial processes, practices and needs. This is one of the main reasons that much of the teaching in the Polytechnics is theoretical and divorced from field realities.

The recommendations given in National Policy of Education 1986 emphasise the need of industry-institute collaboration to a greater extent but the policy is lacking in suggesting the concrete steps to achieve the objectives put forth by it.

2.4 A Critical Assesment of Growth of Polytechnic Education in India : Method of Study

From figures 2.3(1), 2.3(2) and 2.3(3) it can be seen that though the polytechnic education over the last four decades has made significant growth in terms of increase in number of polytechnics, technicians' outturn from polytechnics and the diversification of engineering disciplines, yet the technicians and the outturn of polytechnics are not keeping pace with the industrial growth and the technological advancement. The reasons may be many but the important amongst them are: students with varying backgrounds, inadequate utilisation of existing instructional facilities, lack of adequate departmental operatiing cost, lack of motivation of staff and students, lack of industry-institute interaction, lack of R and D for harnessing science and technology to profitable and productive processes of economic growth and social well being etc. However, to understand the precise nature of these reasons, a survey technique of research was adopted to know the perceptions of different constituents.

2.4.1 Methodology for Assessing the Perceived Objectives of Education

A questionnaire was prepared to study the perceptions of teachers about the objectives of education. Questionnaire consisted of twenty five qualities which are common to most adult situations considered essential for living. The teachers were requested to rank these qualities and suggest which of these qualities the process of education should try to achieve or which can be achieved. The responses to these questions were sought under Yes/No categories. The copy of the questionnaire is given in Appendix 2. In addition, interviews were held with teachers.

Sample

Table 2.4.1 shows the numbers of polytechnic teachers from different disciplines who responded to the questionnaire (Appendix 2).

Table 2.4.1

Sample of Teachers for Assessing the Perceived Objectives of Education

Discipline of Teachers.	Number of Teachers.
Engineering	29
Science	16
Humanities	07
Management	05
Total	57

2.4.2 Methodology to find Achievements and Deficiencies in Polytechnic Education

To assess achievements and deficiencies in polytechnic education, a set of questionnaires was prepared for employer, students, teachers and passed-out employed students, descriptions of which are as under :

2.4.2.1 Questionnaire for Teachers

A questionnaire for teachers consisted of five sections namely the characteristics of the inputs i.e. students, resources availability, effectiveness of the management, methods of evaluation and the position of the output (students) in the world of work. The responses to the questions were sought under Yes/No and descriptive categories.

The teachers were requested to give their opinions about the background of the students, availability of resource centre, facilities and their utility, effectiveness of the training and suggestions to improve upon it, the effectiveness of the evaluation system and suggestions for reliable and valid measurement of the students achievements, and finally, about the standard of output and the reasons for the substandard products from the polytechnics. A copy of the questionnaire is given in Appendix 3.

2.4.2.2 Questionnaire for Final-year Students of Polytechnics

A questionnaire was prepared to study the working system and the effectiveness of polytechnics for imparting education. The questionnaire was divided into five sections namely, input, processes, resources, output and the management. The responses to these questions were sought under Yes/No and descriptive categories.

The students were requested to give their opinion about their awareness about the engineering profession, motivation towards the profession and the understanding of instruction in English; their perceptions about the methodology of teaching, difficulty in learning, views about the evaluation, visits to the work environment, performance in practicals and theory, reasons for the mass cuts from classes, availability of raw material for working, equipment in laboratories, furniture in class rooms, availability of print and non-print material, their competency after completing the polytechnic education and training and the effectiveness of management of the institute, department and the hostel. A copy of questionnaire is given in Appendix 4.

2.4.2.3 Questionnaire for Passed out Employed Students

A questionnaire was prepared to study the needs of industries, identify the strengths and weaknesses of the present curriculum and the areas to be included in the curriculum. The questionnaire contained twenty items. The responses to these questions were sought under Yes/No and descriptive categories.

The employed students were requested to give their views about the attainment of the positions in the various organisations, activities under taken like research and development, testing and inspection, production, maintenance and servicing, teaching, purchase and sale, management and supervision, effectiveness of teaching and suggestions for improvement, methods adopted to acquire specialised knowledge, industry-institute collaboration and collaboration between institute and passed out students. A copy of the questionnaire is given in Appendix (5).

2.4.2.4 Questionnaire for Industries (Employers)

A questionnaire was prepared to study and identify the present and future activities of technicians in the context of changing technology and also to redesign the curricula of polytechnics so that the product of institutions matches the requirement of the different types of industries. The questionnaire contains fourteen items. The responses of these questions were sought under Yes/No and descriptive categories. The findings of the report of the Government of India [29] were also taken into consideration.

The industries were requested to give their views about the employment potential in the large, medium and small scale industries for technicians in research and development, design and drawing, production, management and supervision, repair and maintenance, sales and after-sale service, purchase and stores, the shortcomings in the performance of technicians in the world of work/industries, and likely changes in the role of technicians, and the involvement of industries while conducting the diploma course for technician in the polytechnics. A copy of the questionnaire is given in Appendix (6).

2.4.2.5 Interview

In addition, interviews with 60 personnel from various industries, nine polytechnic's students, 70 teachers and 75 passed out employed students were conducted. The views of the various categories of people were taken on following aspects.

- Shortcomings in polytechnic education and remedies for bridging the gaps.
- Admission procedure to be adopted for polytechnic education in the country and the present system of admission in various states
- System of evaluation of the students in different states.
- Political interference in the polytechnic education.
- Internship based on the job training through practice school system of Birla Institute of Technology and Science, Pilani.
- Unemployment in Polytechnic products and remedies for it.
- Institute-industry co-operation.
- Quality improvement in Polytechnic education.
- Credit system in the Polytechnics.
- Strengthening of the community Polytechnics.
- Establishment of continuing education centres and departments in the polytechnics.
- Enhancing technical education for women.

- Providing student hostels and residential facilities for faculty and supporting staff.
- Introduction of new programmes in the existing polytechnics.
- Strengthening of state Directorates/Boards.
- Setting up of maintenance system in the Polytechnics for the machinery and equipment.

2.4.3 Samples

Table 2.4.3.1 gives number of polytechnic teachers from different disciplines who responded to the questionnaire (Appendix 3)

Table 2.4.3.1

Teacher Sample for Finding the Characteristics of Input, Resource Availability, Effectiveness of Management, Methods of Evaluation and Output

Discipline of the Teacher	Number of Teachers	Percentage
Engineering	66	63
Science	15	15
Humanities	06	06
Management	17	16
Total	104	100

Table 2.4.3.2. shows students of polytechnics from different disciplines who responded to the questionnaire (Appendix 4)

Table 2.4.3.2

Student Sample to Study the Effectiveness of the Polytechnics for Imparting Education

Discipline	No. of students	Percentage
Civil Engineering	26	33
Electrical Engineering	17	21
Mechanical Engineering	11	14
Automobile Engineering	12	15
Architecture Assistantship	13	17
Total	79	100

Table 2.4.3.3 gives passed out students (employed) working in different organisations who responded to the questionnaire Appendix (5).

Table 2.4.3.3

Passed Out Student Sample for Finding the Needs of Industry, Strength and Weaknesses in the Present Curriculum and to Identify the Areas to be included in Curriculum.

Organisation	No. of students	Percentage
Government	52	47
Semi Government	08	07
Corporations	22	20
Private	25	23
Self employed	03	03
Total	110	100

Table 2.4.3.4. shows type of industries taken from the report of the Government of India [32] and industires responded to the questionnaire Appendix (6).

Table 2.4.3.4

Sample of Industries Surveyed to Identify the Present and Future Activities of Technicians in the Context of Changing Technology and to Redesign the Curriculum of Polytechnics

Types of Industries	No. of responses	Percentage
Large scale	32	34
Medium	40	43
Small scale	21	23
Total	93	100

2.4.4 **Administration of Questionnaire Metholology to :**

2.4.4.1 **Teachers**

A large number of teachers, principals of polytechnics of various states of the country and faculty of the technical teachers of the states were contacted and the data was collected either through personal interview or through questionnaire. Some of the data was also collectd through correspondence.

2.4.4.2 **Students**

The data from the students was obtained by getting the questionnaire filled in the polytechnics.

2.4.4.3 **Passed out Employed Students**

The data from the passed-out employed students was collected either by personal interview and questionnaires filled or through correspondence.

2.4.4.4 **Industries**

A number of Industries, authorities of Punjab, Haryana and Delhi Chamber of Commerce, employers of passed out students were contacted in person and the data collected either by personal interview or by getting the questionnaire filled. Some of the data was also collected through correspondence with the industries.

TABLE 2.5.1.1 TEACHERS RESPONSES INDICATING RANKS FOR VARIOUS QUALITIES LISTED IN QUESTION 1 OF THE QUESTIONNAIRE AS TO THEIR PERCEPTION OF THE IMPORTANCE OF THE QUALITIES IN LIFE.

RANK	PERCEPTION	ANALYSIS	DIAGNOSIS	PROBLEM SOLVING	JUDGEMENT	COMMUNICATION	UNDERSTANDING	SYMPATHY	TOLERANCE	SENSE OF RESPONSIBILITY	LEADERSHIP	DECISION MAKING	COPING WITH FRUSTRATION	KNOWLEDGE	CREATIVENESS	SELF RELIANCE	CONFIDENCE	SENSE OF HUMOUR	ABILITY TO MIX WELL	WIDE INTEREST	INDEPENDENCES	HONESTY	AMBITION	COMMON SENSE	LOGICAL THOUGHT
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
0	5	3	7	4	2	2	5	9	4	2	8	1	10	7	5	3	2	5	4	3	4	7	7	2	6
1.0	2	1	0	2	1	1	1	1	1	7	1	2	1	4	0	6	4	1	0	1	2	9	0	1	4
1.5	1	0	1	0	1	0	1	0	1	3	0	1	0	1	1	0	0	0	0	1	0	3	1	1	0
2.0	5	1	3	2	2	1	3	4	3	4	0	3	1	1	2	3	4	1	1	0	0	2	3	2	2
2.5	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	1	1	0	0	0	0	1	0	0	0
3.0	2	4	1	1	1	2	4	2	3	3	1	3	0	3	0	2	5	0	1	1	2	0	0	1	2
3.5	1	1	1	1	1	1	1	0	0	0	0	0	1	0	0	1	1	0	0	0	0	1	0	0	1
4.0	1	4	1	3	3	0	5	2	0	3	1	2	0	1	0	4	3	2	0	0	1	0	1	2	2
4.5	1	0	0	0	0	0	2	2	1	1	0	1	0	1	2	0	1	0	0	1	0	1	1	2	0
5.0	4	1	3	1	1	3	0	2	1	0	3	3	0	2	4	1	2	0	2	2	2	1	0	2	1
5.5	1	1	1	1	0	0	2	0	2	1	0	1	1	0	1	1	2	0	0	1	0	0	1	0	0
6.0	4	5	2	5	6	2	3	0	2	2	0	5	1	1	2	2	1	1	3	1	2	0	2	5	5

1	2	3	4	5	6	7	8	9	10	11	12	13	14
6.5	2	1	0	1	2	2	2	1	0	2	1	2	0
7.0	2	3	5	3	5	3	4	0	1	2	2	6	2
7.5	0	0	0	1	0	0	0	0	0	0	0	1	1
8.0	2	4	1	1	3	3	1	1	0	1	1	4	1
8.5	0	0	1	0	1	0	0	1	0	0	1	0	0
9.0	3	1	3	1	2	2	0	0	3	2	2	3	1
9.5	0	0	0	0	0	0	0	0	0	1	0	0	0
10.0	1	1	1	1	3	2	1	2	0	4	2	1	1
10.5	0	0	0	0	1	1	1	0	0	2	1	1	1
11.0	2	0	1	2	2	1	1	0	1	3	2	1	4
11.5	0	0	0	1	0	0	0	0	0	0	0	0	0
12.5	0	0	0	0	0	0	0	1	0	0	0	0	1
13.0	3	1	3	1	2	1	1	1	3	0	0	2	1
13.5	0	0	0	0	0	0	0	0	0	1	0	0	0
14.0	1	2	3	2	2	2	2	2	1	1	3	0	0
14.5	0	3	1	1	1	0	0	0	0	0	1	2	0
15.0	1	2	1	1	2	3	2	1	3	1	1	1	3
15.5	0	0	1	0	0	0	0	0	1	0	1	0	1
16.0	2	1	2	6	1	2	2	1	2	1	2	3	1
16.5	1	1	1	0	0	1	1	0	0	0	0	1	0
17.0	1	2	1	2	2	4	2	3	2	2	2	2	2

15	16	17	18	19	20	21	22	23	24	25	26
0	2	0	1	0	1	0	0	3	1	2	2
4	0	2	3	0	2	2	3	3	2	6	2
0	0	0	0	0	1	0	1	0	0	0	0
2	4	3	3	3	0	0	2	2	1	2	2
0	1	0	0	1	0	1	1	0	1	0	1
3	3	1	1	2	1	1	1	0	0	3	3
0	0	1	1	1	0	0	0	0	0	0	0
1	3	3	2	2	1	0	0	1	3	1	2
0	0	2	2	0	1	0	1	0	1	0	1
2	4	3	0	2	2	2	2	2	1	1	4
1	1	0	0	0	0	0	0	0	0	0	0
0	1	1	0	1	0	0	1	1	1	0	0
2	1	1	3	0	2	1	1	3	4	2	0
1	0	0	0	0	1	0	0	0	0	0	0
1	1	0	1	2	1	3	2	2	3	1	2
0	0	0	0	0	0	1	1	0	1	0	0
1	2	1	4	1	1	2	1	2	3	2	2
0	0	1	0	0	1	0	0	1	1	0	0
1	1	3	3	1	2	2	4	0	2	1	1
1	1	0	0	0	1	0	0	0	0	0	0
5	3	2	0	4	2	3	5	2	1	4	4

1	2	3	4	5	6	7	8	9	10	11	12	13	14
17.5	0	0	0	0	0	0	2	0	1	0	0	0	0
18.0	1	1	1	1	2	3	1	3	2	0	2	1	0
18.5	0	1	0	0	1	0	0	1	1	0	0	0	0
19.0	1	1	2	1	2	3	3	1	4	1	0	0	1
19.5	1	0	0	1	0	0	0	0	0	0	1	0	0
20.0	0	2	1	2	0	0	1	5	3	1	0	1	1
20.5	1	0	0	0	0	1	1	1	1	0	0	0	1
22.0	1	1	0	0	1	2	0	2	1	0	2	2	3
22.5	0	1	1	1	0	1	0	0	0	0	0	0	0
23.0	1	1	1	1	1	3	0	0	0	1	2	0	4
23.5	0	1	0	1	0	0	0	2	1	0	1	0	1
24.0	1	1	2	1	1	0	0	2	0	0	4	0	0
24.5	0	0	1	0	0	0	1	0	0	0	1	0	0
25.0	1	0	1	2	0	0	0	1	2	0	0	0	8

15	16	17	18	19	20	21	22	23	24	25	26
0	0	1	0	0	0	0	0	0	0	1	0
0	1	1	1	2	4	2	1	0	4	2	1
0	0	0	0	2	1	0	0	0	0	0	0
0	1	0	2	2	4	3	1	0	0	1	1
0	0	0	0	0	1	1	0	0	0	0	0
0	0	2	0	3	2	1	1	1	2	2	1
0	0	0	0	1	1	1	2	0	1	1	0
3	3	1	1	3	3	2	3	1	4	1	0
1	1	0	0	0	0	0	1	0	0	0	0
1	0	0	0	3	4	3	3	1	2	2	1
0	1	1	0	0	0	1	0	1	0	0	0
0	1	0	0	5	2	6	2	0	1	0	1
0	0	0	0	0	0	0	0	0	0	1	0
2	0	0	0	2	1	1	3	2	0	1	1

2.5 Results and Analysis

2.5.1 Results and Analysis towards Determining the Objectives of Education

The questionnaire (Appendix 2) was concerned with the objectives of education. There were four questions in the questionnaire, which centred around the objectives of education. The results and analysis for these four questions are separately discussed below :

2.5.1.1 Question 1 : Results and Analysis for the Qualities Considered Important in Life

The teachers were requested to rank the already listed set of qualities as per their visualisation of the importance of those qualities in life. The results i.e. the teacher responses obtained in this context are given in Table 2.5.1.1. For the purpose of analysis, the teacher responses were processed as follows :

i) Defining of Rank-wise Categories and Assigning of Weightages to Them

All the ranks have been classified into six categories and weightages were assigned to them as per Table 2.5.1.2.

Table 2.5.1.2

Description of the Weightages Assigned to Different Rank-wise Categorizations

Rank wise Categorization	Weightage assigned.
Category C_1 for ranks between 1 to 5.5.	$W_1 = 10$
Category C_2 for ranks between 6 to 10.5	$W_2 = 8$
Category C_3 for ranks between 11 to 15.5	$W_3 = 6$
Category C_4 for ranks between 16 to 20.5	$W_4 = 4$
Category C_5 for ranks between 21 to 25	$W_5 = 2$
Category C_0 indicating no rank assigned	$W_0 = 0$

Further, as can be seen from the Table 2.5.1.1 some of the qualities occupy partial ranks say 5.5. Procedure for arriving at such rank 5.5 is as follows :

For example, a teacher gave a rank of 5 to two qualities, say perception and analysis. For the purpose of analysis instead of ranking the quality as 5 and the other 6, or both 5 or 6, the researcher simply averaged the ranks and gave each above mentioned qualities a rank 5.5.

ii) Calculation of the Average-Importance Index

To obtain the average-importance index for a given quality as emerging from the teacher responses, first a frequency distribution corresponding to the quality under consideration is obtained indicating how many times the quality (i) has responses under the given rankwise category as defined above. Thus, the C_{th} quality one gets six frequencies (corresponding to the six above listed rankwise categories from C_0 to C_5 and Co) namely f_{i1}, f_{i2}, f_{i3}, f_{i4}, f_{i5} and f_{i0} then the average importance index I_I for this quality is given by

$$I_{th} = \frac{\sum_{j=0}^{5} f_{ij} w_j}{\sum_{j=0}^{5} f_{ij}}$$

where fij = frequency of responses for i^{th} quality in terms of its being assigned J^{th} rankwise category and W_j = weightage assigned to the J^{th} rankwise category.

iii) Obtaining Mean I_Q as also the Standard Deviation for the Sequence of the Average-Importance index $\{I_i\}$

Next for the sequence of the average importance index $\{I_i\}$ are calculated the arithematic mean, I_Q and the standard deviation σ_Q .

iv) Categorization of Qualities based on I_Q and σ_Q

It is on the basis of values of I_Q and σ_Q that then various qualities are ordered as per importance or significance or priority level as follows.

Table 2.5.1.3

Quality Priority Level Description

Range of the Average Importance index.	Description of the Quality Importance/ Significance/Priority level
$(I_Q + 3\ _Q)$ to $(I_Q + 2\sigma_Q)$	Highest priority
$(I_Q + 2\sigma_Q)$ to $(I_Q + \sigma_Q)$	Good priority
$(I_Q + \sigma_Q)$ to (I_Q)	Average priority
(I_Q) to $(I_Q - \sigma_Q)$	Less than Average Priority.
$(I_Q - \sigma_Q)$ to $(I_Q - 2\sigma_Q)$	Least Priority.

The results of the Table 2.5.1.3 are then analysed along the above stated approach and the emerging priority level wise categorization of the qualities considered important in life is reported in the 1st column of the Table 2.5.1.6.

2.5.1.2 Question-2

Results and Analysis of Qualities vis-a-vis the Question as to which of these Qualities Education should try to Achieve

As indicated in subsection 2.4.1, the responses requested from the teachers in terms of the query as to which of the qualities education should try to achieve were of 'Yes' or 'No' type. The results of this survey in terms of the percentage of 'Yes' against each quality are given in Table 2.5.1.4. For the purpose of analysis, these qualities are then classified in terms of various priority level wise categories as defined in the Table 2.5.1.5.

Table 2.5.1.4

Teachers Responses in Terms of Percentages of Yes for Questions 2, 3 and 4 of Questionnaire (Appendix 2)

Questions posed before teachers (Qualities)	Qualities that should be achieved	Qualities that can be achieved	Qualities that they have been able to achieve
Perception	76.25	74.55	61.75
Analysis	74.55	60.75	87.27
Diagnosis	62.55	86.25	90.20
Problem Solving	86.27	90.20	76.47
Judgement	90.20	76.47	76.47
Communication	76.47	76.47	76.47
Understanding	76.47	76.47	52.94
Sympathy	76.47	52.94	94.12
Tolerance	52.94	94.12	94.12
Sense of responsibility	94.12	94.12	80.39
Leadership	94.12	80.39	92.16
Decision making	80.39	92.16	80.39

Questions posed before teachers (Qualities)	Qualities that should be achieved	Qualities that can be achieved	Qualities that they have been able to achieve
Coping with frustration	92.16	80.39	60.79
Knowledge	80.39	60.78	90.20
Creativeness	60.78	90.20	88.24
Self-reliance	90.20	88.24	68.63
Confidence	88.24	68.63	78.43
Sense of humour	68.63	78.43	70.59
Ability to mix well	78.43	70.59	58.82
Wide interest	70.59	58.82	31.37
Independence	58.82	31.37	23.53
Honesty	31.37	23.53	11.76
Ambition	23.53	11.76	37.25
Common Sense	11.76	37.25	31.37
Logical thought	37.25	31.37	25.49

Table 2.5.1.5

Quality Priority Level Description

Range of the percentage of 'favourable' i.e. 'Yes' type response.	Description of the priority/ facility/implementation level
100% - 85%	Highest priority
84% - 70%	Good priority
69% - 55%	Average priority
54% - 40%	Less than average priority
Less than 40%	Least priority.

2.5.1.3 Question-3

Results and Analysis of Qualities vis-a-vis the Question as to which of these Qualities Education can Achieve

The responses in the context, as in the earlier situation, were also sought to be of the 'Yes' or 'No' type.

The details of this investigation more or less follow those of the previous investigation. In specific terms, the results of this survey are given in Table 2.5.1.4. These results are analysed consistent with the frame work reported in Table 2.5.1.5 and the emerging "feasibility" levelwise categorization of the qualities that can be achieved through education is reported in the column 3 of Table 2.5.1.6.

2.5.1.4 **Question 4**

Results and Analysis of Qualities vis-a-vis the Question as to which of the Qualities have been Achieved by the Education

The results of this investigation are given in Table 2.5.1.4. These results are analysed consistent with the frame work reported in Table 2.5.1.5 and the emerging "implementation" level wise categorization that has been achieved through the education is reported in the fourth column of the Table 2.5.1.6.

Thus Table 2.5.1.6. which is self explanatory presents the total analysis of the questionnaire I.

Table 2.5.1.6 Summary of Observation Emerging from Questionnaire-1

Items for which the qualities of Questionnaire-I have been analysed	Classification of Qualities from Q-I in terms of Degree for priority for qualites considered important for life	Classification of Qualities from Q-2 in terms of Degree of piority for qualities education should achieve.	classification of Qualities from Q-3 in terms of degree of implementation for qualities education can achieve	Classification of Qualities from Q-4 in terms of degree of feasibility for qualities educaion has been able to achieve.
Highest	Sense of responsibility, confidence, self-reliance, common sense	Problem solving, Judgement, Sense of responsibility, coping with frustration, self reliance	Diagnosis, problem solving, Tolerance, Sense of responsibility, Decision making, creativity	Analysis, diagnosis, sympathy, tolerance, leadership, knowledge, creativity
Good	Judgement Perception, Understanding, logical thought, honesty, analysis, problem solving, creativity	Perception, analysis, communication understanding, sympathy, decision making, knowledge, ability to mix-well,wide interest	Perception, Judgement, communication, understanding, leadership, coping with frustration sense of humour, ability to mix well	Problem solving, judgement, communication, sense of responsibility, decision making, confidence, sense of humour.
Average	Diagnosis, Communication, knowledge, tolerance, Decision making.	Tolerance, Diagnosis creativeness, sense of humour, independence.	Analysis knowledge, Confidence, wide interest	Perception, Coping with frustration, self-reliance, ability to mix well.
Less than	Independence, Leadership, sympathy, Ability to mix well	-	Sympathy wide interest,	
Least		Honesty, Ambition, Common Sense, logical thought	Independence, honesty common sense, logical thought	wide interest, Independence, honesty Common sense, Logical thought.

2.5.1.5 Correlations between Responses to Various Questions in Questionnarie - 1

The correlations between responses to various Questions in questionnaire-I have been given in Table 2.5.1.7.

Table 2.5.1.7

Correlation between the Responses to Various Questions in Questionnaire-I

Questions	Question-1 Qualities that are important in life	Question-2 Qualities that should be achieved by education	Question-3 Qualities that can be achieved by education.	Question-4 Qualities that have been achieved by education
Question-1	-	-0.01 Slightly negligible	0.07 Slightly positive	0.01 Slightly positive
Question-2	-	-	0.72 High	0.61 moderate
Question-3	-	-	-	0.74 high
Question-4	-	-	-	-

It is against the above presented details through Table 2.4.1, 2.5.1.1 to 2.5.1.7 that the next subsection then summarises the emerging observations.

2.5.1.6 Summary of Observations

Table 2.5.1.6 presents the summary of observations as emerging from the analysis of the teacher responses to the questionnaire I. Thus as described earlier, Table 2.5.1.6

gives the degree of priority-wise classification of teacher perception of qualities stated under the questionnaire I in terms of queries as to :

i) Firstly, which of the qualities are most necessary in life.

ii) Secondly which of the qualities should be aimed at by the technician education.

Further Table 2.5.1.6 also gives feasibility wise as well as implementation wise classification of teacher percepation of various qualities stated in questionnaire-I.

It is against the data in Table 2.5.1.6 that Table 2.5.1.7 gives the correlations among the teacher responses to the four questions of the questionnaire I.

Observations

Below are listed some of the main observations thus emerging :

1. In the perception of teachers, the qualities of sense of responsibility, confidence, self reliance and common sense have emerged with the highest priority in the context of what the process of life needs most.
2. Against this, coming to the qualities that the education should try to achieve, the teachers have given amongst other things highest priority to the qualities of problem solving (ability), judgement, leadership, self-reliance, and coping with frustration.

3. With reference to qualities that education can achieve, in the perception of the teachers, qualities like problem solving, decision making, self-reliance etc. have received the highest priority.

4. As regards the qualities, which in the perception of teachers, the education has been able to achieve with the highest priority the qualities of : analysis, knowledge, leadership, etc.

5. Interestingly, while the quality of knowledge has been considered to be of only 'average' importance as far as the requirements of life are concerned, when enquired as to how far the education has been able to achieve this quality under consideration, the teachers have responded indicating 'highest' degree of achievement.

6. Similarly, while common sense has been given the highest priority as far as the requirements of the life are concerned, this quality has received the least priority in terms of the teachers perception vis-a-vis what education should aim at.

7. It is interesting to note that the teacher responses to the question as to 'what qualities the life needs most' show very poor correlations with the teacher responses to the questions as to : 'what education should achieve'. 'what education can achieve' and 'what education has achieved'. Against this, the responses to questions as to 'what education should achieve' show

high to moderate correlations with the responses to the questions as to 'what education can achieve' and 'what education should achieve, respectively. Similarly, the teahcer responses to question as to 'what education can achieve' shows a high correlation with those to the questions as to 'what education has achieved'.

2.5.1.7 Conclusion

While there is an internal consistency among the responses to the questions as to 'what education should achieve, 'what education can achieve' and what education has achieved, the teachers' perceptions of the qualities that education should pursue, can pursue and has pursued are quite at variance from their own perception of what qualities the life requires.

2.5.2 Data Analysis and Results of Teacher Responses on Effectiveness of Present Curriculum

As discussed in 2.4.2.1 the questionnaire to teacher on effectiveness of present curriculum (Appendix 3) was divided into five sections, namely, Input, Resources, Management, Evaluation and Output. The analysis of data and results for these five sections are discussed below :

2.5.2.1 Input

This section listed the perceptions of teachers about the background of the present student intake in polytechnics in terms of education, intellectual level and behaviour. It also included the views regarding the method of selection and the effectiveness of the medium of instructions. The teacher responses obtained in the process are given in the Table 2.5.2.1. below :

Table 2.5.2.1

Perceptions of Teacher towards the Background of the Students

S.No.	Adequacy of background :	% of favourable respondents
1.	Education.	43.96
2.	Intellectual level.	39.62
3.	Behaviour inclusive of communication skills in English.	47.74

It can be seen from Table 2.5.2.1, that the majority of teachers are of the opinion that the present background of the students (i.e. input quality) to the polytechnics is poor in terms of prior educational level (i.e. 10+), intellectual level and the behaviour (inclusive of communication skills in English). In order to overcome these difficulties, the majority (74.88%) suggested the admission and aptitude tests for technician education at the entry level.

2.5.2.2 Resources

This section studies the view of the teachers about the availability of the resource centre facilities for efficient instruction like slide projector, overhead projector etc. and the utilisation of the library facilities by the students. The views of teachers are given in Table 2.5.2.2 below.

Table 2.5.2.2

Percentages of Responses on the Availability of Resources and on Lack of Utilisation

S.No.	Resource Parameters	%age of favourable Respondents
1.	Availability of Resources in terms of - Slide Projector - Overhead Projector. - Film Projector etc.	86.1
2.	Poor utilisation of resources and library facilities	84.88

It is reflected from the Table 2.5.2.2 that 86.1% teachers are of the opinion that there exist resource centre facilities in the institutes in terms of : slide projector, overhead projector, film projector, etc. However, 84.88% teachers are of the opinion that, the utilisation of these teaching aids, and particularly the library facilities, is very less, and enumerated the following reasons in the context.

i) The staff in the library is very inadequate.

ii) The students do not find time to go to library between 9.00 A.M. to 5.00 P.M. as the time table and curriculum do not allow them to utilise this facility.

iii) Most of the libraries of the polytechnics do not have the open shelf system which results in wastage of time for locating the books from the closed almirah.

2.5.2.3 Management

This section lists the teachers' views about the effectiveness of the training and their suggestions to improve upon it.

i) 43.1% teachers expressed their views that they make the students aware about their role in problem solving towards the society with reference to their branch of engineering by giving instances of practical situations, and by exposition of basic principles in the class room, laboratory and field visits, together with news coverage, and also through the project work.

ii) 31.02% teachers felt that indifferent attitude of students towards studies, inter-employee rivalry, lack of support from department, gap in vision and absence of the congenial environment are the major causes of irritation in performance of their duties effectively.

iii) 100% teachers were of the opinion that the indifferent attitude of the management/authority leads to ineffectiveness of the teaching process.

iv) 100% teachers suggested that to avoid masscut in the classes, students should be kept engaged in games, co-curricular activities during their stay in the institute and through training in the industry during vacation. Teachers were also of the opinion that the students are to be guided psychologically and motivated towards the studies by bringing the attitudinal changes.

v) The majorty of the teachers also suggested that on the very first day of the session (semester) the students should be made aware of the goals and objectives to be achieved in a duration of three years of their study in the polytechnics. The curriculum should be revised and the engineering subjects should be introduced in the first semester of First year. They also suggested that students should be exposed to various facets of industries such as management structures, employment potential, career opportunities and career growth.

vi) To improve the quality of output from the polytechnics, 100% teachers were of the opinion that the class room should be linked with the world of work so that the students could visualise the expectations industries have from them.

vii) Majority of the teachers also suggested that better rapport between teacher and taught should be established .

viii) In addition, the teachers also suggested to bring about a change in the curriculum. More contact hours should be given to the practicals than the theory.

2.5.2.4 **Evaluation**

This section lists parameters for effectiveness of the evaluation system and seeks teachers' suggestions for reliable and valid measurements of the students' achievements. The observations of the teachers about evaluation are as under.

i) 48.24% approved the external evaluation system.

ii) 51.76% teachers stressed the need for internal, continuous evaluation system. They were also of the opinion that the internal, continuous assessment should be 40% and the external assessment should be 60%, and the external assessment be further in the ratio of 60% theory written examination and 40% practical examinstions.

2.5.2.5 **Output**

This section enlists teachers' views about the output from the polytechnics and enumerates the reasons for substandard quality of the same. Teachers' responses thus obtained are given in the Table 2.5.2.3 as under :

Table 2.5.2.3

Responses of the Teachers about the Quality of the Output from the Polytechnics

S.No.	Quality of the output	% of respondents
1.	Very poor	16.4
2.	Moderate	83.6
3.	Good	NIL

From the Table 2.5.2.3 it can be seen that 16.4% teachers were of the opinion that the output from the polytechnics was very poor, and 83.6% of the opinion that the product was moderate. Further, no teacher rated the product as "good". Also, when teachers' responses were further researched through additional queries, it emerged that 100% teachers remarked that the training imparted by polytechnics was lacking in the skill and exposure to the work environment.

From the above discussion, the following conclusions emerge :

i) The entry in the polytechnic education (technician) should be made on the basis of aptitude test and the merit of the qualifying examination.

ii) Every polytechnic should have the resource centre, open shelf library and their proper utilisation. The high rate of their use can be achieved by adjusting the Time Table and manpower resources.

iii) For creating congenial environment in the institute, the management and faculty should prepare the students in such a manner that they have stake in education.

iv) The class room should be linked with the world of work so that the students are engaged properly for the utilisation of time, development of skills and exposed to the various facets of industries such as management structure, employment potential, career opprotunities and career growth.

v) The system of evaluation of the students should have continuous and internal component.

vi) The output should be improved to match the requirements of the the world of work by imparting the structured training in work environment.

2.5.3 Data Analysis and Results of the Feed-back of Students towards Their Awareness about the Engineering Profession and the Effectiveness of Educational Processes

As discussed in sub-section 2.4.2.2, the questionnaire on final year students, response to effectiveness of educational process. Appendix 4 is divided into five sections, namely, Input, Process, Resources, Output and Management. The analysis and results for these five sections from adminstration of the questionnaire are discussed below :

2.5.3.1 Input

This section lists the characteristics of students in terms of their awareness about the engineering profession, motivation towards the profession and the difficulty in understanding the instructions in English language. The responses of the students in the above traits are given in fig. 2.5.3.(1).

It can be seen from fig. 2.5.3.(1) that majority (58.27%) of the final year students were aware right at the time of admission itself of the area in which they would be employed after completion of the course. Further, interestingly, same population which responded affirmatively to above query had certain engineering back ground like I.T.I. etc. right at the time of admission. However, 87.34% of students suggested that they had joined the programmes because of the elders and not by their own choice. This is an interesting observation as it suggests that even those who have vocational background do not seem to aspire for a technician career. Finally, 10.12% students expressed difficulty in studying subjects in English, while 88.88% were non committal on the subject.

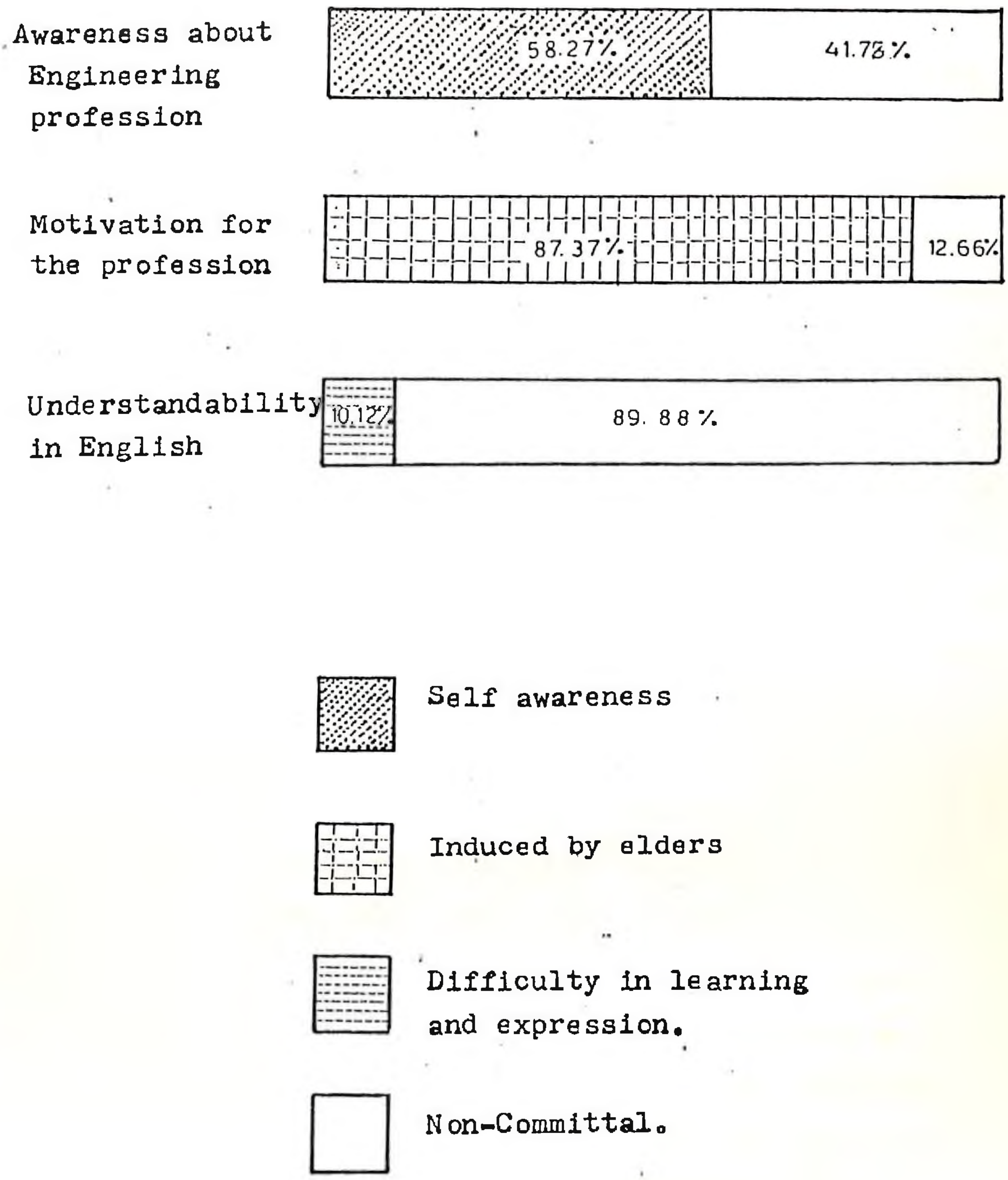


FIG: 2.5.3.(1): Students responses about awareness, motivation and difficulty in medium of instruction at entry level.

2.5.3.2 Process

This section lists the perceptions of students about the methodology of teaching, their difficulty in learning the particular subject, their satisfaction about the methods of evaluation, visits to the work environments, their performance in practicals and theory courses and the reasons for the mass-cuts from the classes. The students' observations are given in figure 2.5.3.(2).

It is seen from the fig. 2.5.3.(2) that the majority (55.96%) of students expressed their satisfaction with the methods of teaching, and the rest of the students preferred to remain silent about this. Only 2% students mentioned that the teaching should always be with the help of audio visual aids in the class, and that there should not be any homework. However, almost all the students expressed that the teaching should be practical oriented. 67.08% of students expressed that they face difficulties in the subjects which are theory based. 32.92% of students expressed that learning in theory based subjects can be more effective if it is linked with the practical situations. 67.08% students expressed their satisfaction for the present system of evaluation, and 32.92% students were of the opinion that the evaluation should be continuous.

72.15% students stressed the need for visits, to the work environment during their course of study for the understanding of the application of subjects and to know

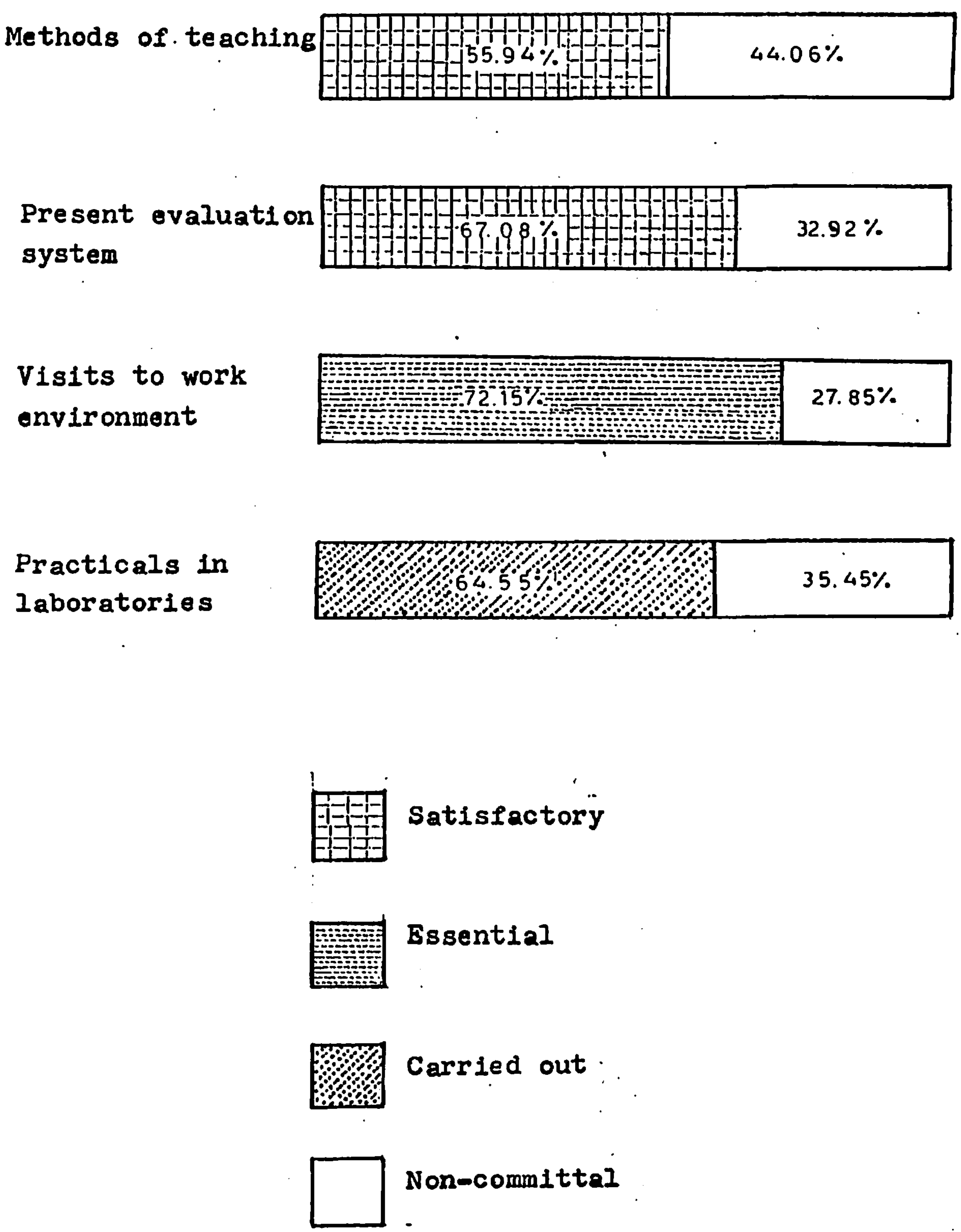


FIG: 2.5.3(2): Students responses in respect of teaching/learning processes.

the working procedure for production, management and inspection, etc. 64.55% students said that they had done practicals in the laboratories, the rest of the students mentioning nothing about it.

79.74% students expressed the reasons for the mass cuts from the classes as follows :

i) Lack of motivation

ii) Shortages of the equipment/materials

iii) Sometimes, indifferent attitude of the management

2.5.3.3 Resources

This section lists the views of the students pertaining to availability of raw material for working, equipment in the laboratories and furniture in the class-rooms etc. This section also includes the availability of the print material required for the courses from library and the suggestions of students for better output from the Polytechnics. The description of the students' views is given in the fig. 2.5.3(3).

It can be seen from the fig. 2.5.3(3) that, 62.02% of students said they got sufficient raw material for the workshops and laboratories. 58.02% expressed that laboratories were well equipped, and 84.08% students expressed that the classrooms were also well equipped with the furniture. However, 68.35% students expressed that they did not get sufficient study material from the

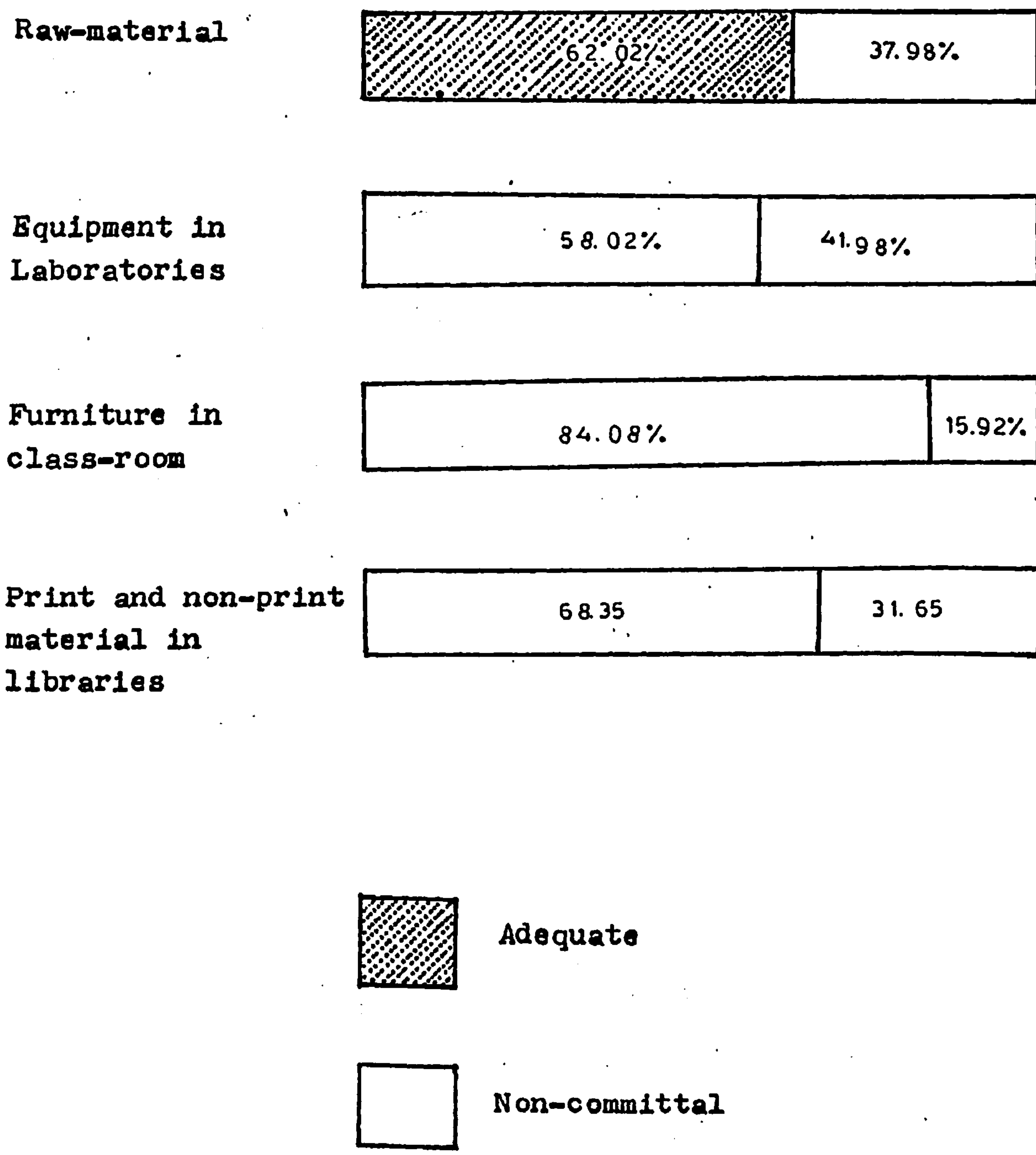


FIG: 2.5.3 (3) : Students assessment about availability of physical resources in Polytechnics.

library. Finally, 100% students suggested that the training in polytechnics should be practical oriented and students must be exposed to the work environment during their course of study in polytechnics.

2.5.3.4 Output

In this section students' views about their competency after completing the polytechnic education and training in terms of theoretical knowledge and practical skill are considered. The observations of studnets are given in the fig. 2.5.3(4).

It is seen from the fig. 2.5.3(4) that, 83.84% of students felt that they would be sound in the theoretical knowledge after polytechnic education. Only 2.54% students mentioned that they were having confidence in the practical skill which they had attained in the polytechnic. 100% students suggested that in polytechnic education, more stress should be given on the practical skill and training should be linked with the world of work or the work environment.

2.5.3.5 Management

This section lists the students views about the effectiveness of management of the Institution, the Department and the Hostel. It also includes students' involvement in their branch of engineering in problem solving of their interest. The students' opinions so researched are given in the fig. 2.5.3(5).

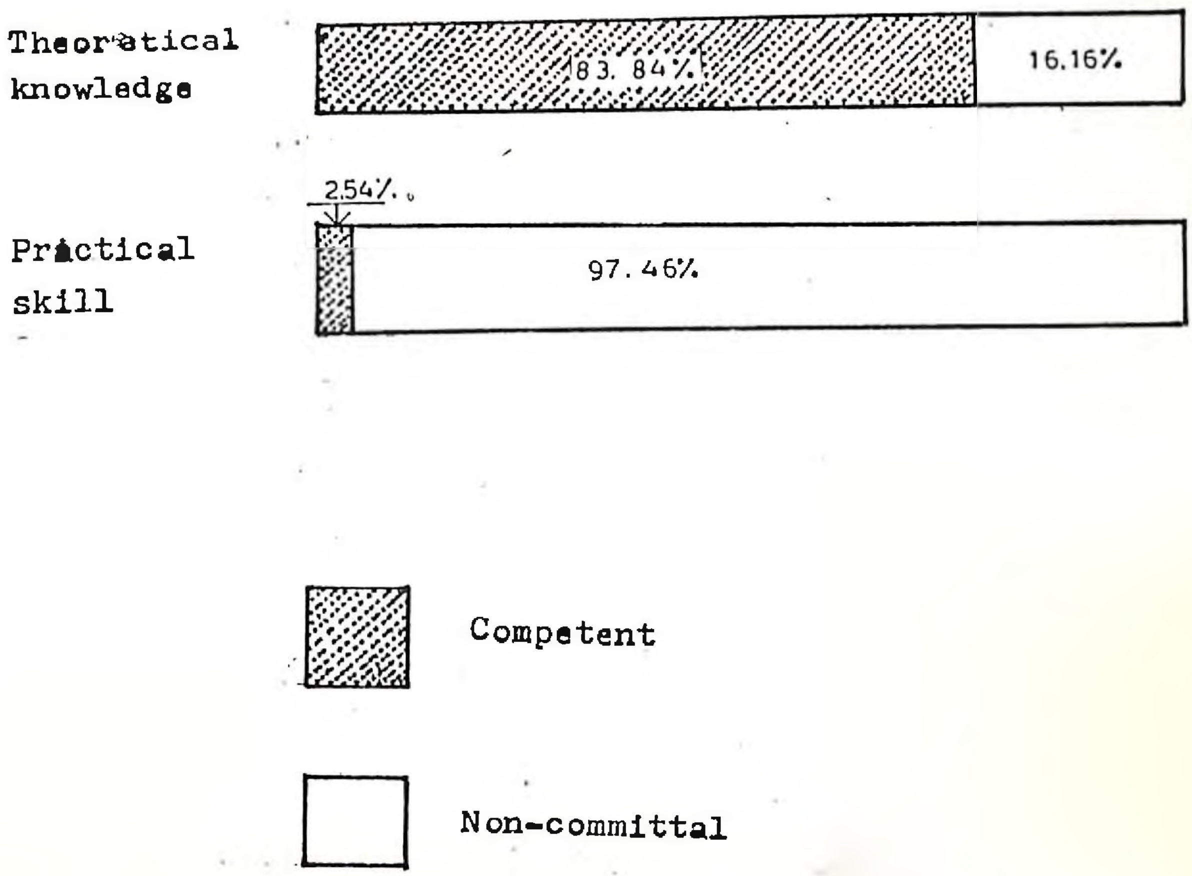


FIG: 2.5.3(4): Student assessment about their competency after completing Polytechnic education.

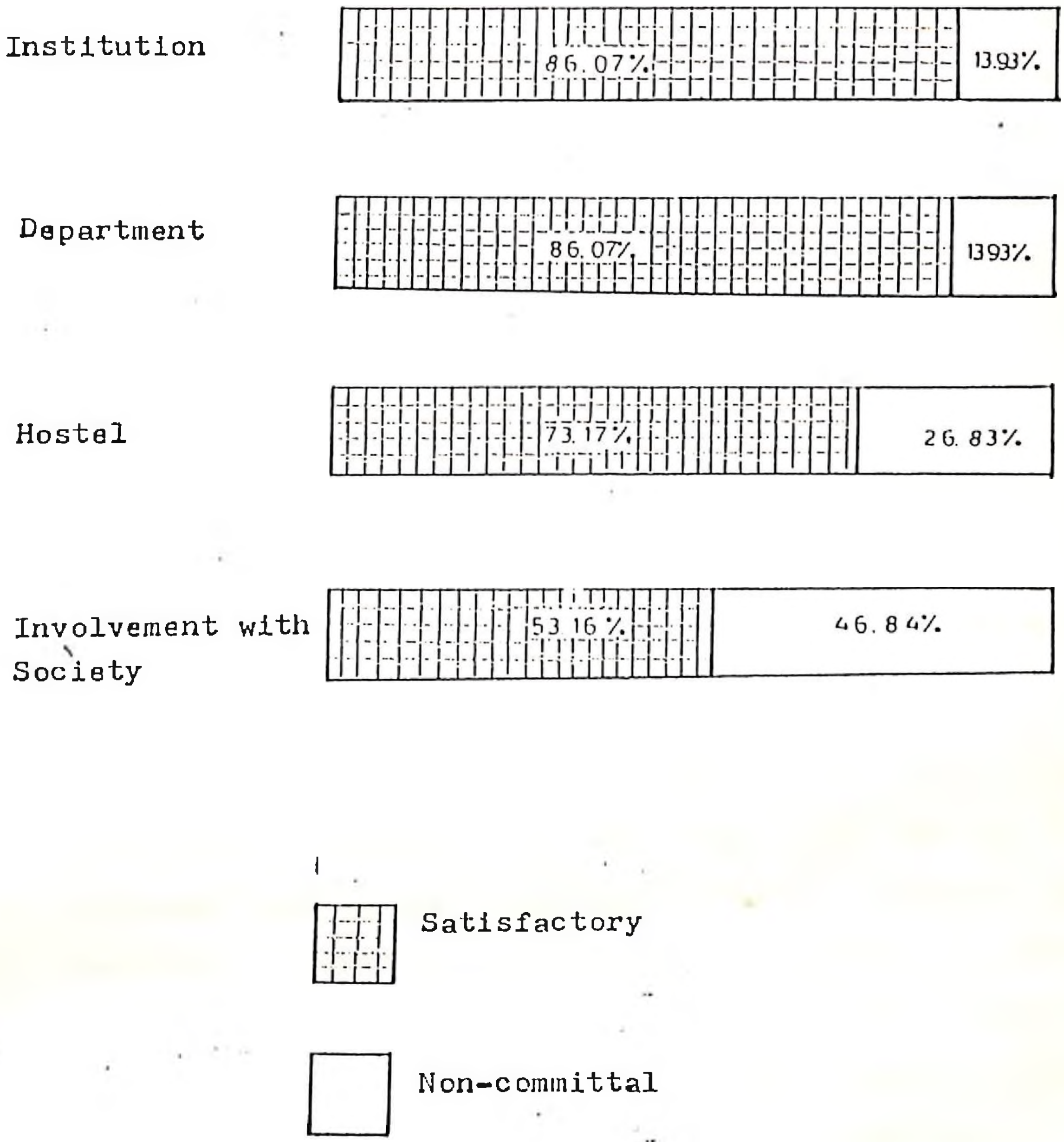


FIG: 2.5.3(5): Students response about effectiveness of management and their involvement with society.

From the fig. 2.5.3(5) it is reflected that 86.07% students were satisfied with the management of the institution, in general, and of their department of engineering discipline, in particular. 73.17% students expressed their satisfaction with the hostel management. 53.16% students expressed that they had the involvement with the environment in problem solving related to their discipline of engineering.

Conclusions

From the above discussion based on the feed back from the final year students, and an informal survey, of different polytechnics as undertaken by the researcher, the following conclusions emerge :

i) All polytechnics surveyed have facilities for practicals. However, it was found that 35.45% of students did not do practicals, thus, missing an important learning experience vis-a-vis problem solving. Of course, research by Prof. L.N. Mittal, TTTI, Chandigarh further shows that when a group of 150 students was surveyed for the quantum of involvement in practicals, only 20% had done experiments individually. While 70% did in a group and 10% had copied from previous years' practical notes; in turn posing a serious question in regards to the very educational utility of the so conducted practicals. Of course, one may argue that practicals have been designed for group activities. Group activities or discussion based on participative learning is meaningful only when there are open ended problems i.e., when what is being taught has more than one answer depending on different constraints within which one has to work. It is only in this situation that one can then conduct participative and group learning activities, while also ensuring that the teacher does not play an autocratic role.

ii) Informal survey of nine polytechnics also reveals that there is another interesting observation and it pertains to the availability of print i.e. text material for use in the polytechnic classes. Normally, this print material which is prepared by T.T.T.Is' is provided to students through institutional libraries, and the student feed back has already suggested inadequacy of this service (Sub-section 2.5.3.3). Further, polytechnic survey shows that a sizeable teacher population does not use this material effectively in teaching, and at the same time they have also not developed any material of their own; thereby making this learning facility non-optimum. And to make the matter more difficult, students also do not have entrepreneurial attitudes to make full use of other learning aids, though, on their own account the resource centres are well equipped with them; thereby once again bringing the question back to the issue of inadequacy of teaching learning process.

iii) Finally, there is the question of courses being practical oriented, and of laboratories being properly equipped and class rooms well furnished. Basis for this is in the need that learning atmosphere should exist in the institute and students should be properly motivated and guided for the problem solving abilities; as by doing so they will gain confidence to handle the problems of life and institutes will have direct link with society or the world of work.

2.5.4 Data Analysis and Results of the Feed-back taken from the Employed Passed-out Students for the Revision of the Curriculum According to the Needs of the World-of-Work

As discussed earlier, the questionnaire on feed back from employed passed out students (Appendix-5) is divided into five sections namely :

i) Nature of employment and activities undertaken,

ii) Curriculum,

iii) Methods adopted to acquire specialised knowledge,

iv) Industry - Institute collaboration, and

v) Collaboration between institute and passed out students.

2.5.4.1 Nature of Employment and Activities Undertaken

The Fig. 2.5.4(1) shows that majority of students surveyed, i.e., 52.8% are working as Junior Engineers, 31.8% working as supervisors, 12.7% as Managers, and a bare 2.7% are self-employed.

It is further seen from fig. 2.5.4(2) that, 57.3% students are engaged in maintenance and servicing tasks, 16.5% in production, and 11.8% are undertaking management and supervision work. Testing and inspection and purchase and sale are the activities of about 4.5% students, while 2.7% students are engaged in research and devlopment and teaching activities.

2.5.4.2 Curriculum

This section enlists various issues pertaining to the effectiveness of teaching learning process and suggestions to improve upon as perceived by the employed passed out students.

It is seen from the feed back that 85.5% students were of the opinion that curriculum offerings at diploma level had been of considerable help to them in their present employment, while 14.5% students opined that it was of moderate use. But all students expressed the need for revision and updating the curriculum and introduction of emerging technologies.

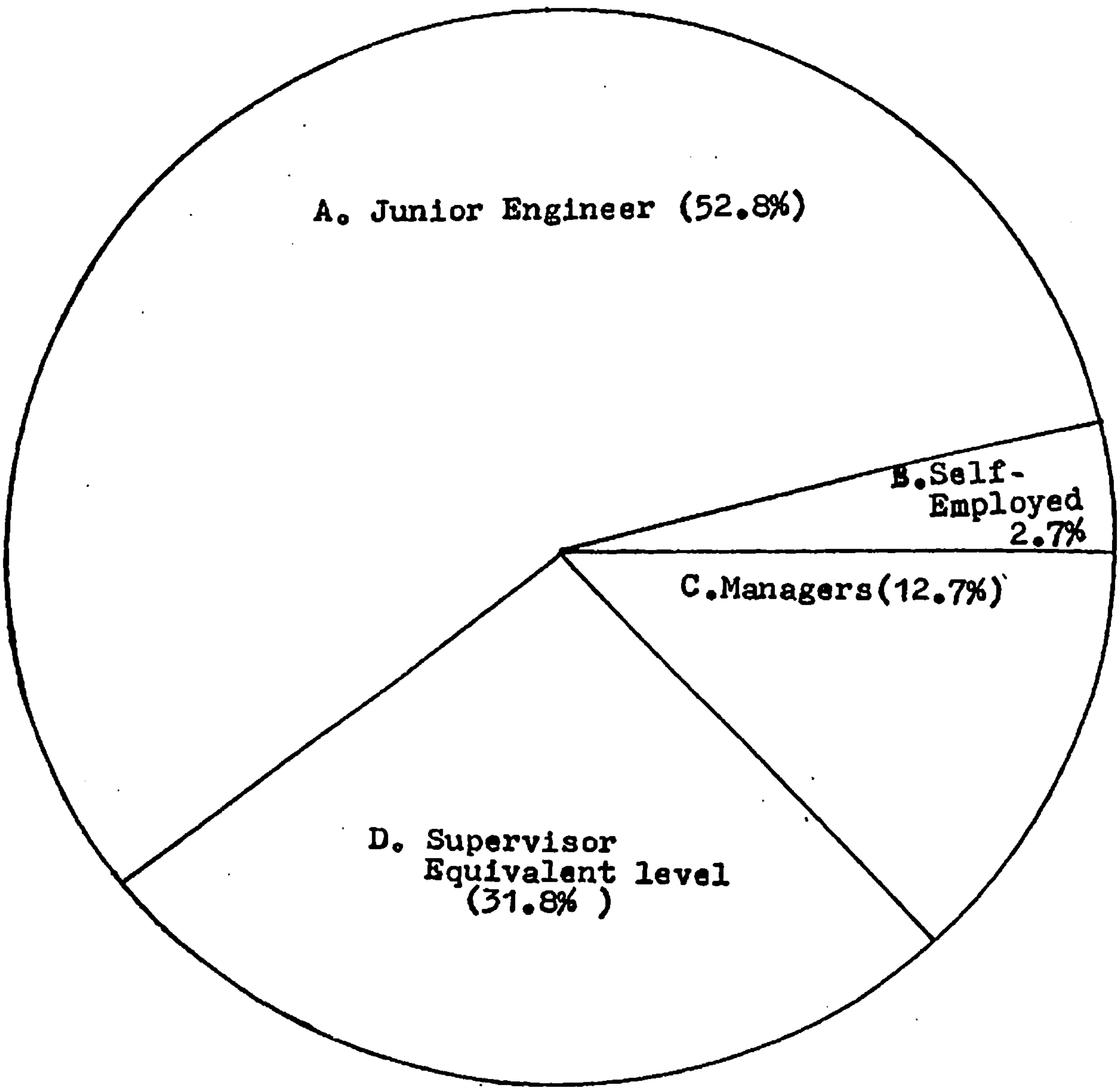
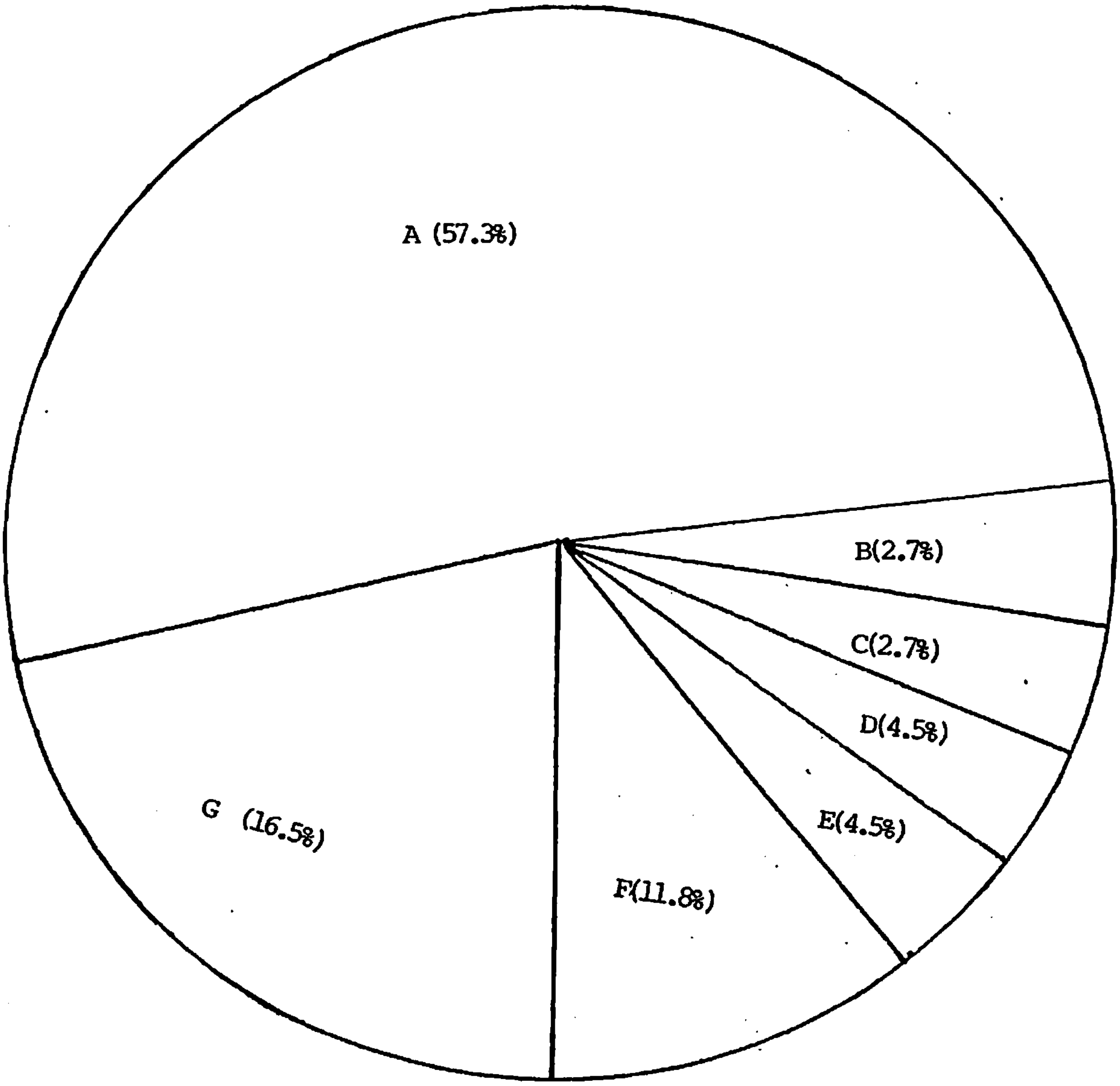


FIG: 2.5.4(1): Attainment of positions in various employing organisations.



A. Maintenance and servicing

B. Research and development

C. Teaching

D. Testing and inspection.

E. Purchase and sale.

F. Management and Supervision.

G. Production

FIG. 2.5.4 (2) : Major activities undertaken by pass out students.

91.8% students felt that they would have benefitted more, if emphasis had been placed on specific engineering problems. All students were of the opinion that the sports/hobbies clubs should be compulsory at diploma level for a team work and new innovation in learning.

All students stressed that extension lectures from industry should be organised and also, were of the view that diploma should be awarded after the completion of industrial training.

Besides this, students expressed that they were facing many problems because of the modernisation of industries for increasing productivity. This will be accomplished by a quantum leap in technology by way of inducing automation, computer aided design and manufacture (CAD-CAM), use of new materials and installing pollution preventive systems.

Analysis of the data thus, indicates that technician will be required to possess specific knowledge and skills in specialised technologies such as energy and power, transportation, instrumentation and control, modern machining methods, new technique of construction, maintenance engineering, CAD-CAM, entrepreneurial skills, etc.; thereby suggesting methods for continual curriculum modernisation so as to meet the work-place based challenges of technology modernization that emerged from this sample of employed passed out students.

2.5.4.3 Methods Adopted to Acquire Specialised Knowledge

The methods adopted by students to acquire specialised knowledge not provided at diploma level, include reading of text books or monographs and technical papers, special industrial training courses and assistance from colleagues.

The Fig. 2.5.4(3) reveals that 40% of students acquired specialized knowledge by undergoing special Industrial training courses, 36.3% students through reading text books, and 13.7% gained knowledge by reading technical papers, and remaining 10% acquired it from their colleagues.

Therefore, acquiring of knowledge is a continuous process, and so is the revision of the curriculum.

2.5.4.4 **Industry-Institute Collaboration**

All the students felt that industry-institute collaboration is essential at diploma level

2.5.4.5 **Collaboration between Institute and Passed-out Students**

All students felt that there should be old students association and passed-out students should be invited to express their views in seminars and in college magazine. They also mentioned that institute should orgainse refresher courses for the passed out students.

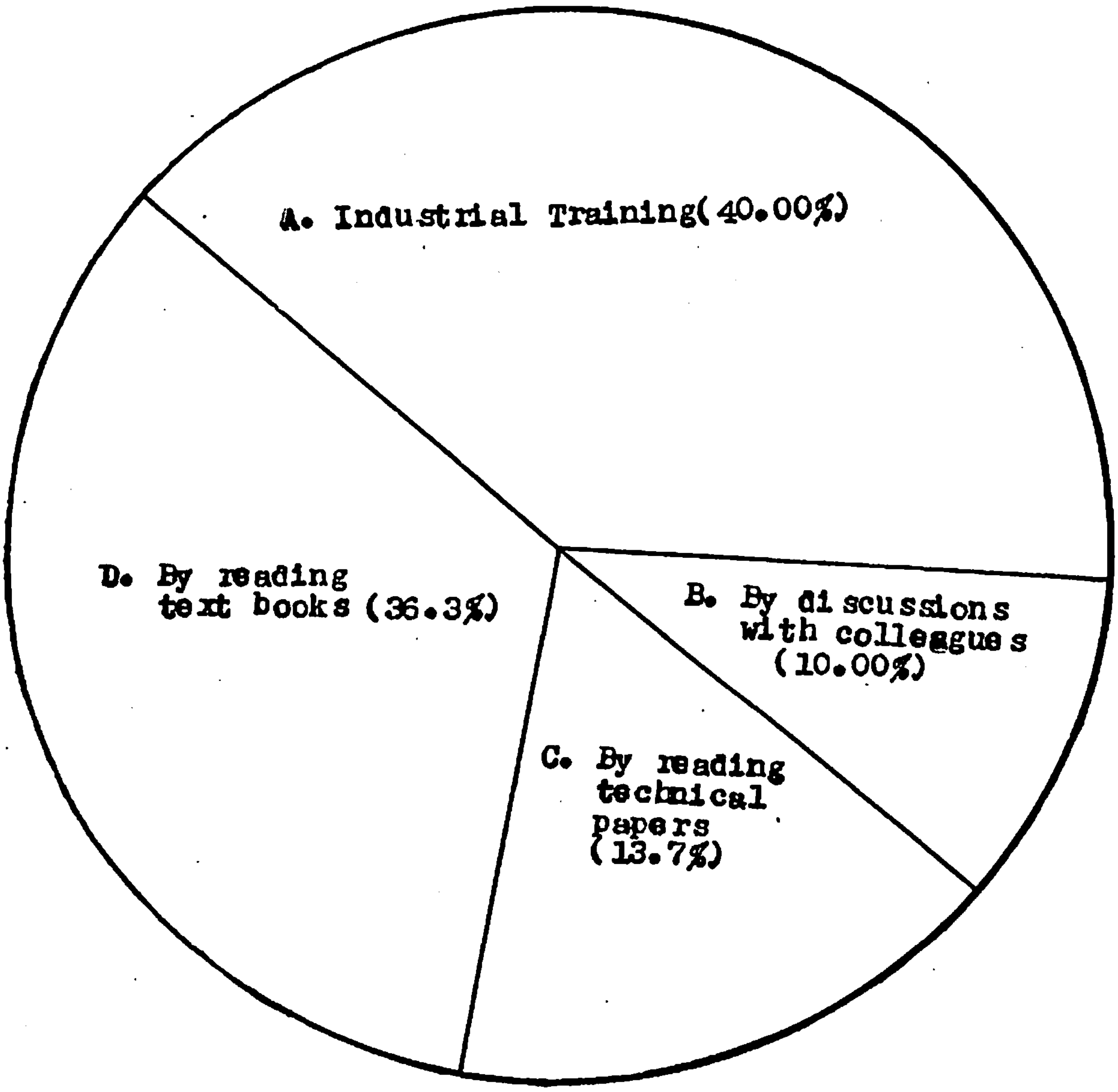


FIG: 2.5.4.(3): Method adopted to acquire specialised knowledge.

Conclusions

Keeping in view the above study, the following conclusions can be derived.

As one critically analyses the feed back response from 110 students passed out from Polytechnic system over last 14 years (Appendix 3), it becomes abundantly clear that only less than 3% are self-employed. Indeed training for technical entrepreneurship which will make the industrial economy regenerative and, in turn create employment potential, was a central thrust of the massive technical education expansion task that independent India took on itself. This certainly brings to the surface inviting immediate attention to all issues of teaching, and particularly of curricula design and structuring, besides polytechnic-industry interface.

Yet another observation of unequivocall and unanimious/category is the response of alumini of polytechnic system in regard to the following :

i) Need for link between Polytechnic and industry.

ii) Opportunity for working in the industry (May be as an intern) while undergoing diploma courses.

This response of students once again throws open a significant issue of validity of present approach to curricula design, though it is not necessary that every observation of students is accepted in toto. Indeed, views of students expressed above in regard to total lack of such interface in the present design, and hardly any enthusiasm on the part of students for entrepreneurial involvement once again mark the significance of possible short coming in the approach to curricula design as pointed out by the investigation.

Further, when asked how they learnt specific problem solving for new technologies, it is interesting to note that maximum precentage of students (40%) replied that it was during their industrial training sojourn.

These passed out and employed students can play a major role in the Institute-industry collaboration in the following areas :

i) Regular exchange of faculty from Polytechnics and Engineers from Industry.

ii) There should be a joint association of industries and Polytechnics at each district/town level.

iii) Need based programmes to be run by Polytechnics.

iv) Effective training to students with improved staff development programme.

v) The curriculum and evaluation scheme needs to be integrated with in-plant training scheme so that industrial involvement is beneficial.

vi) Industrial sector should inform vacancies to technical institution rather than depend on employment exchanges.

vii) Better collaboration with industry in framing syllabus, conducting examination and involving students in the industrial training.

2.5.5 Results and Analysis of the Feed-back taken from the Employer of the Students of Polytechnics

As discussed in sub-section 2.4.2.4 the questionnaire on employer response is divided into three major sections namely :

i) Employment potential in the large, medium and small scale industries for technicians.

ii) The gaps in the performance of technician in the world of work/industries.

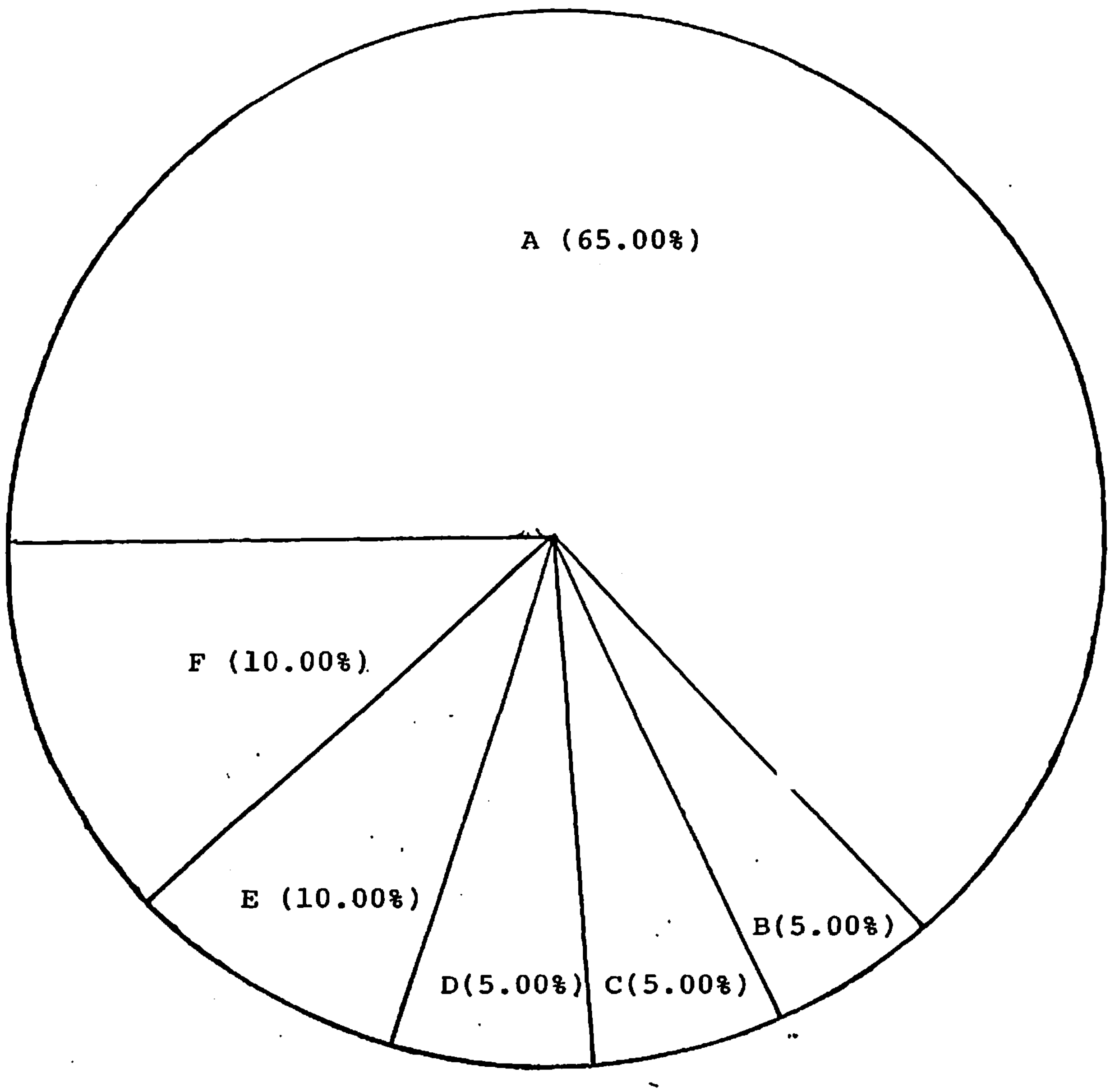
iii) Likely changes in the role of technicians.

2.5.5.1 Employment Potential in the Large, Medium and Small Scale Industries for Technicians

The Figures 2.5.5(1) and 2.5.5(2) shows the employment potential of technicians in percentages.

The study reveals that small scale industry has very meagre potential for providing employment to diploma holder technicians. The main reasons attributed for this are :

i) Small scale industry is unable to pay salaries to technicians commensurate with those paid by Medium and large industry.



A. Production/Construction
B. Research and Development
C. Design and Drawing
D. Production and Planning
E. Repaire and Maintenance
F. Quality Control

FIG: 2.5.5(1): Employment potential of technicians in large scale Industries.

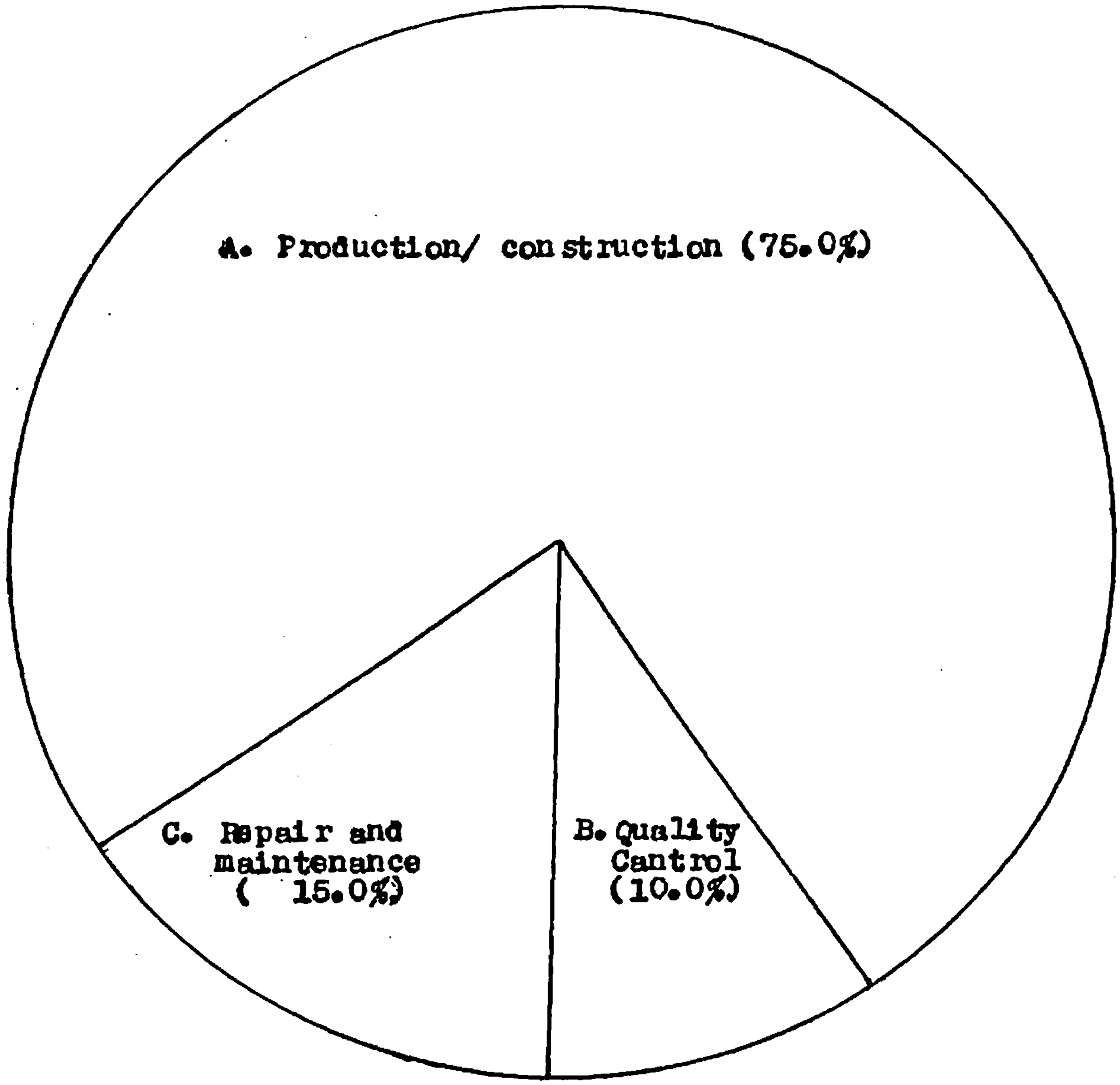


FIG: 2.5.5(2): Employment potential or technicians in Medium scale industries.

ii) Lack of vertical and horizontal mobility discourages diploma holder technicians to seek employment in small industry.

iii) Small scale industries prefer to promote master craftsmen to technicians' positions rather than engaging fresh diploma holder technicians.

The study also reveals that large scale industries require technicians who have broad-based knowledge and skills so that these technicians with little re-orientation and training can easily be made to work in any of the departments of large scale industry. Generalised diploma courses in civil, electrical and mechanical engineering are more suitable for large scale industrial undertakings. Whereas in the medium scale industry, technician having broad-based knowledge and skills but in specialised field of activity like technician in electronics, refrigeration and air conditioning, plastic technology, chemical engineering, etc. are required.

2.5.5.2 The Gaps in the Performance of Technician in the World of Work

The following are some critical gaps in the performance of technicians which have come to light.

i) Lack of competence in reading and interpreting drawings.

ii) Lack of understanding about the significance of accuracy in measurements, fits, tolerance, etc.

iii) Lack of basic laboratory and workshop skills needed for quality control and supervision of production processes etc.

iv) Lack of proper attitudes towards time, team work, economy, safety, etc.

v) Lack of communication and reporting skills.

vi) Lack of knowledge of the procedure for land acquisition, workman compensation, etc.

vii) Lack of knowledge about the industrial and labour laws and the industrial management.

viii) Lack of knowledge and training in judging the psychology of worker, their habits, attitudes and approach to problem solving.

ix) Lack of knowledge in the new emerging areas of studies.

2.5.5.3 Likely Changes in the Role of Technicians

Visits to industry and interactions with executives have revealed that the present role of technicians has to undergo a variety of changes in order to meet the requirements arising out of advancements in technology and industry in the coming decades :

i) Technicians will continue to play a key role in the industrial and other sectors of economy. A large number of them will continue to perform the well established functions in different technologies for making provisions for the improvements in materials, processes and quality control systems.

ii) The analysis of the data indicates that increasing number of technicians will be required to possess specific knowledge, skills in specialised technologies such as energy and power, transportation, instrumentation and control, modern machine methods, maintenance engineering and management, electronics, computer aided design and computer aided manufacture.

iii) The knowledge-skill-mix of technicians is expected to undergo changes in view of the technical advancements. Further, conventional job functions may coalesce into unified jobs calling for a different range of competencies. The technician will be more a knowledge worker and will be required to possess higher order cognitive abilities, a fair amount of managerial capabilities and less of conventional manipulative skills.

iv) Technicians will have to possess aptitude to learn skills and must make effective use of information technology.

And to train a technician for such a changing role, polytechnics will be required to play a more pro-active role in the design and implementation of a variety of programmes to meet the needs of different target groups and the changes in technology and industry. Thus, the future rŏle of Polytechnics will be to :

i) Conduct higher technician programmes in consultation with industry in areas of identified technology on selective basis. The input to such courses should be flexible and determined for each programme.

ii) Conduct technician courses with greater involvement of the industry particularly with an integral component of industrial training in the conventional disciplines and emerging areas of technology and service sectors.

iii) Promote interaction with industry in a variety of areas such as curriculum development, technology updating, problem solving and innovations.

iv) Organise enterpreneurship development programme to promote self-employment.

2.6 Observations

True affluence of a nation should be measured by the quality of human beings living in a country and working organisations of all kinds. The ultimate success of any organisation vitally depends upon the calibre, quality of performance and the trained manpower in it. Though the nation has been conscious of this, the efforts for integrative planning in the context have not been that fruitful. This has resulted in imbalances of demand and supply of specialised areas of manpower. The live registers of employment exchanges and the advertisments in the leading papers show that the manpower being trained in some of the areas is less in demand, whereas some of special talents for emerging areas are rarely available. The former position leads to unemployment and under employmnet, and in the later scarcity prevails. Both these situations lead to dis-satisfaction and low efficiency among employees and leave a great effect on productive processes and economy of the country. This has resulted perhaps on account of less thought being given to the intake/enrolment of manpower in educational and training institutes at different levels without careful and meticulous considerations of demands. It further leads to a dismayed and gloomy sight when one sees financial and human resources being utilised on training of manpower, for the spheres which are not needed for times to come. Further, the manpower under training particularly at technician level by itself has no motivation. This results in indiscipline, under achievements and developing parasites. Such situations have wasted enormous funds, facilities and efforts of the country.

The technical educational system must respond to this issue by evaluating courses and programmes, updating curricula, introducing new courses, modernising resourses and facilities and providing for a close interaction between the world of technical education and the world of employment. The technical educational system will be thus necessarily required to offer a variety of programmes, full time and part time, formal and nonformal, at different levels, over a wide range of diversified and interdisciplinary areas. This need is clearly stated in National Policy on Education 1986.

2.6.1 Achievements in Polytechnic Education

Technical education has made a significant contribution to India's economic development. These programmes which have contributed to industrial and economic development in the country and diversified and augmented its production since independence, have been possible largely because of the manpower produced by India's institutions for technical education. In 1947, there were about 53 institutions conducting technicians courses with a total intake capacity of about 3700 students per year; the total outturn from these institutions was of the order of 1500 per year. Today, we have about 483 polytechnics which are capable of admitting about 70,169 students each year, and the outturn has jumped to about 46,672 students per year.

According to the changing needs of society and technology, new subjects in the existing curriculum are introduced to meet the specific requirement according to the geographical needs. The topics which are outdated are deleted and topics involving latest technologies are introduced in the subjects.

Polytechnics have established their importance in the middle level management due to which there is a high demand ratio (the ratio of the number of applicants to the number of seats available) to polytechnics. Due to this reason students having higher level of knowledge, skills and attitudes are admitted. The diversification of the courses in engineering is another achievement for attracting the talented students to polytechnics.

A wide range of quality improvement programmes have been floated by the Government of India through Technical Teachers Training Institutes during the last two decades. Significant contribution has been made in the areas of curriculum developmnet, educational technology and Industrial training of teachers, educational planning and management, etc.

Further, rules and regulations for diploma holders from polytechnics for seeking admission in the engineering colleges have been amended in an effort to improve their qualifications.

The community polytechnics have made excellent work in transferring the technology in some areas to the rural masses and establishing the linkages with society (sec. 2.3)

2.6.2 Deficiencies in Polytechnic Education

The Polytechnic education in India suffers from a large number of social, economical, educational and cultural handicaps, which counts for the following deficiencies in polytechnic education.

2.6.2.1 General

Till now, the admission in polytechnics is being made on the basis of the marks obtained in the entrance examination (Matric, i.e. 10+) irrespective of the ability of the student to excel in technical trade. No aptitude tests are conducted to judge his ability for technical courses, which hampers the academic activities.

From the study of the prospectus of various states, it is analysed that the admission to polytechnics is made from 10+, 11+, 12+, certificates from junior technical school, I.T.I., etc. with varying percentage of reservation for different categories. This gives a heterogenous group with different levels as input, which ultimately affects instructional processes and academic activities.

From the analysis of admission procedure of various states of India, it is observed that the procedure adopted for admission to polytechnics is different in different states. Some states admit students on the basis of merit in board examination and others on the basis of entrance test. This gives a non-uniformity of educational level amongst various states, adversely affecting the inter state mobility.

Many state governments have imposed ban on fresh recruitment even if a large percentage of the sanctioned posts are lying vacant, which results in acute shortage of manpower at different levels, adversely affecting technicians' training (sub section 2.5.2.2).

There is a disparity of recognition and privileges between the field staff and teaching staff in society which seriously affects the availability of intelligentia in the teaching profession. To attract the intelligentia in industries different incentives are offered, where as this is totally lacking in the teaching profession (sub section 2.5.4.1 : only 2.7% of passed out employed students surveyed had preferred to be in research and development and teaching profession).

Of course, the Government of India has at present started many schemes in polytechnics, for rewarding teaching faculty with some remuneration and to improve the teaching processes by generating interaction between society and polytechnic for equipping technicians with entrepreneurial skills for the unorganised industry comprising small scale/rural industry including the service sector. But this, in turn, has created a problem for polytechnic education in as much as teachers' involvement in such programmes tends to ignore the basic duty of teaching. As a result sometimes teaching is done, particularly in the community polytechnics by fresh daily wage employees, under-qualified and inexperienced. This results in lowering of the standards of technician education manifold. At present, the diploma holders are ignorant of the actual requirements of the industry/world of work due to lack of industrial experience of faculty members. Most industries are aware that at least two years are necessary for a fresh polytechnic graduate to become useful, because polytechnics do not teach what the industry needs from students. The available potential in industry for instructional purposes for curriculum development, practical training of students, industrial training to teachers, use of resources in industry for instructional purposes, etc. have fully not been tapped by polytechnics. (sub section 2.5.5.3).

2.6.2.2 Physical Resources

Availability of suitable and standard instructional materials, such as text books, laboratory manuals, teaching aids, etc. at resource centres is not effectively being used by teachers (sub section 2.5.3.3). In technician curricula, support services like library, reprographic and duplicating facilities are inadequate.

Most of the existing polytechnics were established in sixties. The addition of resources in terms of laboratory/workshop equipment and machinery for these polytechnics has, therefore, been against the role of technicians as visualised then. However, the same has now undergone a sea change (sub section 2.5.5.3), thereby requiring sizeable updating and modernisation of this resource apparatus.

2.6.2.3 Processes

Most of the teaching in the class rooms is through the lecture method and dictation of notes. Skill development in laboratories and workshops is often through observation and study of the equipment. Due to this, the output of Polytechnics fails in actual job situation, world of work (sub section 2.5.3.2).

The output from polytechnics prefer white collar jobs. They prefer to work as technical assistants sitting in offices rather than working in the field as supervisors, foremen, etc. This is due to the reasons that they have not inculcated the habit of working with hands and tools and appreciate value of dignity of labour.

Most industries are aware that at least two years are necessary before a fresh polytechnic graduate can become useful because polytechnics do not teach what the industry needs from students.

Another important aspect to be noted is when an industry agrees to provide training, it has no stake in it, thereby resulting in poor quality of student exposure to industry.

A majority of polytechnic courses do not include the element of on-the-job training.

At present hardly any facility exists for engineers or engineering students to receive proper technical education during training in industries. This is because of lack of understanding of the long term effects of proper training by industrialists. They believe mostly in managing things and not the ways in which these are managed. Improper training demoralises trainees and their interests in creative work and initiative are hampered.

2.6.2.4 Management

Deficiencies in this area have mainly surfaced from the feed back coming from teachers. These deficiencies are : indifferent student attitudes towards studies, inter employee rivalry, lack of departmental support (to teachers), gap in vision and practices and absence of congenial environment. Of course, the question of lack of student motivation resulting in poor output quality seems to worry teachers the most, and to respond to it they suggest an educational strategy of linking class rooms with the world of work (sub section 2.5.2.3).

Much of the reason for lack of such a linkage is to be seen in absence of any method of associating teaching staff with practical problems. This is a serious defect in existing system. Due to this and in view of the fast progress in the field of changing technology, knowledge of teaching staff is becoming outdated because no opportunity is provided to them to come in close contact with industries and higher institutes of learning.

2.7 Need for Institute-Industry Interface : The Direction

If education is seen as a vehicle for economic and social development, and about which there is no second opinion, then the "passed out employed students" i.e. the product of any educational system represent the most significant constituent of the educational organisation under study for its linkages with the world of work, and, therefore, with development. And when one looks into the responses of this constituent, as far as the polytechnic education is concerned, then if there is one aspect on which this constituency of technician education is unanimous and unequivocal, it is the need for polytechnic industry interface (sub section 2.5.4.4).

It is interesting to note that sub section 2.5.4.4 by itself has only one line length which should confound any researcher, as any observation of such a significance should have been backed up by more detailed support. This anomaly can be explained on the count that indeed it is the same observation, directly or indirectly, underline, almost every other response of other constituents of polytechnic education.

- For example sub section 2.5.1 has discussed teacher response to issue of determining the objectives of education. The analysis of their responses in the context shows that while there is internal consistency between teachers' perceptions in regard to what qualities education should, can and has achieved, qualities under these three categories correlate poorly with teacher's own perceptions in regard to qualities needed most in life. Considering that education is preparation for life, this, indeed, is a very unacceptable situation from an educational point of view. This certainly calls for teacher education and competence building for linking skills and competencies as needed in life, i.e. as needed in the work life and those needed for education. Seen in this perspective, investigation as undertaken in sub section 2.5.1 is nothing but a direct basis to conclude that basic issue is that of establishing linkages between the processes of production and processes of education in turn requiring polytechnic-industry interface.

- Similarly sub-section 2.5.2.3 mentioned the teachers' response suggesting efforts by teachers to acquaint students with practical situation for cultivating amongst themselves problem solving abilities in their branch of engineering. However, when one compares this feedback with feedback from passed out employed students, such efforts in present day class room teaching seems to be of particular outcome. This is because firstly teachers themselves admit that students have no motivation for learning (sub-section 2.5.2.3), which could not be the case if teaching methods were to be successful in imparting to students awareness about their responsibilities and skills as they begin their professional life, and secondly because the feedback from passed out employed students also suggests that whatever they learnt of utility they did after joining jobs. As the issue is of making students aware of their role as problem solver in society and, therefore, at workplace in an important one, and as the existing efforts in teaching to create this awareness are not effective, it emerges that new designs of teaching learning processes linking polytechnic education with practical application must be developed. This once again points to the need of polytechnic-industry linkages. This observation gets further reinforced when one notes that teachers in their own thinking also unanimously hold the same opinion when it came to the question of improving the quality of polytechnic output (item VI of sub-section 2.5.2.3).

- Coming to the feedback response obtained from final year students, it is interesting to note that even those who had vocational background prior to their joining polytechnic had pursued technician career by joining polytechnic more because of the parental desire and less because of their own choice. This further reinforces the issue of lack of learner stake in polytechnic education; in turn emphasing need for relevance and, therefore, industrial linkages in the curricula. This is confirmed by response of final year students where almost all of them expressed that teaching should be practice oriented and around 72.15% stressed the need for visits to the work bench (sub-sections 2.5.3.1 and 2.5.3.2). This observation is further reinforced when one notes that while 83.84% of final year students felt that they would be sound in theoretical knowledge after completing Diploma, only 2.54% mentioned that they had confidence in practical skill which they had acquired in the polytechnic (sub-section 2.5.3.4).

- As regards the responses from the passed out employed students, the same has been cited earlier with reference to unanimous view on need for institute - industry linkages. The same is also the observation when one analyses the feed back from employers; one of the significant factors demanding linkages in this case being rapid rate of technological changes at the work place.

One can go on in this manner, but what is important is to understand that the central thread of responses of all constituents is one and the same i.e. need to establish institute-industry linkage.

True, many mechanisms have been practised to achieve above like practical training, sandwich programme, visits, etc., but they have not been able to generate the institutional mechanism as is obvious from educational statistics (sub-section 2.3.3) and from the responses of the constituent researched in this chapter. It is this which then poses the central issue for researching as one emphatically, visualises bridging of gap between institute - industry as the only problem to be resolved.

Chapter Three addresses itself to the issue of the choice of teaching-learning method for this problem solving for training an entrepreneur for tomorrow.

CHAPTER - THREE

POLYTECHNIC INDUSTRY INTERFACE: CHOICE OF TEACHING-LEARNING METHOD FOR NEED FULFILMENT

3.1 Introduction

The linking of the technician education with industry reinforces relevant learning, helps students become productive member of society and contributes to the human resources. Co-operative education programme for interfacing education with work is being developed as one of the methods to make education meet the social needs. Co-operative education is a structured academic programme developed and supervised by an educational institution in which productive work is an integral part of a regular students academic programme. The co-operative programme brings the student in direct contact with industry and engineering profession, and exposes him to problems typical of those encountered in practice. Students are introduced to full scale engineering projects and operations, far beyond the scope of any laboratory or workshop or class room learning of any educational institution. Polytechnics offer summer vacation jobs, work experience unconnected with the student's educational objective, field experiences, educational tours, etc. which are worthwhile experiences but do not comprise co-operative educational systems. Taking a world-wide view of the educational situation of technician education - industry linkages, however, the success of the quantitative reforms has not been so great as to conceal the disproportion that exists between the immensity of the efforts made and the comparative slenderness of the results achieved. There is, therefore, a particular urgent need for fundamental renewal and change in content in curricula, in the approach to the problems and, of course, in teaching methods.

3.2 Co-operative Education : Educational Pedagogy

3.2.1 Co-operative Education

A co-operative education programme possesses all the important requirements of an educational programme, such as academic, experimental and career orientation. It is academic because students enrol in an academic/technician institution and receive instruction in theoretical aspects of their chosen field of study. It is experiential because built into the systems are frequent breaks from the institution into the work places; the students have an opportunity to experience the real world of work and have opportunities to interact with people in many situations than most students have even experienced up to this point in their life. It is career oriented because experiential aspect is directly related to the student's long or short range employment interests. Co-operative education is also known as "professional practice programme" since students receive substantial amount of relevant professional practice during the tenure of their academic programme.

3.2.2 Educational Pedagogy for Co-operative Teaching

Traditionally, education has adopted the narrative method of teaching in the form of 'Lectures' which are essentially autocratic (Nolker & Schoenfeldt 79). From time to time, this has been supplemented by labs, practical training, home projects, use of charts, displays, etc. But, understandably, these teaching techniques have their own limitations in training a student in the art of problem solving. The educational pedagogy of transfer of learning reflected through co-operative teaching attempts to offset this limitation by introducing in the curricula and time table, specific time slots when student and teacher directly interface with the work-bench to establish a triangular relationship between student, teacher and work-bench. Thus work-bench becomes classroom-cum-lab. Manpower specifications at work-bench become student's prior preparation, and work-progress becomes student's evaluation, forming an effective interface for co-operative teaching (17).

Transfer of learning refers to the extent to which knowledge and ability learnt in one situation will be used in new and different situations (Saupe 1961). In the present context, therefore, while the first situation forms the class room, the second understandably is the environment or work bench. Thus introduction in the curriculum of such situations as described above, which are indeed environment oriented, are essential for co-operative teaching. This is supported by research which indicates that for acquisition of skills of synthesis and creativity such student-centred learning experiences need to be provided (Heywood 1977). The concept has also been introduced under co-operative education at the post-graduate engineering level (Mandke 1983) through teaching techniques which are project-based and evaluation techniques which are professional in nature. Understandably, therefore, evaluation under the pedagogy of Transfer of Learning calls for extensive examination reforms which now need to be oriented towards measuring skills of application and problem-solving, intrinsic to the work bench.

This calls for teachers to know about the conditions under which maximum learning takes place and about other significant variables associated with it: learning ability, forgetting, motivation, attitude, interest, purposes, goals, aspirations, reward or punishment, practice and transfer of training. It is only then that they can set conditions and guide the activities of learners to achieve the educational goal.

Principles of teaching like simple to complex, concrete to abstract, known to unknown and easy to difficult though desirable, do not clarify learning principles for "problem solving". This also applies to various approaches to learning: trial and error, observation and learning by doing. It is against this backdrop that one can understand the need for co-operative training.

3.2.3 Educational Pedagogy : The Need for Co-operative Training

The advance of science and engineering stimulates expansion of engineering departments in large scale educational institutions. Such institutions, provide favourable conditions for enriching students intellectually and for training researchers and instructors. What is central to this training in the context of rapidly changing Science and Technology is that the learners must be equipped to be the contributors to real life problems of technology implementation and modernisation.

This, in turn, calls for curriculum in teaching of technology which is science based, as engineers of future, should be people of creative action and wide learning. Further, by its very nature, the training in technology requires learning component of practical training in plants. It is here that students are expected to acquire to do things by themselves.

To achieve this educational objective, the most acceptable form is co-operative teaching, i.e., to "employ" the student as a "worker" in the plant. This educational need could be integrated with the curriculum by providing for "project/thesis" component in diploma education. However, this "employment" is a controlled one, in the sense, learner here is basically a "student" and not a "wage earner", and, therefore, such "project" component in the curriculum would call for a role for the teacher who in accompaniment with employer would play the part of "advisors" to the learner as he discharges his work responsibility as a by-product of his main task of technology learning.

The training of vocational teachers should, therefore, be aimed at improving their scientific knowledge and simultaneously at their mastering of above pedagogy. Further, a pedagogy such as the one described above automatically provides for academic faculty contributing as consultants in industrial enterprises, and, for prominent workers of industry attending to students of technical and vocational education as teachers during educational years.

3.2.4 Importance of Pedagogical Training of Teachers

In Polytechnic, the teacher is the main intermediary of education. Traditionally his basic function has been to transmit knowledge which pupils have only to register in a more or less receptive manner and memorize. However, today, the educational centre of gravity is shifting: from the teacher to the pupils. By observing, experimenting, selecting and classifying phenomena, by solving problems on his own, etc.,the pupil should acquire new knowledge alone, in so far as possible, discover characteristics and structures of phenomena and make his own generalisations.

In this way, the teacher's role ceases to be that of informing and examining, and becomes one of stimulating, organising and regulating the study activities of pupils.

Forging a link between subject training and that of other specialities, particularly in pedagogy, thus emphasising the specialised nature of teacher training Institutions, would be the most significant consequence of this development. It is a trend that ought to bring with it a definite improvement in the quality of instruction which is presently quite inadequate.

3.2.5 Aims of Co-operative Education in Polytechnics

The Polytechnic Industry interface programmes intend to develop professional competency and maturity as well as ability to work in industrial environment. It is a controlled simulation of the professional life during education years.

Polytechnic-Industry Interface Programmes will keep the faculty of the polytechnics in tune with the requirements of industry, ensure better utilization of resources, deliver realistic and fruitful output through closer liaison between polytechnics and industries and make students more motivated.

Further, Polytechnic-Industry Interface Programmes will provide opportunities to employers in selecting appropriate technicians, enhancing the image of the company, and to academician in serving the community to build need-based education and training programmes for mutual growth.

Thus, our planning should be such that the polytechnic education develops entrepreneurial attitudes, skills and self reliance amongst its students. If polytechnics succeed in this objective, the diploma holders will not only have a rewarding professional life, but also have active participation in the industrial development of our country.

Finally, it should be remembered that the main aim of the polytechnic is to provide opportunities for and facilitate the development of responsible, confident, self directed and innovative technicians, who can solve practical problems at the grass root level of industry/world of work.

3.3 Co-operative Education : A Historical Background

The basic idea of co-operative education first came in the mind of Herman Schneider, a civil engineer in America. His basic observation was that most of the students in America take up employment on a part time basis, in order to earn money to off-set part of the cost of their education. In most of the cases, the jobs obtained have no relation to ultimate career aims and do not contribute to the occupational or professional development of the student. He thought that this need of most American students to work their way through educational institute could be turned to positive advantage by assimilating work periods into course programmes and using them to provide relevant and professional experience.

In this way in 1906 the university-industry linkages programme in the name of co-operative education was found in the School of Engineering at the university of Cincinnati, Ohio, United States of America. The organising committee of the 4th world conference on Co-operative Education defined Co-operative Education as a strategy of applied learning which is a structural programme developed and supervised by educational institution in collaboration with an employing organisation, in which relevant production work is an integral part of a student's regular academic programme and is an essential component of final evaluation. Such programmes should normally commence and terminate with the academic period and the work experience component should involve productive work and should comprise a reasonable proportion of the total programme. At present there are five basic types of programmes operative in United States of America using experience in a work situation:

A) For general education purposes

- Work observation programme
- General work experience programme

B) For occupational education purposes

- Work-study programme
- Internship
- Co-operative education programme

In United Kingdom, some form of co-operative education, began in 1840 at the University of Glasgow in the name of "Sandwich system", specially to provide a mode of professional education.

In the Indian setting, it has been a case of plenty of planning and no execution in the right and desired direction.

Indeed, so far as the subject matter of education is concerned, it will not be an overstatement to say that no national level decision has been able to command, at all times, as much unanimity of view as happens to be the case with regard to the need for establishing close linkage between the system of technician education and industry. This can be abundantly seen from the time-to-time recommendations of various councils, committees and commissions, the important amongst them being the Wood's Despatch (1854), Dr. T. Raleigh (1902), Educational Policy Resolution (1913), Sadler Commission (1917-19), Report on Vocational Education in India by A. Abbot (1937). The report of the Technical Education Committee of the Central Advisory Board of Education (1943), Scientific Manpower Committee (1947), Radhakrishnan Commission Report (1949), Engineering Personnel Committee (1956), Committee for Post-Graduate Education Commission (1966), High Power Committee of All India Council for Technical Education on studying collaboration between Technical Institution and

Industry (1970), and National Policy on Education 1986 (For details see section 3.5).

But in spite of frequent reiteration of the firm Policy decisions to organise practical training, Practice School(PS) and Sandwich Programmes towards establishing closer interaction between the academic world and the industrial world and in spite of all the promise of necessary help, the attainment of the objective has all the time eluded the nation, except in the case of Practical Training Scheme which was started in 1947, due to the untiring efforts of the All India Council for Technical Education. Thus by 1966, the number of fresh engineering graduates and diploma holders receiving in-plant training in the industrial enterprise had risen to 3000, because during the training period the Government undertook the responsibility of payment of monthly stipend. This gave spurt to the introduction of practical training in the degree and diploma programmes, but basically without fruitful results (9).

As the years passed, it was becoming clear that the practical training scheme could not be the basis for achieving such desired linkage between the Insitute and the Industry, and at the same time no definite model was emerging for the implementation of Institute-Industry collaboration programme. During subsequent years, the report of the standing committee of University Grants Commission on Engineering and Technical Education (1971) shows that the pattern of effort put in by the various previous committees, like Scientific Manpower Committee (1947), Engineering Personnel Committee (1956) and High Power Committee of All India Council for Technical Education on studying collaboration between Technical Institutions and Industry (1970), reiterating the firm policy decisions to establish Institute-Industry linkages, remained repeated without any concrete outcome. Hence, in May 1974, All India Council for Technical Education considered the question of Institute-Industry linkages and recommended the establishing of Practice Schools (which was first considered in 1958). It is notable that in 1967, HBTI Kanpur started its Practice School programme in the Chemical Engineering discipline at the post-graduate level on the lines of such a programme operative at Massachusetts Institute of Technology (MIT), USA. Also, Birla Institute of Technology and Science, Pilani, Rajasthan, during 1973 launched its Practice School programme at the first degree level, for a few selected students.

The reflection of all these developments is to be found in the 9th report on Higher Technical Education of Estimates Committee of the 6th Parliament (1978). This report, while summarising the ways and means in terms of Institute-Industry collaboration, reiterates the need for organising Practice Schools.

In 1968, Government of India, through its National Policy of Education emphasised that for the proper balance of the out- put from educational institutes to the employment, Sandwich Courses should be started in which a student spends specified periods alternately in an educational institution and in industry. In this method of study a major draw back is that during the training at the work bench, the teacher does not play a direct role in training and evaluation and the industrial personnel are vested with the responsibility of supervision with occasional visits from the teacher. As a result, this method of polytechnic -industry interface suffers from the basic problem of "teacher" not being an integral part of interface implementation, thereby affecting the rigour in education.

L.S. Chanderkant in (1982), while analysing Sandwich Programme and Practice Schools, pointed out that innovations in technical education are few and far between and without any specific linkages with the world of work. Whatever is claimed as an innovation is no more than a change in class room practices centred around teacher's activity in a subject field. Further, he remarks that Polytechnic education, though wide spread in India, is in a bad shape and thorough reorganisation is urgently warranted. In this context, he points out the merit of Practice School System of education.

Internship is another form of co-operative learning in India in the field of medicine. It is undertaken after completion of the formal degree programme and involved several months of work at relatively low emoluments. Internships usually involve experience that is necessary for licensing certification, or registration in a particular profession.

3.4 Co-operative Education : International Scene

Linking of the technical education with the world of work reinforces the relevant learning, helps students become productive members of society and contributes to the development of human resources. Every country has developed its own technical courses in relation to the needs of the industry. Structure, contents, standards of courses and evaluation procedure vary from country to country.

There are full time integrated courses of two to three years duration and Sandwich Courses in which student spends stated periods in industry and then goes back to the institution in the alternate layers of learning and practice. There are block-release courses, day-release courses, evening courses and correspondence courses. Each type of courses in a particular country has some bearing on the history of that country. The main point of technician courses is to give an integrated sequence of instruction in science, mathematics, in technological subject matters and in related shop and laboratory practical work. Employers have recognised the value of Sandwich Course not only as a marriage of theory with practice, but as a scheme that eases the transition from the academic educational work to the rough and tumble of industry and commerce.

In the U.K. the Sandwich and block release courses are typical examples of the close co-operation that has been established between industry and technical institutions, one is complementry to the role of another and both sharing the responsibility for training technicians. Here the two aspects of sandwich courses are important, the first is the total duration of the courses and types of the students, and second is the evaluation method.

In the first aspect the duration of the courses varies from 3 to 4 years and the type of the students are :-

i) Institution-based sandwich students.

ii) Industry-based sandwich students

iii) Full time degree course students.

Institution-based students depend very much on the institutes to find them suitable work-bench. In case of industry-based students the organisations concerned carry out a recruitment compaign and select students for career development within their company. These students are then employees of the company and are sponsored at the educational institution for a Sandwich degree/diploma course. They have their work experience within their own company under the guidance of company training officer.

In the second aspect, i.e., the evaluation method, evaluation under the Sandwich (co-operative education) is usually based on a student's report on his work experience together with an assessment by the organisation. Academic staff visits students at regular intervals and this assessment is also taken into account alongwith others by a Board of Examiners at the end of the course. In all these cases, specific criterion of assessing reports/interviews, is not spelt out and formats of evaluation are not available indicating absence of a structured, rigorous evaluation system.

In the U.S.A. there have been undergraduate and graduate co-operative education programmes in the school of engineering of Cincinnati University since 1906. The idea of co-operative education was developed by Dean Herman Schineder when he was a professor at Lehigh University, Pennsylvania. The first real growth situation of cooperative education occured between 1906 and 1921. Ten other Universities followed the example of Cincinnati. They were North-Eastern University (1909), University of Pittsburg (1910), University of Detroit (1911), Georgia Institute of Technology and Rochester Institute of Technology (1912); University of Akrston (1914); Drexel University; Massachusetts Institute of Technology and Marquette University (1917) and Antioch College (1921). The model of co-operative Education that MIT developed was that of Practice School.

By 1970, 178 institutions were running cooperative education programme and by 1983 about a thousand. In many American institutions operating on the cooperative plan, a contractual arrangement exists between the student and the educational institution. According to this arrangement, the student placed in industry holds a regular job under actual business conditions in competition with other sources of supply. No such industrial-educational contract arrangement exists in the sandwich plan, although the industry-based student can normally expect to be employed by sponsoring firm at the end of course.

Every Institution offering a co-operative programme usually requires a written evaluation of performance of each student in each work assignment. The student's immediate supervisor is responsible for preparing an honest evaluation which is sent to the Institute Coordinator.

The evaluation is usually in the form of qualitative ratings or attributes viz. relations with others, judgement, ability to learn, attendance, attitude, application to work, dependability, quality of work, punctuality etc. This usually forms the basis for award of grades in Universities granting credit for cooperative work. The attributes' ratings are based on the supervisor's observations of the co-operative student and are not known to be an outcome of structured measurement through any type of examinations, with these attributes as objectives.

In all these cases, it may be mentioned that student involvement is more in the nature of training or exposure to organisational activities. The assignments are not in the nature of problem solving and the teacher has no direct responsibility.

Perhaps the most organised cooperative programmes are those offered by North-eastern University, Boston and the School of Chemical Engineering at MIT, Cambridge.

At North-eastern University, Boston the evaluation is based on the employer's rating of the following attributes:

> Relations with others, attitudes, application to work, judgement, dependability, ability to learn, quality of work, attendance and punctuality.

The ratings are used to provide feedback to students on performance and finally forms part of the student's permanent record. As in the previous case (U.K.), it was observed that no formal regularised structure of examinations existed to arrive at ratings on the above attributes which were largely based on employer's observations of students' work performance.

MIT co-operative education is implemented in the form of the problem solving system. However, this is only at the post-graduate level and is applicable only for the Chemical Engineering discipline. Students' performance is evaluated in three general areas: Technical ability, effectiveness of contribution and skill in leadership and human relations. Practice assignments are problem solving oriented and student progress is constantly monitored by resident faculty vested with the direct responsibility of evaluation, monitoring of progress and instruction at the work-bench. Monthly counselling sessions are held when a thorough appraisal and suggestions for improvements are made. The evaluation is based on qualitative ratings (by student & staff) on a wide range of characteristics viz. intellectual ability, knowledge of engineering fundamentals, creativeness and originality of ideas, judgement and commonsense, self expression, industry, sense of responsibility, initiative, self-reliance, cooperation and leadership which are intrinsic to successful work contribution. Students are asked to evaluate each other and the anonymous student evaluation is affected into the final evaluation. At the end of the student's tenure at Practice School, he is awarded a terminal rating on the basis of interview rating by students and staff (18).

It, thus, emerges that among the various co-operative education forms, Practice School is perhaps the most vigorous and more demanding on both the students and faculty. The evaluation is more amenable to analysis than the others.

In Canada, through cooperative education programme, close linkages have been established between the industry and the institutes. Evaluation, in general, is based on contribution and skill in leadership and human relations. Practice assignments are problem solving oriented and student progress is constantly monitored by resident faculty vested with the direct responsibility of evaluation, monitoring of progress and instruction at the work-bench. Monthly counselling sessions are held when a thorough appraisal and suggestions for improvements are made. The evaluation is based on qualitative ratings (by student & staff) on a wide range of characteristics viz. intellectual ability, knowledge of engineering fundamentals, creativeness and originality of ideas, judgement and commonsense, self expression, industry, sense of responsibility, initiative, self-reliance, cooperation and leadership which are intrinsic to successful work contribution. Students are asked to evaluate each other and the anonymous student evaluation is affected into the final evaluation. At the end of the student's tenure at Practice School, he is awarded a terminal rating on the basis of interview rating by students and staff (18).

It, thus, emerges that among the various co-operative education forms, Practice School is perhaps the most vigorous and more demanding on both the students and faculty. The evaluation is more amenable to analysis than the others.

In Canada, through cooperative education programme, close linkages have been established between the industry and the institutes. Evaluation, in general, is based on reports from students and/or faculty and/or industry supervisor as in the U.K.

In Australia, the institutes offer cooperative education features similar to Canada and have the same pattern of evaluation as in the case of the U.K. and Canada. At the Royal Melbourne Institute of Technology which offers a co-operative programme in the faculty of business, students are required to submit one work-based assignment report. A member of the academic staff designated as an industrial tutor, occasionally visits the industry to maintain the contact.

The other countries in Europe, Asia and Africa have also implemented co-operative education in some form or the other. In these designs of co-operative education, evaluation, where applicable, is largely based on feedback from the industrial supervisor or institute faculty, towards the end of co-operative tenure.

3.5 Co-operative Education: National Scene

In the national context the matter of the linkage of the world of learning with the world of work has been considered to be of paramount importance. Educational planners in India are impressed with the progress and effectiveness of Industry-Institute interaction in advanced countries like U.S.A., U.K., Germany, etc. Drawing upon the experiences of developed countries, they have taken many steps in promoting meaningful interaction between the technical institutions and the industry around (see section 3.3).

The Scientific Manpower Committee 1947, set up by the Government of India to prepare a perspective plan for developing the scientific and technical manpower resources of the country, recommended the practical training stipends scheme and accordingly the Central Government initiated the same in 1949-50 to encourage fresh graduate and diploma holders to undergo Practical Training for two years. The graduate trainees were paid 150 rupees and diploma trainees 75 rupees (later revised to 100 rupees). In 1953-54 the practical training stipend scheme was reviewed and found deficient in many respects like lack of interest on the part of institution in securing suitable training places, delay in disbursement of stipends, large drop-outs from the training programmes, inadequate cooperation from industry and so on. In order to overcome these handicaps, the Central Government decided to assume direct responsibility for administering the scheme through its four Regional offices. But the Regional Offices, too, could not progress, because they found it difficult to manage the various aspects of the scheme alongwith their responsibilities for the development of technical education.

In 1968, the Government decided to set up Regional Boards of Apprenticeship Training to administer the scheme. Each Board included representatives of industry and technical institutions to ensure close coordination between education and practical training. In addition, each Board was provided with a full-time Director of Practical Training alongwith training officer. The Government also increased the stipends to 250 rupees for graduate and 150 rupees for diploma holders (Presently, it is 700 rupees per month for graduate and 500 rupees for technician apprentices). During this time the feeling was gaining ground that though post-institution apprenticeship was important, sandwich courses should be instituted to bring about a more fruitful integration of theory and practice in the total educational process. All India Council for Technical Education recommended that wherever Engineering Colleges and Polytechnics were in a position to establish close cooperation with industry, they should be encouraged to institute and develop sandwich courses. The Central Government approved the recommendation and decided to extend financial assistance to the institutions for sandwich courses. Accordingly, in the later part of 1960 a basic document was prepared in which the issues raised in the conferences were analysed and a broad framework for organising sandwich courses was suggested alongwith guidelines in respect of course patterns, selection of subject fields, main components of practical training, supervision and evaluation of training. The High Power Committee of AICTE in 1970 also recommended the introduction of the sandwich courses.

The Central Government, in 1973, decided to amend the Apprenticeship Act, 1961 (which was restricted to Craftsman Trainees) to include practical training of graduates and diploma holders as well as students of sandwich courses. The amendment was approved by Parliament and came into force in 1975.

This historical account focuses our attention on four important aspects i.e.:

i. Although technical manpower is the backbone of industrial development, but the industry viewed technical manpower not as a capital resource but as a mere input. From this view point it criticised the products of the system, and did not readily come forward to share responsibility with technical institutions in improving the system for its own benefit.

ii. Technical Institutions rarely took an integrated view of technical manpower development as a process, not just a course, in which bridges must be built between the world of learning and the world of work. As a result, barriers to industry-institution co-operation arose from the differing perceptions and attitudes of persons within the systems.

iii. In the total national planning process, technical education was viewed as a part of social service and clubbed with general education, health, housing and social welfare. The immediate relevance and importance of technical education to the economic systems became secondary and consequently, it did not become a central issue of concern in policy formulations in respect of industrial development.

iv. The Practical Training Scheme initiated by Government, though an important measure, did not go far enough to bring industry into a coherent and purposeful relationship with technical education. Keeping in view the above factors, sandwich courses were introduced in Engineering Colleges and Polytechnics. However, in the earlier part of 1970 the sandwich courses were discontinued at the degree level and were restricted only to the Polytechnics.

The four T.T.T.I.'s, Regional resource institutes, stablished for improvement and development of technician education are strongly committed to the theme of fosterir the spirit of partnership between Industry and technician institutions. Work experience at work-bench through learning components of Practical Training/Apprenticeship/ Problem solving/Sandwich course constitutes an important component of curricula design under the technician stream of education. There are 49 Polytechnics and many technical and management institutions which are having effective interaction with industry. Some of these institutions are:

- Birla Institute of Technology & Science, Pilani.
- Thapar Institute of Engineering & Technology, Patiala.
- Technical Teacher's Training Institutes.
- Indian Institutes of Management.
- Indian Institutes of Technology.
- Institute of Engineering & Rural Technology, Allahabad.
- Mafat Lal Polytechnic, Bombay.
- Y.M.C.A. Institute, Faridabad.
- Seth Jai prakash Polytechnic, Yamunanagar.
- P.S.G. Institute, Coimbtore.
- L & T Institute of Technology, Bombay.
- Technological Institute of Textile, Bhiwani.
- C.M. Kothari Technological Institute, Madras

There is a scope for increasing interaction and its effectiveness in other institutes also.

In the most of above institutes the interaction between the industry and institute is either by Practical Training or Sandwich Courses or Practice School method. The Sandwich Courses are operative in Polytechnics and the Practice School in the Birla Institute of Technology & Science, Pilani. In Indian Institutes of Technology, it is through Research & Development work and Practical Training, and in the Industrial Training Institutes it is through Apprenticeship Schemes.

Experience indicates that past attempts at building such linkages in India between technician-education and industry have only partially succeeded. This is because the models adopted for nurturing linkages have not been fully recognised. Further, distinct differences exist between the objectives and the organisational cultures of the technician- education and the industrial sector.

National Policy on Education 1986, has emphasized strengthening of industry-institute interaction. The Policy states.

> "The curricula of technical & management programmes will be targetted on current as well as the projected needs of industry or user system. Active interaction between technical or Management institutions and industry will be promoted in programme planning and implementation, exchanges of personnel, training facilities and resources, research & consultancy and other areas of material interest."

> "Networking systems will have to be established between technical . education and industry, Research & Development Organisations, programmes of rural and community development and with other sectors of education with complementary characteristics."

The programmes and action formulated for implementing the National Policy on Education, 1986 has specified actions and strategies to be followed for:-

- Planning Industry-Institute interaction
- Exchange of Personnel
- Adoption of Industries
- Establishment of Industry-Institute interaction cells.

These actions are for the consideration of technical institutions and industry to establish symbiotic linkages.

3.6 Critical Analysis of the National Models: Need for Teaching-Learning Methodology for Open-ended Problem Solving

This section attempts a comparative assessment of the various models (as of Institute-Industry interface programme). The important objective of these programmes is the career development of the students as an integral part of the educational process. Therefore, these cooperative programmes are based on paid engagement in practical, curriculum related job, structured to meet the interests, abilities and the aptitudes of students. Through a series of assignments the students thus receive progressive experience, enabling them to become increasingly proficient in the intended career.

Sandwich courses involve organised experience with certain declared objectives in mind, help acquire specific skills and knowledge, insights and values, and relate the learner to colleagues and co-workers under the inherent constraints of the working conditions and economics. These programmes do not imply, one to one correspondence of theory to every practical instance.

In apprenticeship method of training the complete professional education is by apprenticeship, with formal education system having no responsibility in the context. For the preparation of the professions, there are always two dimensions viz. theory and practice. Under the apprenticeship system the accent fell on the practice.

In the practical inplant training in which the students are exposed to the industrial environment, lack of proper supervision and follow up by the teachers, tell the pedagogic limitation of the training.

In the vocational education structure, the main burden of vocational training is required to be taken up by the employers through on the job training and it lacks its integration with the vocational education provided by the institution which tells the pedagogic limitation of training.

There are no institutional mechanisms and formal procedures existent to utilise the capabilities of executives, managers and technical personnel from industry and faculty from institute to supplement and complement the capabilities of the institution and industry. This tells the pedagogic limitations.

The programmes like Research and Development, Consultancy services to industry, organising continuing education programmes for industrial personnel, sharing experiences and expertise of industry in curriculum development, etc., do not solve the pedagogic problems, as the students do not demonstrate confidence and are unable to link theory with practice. Further, the market forces do not encourage the development of indigenous solutions to the problems of industry and industry seems to find it convenient to go abroad for solutions to problems as well as for new technologies.

It is precisely this gap in training of human resource that the pedagogy of "training for open-ended problem-solving ability" aims at in its effort to resolve the issues of education. In concrete terms, the "problem-solving" method of education aims at cultivating in students appropriate attitude towards and analytical skills of decision making and team spirit, sense of responsibility, leadership, importance of time schedule and regularity, self reliance, skills of written and oral communication, initiative, organisational ability, creativity, social sense etc., so necessary to respond to open ended situations. As already explained, Practice School System of co-operative education under which student-teacher teams work on real-life industrial problems during educational years constitutes one mechanism to introduce such "open-ended problem-solving" method of training. During this training period, teacher and industrial personnel evaluate the student for the following traits: judgement, ability to learn, attitude towards work, dependability, quality of work reliability, attendance and also overall performances. These personality traits are evaluated with the help of various components of evaluation, written as well as oral, viz, quiz, viva, seminar, group discussion, project report, observation and technician diary. This evaluation after the conclusion of the work period, is passed on to the co-ordinator of the programme. A student also provides his perception of the work assignments he was given. With this information, co-ordinator is able to obtain a measure of the student progress on the job as well as his scholastic attainment. Comparing this with academic grades, the co-ordinator can judge, at least grossly, whether the student has successfuly combined the theory of the class room with the practical experience of the professional world (3).

These all attributes are not covered in other modes of education like sandwich programmes, Apprentice Training practical inplant training, Vocational Training, Industrial Consultancy and research, continuing education of Industrial personnel, Industrial exposure of faculty, internship, etc.

3.7 Practice School System of Education - Student as an Intern at Work-bench: A Means for Student-training in Open-ended Problem-solving Competence

From above, it follows that "Open-ended Problem-solving" based training system of education is strongly committed to the theme of co-operative education, and aims at building the much needed bridge between the professional world and the academic world. Just as medico undergoes internship in a teaching hospital before his graduation, this training method requires students of engineering, science and humanities to practise their respective profession in the real world during their educational years.

The Open-ended Problem-solving-based training in view of its close linkage with the professional world, makes certain new demands on the university population, both teachers and students, quite often in addition to those demanded by the class room education. In this system both teachers and students become part of a team, being learners, educators, managers all at one and the same time. Students, on their part, have to accept certain consumer obligations, whereas teachers have to appreciate and accept a new role. According to this method, the student can learn how to practise his profession even before his graduation through his direct involvements in industry in problem-solving efforts prominently concerned with solving practice problems, making improvements, and serving immediate needs of the environment. These linkages are established with the professional world defined in terms of production and manufacturing units, engineering design, development and consultancy organisations, national research laboratories, social science, planning cell, banks centres for science communication, science and technology museums, publishing houses, the rural back drop as represented through villages etc.

3.7.1 Application of Practice School System of Education for University-Industry Interface

Practice School System of education for University-Industry linkages firstly was adopted by BITS, Pilani for the undergraduate students of Arts, Science and Engineering. The central theme of this system of practice school of education can be expressed in two fold manner, namely:

i) The need for broad-based education during foundation years so necessary to appreciate and react to interdisciplinary nature of real-life problem-solving efforts followed by,

ii) The need for specialisation alongwith an opportunity for students-teacher teams to go into the professional world with a view to working on real-life problems through the Practice School.

3.7.2 Practice School Components:

Practice School - I: Exposure-oriented Student Involvement at Work-bench

Exposure-oriented Practice School-I aims at initiating 2nd year students (undergraduate level), well drilled in science-based foundation courses and accompanying analytical skills, in the art of information seeking, retrieval, documenting processing and analysis. In the process, the students are introduced to the field-based knowledge.

Practice School II: Open-ended Problem-solving-based Student Involvement at Work bench

Practice School - II provides an opportunity to a student to work on open-ended problem-solving efforts of direct interest to host-organisations aiming at making improvements and serving their (host organisations) immediate as well as long term needs. Indeed, choice of Practice School assignments is central to Practice School education. Particularly, Practice School II assignments are so identified that firstly, each of them necessarily has at least one professional expert from host-organisation interested in it and, secondly, they also form on continuous as well as continual basis, sub-problems in the chain of activities that go to define the developmental needs of host organisation.

3.7.3 Student Allotment to the Work-bench

In view of committed nature of Practice School programme, the procedure of student allotment to different Practice School stations closely initiates what the best of employers do while matching the manpower (to be recruited) to the tasks at hand. Specifically for Practice School II, the University, through continuous prior interaction with host organisation, keeps alive a problem bank of Practice School assignments. Simultaneously, well ahead of students attending Practice School - II stations, the University prepares complete professional profiles of all Practice Schools - II probables. These student profiles alongwith student preferences are then matched against problem bank and its (manpower) needs so as to arrive at the final student allotment.

3.7.4 Practice School Educational Process and Student Evaluation

Ideally speaking, at Practice School stations i.e. at work-benches accommodating Practice School students and teachers through their industrial sojourn consistent with the nature of Practice School assignments, students are divided into inter-disciplinary groups, each group being allotted a prior identified Practice School assignment. One of the members from the group is appointed a leader for that particular assignment and is given total responsibility for planning, scheduling, implementing and defending steps to solution. During the process the professional expert(s) interested in the assignment and the practice school faculty play the role of consultants.

The Practice School educational process seeks to focus attention on many latent attributes which do not surface in the normal class room situations, such as, professional judgement, inter-disciplinary approach, ability for written and oral presentation, team-work leadership, etc. These attributes are judged by the faculty through various instruments of evaluation, namely, quizzes, viva, seminars, group discussions, project reports, daily observations and diary. Marks/grades obtained by the student, as already mentioned, constitute an integral part of his or her degree transcript.

3.7.5 Practice School Educational Administration

The entire co-operative education is operated by a Unit of the University and is headed by a Dean. In this task, the Dean is assisted by members of the institute faculty. This has its own office with a team unit of administrative and subordinate staff.

3.7.6 Validity of Practice School Educational Design

Dubey (Anita), Ghose and Dey, students of Mandke, have extensively studied the Practice School educational experiment at BITS, Pilani, for undergraduate level and found valid with the following investigations:

i) Practice School courses conducted at work bench show satisfactory internal consistency with average R around 0.68.

ii) The examinations of Project Report and Seminar show satisfactory internal consistency with R = 0.6, while examination. Component of seminar showed highest average correlation with other examination components.

iii) The courses with full-time faculty-involvement and multi-disciplinary student input show better internal consistency amongst different combinations of degree of faculty involvement and type of student input; in turn signifying the importance of "teacher" contribution in education-work linkages and significance of this form of work-bench based education being made available to students of all disciplines within and outside technical subjects, inclusive of science and humanities areas.

iv) Amongst all categories of work-benches, process and manufacturing type of organisations seem to afford a work-environment that leads to near uniform all-round development of skills.

v) All types of work-benches demonstrated their stake in the education-work interface by paying honorarium to students for their contributions to the well-being of the organisations.

vi) Students invariably found their Practice School experience of great value by securing good employment offers; thereby experiencing their stake in this form of education.

vii) Practice School system of education constitutes a valid mechanism for industry-technical institution interface for education-work linkage.

3.7.7 Conclusion

From the above, it can be concluded that the Practice School system of cooperative education is a self-contained model of curriculum design for student training for problem solving and includes the following:

1. It is an integral part of educational process and includes, student/work-bench incharge/teacher presence during the education-work-linkage programme.

2. Enables student to come in contact with workbench as learner-cum-intern and, hence, prepares him for the requirements of the world of work.

3. Brings teacher in a continual interaction with work-bench and creates opportunity for him to be a work-consultant.

4. Requires institution to restructure the programmes to meet knowledge and skill requirements as demanded by the work bench.

5. Enables institutions to evolve ability to cope with change and swing into innovation.

6. Makes the objective of education sector an integral part of production sector.

3.8 Choice of the Model : Practice School based Polytechnic-Industry Interface

It is against this critical assessment of various models available for institution-industry interface, that the Practice School system emerges as the most viable choice for making the interface a successful venture. Indeed, this model also has additional regenerative features not spelt out so far. Specifically such an integral linkage between education and production processes, then, also offers work-bench incharges as teachers in the conduct of programme and a teacher as a resource person for continuing education of the workers, as the teacher and the work incharge team comes together in this co-operative educational effort to train a student of formal system as a learner-entrepreneur.

This, in physical terms, ensures sharing of men, material, space and equipment resources between education and production sectors; in turn expanding reach of each one's activities at reduced overheads, thereby, giving self-generative character to the interface.

Final sealing of this choice, understandably, warrants research in respect of educational validity of such exposure-oriented and open-ended problem-solving-based technician-student involvements at the work-bench. Chapters to follow essentially apply themselves to this research investigation through the conduct of relevant educational experiments with reference to conduct of practice school components for the polytechnic-industry interface.

CHAPTER - FOUR

PLANNING OF EXPERIMENT FOR TRAINING OF POLYTECHNIC STUDENTS IN WORK ENVIRONMENT

4.1 Background

For well over 40 years strong pleas for closer co-operation between technical institutions and industry have been made, but concerted efforts are needed to achieve it. Entry into technician occupations require not only an understanding of the scientific principles behind particular technician functions but also a mastery of techniques and the skill, procedures and processes which are a part of these techniques. Application of these techniques implies a careful selection of tools, equipment and their judicious use to the production objectives. Technical Institutes can offer only a part of the training needed to impart competence, because of the limitations of their workshop, laboratory facilities, etc. They may include in the curriculum the training in basic skills, the rest of the above practical competence can only be acquired by problem-solving of the students in industry/world of work.

4.2 Objectives of Student-training in Abilities for Problem-solving

The following are the general and the specific objectives of the training:

General Objectives:

i) Students are exposed to industrial environment which can not be simulated in the classroom.

ii) Students get familiarised with various materials, processes, products and their applications alongwith relevant aspects of quality control and shop-floor management.

iii) Students learn the operations of the specialised plant and equipment which educational institutions cannot purchase.

iv) Students work under factory discipline.

v) Students understand the psychology of the workers, their habits, attitudes and approach to problem-solving alongwith the practices followed in industry or world of work.

vi) Students realise the size and scale of operations in industry.

vii) Students get opportunity to use their knowledge in problem-solving and project assignment.

viii) Students understand time-motion relationship and constraints of time and cost within which goods are produced and services rendered in specified quantum.

ix) Students appreciate the need for co-ordinated effort of various persons at different levels in achieving the goals and targets.

x) Students understand the scope, functions, and their job responsibilities in the industry.

Specific Objectives:

i) To create awareness among the students about the methods of scientific experimentation.

ii) To acquaint the students with the principles involved in various operations and to comprehend their applications.

iii) To make the students understand the economic and industrial systems.

iv) To enable students to acquire the concepts and principles relevant to the subjects included in the curriculum.

v) To develop cognitive abilities for problem solving.

vi) To develop the personal characteristics like initiative, co-operation, leadership quality, communication skills, etc.

vii) To enable the students to practise their profession during educational years.

viii) To make the product of technical institutions more relevant to the present and future needs of industry.

ix) To increase the student's analytical skills.

x) To help students gain practical experience and develop accountability for their decisions and actions.

xi) To allow students to improve working behaviour patterns essential to the world of work.

xii) To enable the students to apply the gained knowledge and skills in the institute to the job.

xiii) To identify areas of interaction between institute and industry for planning of curriculum and for appropriate use of resources for instructional purposes.

xiv) To enable the students to appreciate need for co-ordinated efforts of various persons at different levels in different departments of work in achieving set goals and targets.

xv) To instil in the students the necessary confidence and, thus, prepare them to become self-employed.

For achievement of these objectives, proper planning, implementation, supervision and evaluation is inevitably essential.

4.3 Present Practices in Planning for Industry-Polytechnic Collaboration

In the planning of industry-institution collaboration at polytechnic level, state level and national level, it is appreciated that technicians be exposed to work-environment and following schemes have been implemented.

i) Sandwich Courses.

ii) Apprenticeship Scheme.

iii) Associating industrial experts on boards of technical education.

iv) Industrial training to Polytechnic faculty.

v) Educational tours to industries.

vi) Practical Training in Industries.

About 10% polytechnics offer courses on sandwich pattern. Roughly 4% of the total number of polytechnic students are covered under sandwich course schemes. Faculty are not actively involved during industrial training part of sandwich programme. As a result, there is a lack of co-ordination between the theoretical and practical training.

Apprenticeship scheme is implemented in polytechnic by Government of India since 1973. The diploma holders are placed in the industrial environment, where institutes have no control over them except placement. Further, process of placement itself does not require any rigorous matching of knowledge and skill needs of job and the prior preparation of the student. Additionally, the scheme is not a part of curriculum, as the apprentice may leave the training as and when he gets a regular job or after completing his training for one year. During this period he gets Rs.500/- p.m. as stipend .

As regards the educational tours, these are of two types, namely, long and short educational tours. The purpose of these tours is to expose the students to the work-environment. Short tours are not compulsory and are organised only by some dedicated teachers for giving exposure to the students. In the long tours, industrial visits are rather ignored at the cost of sight seeing. Industrial exposure to the students during their polytechnic courses is not achieved to the extent desired by the planning.

Education being a state subject, a few institutions in some states in India, organise industrial training of students during vacation. Since faculty is not involved in this training, there is no contact with the students during the process of training and such a training remains only a formalistic fulfilment of curriculum. Normally, students are not placed for training according to their individual interests and aptitudes, and, likewise, industry is not getting students of their requirement. Since students are not actively involved in solving the industrial problems, they do not develop confidence of working in the industrial environment.

Similarly, project work has for long been accepted as a part of polytechnic curriculum. These projects are stereo-type, passed on from year to year basis on fictitious data and do not correspond to the real problem-solving of the environment. The project remains an academic exercise rather than achievement of specified objectives resulting in acquiring entrepreneurial capabilities.

Although there are some schemes where extension lectures are organised by the institutes of industrial experts, yet neither the institute nor the industry is taking interest for mutual interaction. Exhibitions of industrial products in the polytechnic environment is being undertaken experimentally so that the products are advertised appropriately and students are exposed to various products, their operations and use, but no systematic planning in the curriculum has been made for organising exhibitions. There is no financial support provided to the institution for this purpose.

Finally, though provision exists for Industrial training of polytechnic teachers, faculty demonstrates total lack of motivation for the same and this scheme is more or less non-operative.

Though the objectives of above mentioned schemes for polytechnic-industry interface are emphasised to a considerable extent in educational planning, in practice, this interface suffers at different stages of implementation. This ultimately leads to lack of cooperation and mutual interaction in the Industry, Institute, faculty and students, and, thereby to missing links in present planning of educational system.

4.4 Limitations in the Planning of Polytechnic-Industry Interface

Much has been said about the effective training of the students in Polytechnics at the National and at State levels, and in some states, efforts have been initiated in this direction within their own limitations as enumerated below (5).

4.4.1 Planning

Although the institute-industry interface is stressed in the planning, yet no guidelines have been laid at the micro level as to how this will be achieved. In the absence of it, each state is following its own adhoc ways which hampers ultimately the training of the students. Moreover, planning for training is done at the apex level without taking into consideration the environment existing in the Polytechnics. Thus, if at all some recommendations were made to the states, they could not be implemented.

4.4.2 Management

A scheme may be well planned and financed, yet there would not be a flow of information and desired results unless it is properly managed. At present there are no management-links between industry-institute, students-industry, faculty-work in charge (i.e., employer) faculty-directorate, institute-regional centres, institute-research and design, Institute-community, Institute-National bodies, etc.

4.4.3 Administration

Policies and plans are formulated in such a manner that they are implemented up to bureaucratic levels only, even though the schemes may be intended for implementation up to grass-root levels. For example, there is no person in the institute or at industry level who can make arrangements for the placement of students in the industry, record feed-back, collect problems, achievements, etc., and evaluate the training of the students systematically. In some states, Training and Placement Officers are appointed but they are unable to make students' training effective due to their own limitations and lack of interest in industry, faculty of the institute, students motivations, etc. Even at the directorate level there is no specific person to look after the students training.

4.4.4 Curriculum

With the advancement of science and technology, curriculum of the technical institute should be a dynamic one. But it has not been revised for a long time. It is known that industry normally approaches foreign technologists for consultancy and guidance, and that they have to recruit and retain the technicians for their job requirements in the context. However, due to non-revision of curriculum from time to time, the knowledge and skills of the students are not updated, leading to difficulties in their recruitment and, thereby, adding to "unemployment". Further, at present the curriculum has no provision for incentives to the students from the world of work which would improve employees' competence for incoming technologies. Thus, no interest is exhibited either by the student or employer/employee in linkages offered.

4.4.5 Financial Limitations

Sometimes improvement in the technician-training and interaction between industry and institute are planned at the policy level, but sufficient finances are not available at the grass-root level to have the desired results. If some provision is made, it is initially for a limited period of five years after which the states have to bear the expenditure for the training. There is no transport and secretarial assistance in the polytechnics for training of students. Polytechnics do not have enough provision to spare funds for travelling, boarding and lodging arrangements for teachers, students and industrial experts for practical training on regular basis. No separate funds are earmarked either at the Directorate level or at the Institute level by the state Governments for the practical training. And to make the matters worse, the polytechnic-industry interfaces planned are also not in a position to generate their own resources.

4.5 Strategy Planned for Promoting Effectiveness in Interface Implementation : Planning of Experiments

In polytechnic-industry collaboration programme, planning in a polytechnic begins with the admission of the student in the polytechnic, his study in the polytechnic campus and his learning in the industry. This process is continuous and ends only with the student passing out of the polytechnic. Such a planning would basically have to revolve around the student. Particularly coming to the planning component of "Student learning in industry", as already mentioned (19) the practice school system of education offers the most viable model. Planning for this model, thus, amounts to planning for "exposure oriented" and "problem-solving oriented" student involvements at work-benches. The "exposure oriented" involvement acts like an advance organiser for the "problem-solving oriented" student involvement at work-bench, and both involvements have the planning features of: Planning for placement of students at the work-benches, conducting of instruction under polytechnic-industry linkage, evaluation of the students, and monitoring of all the activities and progress made at the work stations.

It is with this perception that, from this section/onwards, the remaining chapter presents a design for planning of educational experiments for student involvements at work-benches as per the two categories mentioned above. Specifically, the researcher has conducted three experiments, one for the "exposure-oriented" involvement and other for "problem-solving" based involvement, details and analysis of their results being reported through chapters 5 and 6.

4.5.1 Exposure-oriented Student Involvement at Work-bench

For polytechnic students, this would mean the understanding of vast engineering operations and introduction to the theme of industrial infrastructure and development defined in terms of problems such as inventory, productivity, management, industrial relations, information systems, wage administration, etc.

The students would attend exposure oriented training during winter vacation after one and half years i.e. 3rd semester of class room studies, when they are supposed to have completed fundamental core courses of science, mathematics, language, workshop, graphics, applied mechanics, etc. Therefore, it is not expected that they participate actively with total involvement in the problem solving efforts. Thus, this period can best be utilised by exposing the students to the entire activity of the organisation, and small assignments can be given, may be, in terms of documentation, collection of data, study of organisation structure and production processes, etc.

4.5.1.1 Interaction with Industry: Linking Information, Documentation and Analysis-based Work-tasks with Process of Student Learning

The first task in imparting technician-education, characterised by collaboration with industry (work-bench) for set of objectives and goals of training a learner entrepreneur, is to plan for educational placement of a student at work place during his educational years. This would certainly need tremendous planning so as to match educational objectives and techniques with requirements of work task and their progress. The subject matter of "exposure oriented" training can essentially be in terms of assignments, lead questions or tasks; providing the students the first exposure to the activities of the professional world, and then systematically studying the nature of the real life problem complexities. The exposure oriented training should normally be conducted in large units. The students attending the training are supposed to be unaware of the industry and its activities, and probably are going to it for the first time.

Therefore, the objective of this first exposure resulting in information collection from the professional world, can be best achieved by giving students some lead questions; e.g. various products of the units; customers of these products; the future estimates of demand; the various raw materials used; the sources of raw material; manufacturing processes, etc. The students should collect answers to these questions which would ensure a good exposure to the organisation. During this period, the students can also work on small, specific assignments of direct interest to the host organisation.

To achieve this, a liaison officer/co-ordinator out of the faculty will be appointed, who will contact the industries personally or through correspondence for placing of students for training. He will collect the information and evaluation reports, tests, viva marks etc. to be submitted by the faculty to be analysed subsequently.

4.5.1.2 Interaction with Students: Students' Exposure to Work-bench for Integrated View of Knowledge

The meeting of the second year students will be called and students made aware of the training in the industry and their interaction be recorded. During exposure, the group leader (faculty) and the incharge of the site will assist the students for exposure to the world of work. They will be exposed to the application of different theoretical knowledge required to accomplish a task at site.

4.5.1.3 Interaction with Faculty: Environment-oriented Teaching-learning Methods for Analytical Abilities

During exposure oriented training at a work-bench, it is visualised that there are three main actors who play the major roles; the students, the faculty and the professional experts. In addition to them, there will have to be a person from Institute to be designated as the co-ordinator faculty member. The co-ordinator will call a meeting of the faculty of the institute to review and suggest them the effective methods of teaching-learning, linking student activity at work-bench with the classroom teaching, so that the analytical abilities are inculcated in the students.

4.5.2 Problem-solving based Student Involvement at Work-bench

The students' education would be in terms of his involvement in the problem-solving efforts of direct interest to the host organisation. The process of education during this work period is to be in terms of working on the real life problems of industry. Such problems, in any industrial unit, are not normally confined to a particular discipline but they are multifarious in nature. Some of these problems are the ones, on which teams from the orgnisation are already working, and the others may be of immense importance to the organisations but are not taken up. Students could be attached to the teams already working on some problems or a team of students from various disciplines could be formed, depending upon the nature and requirements of a problem. This would be done in consultation with the organisation.

The problems assigned to the students should be such as can be completed during the training period. In case the problems need a longer duration than that of a practice period, they can be divided and assigned to successive teams from successive batches. These problems or sub-problems, henceforth, will be referred to as project assignments.

In concrete terms, the Polytechnic-Industry Interface is a process of education which establishes the so-called class room in the professional world, production and manufacturing units, engineering design, development and consultancy agencies, national research laboratories, social science planning cell, banks, centre for science communication, science and technical museums, publishing houses, the rural backdrop as represented through a village, etc. The immediate locale in and around the campus could also be used for the purpose in order to make education more fruitful to society.

It is extremely important that the knowledge and skill gained during the institutional study is applied to the world of work, so that the confidence in the student is developed, gaps, if any, between institute and industry are bridged and the curriculum accordingly designed/modified.

This is only possible if students are given problems related to their branch/other branches of engineering and are constantly guided and evaluated to get the required objectives.

4.5.2.1 Interaction with Industry: Linking Innovative Work-tasks with Process of Student Learning

The co-ordinator of the institute will contact the industries and departments to know about the problems faced by them. Information on each problem will be collected in terms of : brief problem statement, problem description, name of the professional expert of host organisation with direct interest in the problem, possible method of attack, type of student input needed defined in terms of number, discipline and quality, any special knowledge or skill needs, library and equipment needs, time targets, etc. The problems so collected will be analysed to achieve the predetermined objectives of the training as reflected through assessment method (See professional traits identified for assessment in Sub Section 4.5.4). These problems so collected would be referred to as the problem bank of the organisation. And the union of problem banks of all the industries after classification would be referred to as **problem bank** for that session.

The co-ordinator will match the problem needs with type of student inputs available during the session. In doing so, he would also account for student preferences for problems and work-benches. The co-ordinator will, then, inform the industries/departments regarding students and faculty allotted to them, and to the students and faculty about the problems and work-stations with which they would be attached.

The students will report at their work benches as per the schedule of training. Faculty from the institute and experts from industries will guide, supervise, organise group discussions and evaluate them in the process of finding solution to the problems.

4.5.2.2 Interaction with Students: Students as Interns

The first step in initiating the interaction with the student is in terms of their allotment to work places. This mechanism has been presented in detail through sub-section 4.5.3. Here, an effort is made to present planning details with respect to only those interactions that the student undergoes as an intern in the process of working for the solution to the problems assigned to him. Once again, therefore, the interactions that relate to student assessment are excluded here, as the evaluation methodology is separately discussed through sub-sections 4.5.4 to 4.5.6.

Thus, once a group of student is allotted the work-bench and they report there along with their teacher, the interactions within them begin in their search for solutions to the problems assigned to them. Planning for these interactions requires the co-ordinator to acquaint the students before their reporting at the work place with techniques of problem planning, organisation of data, generating new informations, discussing pros and cons of different proposals, deciding alternatives, etc. These techniques are reflected in activities like library referencing, personal and group discussions, arranging of seminars, preparation of technical memoes, etc.

Above are essentially team activities. This, in turn, necessitates planning for preparing students & teachers for group participation, where a student may be a leader or convener and others have to work with him or he has to get feed back from them. The teacher, and the professional experts have to play roles of scientist leader.

4.5.2.3 Involvement of Faculty: Environment-oriented Teaching-learning Methods for Problem-solving

Coordinator will identify faculty from the institute to be associated with the group of students, so that the faculty can discharge the responsibilities enumerated below:

i) During the process of interaction, faculty will guide the student in identifying, synthesizing and analysing the problem and on how to utilise the institutional facilities like library, etc.for the solution of various problems.

ii) Alongwith the professional expert he will participate in the student evaluation for his contributions at the work-place.

iii) He will also record and suggest addition and deletion in the curriculum of his subject to the institute, based on his interaction with the world of work.

iv) He will also suggest to the industry the latest innovations and modifications useful to them. In this way he will act as a consultant to the industry in his field of experience.

4.5.3 Mechanism for Placement of Students in Industry

In Polytechnic-Industry interface programme, designing an experiment for the interface for exposure oriented training and problem-solving will include planning for the placement of students at the work benches, implementation of Polytechnic-Industry instruction, evaluation of the students and also monitoring of all the activities and the progress made at the work stations.

The most important task is to place the students at the work benches of the organisations with the set of objectives and goals which needs a greater vision and tremendous amount of planning whether it is exposure-oriented training or Practice School. Some of the requirements of exposure oriented training are different from the Practice School, but the basic pedagogic purpose and objective remains the same, which are as under:-

i) Identification and finalisation of the eligible students.

ii) Identification and finalisation of the organisations to conduct the Exposure-Oriented Training and Practice School.

iii) Identification and finalisation of faculty to conduct the programmes.

iv) Allotment of students to various organisations, etc.

v) Monitoring of education.

4.5.3.1 Identification of Eligible Students

The task of the identification of the eligible students is to be performed as per the academic rules and regulations of the Polytechnic. In case, Polytechnic industry interface programme is made optional, the first step is to enrol the students in the programme who opt for it. This group of the probable students should now be checked for their eligibility as per the academic rules and regulations of the Polytechnic to attend Exposure Oriented Training. The rules and regulations would be spelling out the pre-requisites or conditions to be fulfilled for attending exposure-oriented training. After checking the eligibility, a list of students during a particular vacation be finalised. The eligibility criteria for problem-solving would be more demanding as this component would normally be implemented towards the end of Diploma course.

4.5.3.2 Identification of Work-benches

Polytechnic has to first make a list of industrial units for conducting exposure-oriented training. These organisations should be contacted for providing facilities required for conducting exposure-oriented training for a desired number of students. It is important that these facilities are not only in terms of physical infrastructure, but are rather vis-a-vis commitment of the organisation to offer its daily and long term problem-solving needs as vehicle for education and its professionals connected with the relevant tasks as student consultants with an additional requirement that they participate in a student evaluation process. This, indeed, is an integrated and total educational participation. Thus, a host organisation should be so chosen that the philosophy and the rigour of the programme can be maintained.

On receipt of approval from the organisations contacted, list of stations be finalised keeping in mind the factors like overall economy of operating facilities provided by organisations, number of students to attend training, number of faculty members available to conduct the programme, an exact faculty-student ratio etc.

Coming to problem solving component, it may be noted that these stations can be so organised as to run throughout the year with students changing after three months. Therefore, these stations should be so chosen that they have project work session after session. They should also be able to accommodate an adequate number of students. It is expected that these organisations would also be having multi-disciplinary projects and they would be able to accommodate students of more than one discipline.

The organisation should have a clear understanding of the philosophy and objectives of the programme and their decision to hold the programme should be a long term decision so that the programmes run continuously with full co-operation from all quarters.

Since the students would be working on the projects in the organisation and contributing in their activities and growth, it is natural to expect that industry will reciprocate by offering certain basic facilities of desks, stationery, office help, some stipend and accommodation to the student. The payment of stipend would not only motivate but also bring a sense of responsibility and commitment amongst students besides giving a feeling of professionalism.

4.5.3.3 Allotment of Students

The actual placement of students at industry would take place after finalisation of list of eligible students to attend work periods and also that of industrial organisations to host the programme.

The allotment of students is not a random process, but it is the matching of students' disciplines, their academic performances, their professional interests, physical facilities available at the work-bench, the academic needs and requirements of the projects at the work-bench, and, of course, the students' preferences. Certain genuine personal problem of the students may also be considered.

Matching, challenging and satisfying opportunities for students with satisfaction for industry by its getting capable learner-workers to work on its assignments, would be a successful placement.

Coming to allotment in Exposure Oriented Training, it is required that information on the following be collected from the students and/or students' record-files: total academic performance upto the end of the 3rd semester, extra academic work done, preference for each station (whether they have their own accommodation or can arrange at the stations) where the work stations are situated, and also their grievance and problems, if any.

After collection of information, analysis of preferences for each station be made. This analysis would be in terms of students from a particular discipline giving a particular preference to a given work-bench. This would generate a preference discipline matrix for each work-bench.

Considering the matrix as well as the requirement of work-bench in terms of the number of students and disciplines which can be accommodated at that work-bench and also considering the number of students from each discipline, the student number to be allotted to that work-bench be fixed.

The process of actual allotment should follow this step. For this purpose, a discipline-wise list of students in descending order of their academic performace be prepared and station allotment be made as per their preferences and number fixed for that work-bench under that discipline.

4.5.3.4 Accommodation

For student accommodation at the locales of the work-bench, the following could be the alternatives:

i) The polytechnic takes full responsibility.

ii) The polytechnic does not take responsibility but assists the students who are not able to arrange.

iii) The students are left to arrange their own accommodation.

iv) The students are placed near their homes if the training facilities exist at that place.

4.5.4 Evaluation of Trainees

The work-bench based method of education is a vehicle through which one can affect meaningful innovations in methods of student education and evaluation to bring these closer to real-life situations. The educational process under this pedagogy seeks out and focuses attention on many latent attributes which do not surface in the normal class room situations such as: intellectual ability, professional judgement and decision-making ability, interdisciplinary approach, skills for data handling, ability in written and oral presentation, sense of responsibility, etc.

At work-bench, these attributes are judged by the faculty accompanying the student through various instruments of evaluation, namely, quiz, seminars, viva, group discussions, project report, daily observation of students' performance, diary, etc.

4.5.4.1 Evaluation Scheme

In order to bring about uniformity in evaluation at each of the work-benches and minimise subjectivity in evaluating students, it is essential to adopt a unique rationale and unified evaluation procedure at all the work-benches.

The instruments of evaluation are quiz, seminar/viva, group discussion, project report, daily observation by the faculty and the students' diary (20). Through these instruments students would be judged for various characteristics namely:-

i) Knowledge of concepts,

ii) Application of principles,

iii) Intellectual ability,

iv) Creativeness and originality,

v) Professional judgement and decision making ability,

vi) Inter-disciplinary approach,

vii) Skills for data handling,

viii) Documentation,

ix) Self-expression,

x) Initiative,

xi) Self-reliance,

xii) Co-operation,

xiii) Leadership,

xiv) Industry, and

xv) Sense of responsibility and social sense.

It may be emphasised here that the evaluation scheme as suggested would provide objectives of various instruments of evaluation as well as guidelines on what to look for in these instruments, and thereby develop them.

4.5.4.2 Weightages of Different Evaluation Instruments

The above mentioned six instruments of evaluation have been given weightage as follows:

Sr.No.	Instruments	Weightage	Suggested frequency
1.	Quiz	15%	2
2.	Seminar/Viva	25%	2
3.	Group discussion	15%	2
4.	Project report	25%	2
5.	Observation	15%	Continuous
6.	Diary	5%	Continuous

However, if a faculty member wishes to deviate from the suggested evaluation scheme given above, due to any special reasons, he should seek prior permission from the Co-ordinator.

4.5.4.3 Points Judged Through Each Evaluation Instrument

It is suggested that while evaluating a student under a particular instrument, following points with their weightage be taken into account.

4.5.4.3.1 Quiz (Total Weightage - 15%)

A quiz is designed to test the students in terms of the following:

1.	Knowledge of basic concepts and physical principles	3%
2.	Additional knowledge acquired	5%
3.	Ability to apply the knowledge of basic concepts and physical principles	5%
4.	Ability to analyse a given problem or situation	1%
5.	Logical path followed in problem solving efforts	1%

4.5.4.3.2 Seminar/viva (Total Weightage 25%)

The seminar/viva tests the students in terms of the following.

1.	Knowledge of basic concepts and physical principles	2%

2. Additional knowledge acquired 3%

3. Ability to apply the knowledge of basic concepts and physical principles 5%

4. Ability to analyse a given problem or situation 5%

5. Logical path followed in problem solving effort 3%

6. Effective oral communication 5%

7. Self-reliance and co-operation 1%

8. Moderation 1%

4.5.4.3.3 Group Discussion (Total Weightage - 15%)

In a group discussion the faculty evaluates the students for the following characteristics:

1. Knowledge and comprehension of the problem/topic introduced for group discussions 3%

2. Level of participation 3%

3. Ability to discussion in right direction and to co-operate with the fellow members 2%

4. Ability to suggest new ideas for extending and improving group discussion 2%

5. Ability to initiate the topic when discussions subside 1%

6. Ability to moderate discussions 1%

7. Ability to create a good impression and act accordingly 2%

8. Self reliance and co-operation 1%

4.5.4.3.4 Project Report (Total Weightage - 25%)

The project report, which is a written component of evaluation, carries the maximum weightage. It is judged for the following points.

1.	Knowledge and comprehension of the problem	5%
2.	Introduction of the problem and setting the objectives of the project	3%
3.	Ability to analyse the problem	5%
4.	Logical path followed	2%
5.	Concluding remarks in terms of the objectives set earlier and the future scope of the problem	5%
6.	Presentation of the abstract with precision	3%
7.	Organisation of the matter	1%
8.	Data Handling	1%

4.5.4.3.5 Observation (Total Weightage - 15%)

This component is evaluated by observing the students for the following points.

1.	Regularity and ability to meet deadlines	3%
2.	Sense of responsibility	3%
3.	Initiative and leadership	2%
4.	Industry	3%
5.	Social sense and adaptability to practical situations	3%
6.	Self-reliance and co-operation	1%

4.5.4.3.6 Diary (Total Weightage - 5%)

The technical diary written by the students is judged for the following three points:

1.	Data handling/procedure, calculation and presentation	2%
2.	Thought Process	2%
3.	Regularity	1%

4.5.5 Operation of Various Instruments of Evaluation

Section 4.5.4 has given evaluation components for work bench based student involvement. Of course, normally, these components are fully reflected in a problem-solving based involvement, while only some of these (knowledge and application of scientific fundamentals and technological operations, self expression, sense of responsibility, initiative, co-operation, leadership quality and logical development of argument) may be used for student assessment under exposure oriented involvement. This is mainly because, exposure oriented component is normally of shorter duration than the problem-solving component. In what follows, this section briefly presents operational mechanisms for administering these evaluation components.

In this section modes of operation of the evaluation instruments are discussed.

4.5.5.1 Quiz

First Quiz: It is suggested that the first quiz should aim at evaluating the students in terms of the knowledge of the organisation. Indeed, it will constitute the first assignment at every work-bench.

Second Quiz: This quiz may be based on gap lectures to equip students with additional knowledge or skill inputs so that they might find it necessary in pursuing their work-bench based assignment.

4.5.5.2 Seminar/Viva

It is expected that all students and the accompanying faculty would participate in this component. In seminar a student is expected to defend his report/work. Since the presence of professional experts helps in judging the credibility of the report/work, it is useful to invite them on such occasions.

Generally, the seminars are held on the project/assignment. The students present their work in seminars. In case more than one student is working on an open-ended project, they may be asked to divide the topics to be presented in seminars. As far as possible, repetition of topics should be avoided.

In seminars, each group of students would submit a short interim report which could also be evaluated. Each seminar should follow a question answer session based on the work presented/carried out by the students at the station.

4.5.5.3 Group Discussion

The group discussion may be conducted by taking all students in one group or by dividing the students in more than one group. Actually, students working on one assignment or on similar assignments may form a group. When a group is having a discussion, other students may attend it as observers. As the participation of professional experts is desirable, it is always beneficial to invite them to such discussions.

Generally, the group discussion is on a topic directly connected with their assignment. If needed, a group discussion may be held on a general topic not connected with any assignment, but relevant to the organisational activities. The topic for a group discussion may be given to a group, one or two days in advance or 2 to 3 topics may be set afloat by any one on the floor and the students asked to choose the one that suits them (21).

After deciding the topic the faculty should give students 5 to 10 minutes' time to think about the topic. Every member of the group involved in the group discussion should participate in the discussion and see that discussion goes on in the right direction. The faculty member should see that every member gets equal opportunity to present his views and should guide the group, wherever necessary. For example, if a student is found to be a silent listener, he should make him participate in the discussions.

The leader of the group understandably chosen from amongst the students, as is expected, would be at the helm of affairs and the faculty member and the professional experts associated with the assignment would participate in the group discussion. These group discussions give the faculty a meaningful means for observing contributions of every member of the group to the progress of the assignment/project. Further, these discussions also provide proper feed back means for improving students' social skills.

4.5.5.4 Project Report

The report is a written presentation of the work done by the students on a given work-bench based assignment. Each assignment should have a separate report. In the case of group work, the leader has the total responsibility of planning, scheduling and implementing. The work of the group in a given assignment is documented in a joint report. Continuous faculty interaction with students provides powerful channels to the faculty to clearly discriminate between the competence level of different group members. Indeed, from the point of view of new educational pedagogy, the challenge of work-bench based assignment is to evaluate individual's performance within the framework of cooperative endeavour. In other words, every member of the group should get his due credit in terms of his total contribution to the collective efforts. In view of this, there is no basis for awarding equal marks to each of the group members for their joint project report.

4.5.5.5 Observation

Observation in this context is a channel for the evaluation of students' performance at the work-bench by the faculty on the basis of their day-to-day interaction with the faculty and the organisational personnel. Indeed, it is one of the best methods of continuous evaluation.

4.5.5.6 Diary

The diary maintained by a student enables the faculty to judge the points mentioned in sub-section 4.5.4.3.6. This also provides an opportunity to the faculty to study and evaluate the students' ability to collect information and employ information analysis techniques. Writing a diary has to be a periodical, preferably a daily affair. Both the faculty and students should understand the philosophy behind recording a diary. It is an attempt to cultivate the habit of documenting and encourage the student to search for details. It may include the students' own thought processes and reasoning abilities. The faculty member should check and sign the diary periodically.

4.5.6 Feed Back to Student

The aim of these evaluation instruments is not only to evaluate students for various characteristics as mentioned in sub-section 4.5.4.3, but also to impart education and train them to improve upon their deficiencies. In order to achieve this objective, the faculty should let students know, within 2 to 3 days of holding a component of evaluation, the marks obtained and their (students') good points and also the deficiencies. He should also tell them the ways to improve upon their performances.

4.5.6.1 Mid-term Grading

It is suggested that roughly after half the period of training, a mid-term grading of the students should be done. Here the marks obtained by each student until that time should be communicated to the students, indicating relative position in the group as well as the recommended grades to various clusters of the students. This is common and healthy practice in a project based course like one conducted at work-bench through the PS based co-operative education.

4.5.6.2 Final Grading

At the end of the work-bench based involvement, the marks obtained by a student on various evaluation instruments, described above, are added to give the total marks earned by the student out of 100 marks. Having

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4.5.6.2 Final Grading

At the end of the work-bench based involvement, the marks obtained by a student on various evaluation instruments, described above, are added to give the total marks earned by the student out of 100 marks. Having obtained this information for all the students, the faculty will prepare a list arranging their marks in descending order. Considering both the relative performance and the absolute performance, the faculty should recommend letter grades reflecting clusters of student performances. If more than one faculty member is involved in evaluation, the co-ordinator is expected to moderate the evaluation through collective effort. Even though from time to time the faculty may be taking help from professional experts/consultants, it is to be borne in mind that the entire responsibility of evaluation and grading rests with the faculty only.

4.5.7 Monitoring of Work-bench based Education

4.5.7.1 Student involvement at the work-bench.

4.5.7.2 At the end of every session, each industry where training is imparted shall raise institute wise report on the effectiveness and utility of the training of students of each institution from the industries' point of view.

4.5.7.3 Similarly, each institute will raise reports industry-wise giving details on types of technology projects of interest to industries and the kind of manpower inputs needed by the industry for the same.

4.5.7.4 Above reports will be reviewed by the institute level monitoring committee. Comments of the institute level monitoring committee will be placed before the state level monitoring committee. These comments will basically be in terms of technology upgradation and production improvement needs of industries in the vicinity of the institution, manpower needs in kind and number as envisaged by industry in the context and the type of R and D inputs as made available to the industries by the School faculty and students through the Practice School based programme of institution-industry linkage.

4.5.7.5 Review comments of the various states will then be considered by the board at the national level for policy reformation purposes based on planning data as above, coming from the field.

4.5.8 Role of Faculty

In a committed education of this kind, the role of faculty is seen as multi-dimensional. Apart from the job of liaison between the polytechnic and the host organisation, the major tasks of the faculty would include.

i) To conduct the polytechnic-industry interface as per academic rules and regulations and execute day-to-day tasks.

ii) To ensure that the students work sincerely to the best of their capacity and to the satisfaction of the organisation.

iii) To maintain students' attendance.

iv) To ensure that students do not unnecessarily take professionals' precious time.

v) To arrange meeting of the students with the professionals when they are in the dire need of consultation.

vi) To send and provide progress/information as per requirements of the polytechnic.

vii) To help the students in their projects in what ever way they can.

viii) To evaluate students for their personality traits through various components.

ix) To see that students maintain discipline and follow the value of the host organisation.

x) To act as local guardians of students at the work station.

xi) To diagnose the problems of the organisation and to get these included in the problem bank.

Thus, the role of the faculty as perceived above is synonymous with that of a scientist leader guiding a team of students on an interdisciplinary and time-bound functional task, where every faculty will have to extend his competence beyond his own discipline and demonstrate a human resource builder's perception in nurturing and assessing young mind.

4.5.9 Role of Industry

The role of industry is very vital in this co-operative educational venture. The major tasks of the industry would include:

i) To appoint supervisors in each department for guidance and supervision of students undergoing work involvement.

ii) To study students' problem-solving schedule and make provision for its implementation.

iii) The industry supervisor should take care of the following aspects for each student:

- Discipline
- Relations with workers
- Initiative and efforts in learning
- Technical knowledge and skill improvement.

iv) To guide the students in case of any difficulty.

v) To inform the institute faculty regarding his progress in case of any problem.

vi) To participate in the group discussions and to help students in solving various problems.

vii) To go through the student reports before approving and assist faculty in evaluating the student according to his reliability, personal appearance, personality, cooperation, attitude towards work, job skills, work habits and actual performance.

viii) To provide facilities to the students and faculty.

ix) To make use of the institute faculty as consultants.

4.5.10 Interaction with TTTI: Issues of Educational Planning and Design for "Activity" in Learning

As already mentioned, institution-industry linkage planned as above, would enable institutions to accumulate data base on technology and manpower needs of industries in their immediate surroundings. The Regional Institutes will consolidate such data base collected from various Polytechnics, the same would pass on as a problem bank for them. Solutions of such problems can effectively be done by the institute, so as to help Polytechnics in designing courses of study in new and relevant areas, matching requirements of neighbourhood industries, alongwith the infrastructural material and facilities for implementing the same.

CHAPTER - FIVE

CONDUCT OF EXPERIMENTS

5.1 Background of the Experiment

The gaps and deficiencies in Polytechnic education identified in chapter two, and chapter three argued that this requires linkages between Institute and Industry. Chapter four discussed various models of education for these linkages and in the process argued Practice School system of education as the most significant one. This chapter presents the details of the conduct of experiments on institution-industry linkage based on Practice School system. For the purpose of experiments, Government Polytechnic, Sundernagar, the place of work of the researcher, was chosen. The results of the experiments would be used to validate the choice of this model.

5.1.1. Profile of the Institute

The major part of the work-bench-based training was conducted in Himachal Pradesh, which is a small hilly state, situated in the northern part of India with a total area of 2,55,673 km^2, having total population 42,80,880 as per 1981 census. The literacy rate of the state is 42.48%. The literacy rates for males and females in the state are 53.19% and 31.46%, respectively.

In Himachal Pradesh, Government Polytechnic, Sundernagar, is located on the National Highway No.21 in

Mandi District. It is 425 km. from Delhi, 175 Km. from Chandigarh and 125 Km. from Shimla.

This Institution was started in 1959 with only three Engineering Diploma courses viz Civil, Electrical and Mechanical Engineering. Automobile Engineering Diploma and Architecture Assistantship Diploma were added in 1971 and 1977, respectively.

The Institution is running many schemes, viz Quality Improvement Scheme, Community Development Scheme, Rural Sanitation Project, 'Trysem', training for un-employed rural youth and also has an independent wing of Science and Technology Department of the State.

The present intake of the Institute is 100 students against the sanctioned intake of 150 students in all the disciplines. A significant aspect of intake to this Polytechnic is the increase in the number of female students in almost all the disciplines, which earlier attracted only male students.

The Polytechnic campus also houses the Directorate of Technical Education and the Industrial Training Institute for the Physically Handicapped. The Institute at present has about 51 staff residences for over 130 staff members of: Polytechnic, Directorate of Technical Education and I.T.I. for Physically Handicapped. Hostel facility for 90 male students is also available in the campus. No facility of a hostel for girls exists.

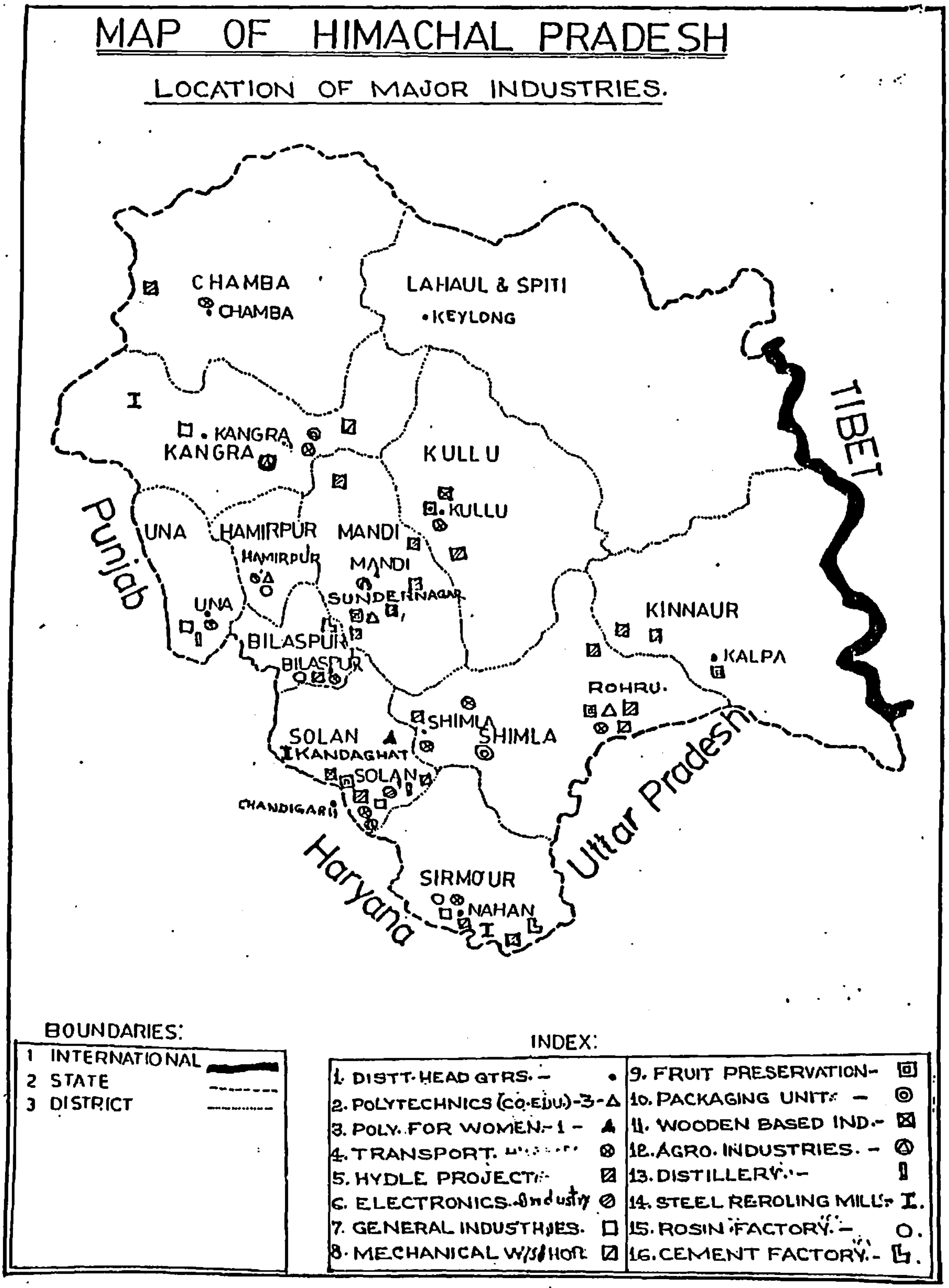
Head Quarters of Beas Satluj link Project and Kol Dam project are very close to the Polytechnic. Dehar Hydroelectric power plant with a generation capacity of 900 MW is situated at Slapper which is 20 Km. away from Sundernagar. A most sophisticated cement plant of ACC is situated at Barmana, 25 Km. away from Sundernagar. In addition to these, a number of unorganised small scale industries are also located in the surroundings of Sundernagar. Thus Government Polytechnic, Sundernagar, has an industrial environment.

The location of the Institute, various industries and other institutes (Technical) in the State are shown in the Map.

The Institute is well connected with other parts of the State by road transport. However, there is no rail link to Sundernagar.

5.1.2 Profile of Students

The admission to the Institute in various disciplines is purely on the basis of percentage of marks obtained in matric (Xth) examination. Suitable credit for higher qualification viz. certificate from I.T.I., Certificate from Junior Technical School Part II (J.T.S.II), 10+2, etc. is available. On the above basis one hundred and eleven students were admitted in different branches of engineering during each of the years, namely, 1986 and 1987. Out of the admitted students 80% were from rural areas and 90% students were having Hindi as medium of instruction in their schools.


MAP OF HIMACHAL PRADESH
LOCATION OF MAJOR INDUSTRIES.
CHAMBA
CHAMBA
LAHAUL & SPITI
KEYLONG
TIBET
KANGRA
KANGRA
KULLU
KULLU
Punjab
UNA
HAMIRPUR
MANDI
HAMIRPUR
MANDI
SUNDERNAGAR
UNA
BILASPUR
BILASPUR
KINNAUR
KALPA
ROHRU.
SHIMLA
SHIMLA
SOLAN
KANDAGHAT
SOLAN
CHANDIGARH
Uttar Pradesh
Haryana
SIRMOUR
NAHAN
BOUNDARIES:
1 INTERNATIONAL
2 STATE
3 DISTRICT
INDEX:
1. DISTT. HEAD QTRS. -
2. POLYTECHNICS (CO-EDU.)-3-
3. POLY. FOR WOMEN-1 -
4. TRANSPORT.
5. HYDLE PROJECT.
6. ELECTRONICS Industry
7. GENERAL INDUSTRIES.
8. MECHANICAL W/SHOP.
9. FRUIT PRESERVATION-
10. PACKAGING UNIT. -
11. WOODEN BASED IND.-
12. AGRO. INDUSTRIES. -
13. DISTILLERY. -
14. STEEL REROLING MILL.
15. ROSIN FACTORY. -
16. CEMENT FACTORY. -

Out of one hundred eleven (111) admitted students, ten (10) were female and one hundred one (101) male in 1987 and 12 were female and 99 male in 1988. 55% of the students were from the middle income families and the rest belonged to poor income group.

The qualitative and quantitative data of students were as under:

Table - 5.1.2.1

Category-wise number of Students admitted in 1986 & 1987

Name of the course	General 50%	S.C 22%	S.T 7.5%	B.C 2%	B.A 4.5%	Def 10%	Pol suf 2%	SPT 2%	Total
Civil Engg.	16	8	2	1	1	3	1	1	33
Elect.Engg.	17	7	2	1	2	3	1	-	33
Mech.Engg.	6	3	1	-	-	1	-	-	11
Auto.Engg.	8	4	2	-	1	2	-	-	17
Arch.Assistantship	8	4	2	-	1	1	-	1	17
Total:	55	26	9	2	5	10	2	2	111

Remarks: S.C = Scheduled Caste

S.T.= Scheduled Tribe

B.C = Backward class

B.A = Backward Area

Def = Defence person

Pol.= Political

suf = Sufferer

Spt = Sports person

Table - 5.1.2.2

Admission Quality for years 1986 & 1987 based on Percentage Marks Obtained in Matric (Xth)

Description	Less than 45%	46-59%	60-74%	75% and above	Total
Civil Engg.	-	1	1	31	33
Elec.Engg.	-	-	3	30	33
Mech.Engg.	-	-	1	10	11
Auto.Engg.	-	-	3	14	17
Arch.Assist-antship	-	-	3	14	17
		1	11	99	111

5.1.3 Profile of the Industries

During last 8 to 10 years various types of industries have grown rapidly in Himachal Pradesh. The number of registered manufacturing units (including tiny units) at the end of the year 1982 were 4360. These industries provided employment to about 20,000 persons. Most of tiny industrial units are located in high altitude, remote areas, whereas other industries are situated in areas adjoining the plains. The policies of State Government are liberal and encourage entrepreneurs and investors in establishing new industrial units. Favourable climate and availability of cheap labour have helped establishment of electronic industries in the State.

District-wise distribution of industries in the State is given in Table 5.1.3.1.

Table - 5.1.3.1

NIC Code Showing Different Industries (Districtwise) in Himachal Pradesh

S. No.	Name of District	Tiny	Small	Medium	Large
1.	Solan	316	85	13	16
2.	Mandi *	688	17	2	2
3.	Una	279	27	3	1
4.	Kangra	598	17	2	1
5.	Hamirpur	240	-	-	-
6.	Kullu	454	3	-	-
7.	Chamba	284	4	-	-
8.	Bilaspur	318	1	2	-
9.	Sirmaur	285	28	6	2
10.	Kinnaur	66	-	-	-
11.	Lahaul & Spiti	35	-	-	-
12.	Shimla	563	2	-	-
Total:		4126	184	28	22

Data From:- A master plan for Designing Technical Education in Himachal Pradesh, 1983

* Government Polytechnic, Sundernagar, where the present research to link institution-industry was undertaken is situated in this District.

5.1.4 Profiles of Teachers

Profile of the teachers of the Government Polytechnic, Sundernagar, with respect to qualification and experience is given in Table 5.1.4.1.

Table - 5.1.4.1

Qualification of Teachers

Discipline of Engg.	Qualification								
	M.E	M.Sc	MA.	BE	AMIE	TTTI Dip.	DIP.	ITI & others	TOTAL
Civil	1	-	-	3	2	1	-	2	9
Elect.	-	-	-	3	-	2	-	1	6
Mech.	-	-	-	-	2	4	-	12	18
Auto.	-	-	-	1	2	-	1	2	6
Applied Science	-	2	2	-	-	-	-	-	4
Arch.	-	-	-	2	-	-	1	1	4
Total:	1	2	2	9	6	7	2	18	47

Experience of Teachers

Discipline	Total No. of teachers	Teachers having Experience of:			
		15 yrs.	10 yrs.	5 yrs.	1 yr.
Civil	9	6	1	-	2
Elect.	6	2	-	1	3
Mech.	18	14	1	1	2
Auto.	6	4	2	-	-
Arch.	4	-	-	4	-
Applied Science	4	4	-	-	-
Total:	47	30	4	6	7

5.2 Earlier Institutional Efforts for Interactions with Industries: Approach and Impediments

Efforts for interacting with industries taken by the Institution are summarised below:

5.2.1 Industrial Training Opportunities for Teachers and Educational Tours for Students

Normally, the Institution has confined its educational processes within the frame work of curriculum as suggested by State Board of Technical Education, Himachal Pradesh. Work-bench-based training offering professional linkage with industries for teachers and industrial exposure to students has thus not been a part of this curriculum. A few of the teachers did take training in industries under 'Quality Improvement Programme', of Government of India. However, due to non availability of leave vacancy positions, it was not possible to send more teachers for training in industries (GPS/TP File). Interaction with industry was limited to occasional visits of students to industry and educational tours for final year students.

5.2.2 Practical Training

Before the starting of the research effort by the researcher in this Polytechnic, from the available information, it was found that no student was sent for practical training in industry even during vacation. The reasons were that there was no provision of industrial training and the management also did not consider this to be an important component of educational process.

5.2.3 Campus Interview

The effort for the placement of the students through campus interview was initiated in the year 1978. However, from 1978 to 1987, i.e. in the span of 9 years, only two industries visited the campus for interviewing the students mainly because of the absence of any linkage of the polytechnic with industries (GPS/TP File).

5.2.4 Apprenticeship Act

Under the apprenticeship Act,very few students (2%) undertook practical training in industries after completing their diploma.

This is because :

(i) Students prefer to try for regular jobs rather than taking training in industries on fixed amount of stipends(GPS/TP file).

(ii) Non availability of suitable training places near his (student) place of stay (GPS/TP file).

5.2.5 T.T.T.I. Involvement

Inspite of efforts made by T.T.T.I., Chandigarh, to improve the quality of Polytechnic education through teacher training, curriculum development and extension services, the Polytechnic remained confined to teaching students through class-room instructions and through laboratories/workshop practices, without going for interaction with industries. This is because the curriculum developed in association with T.T.T.I. did not envisage an effective interaction with industries for student learning. Also, the quality improvement effort of T.T.T.I. focussed only towards improvement of instruction through institution-based training (GPS/QIC file).

5.2.6 Industries' Attitude

Even after the legislation for compulsory apprenticeship training in industry, the industries' attiude has not been very encouraging. More often than not, the industries are engaged in meeting the legal requirements of training of students under the scheme. As a result, the students undergoing practical training under this scheme are by and large, left to themselves without having any guidance or supervision from the industry as well as from the polytechnics.

5.2.7 Critical Assessment

Above observations lead to following critical understanding of the various gaps in efforts for Institute-Industry linkages as undertaken at the Government Polytechnic, Sundernagar:

1. Curriculum design does not envisage the involvement of students in industries during the period of their training in the institution.

2. There is no organised effort by the polytechnic management to interact with the industries for improving quality of student training.

3. All teachers are not sent for industrial training because of nonavailability of training reserve.

4. Both teachers and students remained satisfied through class room based teaching-learning, as none of them is exposed to industries.

5. The examination system for award of Diploma does not call for evaluation of students' abilities which are required by the world of work.

6. The teacher training institute also did not lay any emphasis on teacher and student involvements in industrial problem solving as a part of curricular activities.

7. Industries generally find it as a burden to impart practical training to students as they do not perceive any direct gain in this process.

5.3 Initiating Planning for Removal of Impediments

Section above has critically studied various efforts for Institute-Industry linkages as undertaken or operative at Government Polytechnic, Sundernagar. This study has mainly been in terms of identifying approaches followed for interaction and enlisting of impediments, which have been later generalised in terms of broad reasons for these linkages not taking place at the Institute.

The main research objective that the researcher has at his hand, at this stage of investigation, is to plan an experiment for a Practice School based model of Institution-Industry interface.

As explained in previous chapter, this model demands involvement of teachers, students, industries and institutional authority. As a result, any planning for such an experimental design would need to begin by first planning for removal of impediments in respect of these constituencies of polytechnic education.

It is within this framework that this subsection presents the details of the initial interaction the researcher undertook with teachers, with industries, with polytechnic authority and with students, with a view to removing the impediments. Needless to say, in doing so, the researcher has meaningfully utilised the information base as available to him from the questionnaire study reported in chapter two, under which the researcher had interacted with large number of teachers, students, industrial executives, Directors of Technical Education Department, T.T.T.I. faculty, etc., inclusive of the concerned population in relation to the Government Polytechnic, Sundernagar.

5.3.1 Interaction with Teachers

This can be discussed depending on teacher category; namely, issues pertaining to interaction with senior faculty and younger faculty.

5.3.1.1 Senior Faculty-Critical and Pessimistic Approach for their Involvement

When the senior faculty was contacted initial response was poor and some of the senior faculty members replied:

- Oh, this has been done many times, nothing happened.
- How are we going to benefit out of this ?
- This is good, but impracticable.

This was a critical stage when the researcher had to find out an alternative, as involvement of faculty of all disciplines, in this experiment, was considered a must for guiding students on interdisciplinary problems at the work-bench. This alternative emerged in terms of emotive appeal on the part of the researcher by asking his senior colleagues to join in the experiment for "old timer's sake". Of course, the senior faculty did respond to this appeal, but only after they observed the success of the first experiment.

5.3.1.2 Younger Faculty-Romantic and Desirous to do Something

Majority of the young faculty, though not all, when contacted for their association in the conduct of student training at industry, came forward to participate in the conduct of this experiment. They expressed the desire to contribute towards this innovative approach to students' training in the industries; thereby hoping to gain practical experience for themselves.

5.3.2 Interaction with Industry

When industries were contacted, their immediate response towards the training of Polytechnic students was rather poor. They observed that the training of polytechnic students was a burden, as they do not gain anything out of it.

The researcher, then, held separate detailed discussions with the passed out students of this Polytechnic, working in these industries. They were explained as to how the proposed Practice School based training was different from the conventional training of students in industry and also explained how both the parties, i.e., the Polytechnic as well as industries could benefit from this, particularly as the training was to be wholly supervised by the polytechnic teachers; thereby on one hand it not being a "burden" to industry and on the other hand enabling polytechnic to impart better education and improve teacher quality.

The industries were, then, approached again through these employees who were the passed out students of the Polytechnic. The management of industries, then, agreed to co-operate in the Practice School training of students when they saw that this scheme was totally different from the previous ones, i.e., in this scheme, the students would be involved in problem-solving activities which could be of their direct benefit and a teacher from the Polytechnic would guide the students in industries.

5.3.3 Interaction with Polytechnic Authority: A Basis for Entrepreneurial Inputs from Researcher

Polytechnics normally receive grant on approved projects and programmes. The Polytechnic Principal, although appreciative of this particular scheme of students' training at the work-bench, expressed his inability to provide support in the form of any manpower deployment or any other expenditure. However, he agreed to allow the researcher to use the Institute facilities within the provisions of official educational operations. The researcher, thus, decided to conduct the experiment with this marginal support of the Principal, as the validation of the experiment had wider implication to the revision of existing curriculum and design of future course curriculum.

5.3.4 Motivation of Students

The students were made aware of the prospects of the Practice School training in the work environment. It was also emphasised that their participation in this industrial training and their hard work in developing problem solving skill in work situation, would definitely help them in finding suitable employment in industries. This worked as a motivator to the students, as they expressed their willingness to take industrial training. However, the question of stay arrangements for students during Practice School training as well as facilities for transport were raised during the discussion. It was decided that the students, as far as possible, would be placed in industries near their homes.

During above interactions, some other issues also came up and they related to time-table slot for work-bench-based involvement, use of tiny units as work-benches and provision of organisational inputs for educational administration of the student training in industry. Various suggestions/approaches that emerged to account for these issues are enumerated below.

5.3.5 Time Table slot for Work-bench-based Involvement

As industrial training was not a part of curriculum at the Institute, it was suggested that researcher could adopt a strategy of utilising the vacation periods of winter and summer for student's Practice School training at work-bench.

5.3.6 Designing for Using Un-organised Work-bench as Class Room-cum-Laboratory

The point in problem-solving approach to learner education at work-bench, introduces functional requirements of planning, designing, decision making, organising and implementing to the satisfaction of solution user; thereby raising the job or student involvement much above the traditional skill training at the place of work. This, then, allows use of un-organised sector for educational objectives of training in open ended problem solving for entrepreneurial ability, though specifics of skill contents may be at a lower level than in an organised sector. This understandably makes an un-organised work-bench a valid candidate for education-work linkage.

5.3.7 Providing Oganisational Input for Infrastructure Management/Educational Administration

The need for administrative support for establishing Polytechnic-Industry interface cannot be under stated. In the absence of it, the researcher himself assumed the mantel for it. Thus, researcher undertook the tasks of : interfacing with industries; delineating problem bank; finalising student eligibility; teacher orientation; matching of student background with manpower needs of industrial problems while simultaneously accounting for constraints of accommodation, transportation, monthly expenditure; conduct of examination assisted by employers and polytechnic teacher; etc. This certainly helped the experiment design to tide over this impediment for the time being. However, this also brought forth a point, that such a continually dynamic educational strategy for linkages, under which manpower needs and problem areas fed back periodically from industries is a constant reality, would need a scientific and research oriented management of this interface; in turn requiring a teacher-cum-scientist-cum-manager as an interface administrator, teacher because he has to examine, scientist because he has to lead an exploratory task and manager because he has to operate.

5.4 Three Experiments: Brief Introduction

It is after this initial preparation aiming at removal of impediments, that the researcher undertook three experiments in terms of Practice School based student involvement at work-bench. The experiment-I aimed at exposure oriented student involvement. In all 12 students, 2 teachers and one industry participated in this experiment which had a total training duration of 10 days and was conducted during winter vacation of 1987.

Experiment-II and III revolved around problem solving based student involvements at work-bench and were conducted in Summer Vacation of 1988 and 1989, respectively. These experiments were of three weeks and five weeks duration. While three weeks long experiment-II conducted in June-July, 1988 accommodated in all 74 students from all disciplines across Polytechnic, 10 teachers and 44 work-benches; five weeks long Experiment-III was held in June-July, 1989 and involved 77 students, 10 faculty and 48 work-benches (including one tiny unit).

In what follows, this chapter presents details of these three experiments.

5.5 Experiment - I : Exposure-oriented Student Involvement at Work-bench

The selection of target groups/the participants, and the problems, the preparation of problem bank, prior preparations undertaken at Institute including programme planning, method of conduct of the experiment, observations made and the conclusion drawn are presented below:

5.5.1 Selection of Students and Teachers

As already mentioned, this experiment was conducted in December, 1987 (12th December 1987 to 21st December 1987). Specifically, this experiment accommodated students of second year (Third Semester) of Government Polytechnic, Sundernagar. These students were drawn from Automobile engineering branch and were from the batch admitted to the Polytechnic in July, 1986. The profile of this batch of students, as at the time of admission, is given in Table 5.1.2.1.

The procedure followed for selection of students was as follows. In the beginning, second year students were made aware of the project through lectures. These lectures were conducted in the first week of November, 1987. For each discipline, different lectures were given, and this was followed by a lecture, which all students attended together, wherein the total operational mechanism of Practice School training was explained. Following this, students were asked to express their willingness to undergo exposure oriented involvement at work-bench in a proforma given in Table 5.5.1.1.

Out of a batch of 87 second year students, only 21 students opted to participate in this experiment. May be it is because the researcher himself is the Head of the Department of Automobile engineering at Government Polytechnic, Sundernagar, or because of better explanation for the need for such training in Automobile engineering, majority of these 21 students consisted of those from Automobile engineering. (This lacuna was corrected in Experiments II and III as the educational concept received overwhelming students support on completion of Experiment-I. Indeed, in subsequent experiments, almost total eligible student number (85% for Experiment-II and 87.5% for Experiment-III) volunteered their participation).

It is against this backdrop, further constrained by the fact that the researcher had been able to work out the arrangement for exposure oriented training only with one

Table - 5.5.1.1

APPLICATION FORM FOR INDUSTRIAL TRAINING

Principal

Sir,

I would like to undergo industrial exposure/training during this summer. Kindly provide me an opportunity for this purpose. My particulars are given below:

(1) Name:______________________ RolNo.__________
Class:__________
Branch:__________

(2) Name and Address of my father/Guardian: ______________________
____

(3) Qualification:

Percentage of Marks in			
Matric	10 + 2	10 + 2	Any Other

Percentage Marks in Diploma				
1st Semester	2nd Semester	3rd Semester	4th Semester	5th Semester

Declaration:

1) I hereby undertake that I will arrange for my accommodation and meet with personal expenditure during the training.

2) I will abide by rules and regulations of the industry during the course of my training and shall be responsible for any accident during above training.

3) I will be regular, punctual, dutiful and follow the instructions given by the industrial supervisor(s) and teacher(s) during industrial training.

SIGNATURE

industry accommodating 12 students, that it was decided to limit selection of students for Experiment-I only to those from Automobile engineering. This also made the task of persuading the teachers to join in this experiment easy, as the number needed was only one teacher in addition to the researcher himself and that number could be fulfilled from amongst the faculty of the Automobile Department itself. The faculty so chosen was from the younger lot and this involvement of his was on a spontaneous and voluntary basis for the advantage of gaining the industrial experience.

5.5.2 Selection of Industries

This activity was completed before the researcher approached the students and teachers for their participation as explained above. In all, four organisations, namely, Himachal Pradesh Public Works Department (H.P.P.W.D.), Sundernagar, Himachal Pradesh State Electricity Board (H.P.S.E.B.), Sundernagar, Beas Satluj Link Project (B.S.L.), Sundernagar and Himachal Pradesh Road Transport Corporation (H.R.T.C.), Mandi, were contacted for work-bench facilities for exposure oriented students' involvement as described in section 4.5.1. Two organisations H.P.P.W.D. and H.P.S.E.B. responded favourably. This did not, particularly, affect the educational objective, firstly because experiment could be undertaken with less number of students and secondly because each of these organisations had multifarious range of basic engineering operations. This, ultimately, brought the problem of choice of organisation to the question as to which organisation would permit better teacher control throughout the experiment, as in Practice School system of education teacher presence (as already explained in Section 3.7.5) constitutes the most significant parameter amongst the various models of education-work linkages.

It so turned out that H.P.P.W.D., though at a longer distance from the Institute (12 KM), had all its works going on at the same place, while H.P.S.E.B., though located within a smaller radius from the Institute, had its departments situated at different locales, thereby making the teacher task of guiding, supervising, and assessing at work sites more difficult.

This being the first experiment, the researcher took a conservative view of organisational needs, and thus H.P.P.W.D. was selected as a collaborating industry. To a smaller extent this decision was also governed by the fact that the H.P.P.W.D. had emphasis on mechanical works such as material management, inventory control, production, repair and maintenance, safety, etc. which were closer to the researcher's own professional preparation, thereby facilitating better convenience in guiding students.

5.5.3 Selection of Co-ordinator of the Collaborating Industry

In design of Practice School course leading to exposure oriented or problem solving based students involvement at work-bench as presented through Section 4.5.1 has not mentioned of a co-ordinator of the collaborating work-bench to facilitate the educational process. However, as the permit better teacher control throughout the experiment, as in Practice School system of education teacher presence (as already explained in Section 3.7.5) constitutes the most significant parameter amongst the various models of education-work linkages.

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Specifically, he was responsible for notifying different Section Heads of arrangements for Practice School training as described by the researcher, and asking all Section Heads and a Junior Engineer to play the role of work incharges and requiring them to maintain the educational and evaluation schedule as designed by the researcher. Further, he also gave an orientation lecture to the students when they arrived at the work site to begin their site based educational involvement. Over and above this, alongwith work incharges, he also participated in the group discussion and seminar conducted at the site and contributed to the process of student evaluation.

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*(Mandke (17) has mentioned of need of such co-ordinator in the design of Practice School educational organisation. The researcher did not emphasise this detail while describing the design, mainly because the issue to be investigated here is to see how Practice School pedagogy applies to polytechnic education. Once this is known, an educational organisation will have to be set up where such student and faculty involvement in industry would not be a voluntary exercise, but would be an integral curricular need. It is, then, that such organisational desks within polytechnics and industries would have to be set up, discarding any adhoc arrangements as attempted vide subsection 5.3.7.).

5.5.4 Selection of Problems: Problem Bank Preparation

This was an important step in preparation of the problem bank for student education at the work-bench. The total responsibility for this was with the researcher. He, thus, established contact with Junior Engineer incharge of construction and Section Heads of H.P.P.W.D. and with their help identified problems faced by them. These are described below:

i) Frequent break down of the construction machinery.

ii) Problems of construction joints in the concrete pillars.

iii) Pilferage of the construction material.

iv) Irregular supply of construction material by Contractor.

Besides these problems, the researcher also noted the following problems:

i) No safety precautions observed.

ii) Sufficient copies of drawings not available.

iii) Network approach for the progress of work not followed.

(iv) The working of the different sections not sequentially arranged.

A detailed discussion was then held with Executive Engineer, the Junior Engineer and Section Heads to transfer

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A detailed discussion was then held with Executive Engineer, the Junior Engineer and Section Heads to transfer the statements of the above problems to knowledge of functional engineering areas of : management of men, material, equipment and machinery, store handling, production techniques, repair and maintenance and safety management. The idea was any student of second year, irrespective of the discipline, could work on information gathering and analysis based projects in these functional areas and in the process he should be able to come with data base that can aid the work incharge, Junior Engineer in this case, to have some answers to the problems at hand. Accordingly, then, specific problems against above functional areas were identified to create circumstance for student participation in information-based problem solving tasks during the exposure-oriented involvement. The problems based on functional areas thus identified were:

Statement of Problem Bank.

- Management of men, material, equipment and machinery:

1. To study the causes of delay in shifting material from one section to the others.

- Store handling:

2. To study store and purchase procedures and to suggest where they deviate from standard practices.
3. To study spare parts problem for minor repairs.
4. To study security issues to avoid pilferages of material from stores.

- Production Techniques:

5. To study application of bar chart technique for improvement in work productivity and for timely execution of work.

6. At Buhana Bridge work site, tractors are engaged to carry stones from stone quarry to crushing site. To study the optimum use of tractors and suggest ways and means for frequency improvement.

- Repair and Maintenance.

7. It was observed that tractor tyres were subjected to heavy wear and tear due to lack of quality of approach road between quarry and crushing site. The problem was to decide cost-benefit between frequent tyre replacement and improvement of road.

8. It was observed that ring gear of crusher drum was often slipping. Problem was to diagnose the cause and to remove the same.

- Safety precautions.

9. To study the availability of safety precautions at the work site.

10. To study the precautions for overhead welding assignments to avoid accidents.

Thus, it is based on the functional areas and the problem bank so defined that the researcher, then, worked out the programme schedule for the student involvement at the work-bench through Experiment -I. This schedule consisted of two parts:

- First part was that of exposure which was planned as per schedule given in Table 5.5.5.1.

- The second part was, right from the beginning a group of two students was given specific assignments from the problem bank mentioned here. As students went through exposure to functional areas, they were also required to search for answers to problems provided and submit their reports and recommendations, for which, then, they were assessed through seminar, project report, group discussion, etc.

5.5.5 Prior Preparations at Institute including Programme Planning

It is after such an intense educational interaction with collaborating organisation, namely H.P.P.W.D., and armed with the problem bank, that the researcher, as mentioned under subsection 5.5.1, approached the second year students and the polytechnic faculty for their participation in the experiment and their subsequent selection. The problem bank obtained from the work-bench was, then, shared with selected students and faculty at this stage of the experiment itself; thereby leaving enough time for them to prepare for the proposed contributions at the work-bench.

Further, other operational problems were also discussed. Specifically, the work site was 12 kms. away from the Polytecyhnic. It was decided that the students would report to the Polytechnic everyday in the morning and they would be accompanied by two teachers (inclusive of the researcher) to the work site. The Principal was approached for providing the Institute's transport for this purpose, for which he accorded necessary permission.

The list of faculty of the Institution and Trainees selected for participating in the experiment, along with the training schedule of Table 5.5.5.1, was, then, given to the Executive Engineer of the Works, so that he could take necessary steps at his end well ahead of students arriving at the site. In working on these details, as can be seen from Part II of Table 5.5.5.1, a care was taken of assigning specific information-based-problem-solving-assignments to selected students as mentioned already through sub section 5.5.1.

Table - 5.5.5.1

Part I: Training programme in Buhana Bridge, Jarol, Sundernagar, Distt. Mandi in H.P

S.No.	Activities	Time in days
1.	Awareness of H.P.P.W.D. organisation and Bahana Bridge organisation	Half
2.	Planning of the execution of work	1
3.	Application of the principles of Design and Construction	1
4.	Management of men, material, equipment and machinery	1
5.	Store handling	1
6.	Production Techniques	2.5
7.	Repair and maintenance	1
8.	Safety precautions	Half
9.	Group discussion/seminar	Half
10.	Evaluation	1
	Total Time	10 days

Part II: Assigning of information-based-problems to student groups

Group* No.		Assignment allotted **
I	1.	To study the causes of delay of shifting material from one Section to other.
	2.	To study store and purchase procedures and suggest where they deviate from standard practices.
II	3.	To study spare parts problem for minor repairs.
	4.	To study security issues to avoid pilferages of material from stores.
III	5.	To study application of bar chart technique for improvement in work productivity and for timely execution of work.
	6.	To study the optimum use of tractors and suggest ways and means for frequency improvements.
IV	7.	To decide the cost-benefit between frequent tyre replacement and improvement of road between quarry and crushing plant.
V	8.	To diagnose the cause of slipping of ring gear of the concrete mixture ring gear and to remove the same.
	9.	To study the availability of safety , precautions at the work site.
VI	10.	To study the precautions for overhead welding to avoid accidents.

* Each group consisted of two students.

** For all these assignments, Junior Engineer has to act as Work Incharge.

5.5.6 Conduct of Exposure Oriented Work-bench based Instruction

5.5.6.1 Orientation

It was after all this preparation that on the appointed date of 12th December, 1987 all the 12 students of Automobile Engineering alongwith researcher and his colleague faculty member reported at the work site to Executive Engineer incharge of training of Buhana Bridge Jarol, Sundernagar, to begin the exposure-oriented student involvement at the work place. As per the programme schedule, on the first day itself the students were made aware of the H.P.P.W.D. organisation set up, in general, and Buhana Bridge Organisation, in particular. This was, then, followed by additional two days of orientation.

Specifically, the students and faculty were made aware of the history of the Buhana Bridge including its importance on the national highway. They were also made aware of its design and construction techniques.

To give an overview of the importance of planning of Works, factors affecting the planning for execution were briefly described. These were: Number of supervisory staff, labour (skilled, unskilled), operators, machines like concrete mixtures, conveyance vehicles (Truck, Tractor, Jeeps, etc.), vibrator, bar bending machine, crusher, welding set, Quality of various construction materials like coarse aggregate, fine aggregate, mild steel, binding wire, shuttering, tools, machinery and equipment for site workshop, site store, office, residential huts, enlisting the execution activities, PERT, etc.

After this, students were asked to begin their "exposure" schedule, while simultaneously being required to apply, within groups already identified, their minds to problems posed to them. For the purpose of these problems, Junior Engineer was assigned as work-incharge, while for functional areas, various Section-Heads were announced as work-incharges. However, Junior Engineers were given the responsibility of overall work-incharge.

5.5.6.2 Student Involvement

5.5.6.2.1 Exposure to Functional Engineering Areas

From the fourth day the students began their exposure to various functional areas as listed under Part-I of Table 5.5.5.1 describing the programme schedule that was adhered to during the experiment. This exposure they acquired by observing activities at the works, by interacting with experts, by studying literature and by keeping technical diary for further internal discussions within the group. All through this, the Junior Engineer and the teachers guided the students.

5.5.6.2.2 Information-based Problem-solving

Simultaneously, from the fourth day itself, students in groups of two, began their work on solving problems assigned to them well ahead of time. Thus, they organised the information as collected during exposure, plánned approach to solution, considered alternatives and decided on their own answers. They carried out this work on their own, treating it as a kind of job responsibility, with teachers and Junior Engineer available all the time for ready reference, suggestions, intervention and guidance. Finally, they presented their findings in writing through project reports.

5.5.7 Evaluation of the Students

In the process, while they were at the site, students were assessed through group discussion, seminar, viva, and observations for their contributions in solving the problems assigned to them. As regards project reports submitted by them on the last day of their training sojourn, these were evaluated at the Institute.

Coming to their exposure oriented involvement, it was assessed at the site through a quiz, while the diary prepared by them incorporating their observations and information as obtained till last date was assessed at the Institute.

In all, the concept of continuous evaluation was followed. At the end of the training, the evaluation focussed attention on many latent attributes which do not surface in the normal class room situation such as intellectual ability, interdisciplinary approach, skills for data handling, ability for written and oral presentation, initiative, team work, leadership quality, sense of responsibility to meet the dead lines, etc. These attributes were judged by two teachers assisted by the Executive Engineer and the Junior Engineer, through above mentioned instruments of evaluation as per Evaluation Matrix presented in Table 5.5.6.1.

Table - 5.5.6.1

EVALUATION MATRIX FOR STUDENTS

Name of Student: ________________ Roll No. ____ Branch _____

Industrial Estblishment/place for Training: _____________

S. No.	Characteristics	QUIZ	SEMINAR/ VIVA	GROUP DIS-CUSS-ION	OBSER-VATION	PROJECT REPORT	DIARY	TOTAL
		EVALUATION TOOLS						
	Marks	(15)	(25)	(15)	(15)	(25)	(5)	(100)
		MM MS	MM MS	MM MS	MM MS	MM MS	MM MS	MM MS
1.	Clarity of concepts,principles and processes	6 -	7	- -	- -	3	2	18
2.	Level of practical skills acquired	3	7	3	2	2	-	17
3.	Ability to solve problems	5	6	3	2	3	-	19
4.	Skills in data collection and information gathering	- -	-	- -	- -	3	2	5
5.	Self Expression/communication	- -	3	3	- -	2	-	8
6.	Report Writing	- -	- -	- -	- -	5	-	5
7.	Punctuality and regularity	- -	- -	- -	3 -	-	1	4
8.	Maturity and initiative	- -	- -	2 -	2 -	-	-	4
9.	Dealing with workers and colleagues	- -	- -	2 -	- -	-	-	2
10.	Sense of responsibility	- -	- -	- -	2 -	5	-	7
11.	Leadership qualities	- -	- -	2 -	4 -	-	-	6
12.	Creativity/conceiving new and unusual ideas	1 -	2 -	- -	- -	2	-	5
		15	25	15	15	25	5	100

MM = Max Marks : MS = Marks Secured.

5.5.8 Outcome of Student Involvement and Investigations – Practical Suggestions for Improvements: Benefits to Participating Industry

As could be expected, such a planned, teacher-controlled student involvement in a problem solving circumstance understandably gives rise to many practical suggestions for improvements which were immediately accepted by H.P.P.W.D. For the purpose of exhausting the details in the conduct of the experiment, these recommendations are briefly mentioned below:

1. The approach road to the quarry should be proper otherwise the cost of tyre maintenance of the tractor will be more than the carriage cost.

2. The variations in the work progress can be avoided by having the net work approach for construction.

3. The spare parts which require frequent replacement may be procured/stored before hand.

4. There should be a site workshop for maintenance of the equipments.

5. Red flags should be hoisted on the road sides from the safety point of view.

6. There should be stand by arrangements for crusher, concrete mixture, etc.

7. There should be a bar chart of the progress. This suggestion was illustrated by making bar charts for concreting the columns of the Bridge.

8. More copies of drawings, blue prints should be made available at the site.

9. There must be some incentive for good workers.

10. While concreting gloves and rubber-shoes should be provided to the workers.

11. Medical first aid facilities should be made available at the work site.

5.5.9 Discussion on Experiment

Though the duration of training was short and the trainees were few in number, but the knowledge and experience they gained in work situation benefitted all the students, faculty and organisation. Further, the trained students motivated other students for such training. Consequently the Experiments II and III, revolving around problem solving involvement, were conducted for more students.

Behavioural and attitudinal changes were also found in these trained students. Particularly, these students were found taking interest in skill development in the workshop, systematic experimentation in the laboratories and conceptual understanding of the theoretical subjects in the class room. This attitudinal change in the students generated a lot of discussion among the faculty of the Institute for inclusion of the Practice School based training in the curriculum; more importantly on immediate basis paving the path for greater faculty involvement (even on the part of senior faculty) in the further experiments planned.

5.6 Experiment - II: Problem-solving based Student Involvement at Work-bench

5.6.1 Selection of Students

As polytechnic programme is of three years duration only and as time requirement for a problem solving type involvement of students at work-bench was considered to be of the order of three to five weeks, summer after second year was the only proper duration available for the researcher to conduct second experiment. True, summer after 3rd year would have been better, but organising it was not easy as students leave for homes or jobs as the programme by, then, gets over.

The batch that the researcher, thus, considered for the second experiment was the one that came after completion of fourth semester. As a result, the students for this experiment came from the same batch as the one which was admitted to Polytechnic in July, 1986 whose admission profile is given in Table 5.1.2.1.

More specifically, Table 5.6.1.1 gives the distribution of 4th Semester second year students in 1987-1988 who were approached by the researcher in February, 1988, for participating in Experiment - II.

Table - 5.6.1.1

Details of Students who participated in the Experiment-II

Branch of Engineering	No.of Students		No.of work benches
	Total Nos.	Opted	
Civil	31	27	19
Elect.	26	25	08
Mech.	07	07	06
Auto	08	06	05
Arch.Asst.	15	09	06
Total	87	74	44

Understandably, as in Experiment-I, prior to his approaching the students, the researcher had already selected the industries and the work-benches and identified the problem bank as explained in subsection 5.6.3. All these details alongwith the educational objective of the experiment, the researcher, then, presented to students from each discipline and to their teachers. These lectures were followed by a combined lecture for students from all disciplines and teachers of the Polytechnic, so as to provide a unified view of the educational objectives and operations.

This was followed by students, indicating the willingness to participate in the experiment by their filling in proforma same as the one given in Table 5.5.1.1. Out of 87 eligible students, 74 students (inclusive of 6 girls) confirmed their willingness. Branch-wise number of students for the Experiment-II conducted in summer 1988 is given in Table 5.6.1.1. After this, the students were asked to give their choices for 44 work-benches in terms of their preparation to undertake identified problems. This information base as obtained from students was, then, matched with a student's requirements at the work-bench so as to complete the student allotment process. The student allotment information, disciplinewise - to different work bench is given in Table 5.6.1.2.

Table - 5.6.1.2

Student allotment information-discipline wise - to different work benches

S.No.	Particulars of the (Work bench) Organisations	No.of students took training in 1988						No.of students took training in 1989					
		C	E	M	A	Ar.	Total	C	E	M	A	Ar	Total
1.	Dy.Manager Training, National Fertilizer Nangal Punjab		3				3		2		1		3
2.	Executive Engineer, M & T Division H.P.S.E.B. Sundernagar, H.P.		2				2		3				3
3.	Assistant Executive Engineer, H.P.S.E.B. Sub Division, Sundernagar, H.P.		3				3		1				1
4.	Executive Engineer, H.P.P.W.D. (B&R)Division, Sundernagar, H.P.	4				1	5	2					2
5.	Executive Engineer, H.P.P.W.D. (I&PH)Division, Sundernagar, H.P.	1					1	3					3
6.	Superintending Engineer, DPH Circle, BBMB PW.Sundernagar, H.P.		2				2		1				1
7.	Executive Engineer, BBMB Workshop, Sundernagar, H.P.			3	1		4			2			2
8.	Asst.Engineer, H.P.S.E.B. Sub Division Nagwain, Sadar Mandi, H.P.		1				1		1				1
9.	M/s Supreme Motor, Mandi, H.P.		2				2			1			1
10.	Executive Engineer, I&PH, Mandi, H.P.	1					1	1					1
11.	Manager, Cousin Gun Manufacturers, Mandi, H.P.			1			1		1				1
12.	Executive Engineer, H.P.S.E.B. Division, Sarkaghat, Mandi	1	1				2		1			2	3
13.	Assistant Engineer, H.P.P.W.D. Sub Division, Sarkaghat.	2					2	3					3
14.	Assistant Engineer, H.P.S.E.B., Sub Division Chonntra, Jogindernagar, H.P.		1				1		1				1
15.	Assistant Engineer, H.P.P.W.D.(B&R) Joginder Nagar, H.P.	3					3	1	1	1			3
16.	Executive Engineer, I&PH Division, Baggi, Mandi			1			1			1			1
17.	Assistant Engineer, H.P.S.E.B. Sub Division, Arki, Solan, H.P.		1				1	2					2

18.	Executive Engineer, Tube well division IPH Nalagarh, Solan, H.P.	1					1									
19.	Assistant Engineer, H.P.P.W.D.(B&R) Sub Division, Arki, Solan					1	1		1						1	
20.	Executive Engineer, H.P.S.E.B. Division, Dharmshala, Kangra			2				2		1						1
21.	Executive Engineer, H.P.S.E.B. Division Palampur, Kangra.			1				1			1			1		2
22.	Assistant Engineer, H.P.S.E.B. Sub Division Haripur, Kangra			1				1								
23.	Executive Engineer, H.P.P.W.D.(B&R) Division, Nurpur, Kangra.	2					2			1			1		2	
24.	Assistant Engineer, H.P.P.W.D. (B&R) Sub Division, Jaisinghpur, Kangra. .	1					1									
25.	Assistant Engineer, H.P.P.W.D. Sub Division, Baijnath, Kangra.	1					1			2					2	
26.	Assistant Engineer, I&PH Sub Division, Jawali, Kangra, H.P	1		1			2		1						1	
27.	Himachal Metal Industries, Kangra, H.P.				1		1									
28.	Project Manager, H.R.T.C. Central Workshop, Jassur, Kangra				2		2					2			2	
29.	Executive Engineer, H.P.P.W.D. (B&R)Division, Kangra.					1	1						2		2	
30.	Executive Engineer, Electrical Workshop Division, Jammu, J&K		1				1			1					1	
31.	Executive Engineer, Bhuri Singh Power House, Chamba		1		1		2			1					1	
32.	Executive Engineer, H.P.P.W.D.(B&R), Chamba	1					1		2						2	
33.	Executive Engineer, H.P.S.E.B. Division, Kumeharsan, Shimla		1				1									
34.	Assistant Engineer, H.P.P.W.D.(B&R) Jubar Hati, Airport, Shimla.	1					1									
35.	Executive Engineer, H.P.P.W.D. Division-1, Shimla-1	2					2		1						1	
36.	Assistant Engineer, H.P.P.W.D.(B&R)Hatkoti, Jubal ,H.P.			1			1			1					1	
37.	Assistant Engineer, I&PH Sub Division-II, Shamshi, Kulu.	2					2			1			1		2	
38.	Executive Engineer, H.P.P.W.D.(B&R)Division, Ghumarwin, Bilaspur.	1	1				2		2	1					3	
39.	Executive Engineer, H.P.P.W.D.(B&R)Division No.1, Bilaspur	1			1		2									
40.	Assistant Engineer, H.P.P.W.D. Sub Division, Namhol, Bilaspur					2	2			1					1	
41.	Executive Engineer, H.P.P.W.D. B&R Division, Hamirpur.					1	1									
42.	Assistant Engineer, Sub Division Town Planning, Hamirpur.					3	3						2		2	

43.	Assistant Engineer, I&PH Sub Division, Nagrota, Kangra.		1				1	1					1
44.	Assistant Engineer, I&PH Sub Division, Baldwara, Mandi, H.P.	1					1						
45.	Executive Engineer, Bhaba Construction Division Sanjay Vidyut Periyojna, Kinnaur							1	1				2
46.	Assistant Engineer, Civil Construction, H.P.S.E.B., Mandi, H.P.						-	1					1
47.	Executive Engineer, I&PH Division, Barsar							1				1	2
48.	Assistant Engineer, Tahliwala Sub Division, H.P.							1					1
49.	Assistant Engineer, H.P.P.W.D. Sub Division, Nirmand, Kulu.								2				2
50.	Regional Manager, H.R.T.C. Baijnath, Kangra										1		1
51.	Deputy General Manager, Mandi H.R.T.C., Mandi										2		2
52.	Assistant Engineer, Mechanical Sub-Division No.II, H.P.P.W.D., Dharmshala, Kangra										1		1
53.	Assistant Engineer, Kotla Sub-Division H.P.P.W.D.,Kotla							1					1
54.	Scientific Officer, S & Technology Deptt., Sundernagar							1					1
55.	Assistant Engineer Mech., Sub Division H.P.P.W.D. Parchhu, Sarkaghat, Mandi HP									1			1
56.	Training Manager, H.M.T., Panjore									1			1
57.	Chaudhari Entreprise, Mahadev, Mandi								1				1
	Total	27	25	7	6	9	74	27	26	7	7	10	77

C = Civil, E = Electrical, M = Mechanical Engg., A = Auto. Engg., Ar. = Architecture Asstt.

H.P.S.E.B. - Himachal pradesh State Electricity Board, H.P.P.W.D. - Himachal Pradesh Public Works Department.

I & PH - Irrigation and Public Health, B & R - Building and Roads.

HRTC - Himachal Road Transport Corporation.

5.6.2 Selection of Teachers

As mentioned in subsection 5.6.1, discussions were held with students of second years and their teachers, which were then followed by a combined lecture to them by the researcher. It is during these interactions, ten faculty members came forward to participate in experiments. The profile of teachers is as given in Table 5.6.1.3.

Table - 5.6.1.3

Profile of the Teachers involved in Conduct of Experiments-II and III

S. No.	Discipline	Qualification	Designation	Teaching Experience in yrs.
1.	Civil	T.T.T.I.Dip.	Lecturer	20
2.	Civil	B.E.	Lecturer	01
3.	Elect.	T.T.T.I. Dip.	Lecturer	10
4.	Elect.	B.E.	Lecturer	Half
5.	Mech.	AMIE	W/Shop Supdtt.	20
6.	Mech.	T.T.T.I. Dip.	Lecturer	20
7.	Auto	Dip. in Auto	Demonstrator	10
8.	Auto	B.Sc.B.E.	Head of Deptt.	20
9.	Arch.Asst.	B.Arch.	Lecturer	05
10.	Physical Education	B.A.	P.T.I.	20

From the Table 5.6.1.3, it is very interesting to note that these teachers of different disciplines had a varied experience from half year to twenty years.

Since no financial support was available to faculty different man-management possibilities were meaningfully utilised to ensure sustained faculty participation in the experiments. Thus, it was resolved to allocate work-benches faculty-districtwise i.e. the local faculty of the particular District were allocated work benches in its home district.

However, if any faculty was ready to supervise work-benches near the Polytechnic, it was worked out that he would be eligible for earned leave. This facility could be available to only one faculty as other faculty members had to be away from the Institute mainly because of work-benches being so distributed. Thus, one faculty member did avail of this option (and in the process he also managed to remain close to his daughter who also was one of the students to undergo the problem-solving-based involvement as under Experiment - II).

There was another aspect in faculty selection and it was in terms of faculty representing cross section of discipline from engineering to non-engineering. Table 5.6.1.3 has given data in this regard. As regards the non-engineering faculty, he came from area of Physical education. He supervised students education at work-bench near his home place in chamba, namely, Bhuri Singh Power House, Chamba, and H.P.P.W.D. (B&R), Chamba. Understandably, his role had to be defined more in a managerial context, thereby making a team combination of faculty-work incharge as a teacher, a more significant concept. This has further organisational implication, that it brought in the realisation that with greater participation from work-incharges, the faculty spectrum in such an education can be more varied, thereby bringing in organisation flexibility in faculty deployment.

5.6.3 Selection of Industries and Problem Bank

The design of Experiment-II for problem solving based student involvement at work-bench was implemented as per the details of subsection 4.5.1. Of course, in selection of industries this experiment attempted to squarely answer the issue of work-benches being located at different places, which as explained heretofore, was underplayed in the design of Experiment-I.

Further, in answering the question of selection, there was also the issue of identifying proper problem bank to respond to two requirements, namely, ability to accommodate larger student number (from 12 as in Experiment - I to as large as say around 80, reflecting eligible population) and need for proper problem solving tasks to ensure quality education. It is within this perspective the researcher, in his design of Experiment-II, decided to go outside the state looking for adequate number of work-benches.

Specifically, Experiment-II was conducted in June-July 1988 (from 15th June, 1988 to 5th July, 1988). The experiment accommodated in all 74 students from all disciplines of Polytechnic education at Sundernagar (Civil, Mech, Elect, Auto & Arch.Asstt.) and was supervised by 10 faculty members inclusive of the researcher who monitored in all 44 work-benches. Incidentally, the one work-bench which was implemented in December, 1987 was not included in these 44 work-benches.

These work-benches were provided by the sites of 12 industries/organisations (Table 5.6.1.4) from four states, namely, Himachal Pradesh, Punjab, Haryana and Jammu Kashmir. These industries were contacted by the researcher wherever possible, personally, otherwise through correspondence. It is interesting to note that these 12 industries were the total number that the researcher approached and all of them responded positively.

On hearing from them positively the researcher approached the industries once again seeking information in regards to problems on which they desire students could work. The problems, thus, identified covered the areas of design, development, management, production, marketing, storing, repair, maintenance and operation of transport fleet. Specific details of these areas as per the requirements of various industries are given in Appendix (7). These industries were also requested to name the work places which required the solution of the problems.

Thus, as mentioned above, in all 44 work-benches emerged (Table 5.6.1.2.).

Table - 5.6.1.4

Numbers of work-benches of the organisations/industries contacted for conducting problem solving II programme in Experiments II & III

	Organisations/Industries	Work-benches in 1988	Work-benches in 1989
1.	Himachal Pradesh Public Works Department.	17	18
2.	Himachal Pradesh Irrigation & Public Health.	8	7
3.	Himachal Pradesh State Electricity Board.	10	10
4.	Himachal Pradesh Road Transport Corporation.	1	3
5.	Himachal Pradesh Town & Country Planning.	1	1
6.	Jammu & Kashmir State Electricity Board.	1	1
7.	Bhakra Beas Management Board.	2	2
8.	National Fertilizer Ltd., Nangal,Punjab.	1	1
9.	Hindustan Machine Tool, Pinjore, Haryana.	-	1
10.	Metal Engineering Works,Kangra, H.P.	1	-
11.	Supreme Motors Mandi, Himachal Pradesh.	1	1
12.	Cousin Gun Manufacturing Mandi, H.P.	1	1
		44	46+2*

*One work bench in Science & Technology Department.
One work bench in Tiny industries.

5.6.4 Allotment Matrix

From the above Section 5.6.1, it follows that the very process of teacher selection also answered the question which teacher will supervise which work-bench. With teachers and students for each work-bench, the researcher finalised a total allotment matrix and also prepared the same with further specific details on student's and teacher's names and their disciplinewise preparation as intimated to the work- benches. At this stage itself an exercise was also completed to allot each student or group of students specific problem area at the work bench assigned to them.

5.6.5 Programme Schedule

It is with this preparation that the teachers and students, then, reported at their respective work benches on 16th June, 1988. On the first day itself, the students were introduced to their work incharges and right at the outset they began their work in the problem areas. For the coming three weeks their main responsibility was to study the problem, collect information, analyse the same to find alternative and to decide on solutions. Allthrough this the teachers and the work incharges guided the students in a catalytic manner. Finally, students presented their findings in the form of project reports.

As regards the students' grouping at 20 work benches, students were in groups of five or four or three or two. Of course, bulk of the groups were of three or two students. At remaining 24 work benches, students worked individually; wherever the students were in a group, one student was appointed a leader or convener for the group with responsibility for the conduct of the project. Similar approach was also adopted during group activities under the Experiment-I.

5.6.6 Evaluation of the Students

Allthrough their involvement at the work bench, students' performance was assessed through the instruments; quiz, observation and group discussion where only one student was at the work bench, his group discussion assessment was mainly in terms of his participation in discussion with officer at the work bench. This assessment was followed by assessment at the institute through the instruments, seminar, project report, viva and diary. The evaluation matrix for these instruments was as per Table 5.5.6.1.

5.6.7 Outcome of the Student Involvement at Work-benches – Benefits to Participating Industries

As in Experiment-I, during this experiment too student involvement contributed to the advantage of participating industries by making practical suggestions for improvements and enabling increased work productivity. Below are listed a few of these contributions:

i. Pilferage of construction material at the remote area work benches was checked.

ii. Maintenance schedule of transformer of Sundernagar Division was prepared.

iii. Energy meters at Testing Laboratory, Sundernagar, were repaired and tested.

iv. Drawings of transmission lines laying were prepared.

v. Estimates alongwith drawings were prepared for the link road construction at Sarkaghat.

vi. Prepared drawings for sewerage line laying at Hamirpur, and Mandi, also the drawings of type IV Quarters.

vii. Prepared the service schedule of vehicles of H.R.T.C. Region, Mandi.

viii. Prepared water Distribution timing system at Sundernagar.

ix. Processed the comparative statements of tenders at Jogindernagar Sub Division of H.P.P.W.D.

x. Improvement made in the packaging of the industrial products at Kangra.

5.7 Experiment - III

To establish the validity the results obtained under Experiment-II, it was decided to repeat the experiment in the next summer vacation i.e. June-July, 1989. Thus, Experiment-III of five weeks' duration was held from 16th June, 1989 to 21st July, 1989.

5.7.1 Participation

Ten faculty members, 77 students (including eight girl students) and 48 work-benches including Science and Technology Department in Sundernagar Polytechnic and a tiny unit participated in this experiment. Branch wise details of students' participation is given in Table 5.7.1.1.

Table - 5.7.1.1

Branch-wise Distribution of Students in the Work-benches

Branch of Engineering	No. of Students: Total No.of students	No. of Students: No.of students opted	No.of work benches
Civil Engg.	31	27	19
Elect.Engg.	28	26	11
Mech.Engg.	10	07	06
Auto Engg.	08	07	05
Arch.Asstt.	11	10	07
	88	77	48

5.7.2 Planning of the Experiment

Experiment-III followed the same steps as in Experiment-II in regard to selection of students, teachers, and work benches and in regard to working out the problem bank's details. Interestingly, same industries as during Experiment-II offered their participation with two more work- benches than in summer of 1988, and with additonal attraction of industry such as H.P.P.W.D. offering honorarium for best performance. Thus, the 12 industries which had given in all 44 work-benches in Summer of 1988, now gave in all 46 work-benches, of which incidentally 35 were common. Over and above, this researcher was also able to work out two other work benches of unique type (making the total of work-benches covering all three experiments, 58), one in Science and Technology Department at the polytechnic (thereby suggesting that the institutional infrastructure facility can also act as work-bench) and one in a tiny unit characterised by a composite unit (thereby paving a way for considering non-organised sector as a work bench). This tiny unit was incorporated as work-bench as it belonged to a student of the Polytechnic who had volunteered to undergo Experiment-III. This allowed a possibility of including a feasibility study type of problem bank assignment for the composite unit to seek bank loan for further development of the business.

5.7.3 Implementation of Instruction and Student Evaluation

The steps followed here were the same as in Experiment-II.

5.7.4 Honorarium to Students

Experiments - II and III clearly brought forth the advantage that such student involvement at work-bench can give to the collaborative industry. Experiment-III further exemplified this realisation when H.P.P.W.D. in the wake of its promise, found contributions by two students in the areas of supervision to avoid wastage of the material and to carry out of work according to the specifications of ongoing school building of high quality.

Construction supervision and preparing of estimates and drawings of the boundary wall and type-II quarters being activities of direct utility to the organisation, the students' were awarded honorarium of Rupees Six hundred and Rupees five hundred respectively. Incidentally one of these students was a girl student, thereby demonstrating equal ability and competence for girls students to participate in such a collaborative educational effort.

5.7.5 Students' Contribution in Science and Technology Department and at Tiny Unit

It will be worth mentioning at this stage the type of contributions students could make at special types of work-benches experimented during 1989. The student involvement at Science and Technology Department of the Polytechnic was in terms of collecting of data for the water mill. This data was of utility to the researcher at Sundernagar Science and Technology Department to publish research work.

The work at a tiny unit mainly culminated in preparation of feasibility report for fiscal support from Bank for further expansion of the units activity.

5.8 Discussion on Experiments: Regenerative Indicators

The three experiments presented herein aim at quality polytechnic education and institutional development through Institution-Industry interface. As one critically presents details in regard to the conduct of these experiments, what surfaces are the regenerative indicators of these educational experiments. These indicators are exemplified through continuous increase in student, faculty and industry participation, with institutions, industries even paying honorarium to students by the end of two years of their polytechnic education.

Yet another fact of interest is that with initiation of these experiments, over last two years, the polytechnic has every year started getting industries for campus interview, though so far only in small numbers (only two to three). These industries are from those offering collaborative facilities to the polytechnic as under the experiments conducted, as also from those who did not collaborate but with whom the researcher had established interaction as he worked on the experiments. These industries are : Supreme Motors, Mandi; TELCO, Solan and Eicher, Parwanu. Of course, this phenomena has also been accentuated by Himachal Pradesh Government requiring industries to permit State producers, but this does not change the reality that ever since the Institute has initiated the efforts for linkages with the world of work through this research, a definite number is emerging of industries for yearly campus interviews, to the advantage of passing out students. This fact contrasts with the reality that, in almost a decade before 1986, in all only three industries had come to the Polytechnic for campus interview.

Figures 5.5.1 to 5.5.4, giving above details in a graphical form, speak for themselves.

Coming to faculty benefit, at least the young faculty (i.e. five out of a total of 10 who participated in the experiments) found this involvement in industry of great value, as it offered them much needed industrial training and subject confidence. Further, at one work bench at least, the teacher (in this case the researcher himself) was approached by the work bench proposing if his presence could be utilised for continuing education courses for their employees. Specifically, HRTC, Mandi, proposed if researcher could give courses in Body Building of Buses for its workers.

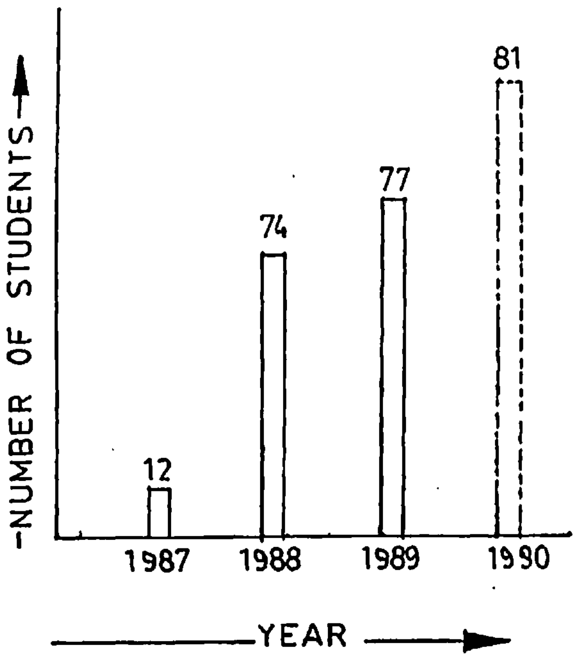

FIG. 5.5(1) STUDENTS PARTICIPATION

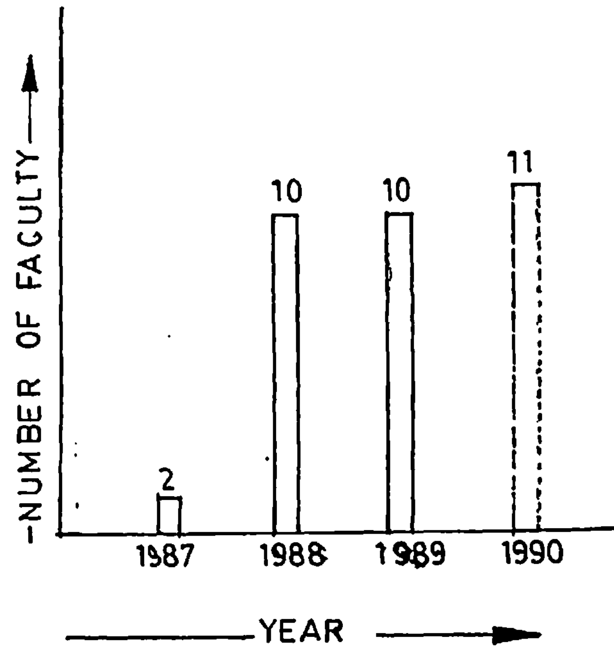

FIG. 5.5(2) FACULTY PARTICIPATION

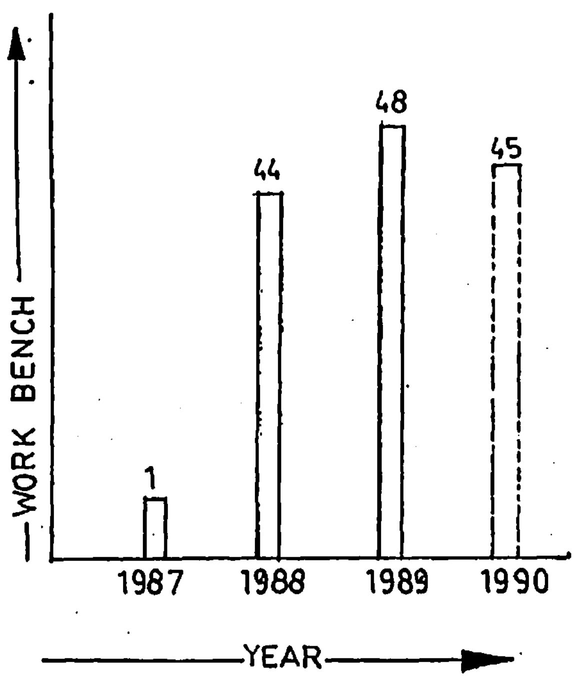

FIG 5.5(3)

STUDENTS PARTICIPATION IN THE NUMBER OF WORK BENCHES

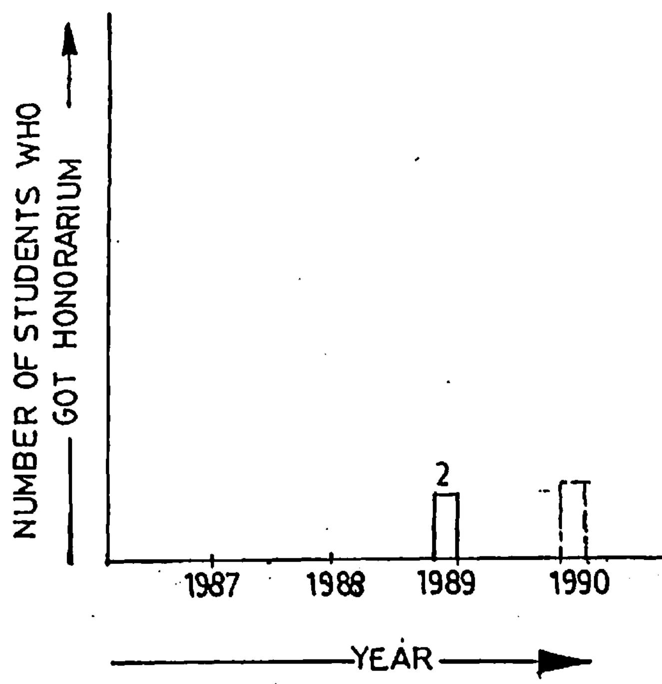

FIG. 5.5(4)

HONORARIUM TO THE STUDENTS

There were also number of instances when faculty and students came back from their industrial involvement, making case for modernisation and upgrading of the curriculum. Specifically, mention, may be made of a suggestion by teachers and students, who attended their problem-solving-based involvements during summer of 1988 and 1989 at HPSEB, Sundernagar, to include computer aplications in the curriculum. Further, students of Automobile Engineering, who attended their industrial sojourn at HRTC, Mandi and Jassur during summers of 1988 and 1989, asked for greater skill component in the curriculum.

Finally, it may be pointed out that out of many work incharges who participated in these experiments, at least four (one from H.P.P.W.D. (IPH), two from HRTC and one from HPSEB) offered to periodically participate in teaching activity at the Institute. Further, they also suggested specific topic that could be added to the curriculum to make it more relevant to industry. Thus, while a professional from HRTC, Jassur, suggested introduction of topic in "Cold Tyre Retreading", a work incharge from HRTC, Mandi, felt that introduction of topic from "Body Building of Buses" would be very helpful, a work incharge at IPH, Sundernagar, proposed need for topic from "Specific application of Irrigation Techniques to hilly areas", and a professional from H.P.S.E.B. suggested introduction of "computer applications" for technicians' training.

The above are, then, various outcomes involving different constituencies of Polytechnic education, namely, students, teachers, industries and work incharges that were observed through the conduct of experiments, as pedagogy was attempted through PS based method of student training for Institution-Industry interaction. These outcomes, as can be seen from their description above, represent self growth character and are, therefore, regenerative indicators of the model of education considered through the experiments undertaken.

CHAPTER - SIX

ANALYSIS AND RESULTS OF EXPERIMENTS

6.1 Introduction

The experiments so conducted were, then, subjected to critical assessment based on student, teacher and industry feed back and examination research to establish the educational as also organisational validity of the experiments. This chapter comprehensively presents the analysis and results of the experiments so assured. It may be mentioned that as the Experiment-I was conducted basically for pedagogic results, its assessment is done only through examination research. Against this, Experiments II and III were conducted to equally study the logistical and organisational issues. Therefore, these two experiments have been assessed through both the methods, namely, the feed back response as also the examination research.

6.2 Student Feed back on Programme Schedule and Implementation

6.2.1 Factors Considered

Towards assessing the experiments, researcher adopted the feed back questionnaire method as one channel for studying the response of different constituencies of the experiments. As mentioned above, the other channel utilised was that of examination research in terms of internal consistency of examinations and correlations between different instruments of evaluation as implemented under the work-bench-based teaching-learning process.

The feed back questionnaires were administered separately to students, teachers and industries (work incharges). Appendix (B) gives the questionnaire administered to the students. As can be seen, this questionnaire covers various aspects of Institution-Industry linkage at prior planning stage, at implementation stage and at post implementation stage. This classification is detailed below:

a) Factors considered in respect of programme planning stage.

i. Student allotment to work benches.

ii. Registration

iii. Training programme Schedule

b) Factors considered in respect of conduct of Experiment.

i. Problem assignment

ii. Work-bench incharge involvement

iii. Faculty involvement

iv. Interpersonnel relations

v. Students involvement.

c) Factors considered in respect of infrastructural requirements for work-bench-based student involvement.

i. Accommodation

ii. Transportation

iii. Food

iv. Expenditure

v. Facilities at training station

d) Post implementation feed back.

i. Overall impressions

ii. Evaluation and feed back

In what follows, this section presents student feed back response to various aspects of Institution-Industry interface as mentioned above.

Programme Planning Stage

6.2.2 Factor I : Students Allotment to Work-benches

6.2.2.1 Factors Influencing Choice of Work-benches

The analysis of students' feed back shows that 82.4% of the students got the station of their first choice in 1988 and 91.20% in 1989 and 17.6% got the station of the 2nd choice in 1988 and 8.80% in 1989; thereby showing the allotment procedure designed to be an effective one.

Table 6.2.2.1 shows the views/evaluation of the students' response to the factors affecting their allotment choices for the work-benches.

Table - 6.2.2.1

Students Response to Factors Affecting Their Choices for Work-benches

S.No.	Factors affecting choices	%age favourable responses in	
		1988	1989
1.	Facilities provided	43.24	57.35
2.	Parents' desire	100.00	100.00
3.	Nearness to the home town	32.43	45.70
4.	Professional interest in the project	94.59	96.45
5.	Reputation of the host organisation	72.27	68.95
6.	Future career in mind	78.37	84.40
7.	Curiosity to learn new things	87.83	90.60

From the Table above, it can be seen that parents' desire was the most important factor governing the students' choice of work-bench as both the student samples, i.e 1988 as also the 1989, have unanimously responded to this factor (100% favourable response).

Coming to other factors, it can be seen that only 43.24% students considered "facilities provided" while seleclting work-benches in 1988, while the corresponding percentage in 1989 was also not very high, i.e., 57.35%.

The factor of nearness to home town was also not a very significant one in choosing work-benches, as can be seen from response percentages of 32.43% in 1988 and 45.70% in 1989. This observation is revealing, as almost all involved in planning of this experiment were worryed about this issue and, as indicated earlier, it was a presupposition, contrary to this observation, that had governed the allotment process in the experiments, thereby limiting the educational potential.

Finally, coming to factors that influenced the students' choices substantially, next only to that of parents' desire were professional interest in the problem (project), curiosity to learn new things, future career in mind and reputation of the host organisation, in that order, as average responses over two years for these factors were 95.52%, 89.26%, 81.4% and 70.6%, respectively.

6.2.2.2 Necessity of Advance Information on Training to the Students

In 1988, 28.37% students reported that they had advance information about work-bench arrangements before two weeks of commencement of training and 45% reported that they had lead time of one week only. In 1989, these percentages became 53% and 38%, respectively; thereby demonstrating steady improvement in planning and implementation of the educational requirements.

One of the most important channel for students to receive information on training before their departure was the lectures that the researcher had delivered at the Institution at the the time of student selection procedure (see section 4.5.3). 96% of students responded favourably to these orientation lectures and 98.64% to their (lectures') timings, in 1988. These percentages in 1989 increased further to the quantums of 97% and 100%, respectively; thereby clearly demonstrating the validity of the prior preparation effort and time table as implemented through the experiments.

6.2.2.3 Prior Preparation by Students after Announcement of Allotments

It was observed that immediately on announcement of allotment to work-benches, in 1988 as also in 1989, 100% students interacted with faculty to do advance preparation for their industrial sojourn. Interestingly, only 28.72% students took advantage of library facilities in the context in 1988. However, in 1989, this percentage rose to 54%; thereby in general indicating improvement in students' perception of their responsibility at work-bench.

6.2.3 Factor-II: Registration

This process, which follows the prior preparation stage, mainly consists of students reporting to the work-bench on due date. In view of the emphasis on problem solving activity, this process acquires importance mainly because any involvement at work-bench is a committed one and demands punctuality and discipline. Therefore, it was considered necessary to assess the procedures laid down in respect of student reporting under the two experiments. Table 6.2.2.2 below shows this information which is self explanatory. Specifically, the Table shows the high degree of discipline demonstrated by the students in fulfilling these educational objectives, with definite trend of increased commitment to discipline as one mc ed from Experiment-II in 1988 to Experiment-III in 1989.

Table - 6.2.2.2

Students Response for Reporting to the Work-benches

Training Stations Reporting Time	%age Yes responses of the students 1988	 1989
Reporting on due date	84%	87%
Reporting after due date	16%	13%
Difficulties faced in reporting	6%	2%

6.2.4 Factor - III: Training Programme Schedule

The researcher had prepared a kind of check list in the form of Directory of suggestions/questions for training in world of work (see Appendix 11). As can be seen, though this check list begins with some details on the work-bench that was implemented in 1987, it (i.e check list) is a general one applicable to bulk of industrial operation.

When the feed back questionnaire asked students if they had received the Directo y in time, all the students (i.e. 100%) in both the years (i.e. 1988 and 1989) responded favourably.

Conduct of Experiment

6.2.5 Factor - IV: Problem Assignment

As one analyses the issues that students had upper most in their minds as they gave their preferences to the work-benches, it becomes clear as to how important is the step of assigning proper problems to the students. Therefore, the feed back questionnaire made rigorous effort to understand students' response to the problems and the process of assigning and conducting them. Table 6.2.5.1 gives students' responses in the context.

Table - 6.2.5.1

Students Response on the Problem Assignment

Activities	%age of favourable responses of evaluation by students 1988	1989
1.Rating of orientation programme at work places	75%	79%
2.Practice assignment allotment within one day/	45%	47%
two days	55%	53%
3.Reaction of the students to assignments	100%	100%
4.(a) Immediate utility of the assignment to industry	56%	72%
(b) Of utility at a later date	40%	25%
(c) Of no utility	4%	3%
5.Attachment(i) On going Projects	68%	74%
(ii)Independent working	32%	26%
6.Completion of assignment in itself.	100%	100%

The data base as given through the above table is self-explanatory. As can be seen from the Table, under both the experiments, all the students (i.e. 100%) enjoyed their problem solving contribution. On an average, 77% students found orientation at work places adequate. However, it looks that only about 50% of assignments were allotted to the students within first two days. This would call for more rigorous monitoring mechanism at the work places. One possible reason could be that during these experiments one teacher was looking after more than one work-bench in many situations. A greater teacher control would certainly give better results. Indeed, this is consistent with the educational design of Practice School system. (Reference teacher role).

Another important and welcome observation is that in 1988, 96% and in 1989, 97% responses indicated that assignments given were of high utility to the work-benches. This goes to demonstrate the validity of the problem bank generation procedure developed through the experiments. This is further strengthened by the fact that majority responses (56% in 1988, and 72% in 1989) indicated that the assignments were of immediate utility.

Coming to further details, it is observed that majority of students were put on ongoing projects with this trend on the increase as one moved from 1988 to 1989. Further, all the assignments were normally completed by themselves. This demonstrates that the method of intense interaction as entertained by the researcher did give rise to a mechanism to integrate educational process with day to day productivity needs of collaborating industries.

6.2.6 Factor - V: Involvement of Work Incharges

The educational process under the Practice School based pedagogy is a triangular one, involving student, teacher and the professional experts i.e. work incharge. Therefore, it was important to see students' response in regard to involvement of work incharges. It was observed that in 1988, 87.83% students responded by stating that involvement of work incharges was favourable. The corresponding figure in 1989 was 96%.

6.2.7 Factor VI: Frequency of Discussion with Work Incharges and with Faculty

A natural corollary to factor mentioned under 6.2:6 above is a query as to the frequency of interaction between students and work incharges; students and faculty.

100% of students responded that they discussed the assignments with work incharges very often. Corresponding figures with reference to teachers were 56.76% and 73% in 1988 and 1989; respectively.

6.2.8 Factor VII: Interpersonal Relations

The work-bench based eduction being a team activity, the ability of a learner to demonstrate and to receive favourable responses from work incharges becomes an important need. Table below gives students' response in the context which is observed to be highly satisfactory. .pa

Table - 6.2.8.1

Students' Response to Interpersonnel Relations

Relationship	%age favourable response	
	1988	1989
Attitude of the professional experts	88%	91%

Infrastructure Requirements

6.2.9 Factor - VIII: Accommodation

All through the planning stage for conducting the experiments, if one issue was considered to be the real bottle neck, it pertained to the ability to work out the accommodation issue at work place. Of course, as one researched the students' mind further, it seems to be the case that this issue is not so important. However, the Table below shows how this problem was solved. The Table is self-explanatory and offers one approach to resolve this issue if polytechnics plunge into this entrepreneurial educational endeavour of linking Institution-Industry.

Table - 6.2.9.1

Students' Response on the Facility of Accommodation

Accommodation	Percentage of respondents	
	1988	1989
Own Houses	88.00	84.00
Houses of relatives	8.00	6.00
Rented Houses	4.00	10.00

6.2.10 Factor IX: Transportation

Another issue that often seems to plague the discussion on infrastructure arrangements is that of transportation. Table below shows how this issue was satisfactorily resolved by accommodative arrangements at various stages.

Table – 6.2.10.1

Students Response on Infrastructure Arrangement (Transportation)

Time taken to reach the training places	% of the students		Mode of transportation	
	1988	1989	1988	1989
15 minutes	20%	18%	52.4%	40.54% on foot
15-30 minutes	30%	46%	31.2%	24.32% on own vehicle
30 minutes to 1 hour	40%	36%	16.4%	35.14% by public transport
More than 1 hour	10%	-	-	-

6.2.11 Factor X: Food

Table below shows how food arrangements were satisfactorily resolved. Indeed as one can see, there was a increasing trend in terms of such facilities coming from the collaborating industries.

Table - 6.2.11.1

Students Response on Food Facilities

Arrangement of food	%age of students availed facilities of food		Rating of facilities provided by host orgn.		Remarks
	1988	1989	1988	1989	
Availability at the host organisation	16.22	21.4	54.09	62	Good
Available outside the host organisation	41.89	37.3	36.48	34	Average
Carried own lunch packets	41.89	41.3	9.43	4	Below Average

6.2.12 Factor XI: Pocket Expenditure

96% students in 1988 and 98.7% in 1989 got the pocket allowance from the parents/guardians and 4% students in 1988 and 1.3% in 1989 did not spend any amount during training. Of course, two students did receive honorarium in summer 1989, thereby providing a direction to how this probelm can be constructively resolved with greater efforts to link educational productivity with industrial productivity.

6.2.13 Factor XII: Facilities from Industries

Table 6.2.13.1 shows the responses of the students on facilities in the training places (work-benches).

Table - 6.2.13.1

Students Response on Facilities at the Work-bench

Facilities in Training station	Students favourable responses in percentage	
	1988	1989
Library	40%	37%
Laboratory equipment	53%	52%
Data Processing	57%	54%
Recreation	15%	10%
Stationery & Typing	52%	46%
Medical facilities	47%	50%
Average	44%	41.5%

Post Implementation Feed back

6.2.14 **Factor: XIII: Overall Impressions**

Table below summarises the overall response of the students to their sojourn at work-bench. The Table is self-explanatory as it shows the majority of the students finding very good use of the industry involvement. Indeed, in all the areas of benefits listed through the table, there is an increasing trend in intensity of benefits received from 1988 to 1989.

Table - 6.2.14.1

Students' Response about their Overall Impression

Item	Students rating in percentages					
	Very Good		Good		Average	
	1988	- 89	1988	- 89	1988	- 89
1. Application of analytical skill	62.2%	71%	27%	26%	10.8%	3%
2. Learning new skills	60.80	79%	31.2%	20%	8%	1%
3. Technique of data seeking and interpretation	62.2%	68%	27%	30%	10.8%	2%
4. Establishing of personnel relation	60%	65%	32%	24%	8%	1%
5. Communication skill	62.2%	69%	33.8%	28%	4%	3%
6. Understanding of professional life	64%	73%	32%	26%	4%	1%
7. General remarks about the training	100%	100%	-	-	-	-
Average	62%	76%	30%	22%	8%	2%

6.3 Teacher Feed back: Analysis and Results

In order to perceive the teacher's response and appreciation of the experiments, a feed back questionnaire given in Appendix 9 was administered after completion of Experiments - II and III. Table 6.3.1 gives analysis of a teachers' response to this questionnaire.

Table - 6.3.1

Teacher Responses on Work-bench based Training

S.No.	Activity	Favourable percentage	
		1988	1989
1.	Training period		
	i) 3 weeks in 1988 & 5 weeks in 1989	20%	0.0 5
	ii) Suggested duration of 3 months	80%	100%
2.	Facilities satisfaction:-		
	i) Accommodation	100%	100%
	ii) Transportation	70%	60%
	iii)Pocket allowance	00%	00%
	iv) Infrastructural facilities	80%	90%
	v) Subsidised canteen	20%	30%
	vi) TA for field visits	00%	00%
3.	Benefitted more by presence of faculty	80%	100%
4.	Participation in group discussion	100%	100%
5.	Allocated work benches supervised	10%	10%
6.	Supervision difficulties faced	100%	80%
7.	Negotiation for Honorarium		
	i) Achieved	00%	03%
	ii) Not achieved	100%	97%
8.	Problems to be included in the Problem Bank	30%	10%

9.	Application of system approach to solve the problems by the students	70%	90%
10.	Curriculum revision needed	100%	100%
11.	Campus interview	100%	100%
12.	Involvements of professional experts	70%	90%
13.	Personal gain from training	100%	100%
14.	Industrial experience needed for faculty from time to time	100%	100%
15.	Refresher courses for faculty	100%	100%
16.	Involvement of industries experts in the conduct of examination of practical	70%	80%
17.	Part time lecturer from industry	100%	100%
18.	Improvement in employment opportunity	80%	90%
19.	Improvement in institutional environment	100%	100%
20.	Development of entrepreneurial skill	100%	100%
21.	Regular placement of staff in the work benches	80%	90%
22.	Industrial Training as a part of curriculum	100%	100%
23.	Separate training cell	100%	100%
24.	Improvement in the present system of training	90%	100%
25.	Overall impression	100%	100%

In what follows this section discusses results of the Teacher feed back under various aspects concerning Institution-Industry interface.

Training Duration

As evident from Table 6.3.1, the majority of the faculty (80% in 1988 and 100% in 1989) involved in the training of students were of the opinion that the duration of the training should be for a minimum period of 3 months. In others, teachers opined for a longer student involvement at work-bench covering almost a semester (Polytechnic semester is of 4 months' duration).

Physical Facilities

The faculty were satisfied with the accommodation arrangement for teachers made by different organisations during faculty visits/stay at various work-benches. However, due to the location of the work-benches in the far flung areas some faculty (30% in 88 and 40% in 1989) faced transportation difficulties.

As mentioned elsewhere, 10 faculty members supervised over 40 work-benches during each of the Experiments - II and III. Thus faculty was not able to give 100% attention to every work-bench. In this context, 80% faculty in 1988 and 100% in 1989 commented that students would have benefitted more if faculty was available to them during their entire period of training on a regular basis. This observation of faculty is very significant as it goes to further confirm the strength of Practice School based model of Institution-Industry interface.

Honorarium to Students

An attempt was made to provide honorarium to students by industries in both 1988 and 1989. In 1989, two students got honorarium amounting to Rs.600/- and 500/- each for their outstanding performance in Nirmand (Kullu) and Haroli (Una) work-benches.

Problem Identification and Solving:

Some 30% faculty in 1988 and 10% in 1989 identified problems during their stay with industries for inclusion in problem bank at a future date. Further, in their problem solving efforts, 70% and 90% faculty in 1988 and 1989, respectively, were of the opinion that the students had applied systems approach taught in courses at Polytechnic.

Revision of Curriculum

100% faculty were of the opinion that there should be continuous revision of the curriculum. Further, through additional comments under their responses (see below), all the faculty suggested that industrial training should be made an integral part of the curriculum.

Campus Interview

100% faculty in 1988 and 1989, were of the opinion that campus interviews should be a regular feature of Polytechnic calender.

Involvement of Industrial Experts

70% and 90% faculty in 1988 and 1989, respectively, were of the opinion that the involvement of professionals (i.e., work-in-charges) was favourable, and that due to this they were also benefitted.

Industrial Training Refresher Courses for Faculty and Industrial Experts as part time Faculty

100% faculty in 1988 and in 1989 were of the opinion that they should have industrial experience from time to time. Further, they also suggested for themselves referesher courses. Yet another unanimous suggestion was in terms of appointing industrial experts as part-time faculty for teaching at Polytechnic.

Training as a part of Curriculum and separate Training Cell in the Institute

100% training faculty in 1988 and 1989 were of the opinion that work-bench based training should be an integral part of curriculum and that such training will improve the employment opportunity and will improve the institution environment academically and otherwise. 80% faculty in 1988 and 90% in 1989 felt that the faculty should be placed at the work-beneches throughout the training of students. They were also of the opinion that in a work-bench more than one or two students should be given training. 100% faculty were of the opinion that there must be training cell in the institute which should look after the allotment of students, implementation of work-bench-based instruction and evaluation and effectiveness of the training.

Change in Methodology of Training

100% faculty felt that training was very useful, but its methodology should be changed (response to Question No.24). They felt that the work-benches should remain operative throughout the year; the training should be in two semesters; and its evaluation should be included in certificates at the time of awarding diploma.

Thus it can be seen that, though this research was a single handed effort, even then the experience gained by students and faculty, in improvements in the routine working of Institute, reflects that this training is a must during the diploma course.

6.4 Industrial Feed back: Analysis and Results

Questionnaire in Appendix 10 gives factors or items for which industry feed back was sought in regard to design of the experiments. The Table below shows the analysis of responses to this questionnaire.

Table - 6.4.1

Work-bench Incharge Responses on the Performance of Practice School based Training

S.No.	Activities	Favourable Percentage	
		Total work benches in 1988 - 44	Total work benches in 1989 - 48
1.	2.	3.	4.
1.	Students Placement	75%	83.33%
2.	Existing facilities		
	i) Accommodation		
	a) Faculty	90.9%	87.5%
	b) Students	00.0%	00.0%
	ii) Transportation	11.36%	16.66%
	iii) Infrastructure facilities	95.45%	91.66%
	iv) Pocket allowance	00.0%	00.0%
	v) Subsidised canteen	13.63%	14.58%
	vi) TA for field trip	00.0%	00.0%
3.	Training Period		
	i) 3 weeks in 1988 and 5 weeks in 1989	27.28%	20.84%
	ii) Suggested duration of 3 months	72.72%	79.16%
4.	Faculty placement throughout year	90.9%	87.5%
5.	Payment of Honorarium to students	00.0%	4.16%
6.	Adverse effect on production	00.0%	00.0%
7.	Problems solved by students	84.09%	89.58%

Table - 6.4.1

Work-bench Incharge Responses on the Performance of Practice School based Training

S.No.	Activities	Favourable Percentage	
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	i) Accommodation		
	a) Faculty	90.9%	87.5%
	b) Students	00.0%	00.0%
	ii) Transportation	11.36%	16.66%
	iii) Infrastructure facilities	95.45%	91.66%
	iv) Pocket allowance	00.0%	00.0%
	v) Subsidised canteen	13.63%	14.58%
	vi) TA for field trip	00.0%	00.0%
3.	Training Period		
	i) 3 weeks in 1988 and 5 weeks in 1989	27.28%	20.84%
	ii) Suggested duration of 3 months	72.72%	79.16%
4.	Faculty placement throughout year	90.9%	87.5%
5.	Payment of Honorarium to students	00.0%	4.16%
6.	Adverse effect on production	00.0%	00.0%
7.	Problems solved by students	84.09%	89.58%

8.	Faculty cooperation in solving problems	90.90%	87.5%
9.	Lack of knowledge of students in problem solving	27.27%	20.83%
10.	Improvement in working condition	79.54%	89.58%
11.	Preference of consultancy from institute	93.18%	93.75%
12.	Students discipline during training	88.63%	95.83%
13.	Reducing of wastage	65.9%	64.58%
14.	Refresher course in polytechnics	88.63%	87.5%
15.	Award of diploma after industrial training	90.0%	95.83%
16.	Association for papersetting and conduct of practicals	88.63%	87.5%
17.	Holding of campus interview	9.09%	10.4%
18.	Curriculum revision with changing technology required	100%	100%
19.	Development of entrepreneurial skill	100%	100%
20.	Improvement in employment opportunity	100%	100%
21.	Preference to the trained student in employment	100%	100%
22.	Overall impression about training	100%	100%
23.	Additional problem given	31.8%	66.66%

In what follows, this section gives discussion on results of this analysis.

Placement of Students

From the feed back from industries (Table 6.4.1), it appears that 75% work-bench incharges in 1988 and 83.33% in 1989 were satisfied with the allotment procedure of students. The remaining work-bench incharges could not get the allotment letters of the students well in time. However, when the students reported to them, they allowed them to join pending receipt of allotment letters. Thus, it can be seen that work-bench incharges were in agreement with the allotment procedure and appreciative of minor organisational limitations while being co-operative.

Physical Facilities

About 90% of the work-benches had the facility of accommodation for faculty. No accommodation facility was available for the students. Transportation facility was, in most of the cases, not available for the students and for the faculty. Only Himachal Road Transport Corporation, Hindustan Machine Tools, Pinjore and National Fertilizer Limited, Nangal provided the transport facility. No pocket allowance was given to students by industry except in the Experiment III where pocket allowance was basically in the form of honorarium for good performance.

Training Period

Majority of the industries (about 80%) have stated that the duration of training should be increased from 3 weeks to a minimum of 3 months.

Placement of Faculty

About 90% of the work-bench incharges felt that the faculty should remain present throughout the training period of the students for guidance and supervision of students.

Honorarium to Students and Effect on Production

In 1988 no student got the honorarium but in 1989, 4.16% students were given the honorarium. All the incharges of training places mentioned that the training did not have any adverse effect on the production.

Solution of Problem

84.09% work incharges in 1988 and 89.58% in 1989, responded that students had solved the problems assigned to them and that these students were given certificates by the industries.

27.27% work-bench incharges in 1988 and 20.83% in 1989 pointed that the students, when joined, were lacking in the desired knowledge for problem-solving.

Improvements at Work-benches

79.54% work-bench incharges in 1988 and 89.58% in 1989 pointed out that the working conditions inclusive of productivity aspects of the work-benches improved due to implementation of problem solutions given by students. Further, 65.9% in 1988 and 64.58% work-bench incharges in 1989 pointed out that this training helped in reducing the wastage.

Consultancy from Institute

93.12% and 93.75% work-bench incharges showed their eagerness to have consultancy from the faculty of the Polytechnic.

Students Discipline

88.63% work-bench incharges in 1988 and 95.83% in 1989 pointed out that the students were regular, hardworking and observed discipline during the training period.

Award of Diploma

90.9% work-bench incharges in 1988 and 95.83% in 1989 felt Diploma requirement should have industrial training as its integral component. Further, they also felt that experts from Industries must be associated for the conduct of practicals at the polytechnics.

Campus Interview

Private industries responded positively to the idea of visiting campus regularly for campus interview to recruit passing out students. The Government Department and Undertakings, though they unanimously favoured campus interviews, expressed difficulties in conducting them as recruitment rules do not envisage this recruitment channel for them.

Revision of Curriculum

All the work-bench incharges in 1988 and 1989 pointed out that there was a need for revision of the polytechnic curriculum to include advanced technology. Further, they also opined that such industry based training helped students in developing entrepreneurial skills (so needed at the work-bench).

Preference to the Trained Students under Practice School for Employment

100% work-bench incharges indicated that they would give preference to the students, trained at work-benches at the time of recruitment resulting in improved employment opportunity for the so trained students.

Additional Effort by Work-incharges to make Programme Meaningful

31.8% work-bench incharges in 1988 and 66.66% in 1989 assigned new problems to the students who completed their initial problems thereby ensuring the educational rigour.

Overall Impression

All the work bench incharges of 1988 and 1989 expressed their satisfaction with the manner in which the training of students was organised.

6.5 Internal Consistency & Correlations of Examination components for Work-bench based Student Involvement

Analysis of Experiments so far has concentrated on analysis and discussion on results of feed back responses of different constituencies of the experiments conducted linking polytechnic education and industry. However, for the completion of investigation on validity of any such educational experiments, it is important to study internal consistency and correlations for examination components designed and implemented in the context.

As already explained in sub section 4.5.4.2, the examination under three experiments was conducted through evaluation components of Quiz, Seminar, Viva, Group discussion, Project report, Observation and Diary. Of course, as described through sub sections 5.5.7, 5.6.4, and 5.7.3, these evaluation components were held at either of the locations, namely, work-site or the Institute, depending on the convenience of the experiments. Thus, for Experiment group discussion, seminar, viva and observation were conducted at site, the project report was assessed at the Institute. Against this, for the Experiments-II and III, evaluation components of quiz, group discussion and observation were held at site, while components of seminar/viva, project report and diary were conducted at the Institution. This inability to conduct all the examinations at the work sites itself could be considered to be a limitation of the experiments. As can be appreciated, this limitation was due to lack of availability of proper calander time and facilities for such educational experiment right within the academic Time Table of the Polytechnic education.

The faculty and the work-bench incharges participated in assessing students through above mentioned instruments of evaluation consistent with the evaluation matrix given in Table 5.5.6.1. Thus, as can be seen, for the purpose of evaluation matrix marks of seminar and viva were combined, thereby leaving a total of six evaluation matrix. Within the above mentioned limitation of conduct of these instruments of assessment, work incharges and teachers assessed the students accordingly and the students' performance, thus available was used as measure of their academic achievement.

To study the reliability of the students' assessment procedure so designed, the students' assessments through Experiments I,II and III were, then, analysed for the internal consistency of the examination and for correlations between different evaluation pairs. Below are given results of this analysis;

a) Students' performance under Experiments II and III was assessed in terms of evaluation components of Quiz (15% marks), Seminar/viva(25%), Group discussion (15%), Project Report (25%), Observation (15%), and Diary (5%), making the total examination of 100 marks as described through Evaluation Matrix 5.5.6.1. These students' performances for summer 1988 and summer 1989 were analysed for reliability of evaluation matrix using the two way Analysis of Variance (AOV) formula given below:

If n = no. of parameters

N = no. of students

C_1 = Sum of column scoring of students

S_1 = Sum of the row scoring of students

and $C = C_1 + C_2 + C_3 + \text{-----} + C_n$

$S = S_1 + S_2 + S_3 + \text{----} + S_n$

then $SE = \dfrac{S_1^2 + S_2^2 + \cdots + S_n^2}{n} - \dfrac{S^2}{nN}$

$SI = \dfrac{C_1^2 + C_2^2 + C_3^2 + \cdots + C_n^2}{N} - \dfrac{S^2}{nN}$

$TSS = \sum X_{ij}^2 - \dfrac{S^2}{nN}$

$RSS = TSS - SI - SE$

and $R = 1 - \dfrac{RSS}{SE(n-1)}$

Where xij = Score obtained by ith student in jth item.

R = Value of the internal consistency.

TSS = Total sum of squares

SI = Sum of Squares for items

SE = Sum of squares for students

RSS = Remainder sum of squares

When analysed as above, it emerged that student's evaluation for the Experiment - II conducted in Summer 1988 had the internal consistency (R) value of 0.899, while the corresponding figure for the Experiment III conducted in Summer 1989 was 0.812.

This shows that the evaluation matrix presented here has a good reliability.

(b) The above mentioned six evaluation components were also studied for correlations between different pairs. This study was done for all the three experiments and the correlation formulae used as follows:

Co-efficient of Correlation (r)

$$r = \frac{\Sigma x\ y}{N\ \sigma x\ \ \sigma y}$$

Where x = deviation of any x score from the mean in test X.

y = deviation of any y score from the mean in test Y.

σx, σy, - Standard deviation of x & y

N = Number of Examinees.

The correlations so studied for different pairs of evaluation are given in Table 6.5.1. As can be seen from the Table, for each pair correlation was obtained for each experiment and the average correlation is also reported in the Table alongwith respective values of correlations for different experiments.

Table - 6.5.1

Correlations among various Evaluation components for the years 1987, 1988 and 1989

Year	Activities	Quiz	Seminar/ Viva	Group dis-cussion	Project report	Observ-ations	Diary
1987	Quiz	1					
1988		1					
1989		1					
Av.		1					
1987	Seminar/	.6361	1				
1988	Viva	·70	1				
1989		.7466	1				
Av.		.69	1				
1987	Group	.7276	.5190	1			
1988	discu-	.59	.70	1			
1989	ssion	.5265	.4963	1			
Av.		.62	.57	1			
1987	Project	.00	.1823	-.2353	1		
1988	report	.72	.83	.69	1		
1989		.6168	.6448	.3982	1		
Av.		.45	.55	.28	1		
1987	Obser-	.3905	.7153	.5999	-.3473	1	
1988	vation	.47	.63	.68	.61	1	
1989		.3112	.4253	.5078	.1316	1	
Av.		.4	.59	.596	.13	1	
1987	Diary	.3015	.4359	.3656	-.0732	.5103	1
1988		.53	.62	.72	.59	.68	1
1989		.1525	.3163	.3174	-.1325	.7159	1
Av.		.328	.46	.468	.13	.63	1

Av. = Average

From this study consisting of 45 correlations, it emerges that, in all, four co-relations were negative, one correlation came out to be zero and 40 correlations were formed to be positive. Specifically, the highest average correlation was formed to be for the pair of Seminar/viva and Quiz (0.69), followed by Evaluation pair of diary and observation (0.63), group discussion and Quiz (0.62), observation and group discussion (0.596), observation and Seminar/viva (0.59), and group discussion and Seminar/viva (0.57), in that order. Minimum average correlation was formed for the pairs of observation and project report and project report and diary.

Further, the evaluation component of Seminar/viva above demonstrated all positive correlations with all other evaluation components with satisfactory correlation values in all cases ranging from minimum of 0.46 with diary to maximum of 0.69 with Quiz. Its correlation with other components of group discussion, project report and observation were 0.57, 0.55 and 0.59, respectively.

Finally, evaluation component of project report, interestingly, contributed to all negative correlations that were obtained through experiments. That observation and diary should give a satisfactory correlation and that project report should demonstrate negative correlations in a very revealing observation emerging through this study, thereby suggesting the kind of deficiencies in the context of training of an entrepreneurial learner force which would have to be surmounted. 6.6

6.6 Observations

The analysis and results of the feed back obtained from the students, faculty and work-bench incharges, and also the reliability of the evaluation system as discussed above, confirm that through the Practice School system of education, it is possible to integrate the Polytechnic educational process with that of the World of Work. In this regard the following observations emerge:

(i) An educational design of Polytechnic-industry linkage should extensively keep in mind parent's views and aspirations for the success of educational endeavour.

(ii) Choice of the work benches be mainly governed by availability of challenging problems, new learning opportunities and possibilities of future career that they can offer to students.

(iii) The question of reputation of the host organisation is less significant from the student point of view in comparision to factors mentioned under (ii) above.

(iv) The factors of facilities provided at the work bench and nearness of the work bench to the place of stay are of least significance from the students' angle in terms of selecting work bench.

(v) Observations under (iii) and (iv) above suggest that the central issue, therefore, even from the point of view of students is not so much the physical convenience, but opportunity for better learning and for better career.

(vi) The faculty response clearly brings out their perception that for beneficial institution-industry interface, the curriculum will have to be restructured. This restructuring will need to come in two fold manner: firstly, in terms of providing for a regular time slot (may be at least a semester long) in the curriculum during which students and faculty could attend work benches for Practice School based training and, secondly, in terms of introduction of new courses aiming at improved analytical understanding and new technologies. This, in turn, then, validates an approach to the Polytechnic curriculum design under PS system as explained through sub-sections 3.7.1 to 3.7.7.

(vii) To elaborate above observation further, it is interesting to note that faculty response has whole heartedly endorsed the need for their full time presence during student involvement at sites. Further, feed back from work incharges has also clearly brought out the utility of teacher's presence alongwith students to properly monitor the education at site.

This emphatically goes to validate and confirm the requirement of Practice School system of education for teacher's presence at site during training. Indeed, it is this feature alongwith concept of student's involvement in open ended problems at sites, that distinguishes Practice School system from other models of institution-industry linkages like Sandwich courses, which in spite of every effort have not picked up.

(viii) As regards the question of industry participation, it can be said that the same can be spontaneous and over-whelming once industry appreciates that the very educational process envisaged for student involvement in industry is such that alongwith requirements of education it also aims at aiding the objectives of increased work productivity and technology modernisation at the work place. In this context, the provision of teacher's presence alongwith students to supervise their industrial training, as through the Practice School, goes a long way in winning the confidence of the industry.

(ix) Once the initial ice is broken as mentioned above (between the Polytechnic and the industry), it (industry) then seems to offer complete support to such joint, collaborative educational endeavour by offering its experts in the conduct of education and evaluation by offering physical facilities in terms of accommodation and transportation support to faculty;

working space for students and teachers in industry; library equipment, data processing, stationery and typing facilities for educational requirements; recreation and medical facilities for teachers and students during industrial training period, etc.

(x) From the industry feed back, it clearly emerges that the industry sees for itself a number of advantages in such collaboration with institution. These advantages are in terms of : (a) Availability of students force as an adjunct human resource to accelerate industries' own work tasks, (b) Opportunity for seeing polytechnic teacher as industrial consultant, (c) Possibilities of implementing through the good offices of the teachers present at the work place, continuing education programmes to the advantage of the industrial workers, etc.

(xi) It is appreciated that the educational methodology of PS as suggested through this research extensively depends on validity of procedures for identification of collaborating industries, structuring of problem statements, scheduling of students programme at work places, establishing inter-personnel relations between students, experts from industries and teachers, etc. As one analyses the overall impressions of the students, teachers and work incharges with reference to these procedures (as presented through the experiments conducted), they (procedures) emerge to be valid ones, thereby constituting concrete and viable methodologies for institutionalising the PS education process at Polytechnic level.

(xii) One of the important areas that has normally bothered the educational planners with reference to student and teacher involvement in industry during the educational year is concerning the logistical issues and they basically pertain to the problems of a student's accommodation and transportation, out of pocket expenses, eating facilities, etc. Understandably, managements of institutions are concerned with these requirements whenever they apply their minds to such collaborative education. However, the experiments undertaken through this thesis suggest a line of action in the context. This line of action is basically in terms of entrepreneurial style of functioning, wherein efforts can be made to optimise and network facilities in regards to above that could be mobilised from students' own resources and from overheads that the industrial and educational organisations can share to mutual benefit.

(xiii) As already mentioned above, teachers' role is central in this form of institution-industry linkage as experimented here. When translated into the curricular requirements, this implies that proper identification, implementation and monitoring of open ended industrial projects drawn from work places is central to the success of this form of industry linked education. All this would understandably require a proper manpower base at the institution to organise such as educational system. This organisational base would be in terms of teacher incharge of PS system assisted by a group of teachers with responsibilities for : establishment of work benches for student trainees, continual identification of problems, advance preparation for teachers and students as explained in sub-section (4.5), allotment of students and teachers, optimising and net working infrastructural needs and resources, monitoring the teacher and the student work at industry, monitoring student's assessment, analysing student, teacher and industry feed back, anticipating curricular update need for future improvement, teacher training to preparare them for such kind of education, etc.

(xiv) The above envisages teacher as a project leader-cum-manager, with responsibilities far different from what a normal polytechnic teacher has been required to undertake so far. This, in turn, would require different parameters to assess such a teacher's performance for promotions and rewards, wherein issues of problem solving ability in industry, work consultancy, conducting of programmes for retraining of industrial workers, etc., may constitute a substantial factor.

(xv) An educational methodology as proposed through this research for polytechnic-industry linkage, would provide an obvious link to enable experts from industry to act as visiting or part time faculty in Polytechnics for courses identified in conjunction with them as a Polytechnic teacher interacts with them during student's involvements at work benches. Of course, this may require a new approach to defining teachers' qualifications as in many situations appropriate industrial personnel may have only experience to show and not the formal qualification that one may be accustomed to in educational planning.

(xvi) In validation of any educational design one important aspect pertains to the reliability of examination. Students' involvement at work bench being essentially a team activity, the examination's design proposed through this thesis utilises interactive instruments of student's assessment like, group discussion, seminar, viva, project report, technical diary, etc. It is important to note that the evaluation matrix as suggested through the Table (5.5.6.1) aiming at assessment of students' personality traits has been formed to be internally consistent. However, of course but for the component of seminar/viva all other components demonstrated, even though in extreme minority, cases of negative correlations. This suggests that intensive training of teachers and industrial personnel would have to be undertaken to strengthen such an evaluation design.

(xvii)Finally, all these observations, in turn, lead to the establishment of regenerative character of the model of Polytechnic-industry linkage through PS, as developed and tested through the research undertaken here. This regenerative character is to be seen in terms of ability of this mechanism of education-work linkage to create stakes of students, teachers and industries in implementation and success of this mechanism. This is evident from voluntary participation by students in the experiments undertaken, ultimately resulting in their demanding such an opportunity even in the Summer 1990 when the field experimentation as a part of the research had already been concluded; this is evident from the response and participation of teachers and by their realising that this would aid the student's education as also their own upgrading; and this is evident from the support as given by the industry, wherein it not only participated in education and gave facility, but also offered, though extremely limited number, honorarium for students during educational years for their contribution through PS base trainings to the well being of the industry, demonstrated increased willingness for holding campus interview for passing out students, requested teachers to play new role as industrial trainer through continuing education, and in selected cases, offered themselves as part time teachers in Polytechnic; thereby showing that if the industry and the polytechnic could come together in such an integrative manner then both could extend their respective activity domains for increased productivity and technology modernisation and for quality education at much reduced costs, while simultaneously giving the industry, the students, the teachers and the polytechnic contributory roles in ensuring a dynamically evolving productivity-manpower matrix of national relevance.

CHAPTER - SEVEN

DESIGN OF A SYSTEM FOR INDUSTRY-INSTITUTE INTERFACE

7.1 Linking Polytechnic with Industry through Practice School based Experimentation

The preceding chapters have attempted to bring out the need, mechanism and outcome of industry-institute interface. The gaps and deficiencies in the industry-institute interface lead to independent functioning of both industry and institute and these do not involve each other in the educational and productive processes. This results in inadequate education in polytechnics and additional training of the technicians in the industry for one or two years. To avoid this, some efforts have been made under polytechnic system by attempting to have educational tours, industrial training of teachers under Quality Improvement Programme, etc., but the expected results could not be achieved.

To overcome this deficiency of industry-institute interface, an educational experiment was designed, planned and conducted as mentioned in Chapters Four and Five. Chapter Six presented the analysis and the results of these experiments and in the process discussed the validity of the PS based educational methodology for establishing polytechnic-industry linkages. In the process as observed through section 6.6, it emerges that such an interface, which at its core has the pedagogy of education-work linkages, is essentially a regenerative synthesis calling for new role for a polytechnic student as an intern and a contributor to industrial productivity during educational years, for a polytechnic teacher as a scientist-teacher-incharge of student project and as work-consultant, and for an industrial expert as a work-incharge-cum-teacher. It is this regenerative character of the linkage methodology as researched through this thesis that firstly requires new curriculum structuring initiatives from the polytechnics, and secondly opens before it, the avenues of growth and educational expansion hitherto unknown.

The chapter six has in detail identified requirements of this curricular restructuring and stated the possibilities thus opening, while simultaneously suggesting various new educational functions in terms of selection of industries for collaboration, allotments of students and teachers to these industries, conducting and monitoring the instruction and examinations at the work-bench, etc., that the polytechnic would thus need to perform. In the process the polytechnic Principal would need to see himself and his institution in the role of an educational entrepreneur with his institution having large number of learning centres distributed at industrial field centres, and thereby the polytechnic operating itself as a training centre for learner entrepreneurs and as repository of continually evolving data base on industrial needs for technology and manpower update which, in turn, could provide on immediate basis a feed back for updating the technician curriculum and on long term basis grass root level feed back for the very national manpower and Science and Technology planning process.

Figure 7.1.1 presents a conceptual schematic of a Polytechnic-Industry Interface Design that could thus emerge within above framework. It is the management of this system design that would, then, be the concrete requirement of the polytechnic for which it would need to develop teacher-managers and structure of educational administration. As can be seen from the figure, this conceptual schematic has been divided into three broad areas, namely, polytechnic representing the world of education, industry representing the world of work, and the basic organisational structures for the interface between these two. Each of these areas has been further divided into functional sub areas, that go to make the total interface design. In the remaining part of this Chapter, these three broad areas and their sub areas have been described in detail.

7.2 Descriptions of the Three Broad Areas of the Schematic

7.2.1 Area-A: World of Education

This pertains to polytechnic educational system. Thus, as can be seen from the schematic, it has three sub areas, namely,

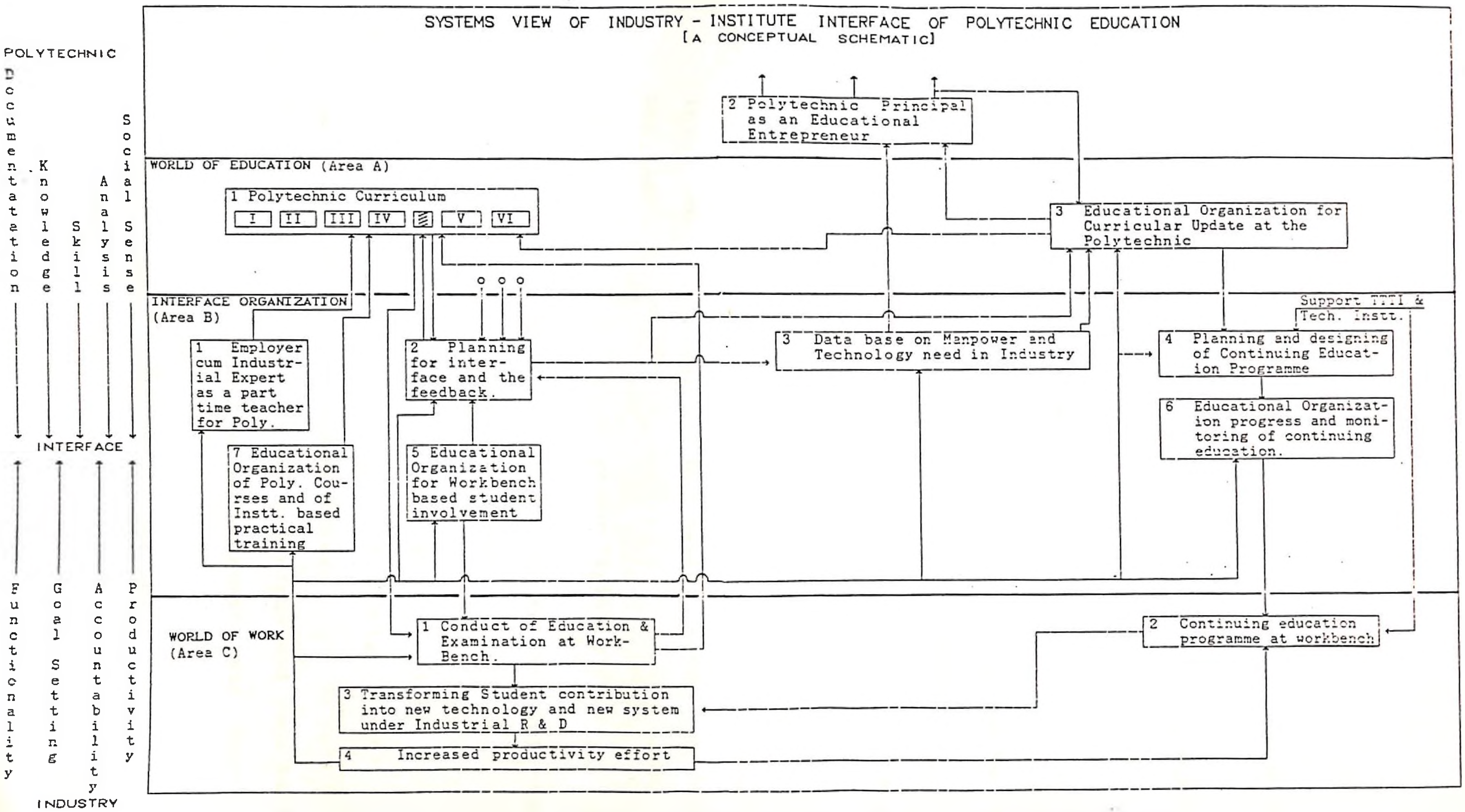

FIGURE 7.1.1 : A CONCEPTUAL SCHEMATIC OF A POLYTECHNIC - INDUSTRY INTERFACE DESIGN

(1) Sub Area (A-1): Polytechnic curriculum,

(2) Sub Area (A-2): Polytechnic Principal as an educational entrepreneur, and

(3) Sub Area (A-3): The curriculum development organisation at the Polytechnic.

7.2.2 Area-C: World of Work

This area concerns the industry. Thus, as can be seen from the schematic, it has four sub areas, namely,

(1) Sub Area (C-1): Conduct of education and examination at work bench,

(2) Sub Area (C-2): Continuing education programme,

(3) Sub Area (C-3): Transforming students contributions into new technology and new system under industrial R&D, and

(4) Sub Area (C-4): Increased productivity effort.

7.2.3 Area-B: Organisational Structure for Interfacing Polytechnic and World of Work

This area consists of seven sub areas, namely,

(1) Sub Area (B-1): Employer-cum-industrial expert as a part time teacher for Polytechnic,

(2) Sub Area (B-2): Planning for interface and feed back,

(3) Sub Area (B-3): Data base on manpower and technology need in industry,

(4) Sub Area (B-4): Planning and designing of continuing education programme,

(5) Sub Area (B-5): Educational organisation for work bench based student involvement,

(6) Sub Area (B-6): Educational organisation for progress and monitoring of continuing education, and

(7) Sub Area (B-7): Educational organisation of polytechnic courses and of instructional based practical training.

Thus, this area representing the interface between the world of education and the world of work can be seen as a co-operative management structure at polytechnic to establish linkages between objectives of documentation, knowledge, skill competence, analytical ability, and social sense as pursued by the world of education and the requirements of goal setting, productivity, accountability and functionality of approach, which are hall marks of the world of work.

In what follows, this chapter presents detailed educational designs for each of these sub areas.

7.3 Description of Sub Areas of the Schematic

7.3.1 Sub Area: Polytechnic Curriculum. (Sub Area A-1)

Figure 7.3.1.1 gives a detailed educational design of semesterwise structural needs of Polytechnic education under PS based polytechnic-industry linkage. This sub area presents need for two things; firstly time slot for students and teachers to work in the industries as an integral part of semesterwise structure, and secondly availability of

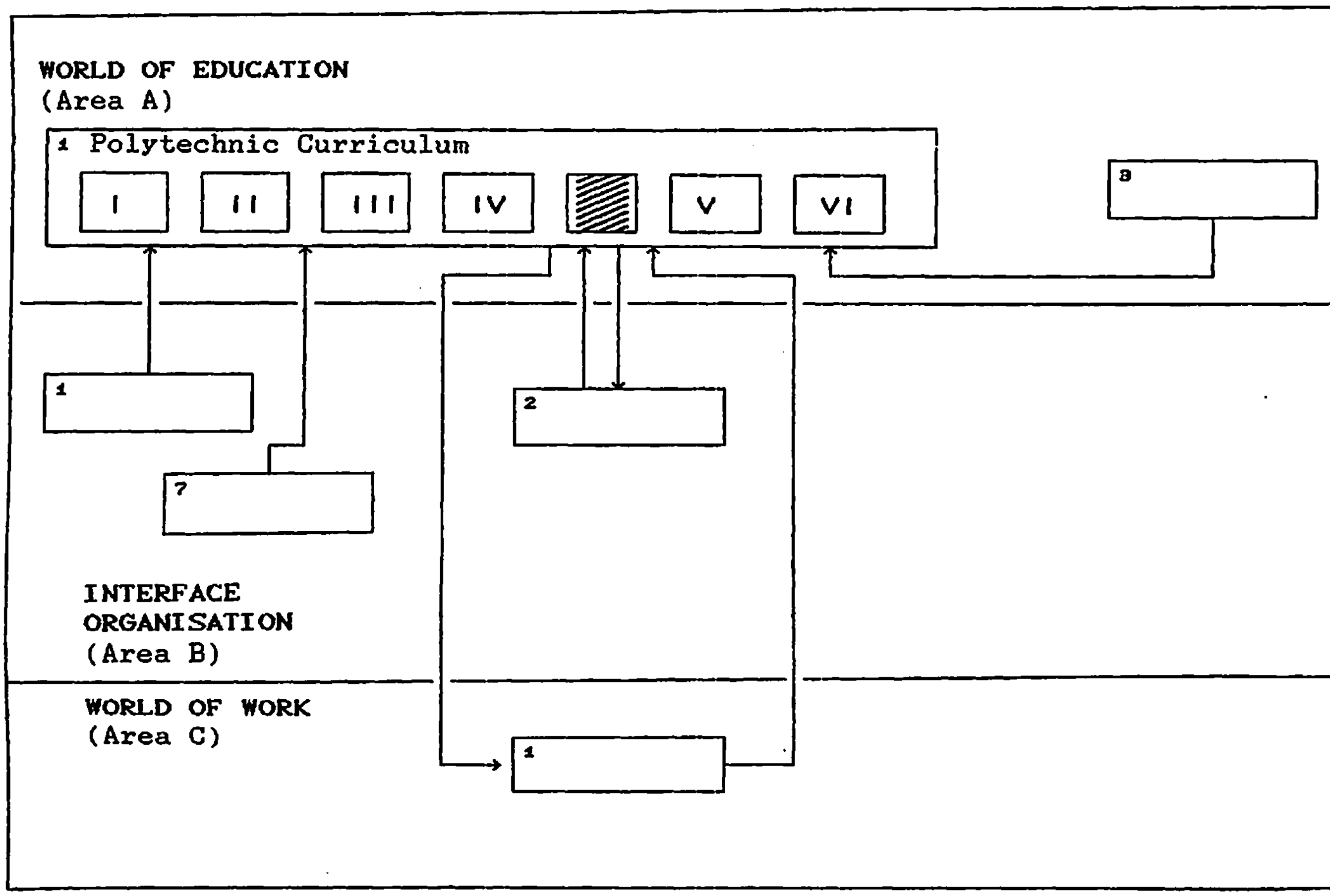

Fig. 7.3.1.1 : Semesterwise Structure of Polytechnic Education (Sub Area A - 1)

courses under, say, electives category wherein employer as part time faculty could come and teach in Polytechnics. Their teaching must lead to the award of marks.

Further, this sub area is connected to sub areas A-3, B-1, B-2, B-7, and C-1. Specifically, from sub area A-3, it would receive inputs with reference to planning, progress and monitoring of the curriculum; from sub area B-1, employer as part time teacher; from sub area B-2, the allotment decisions; from sub area C-1, students who have completed their PS training and returned to the Polytechnic to complete remaining programme requirements, if any; and from sub area B-7, planning and implementation inputs for organising industry oriented elective courses and institution based practical training. Output from this sub area, i.e. from sub area A-1, would be in terms of data base for sub area B-2 to carry out feed back analysis and industry oriented courses and institute based practical training, and in terms student-teacher groups who would join the sub area C-1, as adjunct manpower for employer during Polytechnic education years.

7.3.2 Sub Area : Planning for the Interface and Feed Back (Sub Area B-2)

Figure 7.3.2.1 gives a detailed design for this sub area. As can be seen from the figure, this sub area addresses itself to following activities:

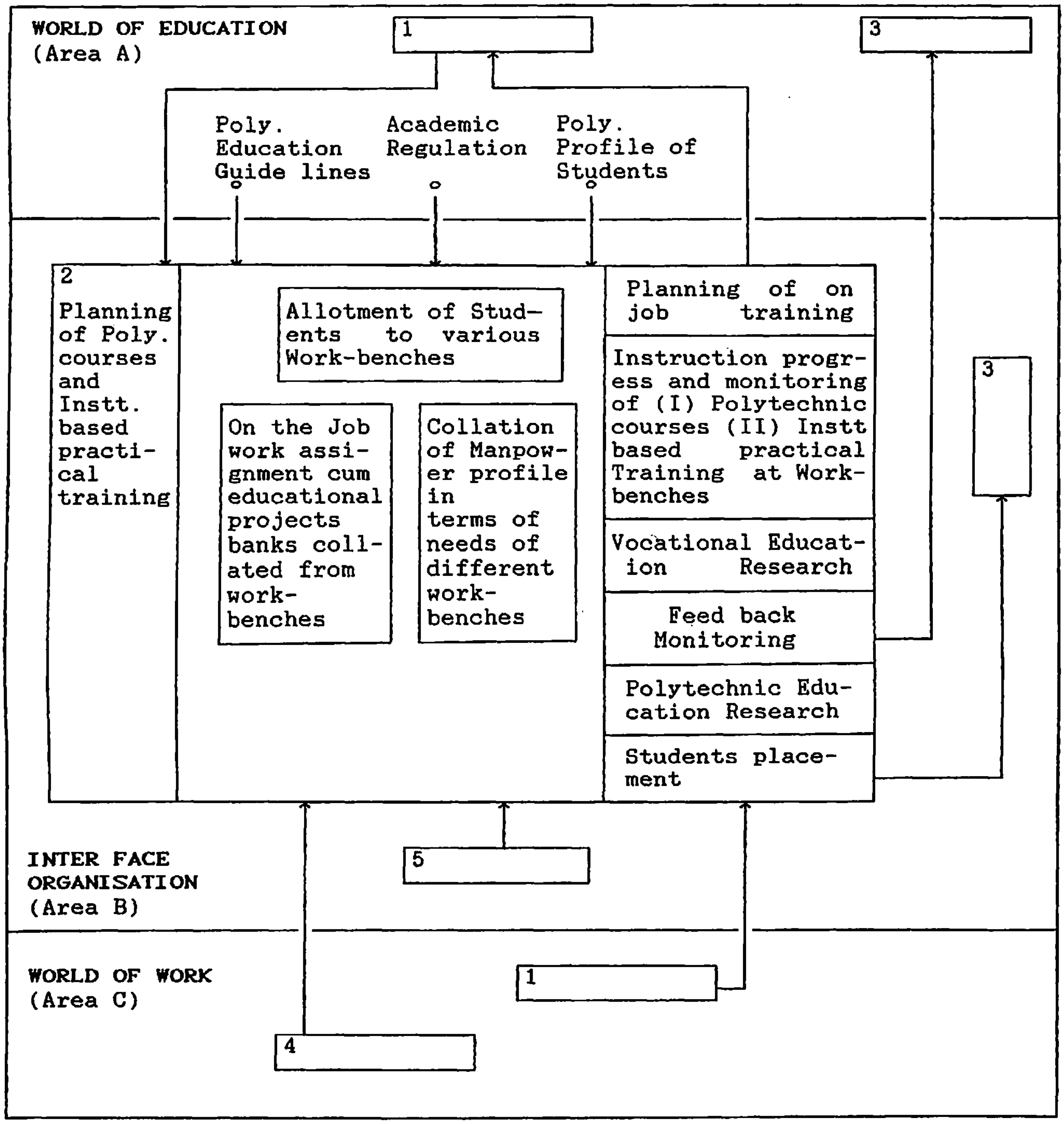

Fig. 7.3.2.1 : **Planning for the Interface and Feed-back (Sub-Area B - 2)**

i) Planning of employment/industry related courses and institution based practical training.

ii) preparation of projects bank collated from work benches.

iii) Collation of manpower profile in terms of need of different work benches.

iv) Allotment of students to various work benches.

v) Planning of on the job training.

vi) Institution progress and monitoring for industry based courses at polytechnic, for institution based practical training and for work-bench based student education.

vii) Educational administration and accounts for the interface.

viii) Feed back monitoring for work-bench based and for industry oriented courses at polytechnic and for institution based practical training.

ix) Educational research on interface design and development.

x) Student placement, i.e. campus interviews.

Specifically, for conducting all these activities, this sub area would receive inputs in terms of details of projects bank identified at work benches (from sub area B-5), details of manpower profile needed by work benches (from sub area B-5), employer availability information for participation in student education (from sub area C-4), feed back on work-bench based courses (from sub area C-1), and feed back on industry related courses and institution based practical training at Polytechnic (from sub area A-1).

As regards the outputs from the sub area B-2, they would be in terms of : information on job specifications and necessary manpower profiles as envisaged by the work-benches (to sub area B-3), student-teacher allotment decisions (to sub area A-1), data base for curriculum development (to sub area A-3) and information on students placement (to sub area B-3).

7.3.3 Sub Area : Educational Organisation for Work-bench based Student Involvement (Sub Area B-5)

Figure 7.3.3.1 gives detailed design for this sub area. Thus, as can be seen from the figure, inputs to this sub area would mainly come from the sub area of C-4 and they would be in terms of information on day-to-day production tasks of the employer and in terms of details pertaining to employer availability in implementation of education at work- bench. Outputs from this sub area would be basically to the sub areas of C-1 and B-2. Specifically, if output to sub area B-2 would be in terms of collation of work bench based problems and information on manpower needs for the same, the outputs for the sub area C-1 would be with reference to design of teaching and student evaluation methods and with reference to performance guide basis for teachers to contribute as work consultant.

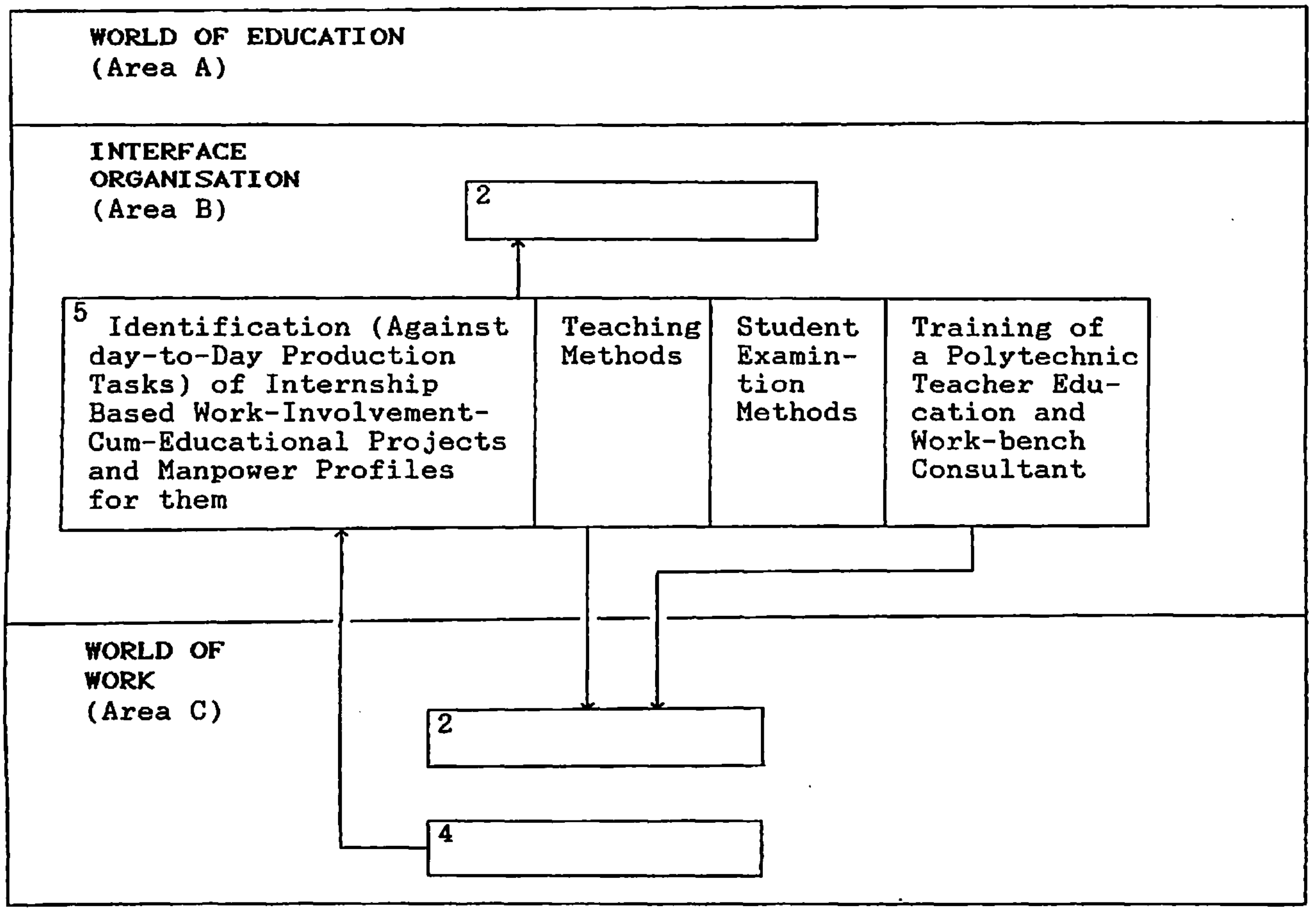

Fig. 7.3.3.1 Educational Organisation for Work-bench based Student Involvement (Sub Area B - 5)

7.3.4 Sub Area : Conduct of Education and Examination at Work-bench (Sub Area C – 1)

Figure 7.3.4.1 gives detailed design for this sub area. Thus, this sub-area of activity would be characterised by following:

i) Students of Polytechnic acting as adjunct manpower for industry during educational years as an integral need of learning process.

ii) Internship-based student learning at the work place.

iii) Student involvement at work places resulting in work output of direct interest to industry.

iv) Feed back from teachers, students and industries on respective educational needs.

v) Innovations in teaching and examination methods for student-centred and industry-oriented education.

7.3.5 Sub Area : Transforming Student Contribution into New Technology and New System under Industrial R & D (Sub Area C-3)

Figure 7.3.5.1 gives detail design of this sub area. Thus, this sub area will have inputs as coming from sub areas of C-1 and C-2, and output going to sub area C-4. More specifically, input from sub area C-1 would be the work out of direct interest to employer for aiming at increased productivity, skill input, systemization and systems

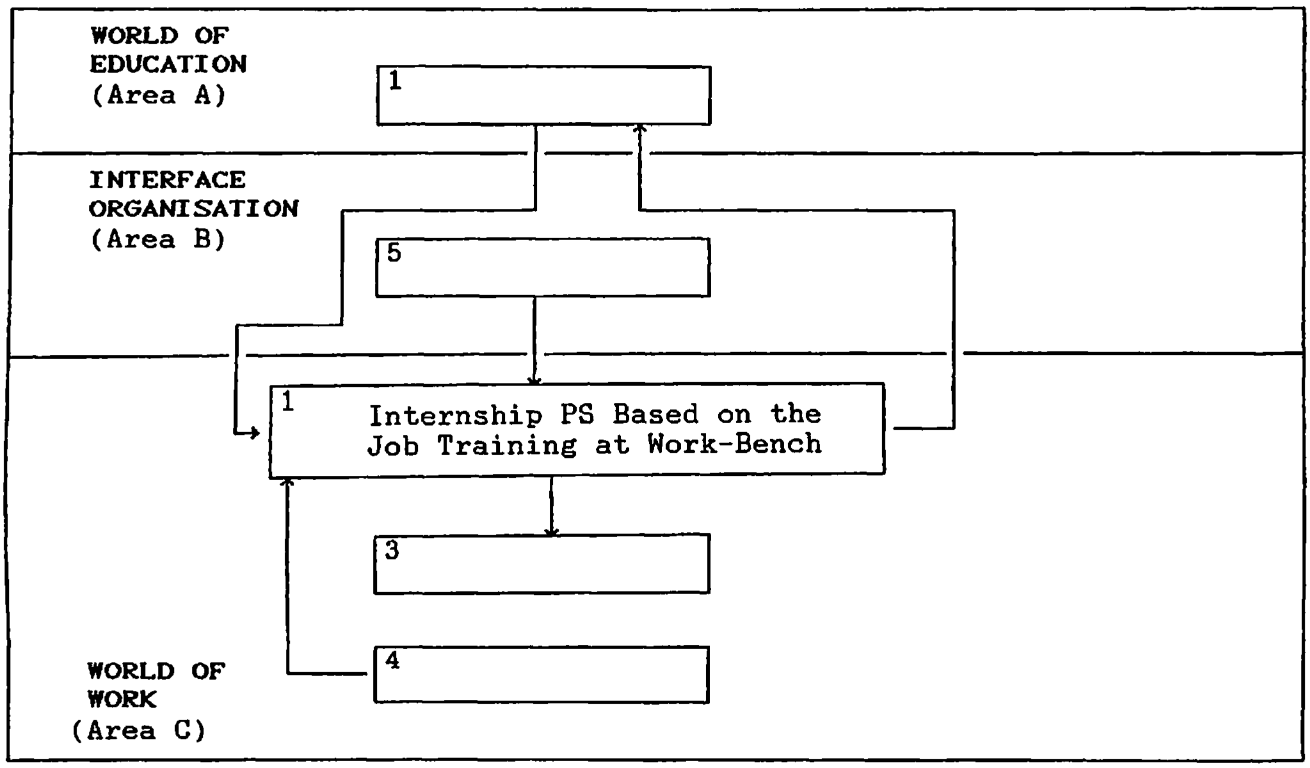

Fig. 7.3.4.1 Conduct of Education and Examination at Work-bench (Sub Area C - 1)

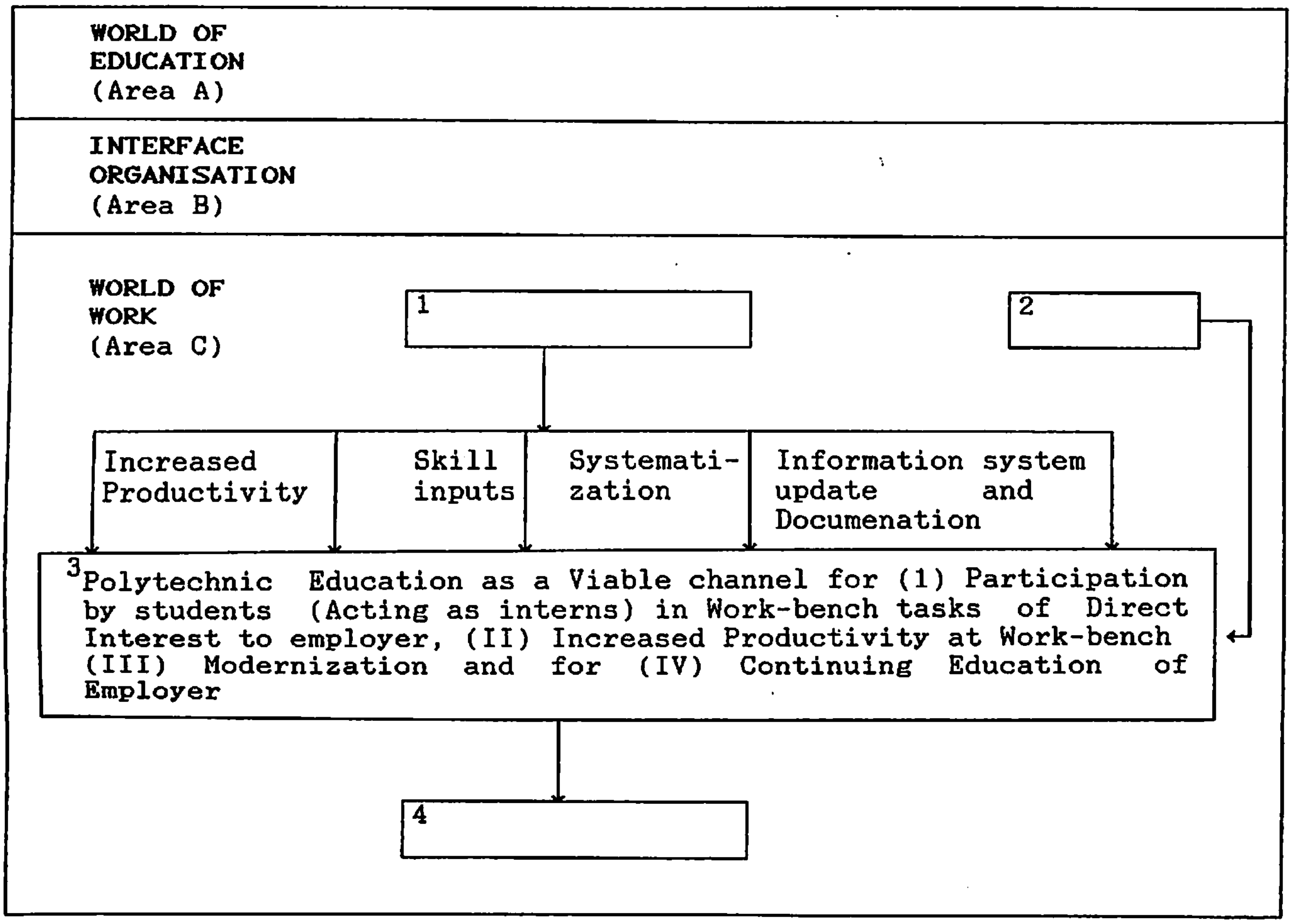

Fig. 7.3.5.1 Transforming Student Contribution into New Technology and New System under Industrial R and D (Sub Area C - 3)

documentation, while the input from sub area C-2 would be in terms of trained employees through continuing education schemes, as inhouse R & D staff. As regards the output from this sub area, it would feed the sub area C-4 and would be in terms of input for increased productivity.

7.3.6 Sub Area : Increased Productivity Effort (Sub Area C-4)

Figure 7.3.6.1 gives detailed design for this sub area. Thus, it receives its input from sub area C-3 which contributes to productivity through increase inhouse R & D. As regards the outputs, all across the interface design, this sub area provides for day to day production tasks from work-benches which in this collaborative endeavour constitutes a basis for structuring and conducting curriculum, and for employer availability to participate in this educational process.

7.3.7 Sub Area : Data base on Manpower and Technology Need in Industry (Sub Area B-3)

Figure 7.3.7.1 gives detailed design for this sub area. Specifically, this sub area aims at generating data base on manpower and technology modernising need at industry, which, in turn, would constitute a basis for evolving an information system at regional and national levels which is continually updatable with reference to :

a) Trends in technology changes at work places and

b) Manpower specifications in the context.

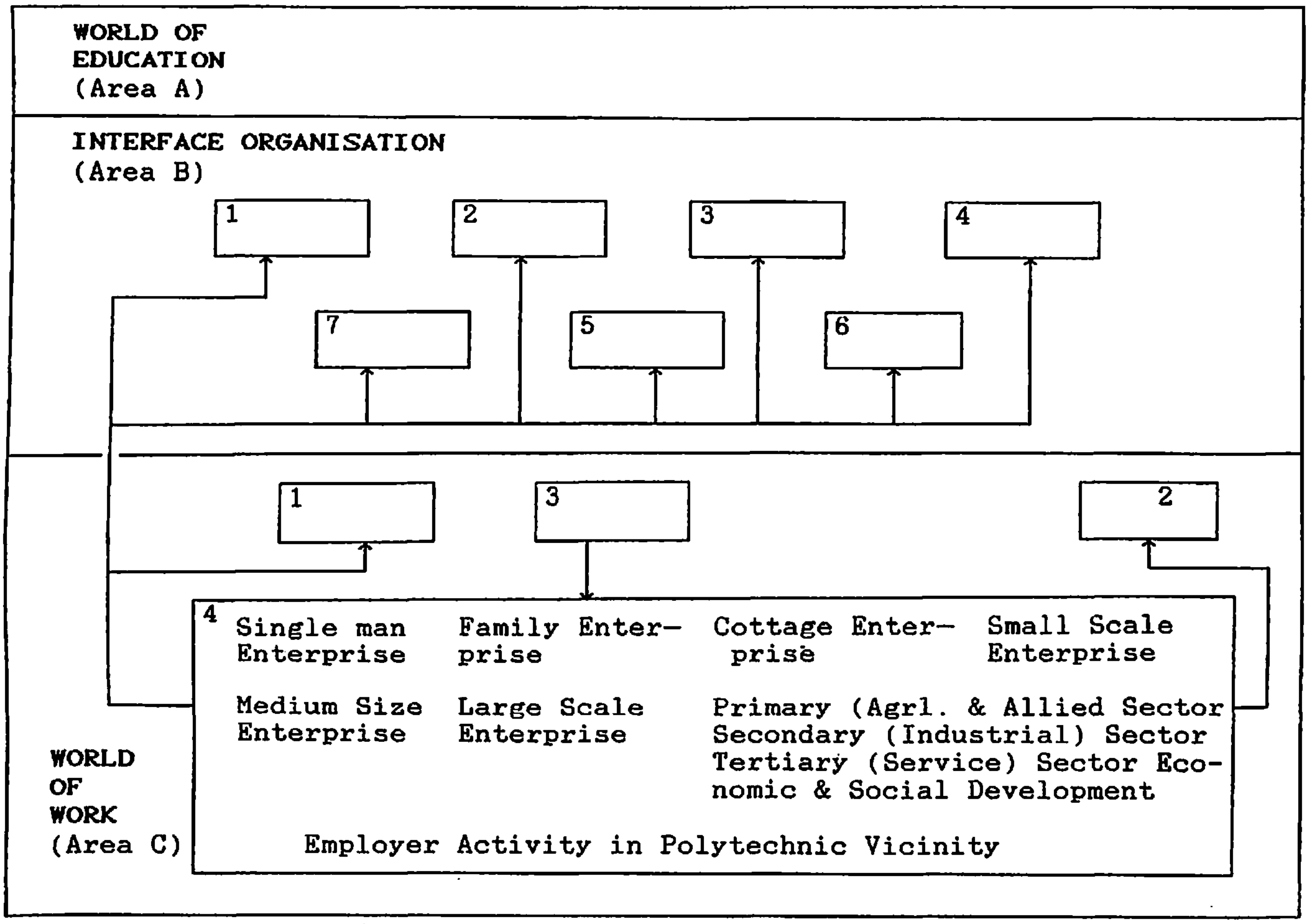

Fig. 7.3.6.1 Design for Increased Productivity Effort (Sub Area C - 4)

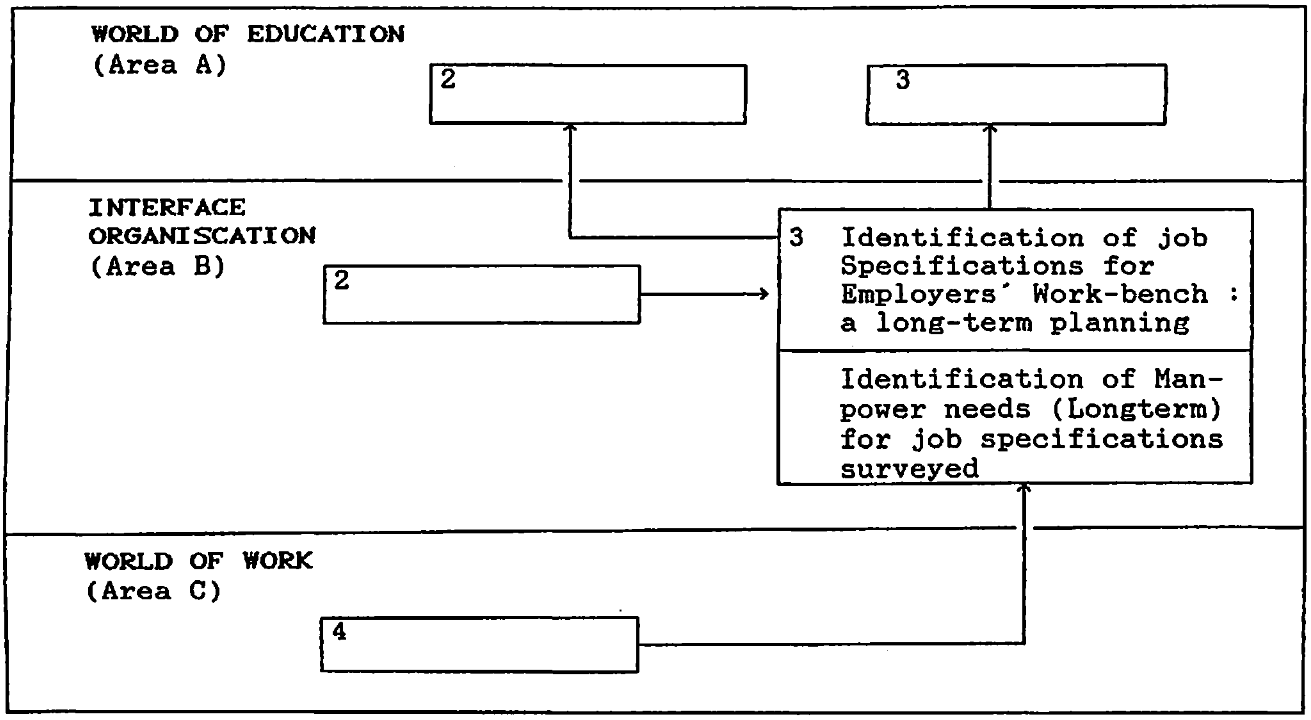

Fig. 7.3.7.1. : Data base on Manpower and Technology Need in Industry (Sub Area B - 3)

7.3.8 Sub Area : Planning and Designing of Continuing Education Programme (Sub Area B-4)

Figure 7.3.8.1 gives detailed design for this area which provides a basis for implementing educational organisation and for conducting continuing education schemes at the work bench. Indeed, possibility of offering continuing education programme for workers at work-benches constitutes a by-product of PS based educational linkage between industry-polytechnic, as such linkage has central to it the presence of teacher at the work bench; who, in turn, provides the much needed input in the context. The sub area under reference refers to various curricular activities for this continuing education, namely,

i) Planning

ii) Instruction

iii) Administration and Accounts

iv) Feed Back

v) Educational Research

In design of these activities, polytechnics should take inputs from TTTI's and engineering institutions.

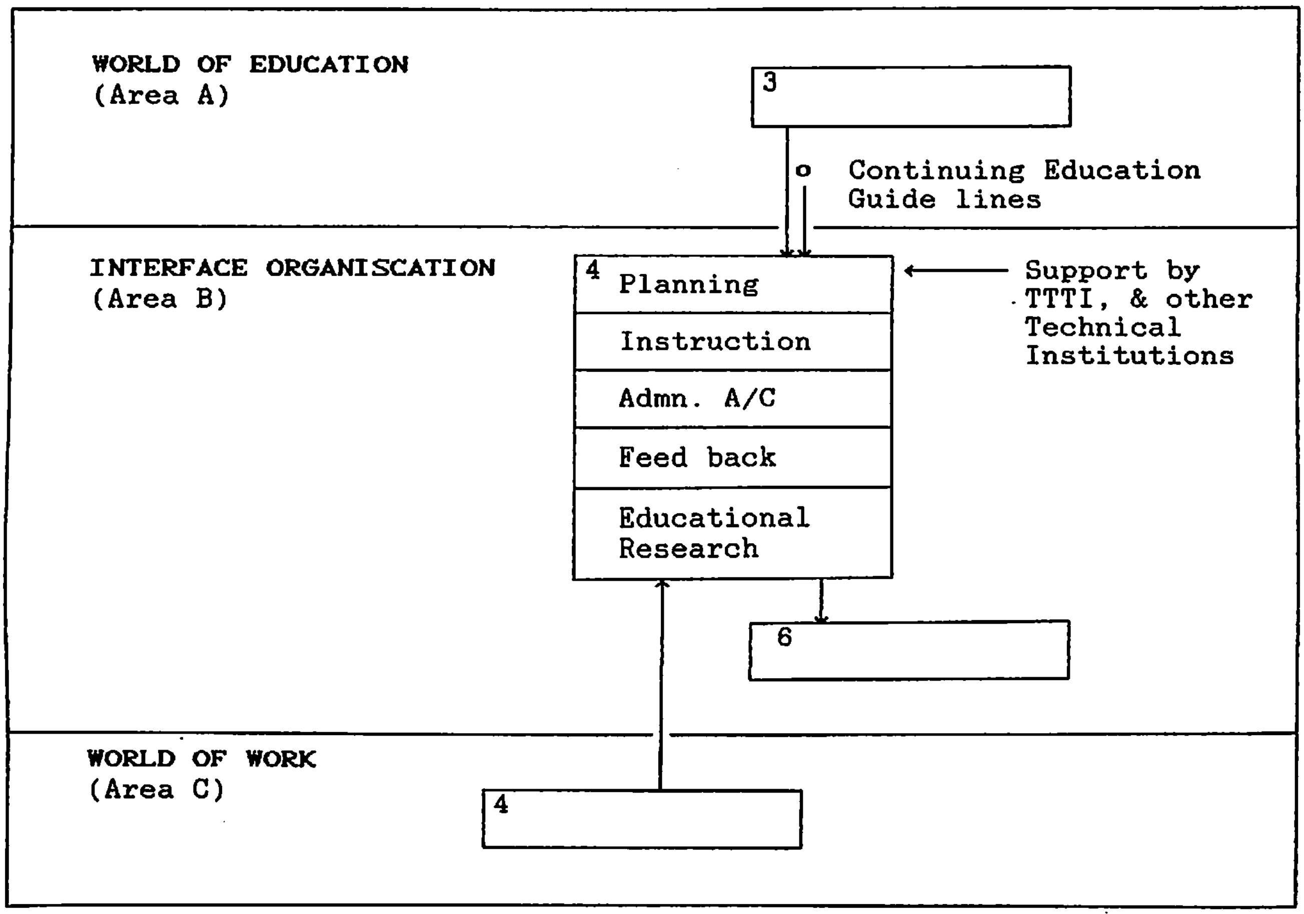

Fig. 7.1.8.1 Planning and Designing of Continuing Education Programme (Sub Area B - 4)

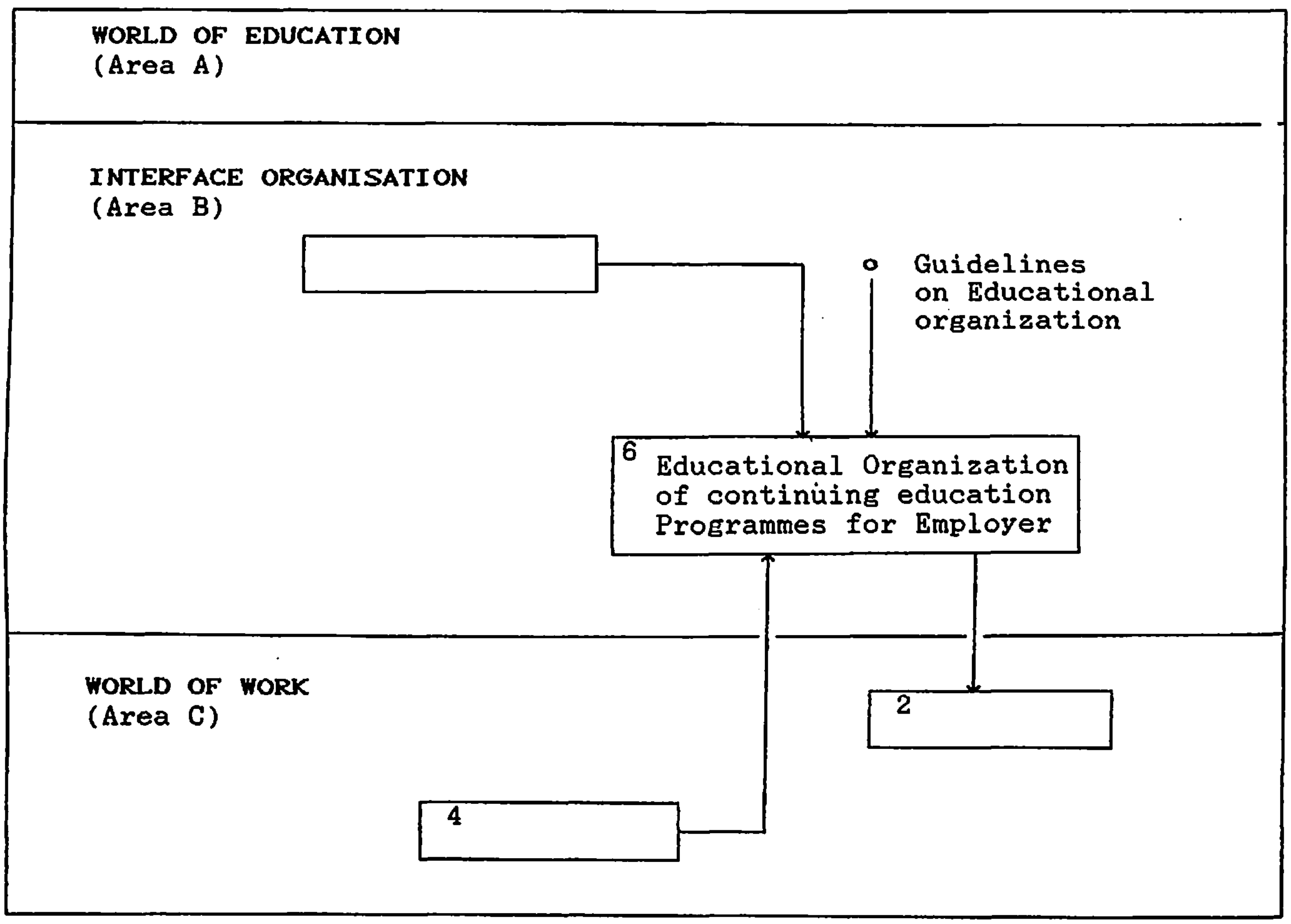

Fig. 7.3.9.1 Education Organisation Programmes and Monitoring of Continuing Education (Sub Area B - 6)

7.3.9 Sub Area : Educational Organisation Progress and Monitoring of Continuing Education (Sub Area B-6)

Figure 7.3.9.1 gives the design details of this sub area. As can be seen, this sub area refers to requirements of personnel management and subsequent organisational structure or implementing the continuing education plan as under sub section 7.3.8.

7.3.10 Sub Area : Continuing Education Programme at Work-bench (Sub Area C-2)

Figure 7.3.10.1 gives design for this sub area. Specifically, this represents implementation of the continuing education programme at the work-bench.

7.3.11 Sub Area : Employer-cum-Industrial Expert as a Part-time Teacher for Polytechnic (Sub Area B-1)

Figure 7.3.11.1 gives design details for this sub area. Specifically, this sub area concerns generating resource base of employers-cum-industrial experts as part-time faculty for teaching of vocational and professional courses at institution.

7.3.12 Sub Area : Educational Organisation for Curriculum Update at the Polytechnic (Sub Area A-3)

Figure 7.3.12.1 gives the design for this sub area. This, specifically, is of great importance as it would introduce feed back mechanism in the curricular organisation at the polytechnic. Activities under this area would, therefore, comprise of :

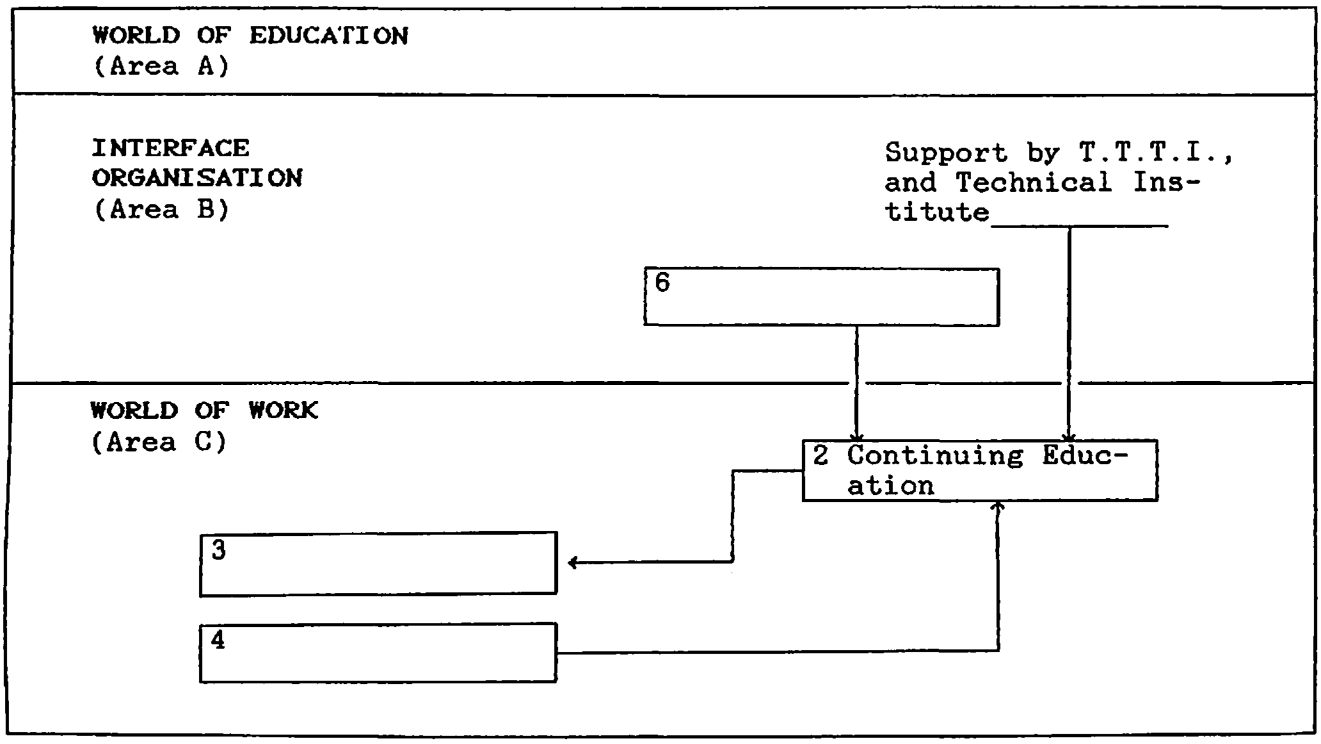

Fig. 7.3.10.1 **Continuing Education Programme at Work-bench (Sub Area C - 2)**

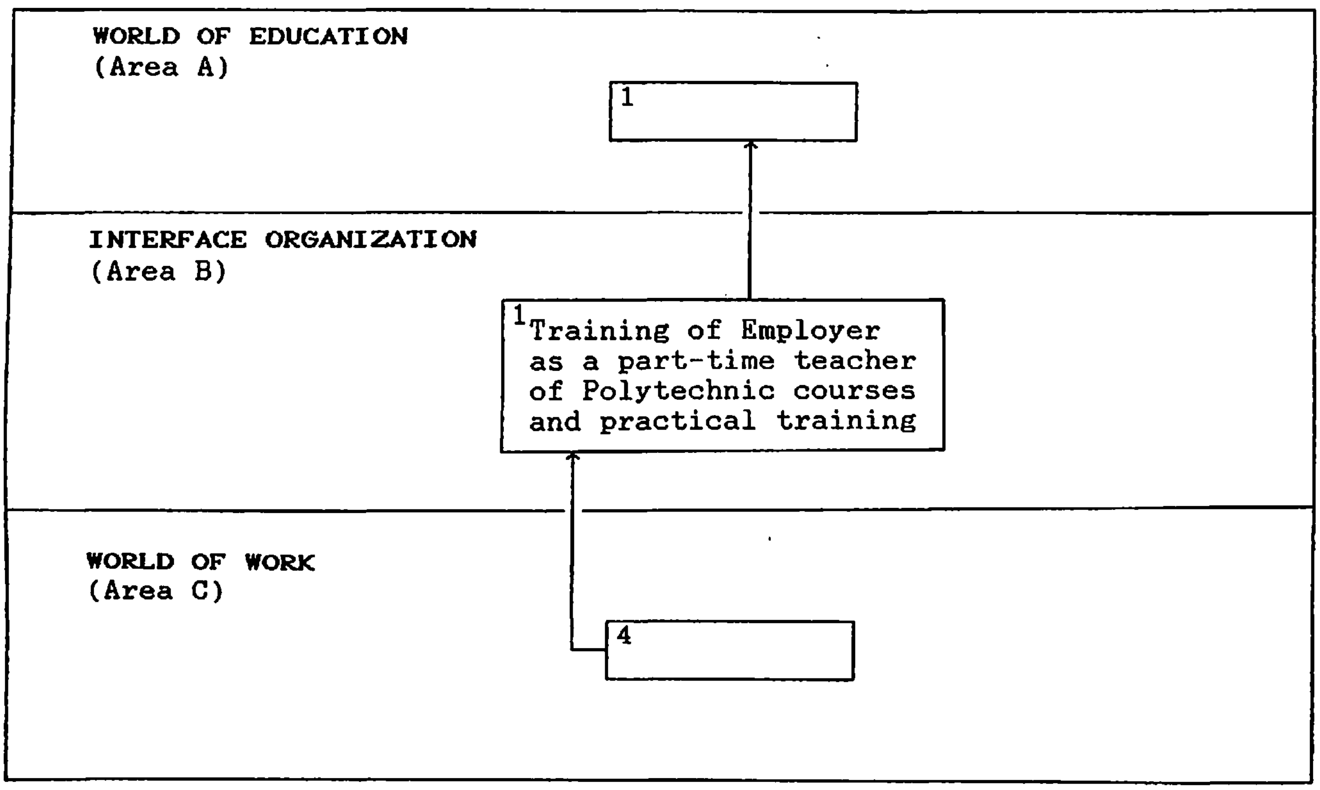

Fig. 7.3.11.1 Employer-cum-Industrial Expert as a Part Time Teacher for Polytechnic (Sub Area B - 1)

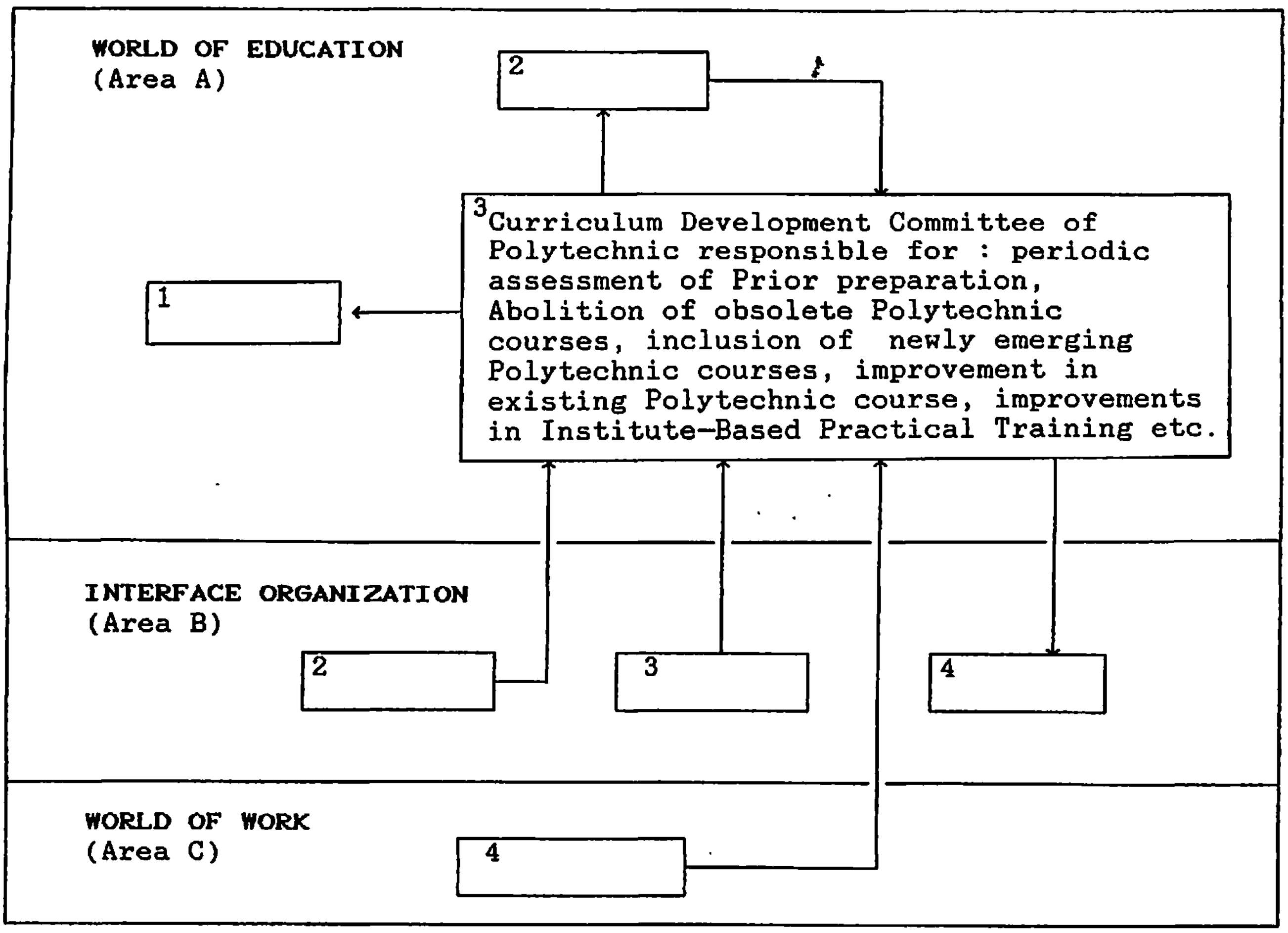

Fig. 7.3.12.1 Educational Organisation for Curriculum Update at the Polytechnic (Sub Area A - 3)

i) periodic assessment of prior preparation for each semester.

Note: educational system visualised here is a flexible one, as it has a concept of semester system characterised by course-wise promotion and offerings of electives. This, in turn, would need prior semester preparation, like proper course offering, teacher and class room scheduling, ensuring proper student preparation for course registration, etc.

ii) Abolition of obsolete courses.

iii) Inclusion of the newly emerging areas.

iv) Improvement in the existing courses.

v) Planning, progress and monitoring of instruction and curriculum.

vi) Information and feed back from work-bench based education.

7.3.13 Sub Area : Educational Organisation of Courses and Instructional-based Practical Training (Sub Area B-7)

Figure 7.3.13.1 gives design details for this sub area B-7. As can be seen, this sub area received its input from sub area C-4 in terms of employer availability to participate in teaching at Polytechnic. The output from this goes to sub area A-1 and is in terms of operational mechanism for conduct of industry-oriented courses and

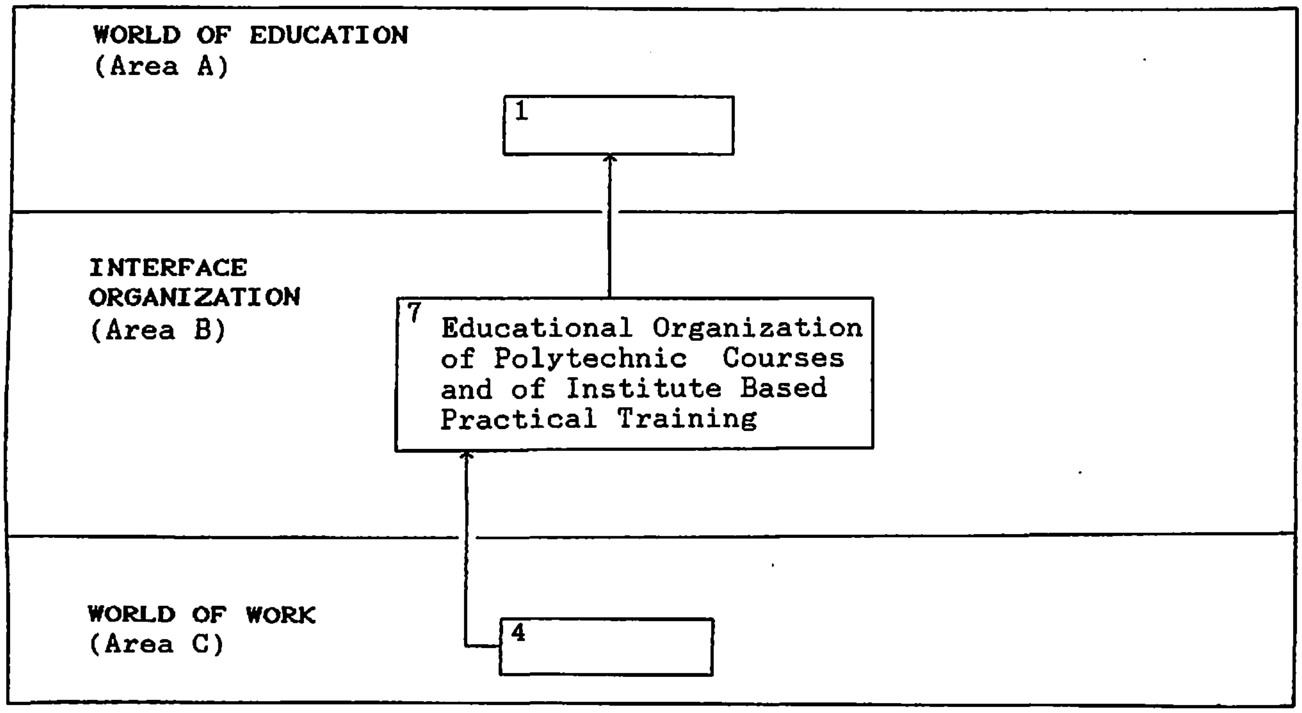

Fig. 7.3.13.1 Educational Organisation of Courses and Instructional-based Practical Training (Sub Area B-7)

institution-based practical training at Polytechnics where employer could contribute as part-time faculty.

7.3.14 Sub Area : Principal as an Educational Entrepreneur (Sub Area A-2)

Figure 7.3.14.1 gives detailed design for this sub area. As polytechnic-interface evolves and operates all above sub areas and their inter-linkages, the Principal of the polytechnic would emerge as an educational entrepreneur with contribution and responsibilities in regard to following three functional objectives:

- Management of content and organisation and operation of educational administration for technician education.

- Generating information base on technician manpower specification.

- Generating information base on job/technology needs at industries.

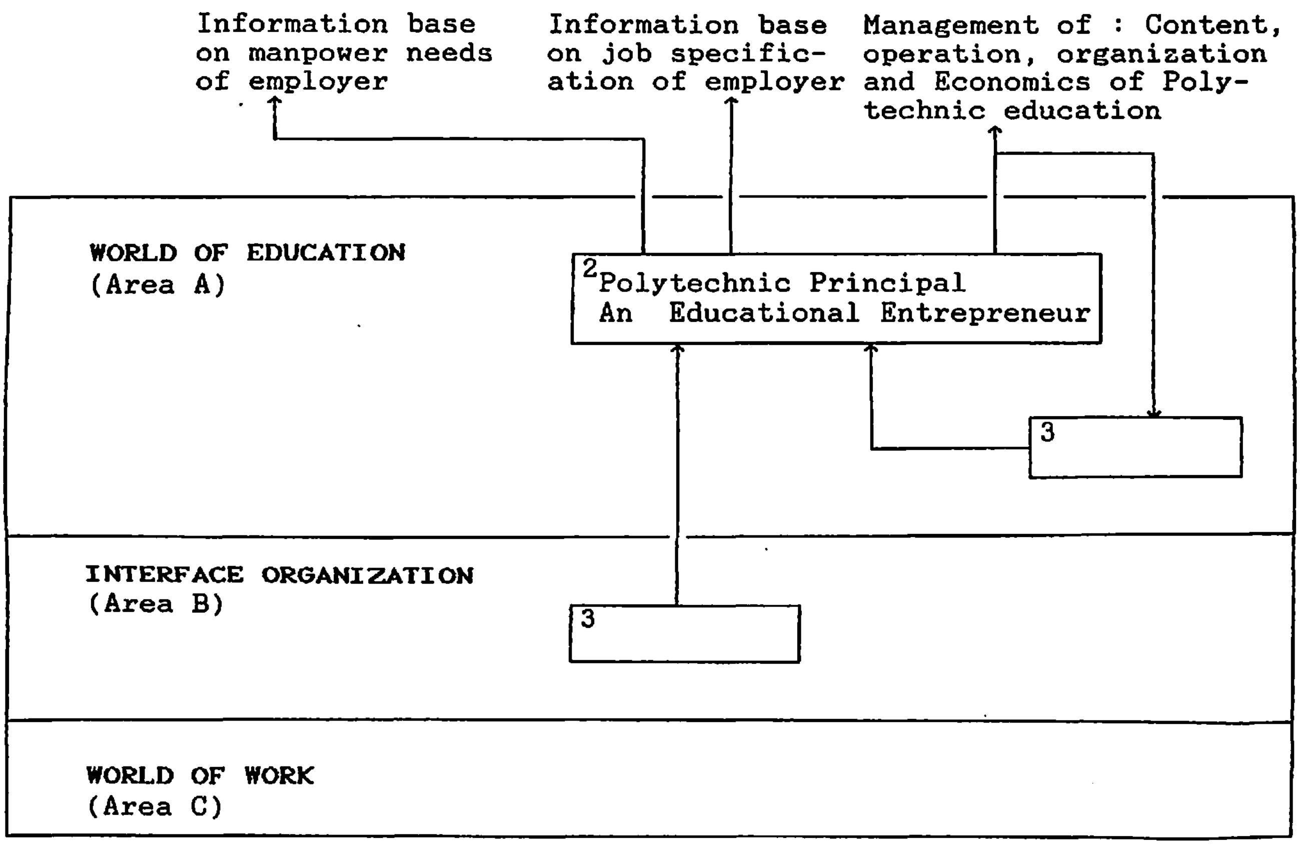

Fig. 7.3.14.1 Principal as an Educational Entrepreneur (Sub Area A - 2)

CHAPTER - EIGHT

CONCLUSIONS

The polytechnic education system, as well as approach to technician education demonstrate inadequacies in fulfilling the changing needs of society. Therefore, there has to be a change in the technician education or, there should be an educational reform by virtue of which the polytechnic education comes closer to industry. In the recent decades, India has made commendable efforts in the growth of industrial sector. To cope up with the demands for technical manpower of industry, technical education has also made phenomenal growth. However, the growth in these two important sectors has been parallel and independent without linkages between the two. Consequently, a considerable degree of distrust on the support expected from each other has crept in. They, quite often, blame each other for various consequential ills. The barriers existing between these two agencies need to be identified and removed. This has also been advocated by various educationists, Education Commissions, etc. But, so far, there are no specific educational experiments at the polytechnics towards meeting this objective. Under the circumstance, the technicians produced by polytechnics lack in entrepreneurial skill and latest developments in science and technology of their discipline.

Thus, this research culminating in design and development of generalised pedagogy results in education mechanism for cooperative education at polytechnic level. The major portion of this thesis focuses on establishing the qualities required in the technicians, the present deficiencies in the polytechnic education system, the need for Institute-Industry interface, choice of educational process for the same, design of educational experiments for testing the model choice, the emerging design, etc.

Specifically, the investigation carried through this thesis has adopted multifarious research techniques ranging from critical study of historical growth processes in development of polytechnic education in India - to administration of questionnaires to teachers, students and industries and subsequent response studies - to assessment of various models available for polytechnic-industry linkages - to choice of models based on pedagogic interpretation - to conduct of field experiments for the model chosen - to analysis of results of experiments, inclusive of reliability and correlation analysis of examinations, - to system design of the interface schematic for the management of institute-industry linkage.

The questionnaires administered have been in two phases. First phase aimed at assessing the perception of teachers on objectives of technician education in regard to what student qualities are needed in life and what qualities Polytechnic education should, can and has achieved in this regard as perceived by the teachers. This was a very revealing analysis while it showed high correlations between what teachers perceived education should, can and has achieved, the teachers' perception about what qualities are needed in life demonstrated poor correlations with all the above three perceptions. Indeed, in some sense, this analysis revolving around cognitive and behavioural objectives of education set the tone for the basic issue of Polytechnic education vis-a-vis its lack of linkages with the world of work that needed the attention and solutions. In all 57 teachers participated in this questionnaire study, which adopted frequency of occurance approach to response study followed by the correlation analysis as mentioned above.

In the second phase of investigation, through questionnaire method, four different questionnaires were addressed to teachers (104 in numbers), final year students of Polytechnic (79 in numbers), passed out students (110 in numbers) and industries (93 in number) i.e. employers. While this questionnaire for teachers had five sections, namely, nature of student input, resource availability, management effectiveness, method of evaluation and quality of students trained, the questionnaire for final year students addressed itself to areas of quality of input (for example, awareness about engineering profession, etc.), educational processes, resources, views on students' competence on completion of Diploma and management of institution.

The questionnaire administered to passed out students required them to give their views about the attainment of positions in various organisations, activities undertaken like research and development, testing and inspection, production, maintenance and servicing, teaching, purchase and sale, management and supervision, effectiveness of teaching and suggestions for improvement, industry-institution collaboration, etc.

As regards the questionnaire addressed to employer group, the same (questionnaire) sought the views of work incharges : (i) On employment potential in large, medium and small scale industries for technician in various functional areas of : R&D, design and drawing, production, management and supervision, repair and maintenance, sales and after sales service, etc; (ii) On the short coming in the performance of technician in the world of work/industries and likely changes in the role of technicians; and (iii) On the involvement of the industries while conducting the diploma courses at the Polytechnics.

Further, the administration of questionnaires under this second phase of investigation was accompanied by personal interviews on the subject of study that the researcher had with all the above constituents of technical education inclusive of Polytechnic Principals, Departments of Technical education and faculty of TTTI's. Without going into the details of responses to these questionnaires, it should suffice to state at this stage of concluding remarks that all the constituencies stated above unequivocally responded to the need for polytechnic-industry linkages for the very health and quality of technician education.

It is at this stage of study that Chapter Three extensively researched educational pedagogy for co-operative teaching-learning and surveyed models available the world over in the context of education work linkages under general, occupational and professional education. The models thus studied were work-observation programme, work-experience programme, work-study programme, internship and co-operative education further represented through sandwich programme (UK) and Practice School (USA). At this stage the Indian scene was also surveyed for efforts to introduce Practical training, Apprenticeship Act and adoption of Sandwich programme from the UK and of Practice School from the USA.

When these models were assessed for their pedagogic implications, the Practice School emerged as the correct choice for Polytechnic-Industry linkages due to its education being based on student participation in open-ended problem solving involvement at the work-bench and this process of education being fully teacher-centred, thereby offering possibilities for this form of industry-based programme becoming an integral part of Polytechnic teaching.

This choice of model was, then, followed by the three experiments that the researcher conducted in December, 1987, Summer, 1988 and Summer, 1989 when students and teachers of Sundernagar Polytechnic coming from across disciplines and a large number of industries participated in a joint education endeavour on strictly voluntary basis. In all, 12 students, one industry and two teachers were involved in first experiment, while around 74 students, over 40 work-benches and 10 teachers participated in each of the experiments II and III. Experiments spread over a duration of 3 to 5 weeks.

In the conduct of experiments, the researcher played a multifaceted role of a designer, planner and project leader cum-manager, whereby he was concerned with the responsibilities of identification of work benches, selection of open ended problems, allotment of students and teachers to work benches, ensuring prior preparation for students and teachers before they arrive at work benches, drawing up programme and examination schedule, monitoring the progress of experiment, conduct of group interactive examinations like seminar, group discussion, project report, networking of accommodation, transportation and food arrangements for students and teachers, optimising educational infrastructural needs in regard to library, work space, stationery, collecting feed back on educational experiments from participating students, teachers, industries, etc.

It is based on the data base generated through such an experimental involvement of different constituencies of Polytechnic-industry interface, that the Sixth Chapter critically analysed the results of the three experiments to study the validity of the PS based model of education for polytechnic-industry linkage. To mention the main conclusions of this analysis, it may be noted that overwhelmingly the students' response was governed by the nature and the extent of educational challenge in the practice-based assignments offered at the work-benches; thereby establishing problem-based character of Polytechnic-industry linkage as implemented through Practice School pedagogy.

Further, the teacher feed back, certainly, suggested need for teacher's presence at the work-benches during the student education, in turn, validating teacher-centred design of the linkage in the choice of the model.

As regards the industries, while on the one hand they strongly supported the teacher's presence, they accepted, on the other hand, the contributions that students can make during educational years and simultaneously expressed a vision that such model of in[illegible]ion can provide three way opportunities, namely, for teacher to be a work consultant, for initiation of continuing education programme at work-bench, and for employer or work incharge to offer himself as a part-time teacher for Polytechnic, thereby displaying the regenerative character of the interface designed.

Over and above, the Sixth Chapter also studied the internal consistency of the examination under the experiments conducted using the two way AOV approach and found the same to be high, thereby confirming the operational viability of the mechanism of planning, instruction and implementation as proposed through the design of the experiments.

It is against the back drop of these regenerative features of the interface that the Chapter Seven suggested a systems design of the interface system which viewed the Polytechnic Principal as an educational entrepreneur with responsibilities for management of technicians' education linked with the world of work; for generating the data base on technology needs in industries; and for establishing information system on manpower needs for such technology update.

This design has three broad areas: world of education, world of work and educational organisation for interface between them. Each of these broad areas has been further divided into sub areas, in all 14 in total. Each of these sub areas corresponds to different functional need of interface implementation. Thus area of the world of education is divided with sub areas of : Polytechnic curriculum, Principal as an educational entrepreneur, and Educational organisation for curriculum updating at the polytechnic.

As regards the area of the world of work, it is divided into sub areas of : Conduct of education and examination at work bench, Continuing education programme, Transforming students' contribution into new technology and new system under industrial R and D, and increased productivity effort.

And various sub areas that go to define the area of interface organisation are : Employer cum industrial expert as a part-time teacher for polytechnic, Educational organisation of polytechnic courses and of Instructional based practical training, Planning for interface and feed back, Data base on manpower and technology need in industry, Planning and Designing of continuing education programme, and Educational organisation for work-bench-based student involvement, Educational organisation for progress and monitoring of continuing education.

Thesis has presented detailed design schematics for each of these sub areas. Understandably, these detailed designs draw upon the functions that the researcher undertook in implementation of the experiments and the functions that emerge from the analysis and results of the experiments.

Of course, all this will call for new role for technician-teacher and new definition of his educational functions. Many of these educational functions would be based on planning, designing and implemenational tasks as mentioned above that the researcher undertook in order to construct and administer the experiments. All this would call for, firstly, regularisation of such a curricular structure allowing for polytechnic-industry interface and, secondly, for appropriate faculty strength and work assignments in the context for the organisation and management of the interface. This, in turn, brings forth many further questions concerning educational planning, design of academic regulations, networking of state level resources, teachers and employers training, etc., and would need another research effort for their resolutions.

However, side by side, this would also need local efforts at polytechnic level to generate grass root level educational data base to facilitate systems design as above. This, certainly, would require technician-teacher's initiative to research these areas, and this, in turn, would need the establishment of small educational R & D cells in the Polytechnics to facilitate such initiatives. Perhaps already existing curriculum development and educational technology application cells at polytechnics could be expanded to include such initiative which will have a basic feature of their being suggested by teachers themselves (as is the case of this research), instead of these initiative per say coming only from the Directors or TTTI's.

TTTI's, Chandigarh, can play an important role in making this preposition viable for the polytechnics of northern region, of which Sundernagar Polytechnic is a part.

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APPENDIX 1

Statewise - Representation of out turn per lac Population

S. No.	State	No. of Poly-technic	No.of Disci-pline	Population of the state	Population per poly-technic	Population one tech-nician	Out-turn per lack Populat-ion
1.	Andhra Pradesh	35	23	5,35,49,673	15,29,972	9976	6.72
2.	Karnataka	44	25	3,71,35,714	8,43,984	5345	10.66
3.	Kerla	29	18	2,54,53,680	8,77,713	6575	10.11
4.	Pandichery	1	5	6,04,471	6,04,471	3355	14.9
5.	Tamil Nadu	48	42	4,84,08,077	10,08,501	6198	11.6
6.	Gujarat	30	34	3,40,85,799	11,36,193	6171	12.30
7.	Madhya Pradesh	27	20	5,21,78,844	19,32,550	11164	5.9
8.	Maharashtra	45	30	6,27,34,171	13,95,204	9005	8.5
9.	Goa	5	15	10,86,730	2,17,454	2196	35.6
10.	West Bengal	31	13	5,45,80,647	17,60,668	12619	5.3
11.	Bihar	19	17	6,99,14,734	36,66,432	32947	1.7
12.	Orissa	11	19	2,63,70,271	23,97,296	20633	3.01
13.	Assam	9	13	1,98,96,843	22,10,760	14651	3.6
14.	Tripura	2	4	20,53,058	10,26,529	11405	1.36
15.	Manipur	1	3	14,20,953	14,20,953	11841	4.36
16.	Meghalaya	1	3	13,35,819	13,35,819	10045	1.36
17.	Nagaland	1	3	1,74,930	7,74,930	10915	3.2
18.	Mizoram	1	3	4,93,757	4,93,757	5488	7.6
19.	Andaman & Nicobar	1	4	1,88,741	1,88,741	2700	5.8
20.	Delhi	11	21	62,20,406	5,65,582	2872	20.1
21.	Jammu & Kashmir	4	7	59,87,389	14,96,845	20644	1.4

S. No.	State	No. of Poly-technic	No.of Disci-pline	Population of the state	Population per poly-technic	Population one tech-nician	Out-turn per lack Populat-ion Remarks
22.	Himachal Pradesh	4	6	42,80,818	10,70,204	18212	2.94
23.	Chandigarh	3	9	4,51,610	1,50,536	895	82.0
24.	Haryana	14	16	1,29,22,618	9,23,004	7719	7.7
25.	Punjab	18	18	1,67,88,915	9,32,718	8052	7.7
26.	Rajasthan	12	19	3,42,61,862	28,55,155	28962	2.01
27.	Uttar Pradesh	76	32	11,08,62,013	14,58,711	10614	6.5
	Total	483	137	68,40,92,543	14,16,346	9749	6.82

APPENDIX 2

Questionnair I for finding out the objectives of Education

Name of Teacher: ______________________________

Courses taken in recent past ______________________________

____

____

____

Following list contains some of the qualities which are desired to be common among most adult situations. They are believed to be essential for living. How would you rate these qualities? Indicate your opinion as to which of the qualities should be achieved by Polytechnic Education, what qualities can be achieved by the education system and finally which of the qualities you have been able to achieve in your course/course.

(S.S. Sen)
Head of Deptt.in Automobile Engg.,
Government Polytechnic, S/Nagar
District Mandi, (H.P.)

S. No.	Desired qualities	Desirable quality rating	Qualities that should be achieved by Edu.	Qualities that can be achived	Qtys. that you have been able to achieve	Remarks
1.	Perception					
2.	Analysis					
3.	Diagnosis					
4.	Problem solving					
5.	Judgement					
6.	Communication					
7.	Understanding					
8.	Sympathy					
9.	Tolerance					
10.	Sense of responsibilities					
11.	Leadership					
12.	Decision making					
13.	Coping with frustration					
14.	Knowledge					
15.	Self reliance					
16.	Greativeness					
17.	Confidence in one's own abilities					

18. Sense of humour

19. Ability to mix well

20. Wide interest

21. Independence

22. Honesty

23. Ambition

24. Commonsense

25. Logical thought

26. Any other specify

APPENDIX 3

Questionnaire for Teachers

(To find the effectiveness of the present curriculum)

BACKGROUND:

1. Name:

2. Polytechnic:

3. Designation and Department:

4. Experience:

   (a) Teachsing —Yrs.

   (b) Industrial/Field —Yrs.

5. Qualification:

INPUT:

1. Does the present student intake in the Polytechnic have good background in terms of: Yes/No.

   (a) Education Yes/No.

   (b) Intellectual Level Yes/No.

   (c) Behaviour Yes/No.

   If no, where they lack

2. Should there be admission test? Yes/No.

   If yes, why________________________________

3. Is the medium of instruction responsible for your students not grasping the subject matter? Yes/No.

RESOURCES

4. Have you got facilities of resource centre? If yes, give a list of the aids available (slide projector, overhead projector, rolling board, film projectors). Yes/No.

5. Give suggestions for the utilisation of library facilities.

MANAGEMENT

6. How do you encourage the students in solving problems of society concerning his branch of engineering?

7. There are many situations personal and professional which irritate you and affect the quality of your work. Make a list of all such irritations and situations, preferably in the order in which each of them effect you.

8. What do you suggest for avoiding the mass cuts by the students?

9. What improvement do you suggest for better output from the polytechnic?

EVALUATION

10. Do you approve the present student evaluation system of your area?

11. If no, what are your suggestions to make it more reliable and valid as a measure of students achievement in respect of:

    (a) Internal Assessment.

    (b) External Assessment.

    (i) Written Examination

    (ii) Practical Examination

OUTPUT

12. Write your overall impressions about the product (Passed out students of Polytechnic)?

APPENDIX 4

Questionnaire for final year students of Polytechnics

NOTE: This proforma is meant for revising the existing syllabus. Your free and frank opinion will help in making improvement in the existing courses.

(a) Name of the Polytechnic ______________________

(b) Branch of Engineering Electrical/Mechanical/Civil/Auto/Arch.Asst./Electronics

(c) Educational Background Matric/Higher Secondary Pre-Engineering

1.0 INPUT

1. Are you aware of the areas in which you will be employed after doing the course at the time of admission?

2. What are the devices or equipment related to a particular branch of engineering, with which you have played before coming to Polytechnics?

3. How were you motivated to take admission in diploma course in Engineering and the specialised branch?

4. Have you experienced any difficulty in understanding and expressing various subjects in English? Yes/No

   If yes, in which subjects: ______________________

2.0 PROCESS

1. Are you satisfied with the method of teaching? Yes/No

   If no, what are your suggestions for improvement. ______________________

2. Name the subjects in which you faced difficulty in understanding and explain why?

(Reasons)
i) ____________
ii) ____________
iii) ____________

3. a) Is the present examination system fair for theory, practical, and internal assessment? Yes/No

b) If no. please give your suggestions.

4. In which subjects teacher creates interest in students?
i) ____________
ii) ____________
iii) ____________

5. How do you study? ____________
Tick mark correct answer

- Class notes ____________
- Library/Self notes ____________
- Independent home study from Test books ____________
- Extra coaching from class fellows ____________

6. List down following aspects of the course.

- Superflous subjects/Chapters ____________
____
- Reetition ____________
____

7. Were you taken to industry sites relevant to your subject/branch of Engineering ? Yes/No

8. Have you actually performed experiments/practicals in laboratories/workshop? Yes/No

9. If no, which laboratories ____________

10. If not performed

(tick mark the reasons)

- Lack of interest by teacher ____________
- Shortage of staff ____________
- Shortage of time

11. What are the reasons of mass cuts from the classes?

i) ____________________
ii) ____________________
iii) ____________________

Physical Resources

12. Do you get sufficient raw material in labs/workshop for practical purposes? Yes/No.

13. Is the equipment in labs/workshops sufficient? Yes/No.

14. Are classrooms well equipped with furniture background? What are the deviciencies? Yes/No.

Information Resources

15. Do you get sufficient print material i.e. books/literature required for your course from the polytechnic library? Yes/No.

16. Are text books available on all the subject? Yes/No.

17. What are your suggestions for getting better qualified students from the polytechnic? ____________________
____
____

18. Describe your most memorable experience of studies in polytechnic? ____________________
____

4.0 Output

19. In what way do you feel more competent now than when you entered in polytechnic? State clearly in terms of theoretical knowledge and practical skill? ____________________
____
____
____
____

20. How can you become a better student for achieving greater success in Polytechnic? ____________________
____

5.0 Management

21. Are you satisfied with the management of:

(a) Institution ______________________

(b) Department ______________________

(c) Hostel ______________________

22. If not, give specific suggestions. ______________________

23. Have you been involved in solving problems of the society relating to your branch of engineering? Yes/No.

APPENDIX 5

Survey of three years Diploma Courses

Where applicable please answer question by puting ticks

1. Name and complete postal address :

2. (a) Year of passing diploma :

   (b) Trade :

   (c) Percentage :

   (d) Sex: Male/Female :

   (e) Marital status :
   Married/Unmarried :

3. Present employment/destination :

4. (a) Year of getting the

   i) Apprenticeship :

   ii) Adhoc job :

   iii) Regular job :

   iv) Permanent job :

   v) Self employment :

(b) Have you improved your qualification. If yes then upto what level ? : Yes/No

(c) Are you a member of Technical Institution or Society ? : Yes/No
If yes, give name. :

5. (a) Name of your employer :

   (b) Please tick your employer

   Central Government/State Government/Public Sector/
   Private Sector/Self employment

6. (a) Are you responsible for initiating and planning new designs and development?

(b) Are you responsible for organising and directing the work of other persons? Yes/No

If yes, give approximate number you control

Technicians _______ Draftsmen_______Operatives______

7. Here is a list of typical duties or functions found in industry, please put a tick against title which best describe your work. If more than one title applies, tick one in which you spend the greater part of your time.

	FUNCTIONS OR DUTIES	PRESENT POST	PREVIOUS POST
1.	Research and Development		
2.	Major project design		
3.	Detailed design draughtsman		
4.	Jig and Tool design		
5.	Testing and inspecting		
6.	Installation, erection		
7.	Production, plant operation		
8.	Maintenance, servicing		
9.	Management or supervision		
10.	Teaching, instruction		
11.	Purchasing, sales		
12.	Estimating, preparing specifications		
13.	Rate fixing/time/motion/ work study		
14.	Other (Specify)________________ ________________		

8. a) To what extent do you feel your studies for diploma in Engineering have been of use to you in your employment?

Considerable use/Moderate use/Some use/No use.

b) Has this been of general use in awakening your scientific appreciation and approach to you work or of specific value in giving you formulae and facts you have used ?

General appreciation________Specific facts___________

9. State difficulties you have faced during First year of your service due to lack of work related knowledge and skill ______________________________

10. Do you feel that hobbies club/sports should be compulsory in diploma engineering courses? Yes/No

11. In the columns below are listed the main sub divisions of the subjects of study in the Diploma course. Please tick in columns (a) and (B) those items which you have had cause to use in the course of your employment in columns (A) during the last one year and columns (B) during your career as whole.

		A	B			A	B
1.	English			12	Workshop Technology		
2.	Applied Mathematics			13	Auto shop practice		
3.	Applied Physics			14	Thermodynamics and I.C. Engine		
4.	Applied Chemistry			15	Engineering Material		
5.	Engineering Drawing			16	Mechanics of Vehicle		
6.	Applied Mechanics			17	Automobile Engine		
7.	Workshop Practice			18	Service station layout and garage practice		
8.	Professional studies			19	Chasis and Transmission		
9.	Strength of Material			20	Electrical Technology		
10.	Mechanical Engineering			21	Metrology and Machine tools		
11.	Hydraulics			22	Industrial Management		

---

12. Do you feel the necessity of introducing the following subjects in the curriculum ?

Entrepreneurship
Computers
Marketing
Accountancy

Electronics
Roads
Metallurgy
Environment Pollution
Fabrication Technique
Design body and vehicle
Accident and Safety
Service machanism
Operational Research
Microprocesses
Tyres remoulding and inspection
Advance combustion problems
Refrigeration and air-condition
Workshop Management
Supervisory skills
Ship building
Any other specify

13. How did yoiu obtain the extra specialised knowledge which was not included in your diploma course?

Reading text book or monograph
Technical papers
Attending special courses at college or university
Special industrial training courses
From a college already familiar with it
Any other means (Specify)

14. (a) Do you feel that extension lecturer in the present curriculum system should be given by the specialist drawn from the industries or universities or any other organisation ?

(b) In your student life which of the following you would have preferred.

Local affairs (Cultural matters and social services)
World affairs Religion Philosophy

(c) As an alternative to the above items would you have preferred instend:-

Lecturers and classes on technical English
Sources of technical information
Biographies of great Engineers
Discriptions of great engineering achievements
Any other items (Specify)

15. Do you think that you would have benefitted if more emphasis had been placed on specific Engineering problems?

Fully Benefitted   Some Benefit   No Benefit

16. Do you feel that the refrees/or courses should be arranged by the polytechnics for the passedout students? If yes than specify the courses.

Yes/No

17. Do you feel that there should be old boy association to share their experiences with the Institute and among the students?

Yes/No

18. Do you suggest that the passed out students to be invited to express their views in various seminars magazines etc?

Yes/No

19. Do you feel that Industry Institute interaction is essential?

Yes/No

20. Do you feel that students should be sent to Industry or worl of work before awarding Diploma?

Yes/No

APPENDIX 6

Questionnaire for ascertaining the categories of supervisory personnel (Diploma holders in engineering) and their functions

---

(To be filled in by Employers)

1. Name and complete Postal address ______________________

2. Address of the organisation ______________________

____

3. Type of your organisation (a) Govt./Semi Govt./Pvt.

(b) Small/Medium/Large

4. Products being manufactured/constructed/maintained/designed

5. (a) Name the following:

- Chief Engineer, SE, EE, AE S/Shri________ ________

(b) Managing Director, GM, WM, RM, TM S/Shri______________

6. Name 5 to 6 experienced Engineers of your organisation who can be invited for extension lectures on specialize topics and for curriculum design purposes:

Name Area of specialization

7. List the total number of personnel you are having under the following categories:-

Engineering Graduates and above	Engineering Diploma holders	Skilled workers		Skilled workers		Unskilled workers
		ITI	Non ITI	ITI	Non ITI	

8. Tick the departments employing Diploma holders in Engineering in your establishment and indicate number.

(a) Research and Development (b) Design and Drawing

(c) Production Planning & Control	(d) Production
(e) Quality Control	(f) Repair and Maintenance
(g) Sales	(h) After Sales Service
(i) Store Purchase	(j) Transport
(k) Stores	(l) Training

List others which are not included above.

9. Indicate the Hierarchy of Supervisory personnel in your organisation.

10. **Activities/Functions of Diploma Holders in Engineering:-**

Tick in the appropriate column the activities of Supervisory personnel (Diploma holders in engineering) in various sections of your orgaisation.

10.1 R and D	Does it frequently	Does it rarely	Likely to do
a) Collects data conducts outine investigation as desired by Engineer	______	______	______
b) Conducts tests under the direction of Engineer	______	______	______
c) Prepares detailed drawings for the manufacture of prototypes/new machines	______	______	______
d) Read blue prints/drawing for the fabrication of prototypes/machines	______	______	______
e) Supervises fabrication of prototypes/new machines	______	______	______
Tests the prototypes as per laid specification	______	______	______
g) Assists the engineer in drafting the specifications for pilot production or mass projection	______	______	______
h) Writes Technical Reports	______	______	______

Any other activities not covered above.

10.2 Design and Drawing:
Tick the activities of Engineering diploma holders

a)	Assists the engineer in designing components/ machines			
b)	prepares working drawing blue prints as per given specifications			
c)	Prepares process plans			
d)	Prepares layout for various jobs			
e)	Works out material requirement and prepare cost estimates			
f)	Allocated duties to Draftsmen and supervises their progress			
g)	Supervises large scale reproduction of drawings/ blue prints			
h)	Storing of drawings/ blue prints			
i)	Procurement and upkeep of drawing office material and equipment			

Any other activities not covered above:

10.3 Production Management and Supervision:

Tick the activities of Engineering diploma holders

		Does it frequently	Does it rarely	Likely to do
a)	Studies Working drawings			
b)	Working quantities of raw-materials for the shift			

c)	Management of men, material and machines in his section			
d)	Supervises production processes			
e)	Undertakes quality control at each stage of manufacture			
f)	Ensures safety measures			
g)	Handles labour problems, technical, mechanical and personnel			
h)	Prepares work schedules and Labour schedules			
i)	Supervisers routine maintenance of machines/equipment			
j)	Supervises installation of new machinery			
k)	Prepares progress report for the shift			
l)	Training of new workers			

Any other activities not covered above:

10.4 Repair & Maintenance:-
Tick the activities of Engineering Diploma holders

		Does it frequen tly	Does it rarely	Likely to do
a)	Reads assembly drawings, manuals, inspection of machines and fault finding			
b)	Prepares material and cost estimates for repair and maintenance work			

c) Undertakes Supervision of repair and over-hauling of machines/ equipment ________ ________ ________

d) Undertakes routine/ preventive maintenance ________ ________ ________

e) Checking/Testing of repaired and over-hauled machines for correctness ________ ________ ________

f) Ensures safety of workers during repair and mainte-nance activities. ________ ________ ________

Any other activities not covered above:

10.5 Sales and After-sales service:
Tick the activities of Engineering diploma holders

a) Conducting market surveys ________ ________ ________

b) Sales promotion activi-ties like advertising ________ ________ ________

c) Arranging demonstration of products ________ ________ ________

d) Writing instruction manuals ________ ________ ________

e) Booking orders and arranging for supplies ________ ________ ________

f) Attending to customer's complaints ________ ________ ________

g) Arrangement of after sales service ________ ________ ________

h) Organises training courses for dealers ________ ________ ________

Any other activities not covered above

10.6 Purchase and Stores:
Tick the activities of Engineering diploma holders

a) Preparing purchase documents such as tenders, enquiries and quotations	______	______	______
b) Processing the received tenders and preparing comparative statements	______	______	______
c) Preparing purchase orders	______	______	______
d) Inspecting the materials received the verification of bills	______	______	______
e) Receiving and storage of materials and components etc.	______	______	______
f) Issuing of materials/ tools	______	______	______
g) Maintaining section ledger for receipt, issue and balance of stores	______	______	______
h) Undertakes physical verification of stores	______	______	______
i) preparing write-off statements for the loss of stores and due to normal wear and tear	______	______	______

Any other activities not covered above:

11. What are the likely changes in technology you are visualising in the next 5 to 10 years?

a) Increase in automation Yes/No

b) Technological upgradation Yes/No

c) Use of computers Yes/No

d) Rise in Production Yes/No

e) Rise in Manpower requirement Yes/No

If possible, kindly indicate the expected manpower required at supervisory level personnel in the next 10 years:

Field	Expected No.of Engg. Diploma holders required
a) Research, Design and Drawing	______________
b) Production and supervision	______________
c) Repair and maintenance	______________
d) Any other type:-	

12. a) Do you think that theoretical content of diploma course in Engineering is: Sufficient/insufficient

b) Do you think skill development in engineering diploma holders is: Sufficient/insufficient

c) Do you think that diploma courses in engineering/ technology should have component of industrial training ? Yes/No

d) If yes, indicate duration Months/Years

13. At present, most of Polytechnics are conducting generalised diploma courses in Civil, Electrical and Mechanical Engineering. Would you suggest what courses be organised in the following specialized areas:- (Please tick)

a) Research, Design and Drawing Yes/No

b) Production and Supervision Yes/No

c) Repair and Maintenance Yes/No

Any other area:-

14. Any other information/suggestion you wish to communicate, kindly detail below:-

a) Any area in which technicians are not available:

b) Any area in which skilled workers are not available:

c) Any other suggestions:

APPENDIX - 7

Problems envisaged by different Organisations

---

1. **Himachal Pradesh Public Works Department**

1. Data Collection and surveys.
2. Testing materials, machines and equipment.
3. Interpretation of Drawings in the work site.
4. Preparing technical reports.
5. Preparation of drawings and detailed sketches.
6. Maintaining record of drawings and blue prints.
7. Preparing specifications for the purchase of materials.
8. Preparation of operational layout for various jobs.
9. Preparation of labour and material schedule.
10. Supervision of construction activities in the far flung areas.
11. Preparation of progress report.
12. Handling labour problems.
13. Ensuring waste reduction.
14. Ensuring safety measures during construction, repairing and maintenance.
15. Preparation of check lists for quality control.
16. Preparation of inspection and test reports.
17. Studying drawing and manuals for fault detection.
18. Preparation of material and cost estimates for repair and maintenance works.
19. Undertaking routine and preventive repair and maintenance measures.
20. Supervision of maintenance and repair of equipment.

21. Keeping inventory control.

22. Processing tenders and quotations and preparation of comparative statements.

23. Classification and storage of materials and tools.

24. Conducting demand surveys.

25. Use below specification materials for construction by the contractors.

26. Pilferage of the petrol, oil, lubricants and building materials.

27. Proper construction and curing of Civil Engineering works at far-off places.

28. Storage of construction material like cement, tools & equipments etc. at site.

2. Himachal Pradesh Irrigation and Public Health Department

1. Skilled labour for laying of the pipe lines.

2. Pilferage of the building materials.

3. Availability of proper surveys of the Schemes.

4. The outdated instruments use for the surveying.

5. Non-existence of central workshop, where all the repairs and maintenance works can be carried out.

6. Testing of soil, water etc.

7. Housing in the field.

8. Proper design, i.e. design according to the topography of the areas is not available.

9. Proper treatment units such as filteration unit, sedimentation tanks, water tanks, storage tanks are not provided before the laying of gravity and distribution line.

10. Proper control for following the standard specifications.

11. PERT/CPM application in the completion of works.

12. Untimely procurement of the material leads to delay the works.

13. Lot of political interference in the administration, works, implementation of schemes, unseasonal transfers which ultimately hamper the work progress and works schedule.

14. Lack of motivation of Junior Engineers which results in no will to work.

15. Preparation of completion plans of schemes.

16. Regular establishment provision, for watch and words of store.

17. Maintaining the records.

18. Preparing specification for purchase of materials.

19. Proper planning, as the planning is done from the offices and due to this there is a lot of deviation in the works.

20. Interpretation of drawings on the work sites.

3. Himachal Pradesh State Electricity Board

1. Storage of construction material at site like cement, steel, tools, equipment, etc.
2. Surveys of works, accuracy of the instruments like levels, theodolities, etc.
3. Use of below specification materials for construction by the contractors.
4. Completion of departmental works in time which are in the farflung areas.
5. Pilferage of petrol, oil, lubricants and building materials.
6. Theft of electricity at the remote places.
7. Timely procurement of tools, equipment, machinery and materials.
8. Application of net work approach for the execution of the works.
9. Transportation of the heavy materials like transformer, tower line components to the remote sites not connected with the roads.
10. Erection/lifting of heavy equipments and machinery on the work site safely.
11. Proper construction and curing of civil engineering works, such as tower line beds, etc, at faroff places.
12. Calibration and testing of the energy meters.
13. Obsolescence i.e. write-off the outdated instruments/machinery.
14. Transportation of the materials to the remote areas.

15. Residential accommodation near the work/project sites.

16. Inter-changeability of engineers from project to field and vice-versa.

17. Maintaining the electric system in the snow bound areas.

18. Handling of labours.

19. Ensuring waste reduction.

20. Preparation of check lists for quality control.

21. Undertaking routine and preventive measures for repairs and maintenance.

4. Himachal Pradesh Road Transport Corporation

1. Taking work on scientific basis from the workers.
2. Poor design of the workshops.
3. Drainage systems in the workshops.
4. Interpretation of drawing and understanding of the drawing by the workers.
5. Sufficient fleet strength.
6. Quality work because of subordinacy in the department.
7. Interference from outside agencies.
8. Control on purchase of material.
9. Sufficient service points on the routes for the fittings and minor mechanical adjustments.
10. Feeling the responsibility of the works.
11. Managing traffic on the routes.
12. Running the vehicles on the unsuitable roads.
13. Preventive maintenance.
14. Pilferage of petrol, oil, lubricants and parts.

15. Residential accommodation near the workshops and bus stands.

16. Obsolescence of machinery and equipments.

17. Dependability of the technical staff on the ministerial staff.

18. Managing properly the amenities like canteen, first-aid dispensary, toilets, etc.

19. Maintaining the operational schedule.

20. Inventory control.

21. Proper arrangement of staying of the drivers on the remote areas.

22. Conducting the refresher courses for drivers and others due to less number of recruitments.

23. Supervision of maintenance and repair of the vehicles.

24. Fabrication of bodies design and drawing.

25. Use of manuals for fault finding and their remedial measures.

26. Preparation of operational layout for various jobs.

27. Record maintaining.

28. Slow working due to the union front formation.

29. Testing callibrating of various components/parts.

30. Classification and storage of materials.

31. Ensuring waste reduction.

32. Environmental pollution due to smoke.

33. Maintenance of job cards for vehicles and mechanics.

5. **Himachal Pradesh Town Planning**

1. Preparation of drawing for sewarage system of the old towns.
2. Supervision of the working site and building construction.
3. Preparation of check lists for quality control operations.
4. Preparation of cost estimates.
5. Preparation of working drawings/detailed sketches.
6. Assistance in preparing specifications.
7. Explanation of working drawings to the owners.
8. Undertaking quality control measures at various stages.
9. Conducting demand surveys.
10. Enforcing of building by laws.

6. **Metal Engineering Works, Kangra, (H.P.)**

1. Supervision and fabrication of prototypes.
2. Preparation, interpretation and explanation of drawings to workers.
3. Determination of unit cost.
4. Preparation of labour and material schedules.
5. Selection of appropriate processes for production.
6. Determination of machine utilisation time.
7. Handling labourers.
8. Reduction in wastage.
9. Packaging.

7. **Supreme Motors Ltd. Mandi, (H.P.)**

1. Drainage systems in the workshop.
2. Preparation of bill of materials.
3. Interpretation and understanding of the drawing by the workers.
4. Testing and callibrating of the fuel pumps.
5. Maintenance of job cards for mechanics.

8. **Bhakra Beas Management Board, Sundernagar**

1. Silt disposal from the Sundernagar reservoir.
2. Pilferage of petrol, oil, lubricants, materials and equipment.
3. Disposal of waste machinery, equipment, etc.
4. Operation of the fleet.
5. Maintaining the training schedule in the Mechanical/Automobile workshop.
6. Adjustments of the retrenched employees.
7. Undertaking quality control measures at various stages.
8. Preparation of machine utilisation statements.
9. Ensuring safety measures.

9. **National Fertilizer Ltd., Nangal, Punjab**

1. Operational schedule of vehicles.
2. Preparation of machine utilisation statements.
3. Ensuring safety measures.
4. Undertaking quality control measures at various stages.
5. Handling of labour problems.

10. State Electricity Board, Jammu & Kashmir

1. Operation and maintenance of the sub stations.

2. Pilferage of materials and electricity.

3. Tubewell connection and their maintenance schedule.

4. Material Management.

5. Preparation of specifications and schedule.

6. Handling of labourers.

APPENDIX - 8

Questionnaire for practical training feed back of Polytechnic students

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Name____________________Roll No.__________Branch_________

Training Place ________________

Practical Training Allotment:-

1. Did you get practical training station out of your first two choices ?

   (A) First (B) Second (C) None of these

To what extent was your choice of practical training station influenced by following factors.?

		To a great extent	To some extent	Not much
2.	Facilities provided	A	B	C
3.	Parents desire	A	B	C
4.	Nearness to home town	A	B	C
5.	Professional interest in the project	A	B	C
6.	Reputation of the host organisation	A	B	C
7.	Future career in mind	A	B	C
8.	Curiosity and Desire to learn something new	A	B	C

9. Minimum how many weeks (A) One week (B) Two weeks before the start of training, you were informed about your training.

After station allotment what efforts did you make to prepare yourself for practical training arrangement.

		Yes	No
10.	Referred to and studied relevant literature available in library and training centre.	A	B
11.	Discussions with faculty	A	B

12. What is your reaction to arrange formal orientation programme for students, to orient them, to various host organisations while at Sundernagar?

    (A) Favourable (B) Indifferent (C) Not favourable.

13. If your answer to Q 12 is "Favourable", what is you opinion, regarding the correct time for conducting the orientation programme?

    (A) Before asking for station preferences.

    (B) After the station allotments are finalised.

14. Did you stay at your home/relative's home/rented house?

    A B C

Transportation

15. On an average how much time did you take to reach training station from your place of stay.

    (A) Less than 15 minutes, (B) Between 15 minutes to 30 minutes, (C) Between 30 minutes to 1 hour, (D) More than one hour.

16. What was your experience with the transportation facility to reach the place of work?

(A) No transportation needed (B) Used own vehicle (C)Used public transport which happened to be satisfactory (D) Used transport facility of the host organisation.

Food

17. What were the regular arrangements for your lunch/snacks/tea during working hours?

(A) Available at the host organisation at subsidised rates,

(B) Available out side the host organisation,

(C) Carried own lunch packet.

18. How do you rate the food arrangements during your training stay?

(A) Good (B) Average (C) Bad

Expenditure

19. What is the average amount you have spent during your training period?

Accommodation - Rs.__________
Food snacks - Rs.__________
Local Conveyance - Rs.__________
Recreation - Rs.__________
Total (including any other items) = Rs.____________

Did you get any out-of-pocket allowance?

Yes (Rs.______________) (B) No

Registration

20. Did you reach the training station on the first day without difficulty?

(A) Yes (B) No

21. Did you find any difficulty in Registration?

(A) Yes. (B) No

If 'Yes', then state the difficulty.

Training Programme Schedule

22. Did you get the training course handout or periodic announcements regarding training programme and evaluation details ?

(A) Yes (B) No

Project Assignments

23. How do you rate the orientation programme?

(A) It did not take place (B) It was not adequate

(C) It was adequate

24. Within how many days did you get the first practice assignment ?

(A) One day (B) Two days (C) Three days.

25. Did you enjoy your practice assignments?

(A) Yes (B) No

26. How do you describe the utility value of the project/ assignment to the organisation?

(A) Presently it has high utility value.

(B) It will be of high utility value at a later date.

(C) Can not say

(D) Of no utility at all

27. Classify your practice assignments with respect to on going activities of the host organisation.

(A) On-going assignment on which the students were asked to work

(B) Independent project

28. Classify your practice assignments in terms of content

(A) Assignments were complete in themselves

(B) Assignments were partly complete

29. How was the attitude of the concerned professional experts towards you?

(A) Favourable (B) Indifferent (C) Unfavourable

30. How was your relation with other trainees in the host organisation?

(A) Relations were good (B) Indifferent (C) Poor (D) There were no such trainees

Professional Experts involvement

31. How do you rate the response of the professional experts from the host organisation?

(A) Favourable (B) Indifferent (C) Not favourable

32. How often on your own, you discuss your assignments with:

Professional experts from host organisation (A) Very often (B) Often (C) Rarely

Training faculty : (A) Very often (B) Often (C) Rarely

Overall impressions

33. Desicribe the nature of your participation in training assignments?

(A) Worked alone

(B) Worked in an inter-disciplinary team

(C)Worked in a multi disciplinary team

How do you rate training that you received in terms of following:

		Very good	Good	Average
34.	Opportunity for applying analytical skills from your own discipline	A	B	C
35.	Opportunity for learning new skills in your own discipline	A	B	C
36.	Opportunity for studying techniques in data seeking and interpretation	A	B	C
37.	Opportunity for establishing personal relationships	A	B	C
38.	Opportunity for learning the skills of written and oral presentations.	A	B	C
39.	Opportunity for understanding the exact nature of professional life.	A	B	C

40. General Remarks if any ______________

APPENDIX 9

Questionnaire for ascertaining the problem solving training of Three year Diploma Students in Engineering

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(To be filled in by faculty involved in problem solving training)

1. Name : ____________________
2. Designation : ____________________
3. Polytechnic : ____________________
4. Qualification : ____________________
5. Experience : Teaching ____________________

   Industrial/field ____________________

Please tick the appropriate you feel. Yes/No

1. Are you satisfied with the time and duration of training ? (If no, then what should be the duration of training) 1,2,3,4,5,6 months

2. Are you satisfied with the following facilities provided by the organisation to faculty and students ?

   i) Accommodation Yes/No

   ii) Transportation Yes/No

   iii) Out of pocket allowance Yes/No

   iv) Infrastructural facilities Yes/No

   v) Subsidised canteen Yes/No

   vi) TA for field visits Yes/No

3. Do you think that students would have benefitted more if the faculty remained present during the full duration of training ? Yes/No

4. Did you participate in group discussions at the work bench ? Yes/No

5. How many work benches you have supervise ? ____________

6. What difficulties you have faced while supervising the training ? ____________

7. Have you negotiated with industries regarding honorarium to students during training? ____________

8. Have you noticed any problem of the work-bench/organisation to be included in the problem bank ? Yes/No

9. Did the students apply system approach for solving problems ? Yes/No

10. Do you feel that the curriculum should be revised regularly ? Yes/No

11. Do you feel that campus interview should be held regularly ? Yes/No

12. How do you rate the involvement of professional experts ? Favourable/Non Favourable

13. Do you think that you are also benefitted by visiting various work benches. Yes/No

14. Do you feel that the faculty should have the industrial experience from time to time ? Yes/No

15. Do you feel that there should be refresher courses for the faculty ? Yes/No

16. Do you feel that the industry people be asked for the conduct of Practical Examination in the Polytechnics ? Yes/No

17. Would you advocate appointment of part time lectures from Industry ? Yes/No

18. Do you feel that the training will improve the employment opportunities ? Yes/No

19. Do you feel that training will improve the institutional environment ? Yes/No

20. Was the training helpful in developing entrepreneurial skill in the students? Yes/No

21. Do you feel that the training and placement staff should be posted in the cluster of work benches through out the year ? Yes/No

22. Do you feel that this training should be made essential part of curriculum and be continued ? Yes/No

23. Do you feel that there should be separate training cell in the institute ? Yes/No

24. In case you feel that this training is necessary but is not useful in present form what are your suggestions to make it effective ?
____
____
____

25. What is your overall impression about this training ?
____
____

APPENDIX - 10

Questionnaire for ascertaining the problem-solving training of three year Diploma students in Engineering

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(To be filled in by Incharge of work bench/organisation involved in problem solving training)

1. Name of the Organisation : ____________________

2. Name and address of the work-bench : ____________________

Please tick the appropriate

1. Are you satisfied with the students allotment to your work bench/organisation? (If no, please indicate reasons) Yes/No

2. Do your organisation/workbench have facilities for the following during training ?

   i) Accommodation for faculty/students Yes/No

   ii) Transportation Yes/No

   iii) Infrastructure facilities Yes/No

   iv) Out-of-pocket allowance Yes/No

   v) Subsidised canteen Yes/No

   vi) TA for field trip Yes/No

3. Are you satisfied with the duration of training ? Yes/No.
   (If no, what should be duration of training 1 month/2/3/4/5/6 months)

4. Do you feel that the faculty for training should be posted in the work benches througout the training period ? Yes/No

5. Have you paid honorarium to the students trainee ? (If yes, amount of honorarium) Yes/No

6. Was your production adversely affected during training ? Yes/No

7. Did the students solved the assigned problems ? Yes/No

8. Did the faculty co-operate in solving the problems ? Yes/No

9. Do you feel that the students were lacking in knowledge about the problem solving ? Yes/No

10. Did the interface improved your
   a) Working Yes/No
   b) Production Yes/No
   c) Economic conditions Yes/No

11. Do you prefer to have consultancy from the faculty of the institute ? Yes/No

12. Did the students remain disciplined throughout the duration of training ? Yes/No

13. Did this training help in reducing waste? Yes/No

14. Do you feel it necessary to have refresher courses for your staff in the Polytechnics ? Yes/No

15. Do you feel that the diploma should be awarded after industrial training ? Yes/No

16. Do you feel, that you should be associated for conduct of practicals and paper setting of polytechnics ? Yes/No

17. Do you feel that the industry should hold the campus interviews ? Yes/No

18. Do you feel that the curriculum revision is necessary with the changing technology ? Yes/No

19. Was this training helpful in developing entrepreneurial skill in the students ? Yes/No

20. Do you feel that the training will improve the employment opportunities? Yes/No

21. Will you prefer to employ the student trainees (who got training in your organisation) in your enterprise after completion of his diploma ? Yes/No

22. Have you assigned some additional problem then the problem bank ? Yes/No

23. What is your overall impression about the training ? ____________

____

APPENDIX - 11

Directions/Suggestions/Questions for training in World of Work

1. Describe the short history of the organisation. Location Transportation route, site layout and name of the organisation executing the work.

2. State information pertaining to the work in which you are taking training.

3. Give details of the material used in the works.

4. Draw a schematic flow diagram of the working procedure of work.

5. Name the equipment with specification used and its availability from different sources.

6. What are the various electric motors and drives used in the plant under consideration?

7. What type of the valves and pipes are used?

8. Describe the time standards fixed for each job.

9. How may shifts are worked for the entire work ?

10. Does the payment to the worker differ shift wise?

11. In terms of difficulties like transportation facilities, food timing, etc.; are there any problems for workers to arrive or leave the site before time?

12. What arrangements exist in the site for storing the different materials?

13. Is it a sub-store or central store?

14. Study how these stores are arranged and maintained.

15. Describe procedures adopted in the stores for the receipt of materials goods, components, etc. and documentation of the same.

16. What is the system by which the inventory is controlled?

17. What is the store issuing procedure?

18. What are the precautions observed for the safety of the stores?

19. What is the system for indenting the spares required by the maintenance department ?

20. How are the materials and financial ledgers updated?

21. Are there any delays in the issue of materials? If so, what are they?

22. Describe the routine set up inside the site for the quality control and inspection of the construction items.

23. Study the reports of the testing laboratory?

24. Name the instruments used for inspection?

25. How are physical attributes like allignments, sequences, parallelism, true cylindrical surface, true flat surface, etc. checked?

26. Study the size of grading of aggregates, strength tests on concrete cubes?

27. Describe the quality in terms of appearance, stage checks, shapes sizes etc.

28. Does the construction unit under study has its own testing unit?

29. What is the time taken for testing the cubes?

30. Know the various quantitative techniques used in the evaluation and selection of works.

31. Does the world of work has any linkage with the Institute?

32. List the various measuring instruments and control devices observed in the construction unit. Also describe the principle of operation for each of them.

33. What are the various corrective methods for improving the progress and quality of the work?

34. Is there any wastage of the material? Give details.

35. Is there any consultancy service?

36. How the drawings are interpreted at the site of work?

37. What is the procedure to execute the work according to the drawings?

38. Draw an organisation chart for the whole organisation responsible for the work execution indicating the level of authority, span of control line and staff functions.

39. In the course of your study, superimpose on the formal organisational chart, the informal organisation structure existing. Indicate the deviations.

40. For each sub-system draw a detailed organisation chart.

41. Study the attitudes of workers to change in the progress of work.

42. How is the working affected by the presence of higher level authorities?

43. What are the documents/cards memos required to be sent whenever a assistance is required from other departments/sections?

44. Who prepares these documents/records?

45. What is the final disposal of the record?

46. Which are the departments/officers who give remarks and sign on these documents?

47. What is the mechanism by which a review of control of the work is undertaken?

48. Study at varous levels the communication net work apart from the dak system.

49. Study the organisation of coordination meetings at various levels where the problems are discussed everyday, every week, once in a month. How are the decisions taken in such meeting communicated to all those who are to take the action?

50. Study and describe the form and structure of letters and memoes in terms of the following:

(i) Requisiting materials, (ii) Requisiting information, (iii) Requisiting appointments, (iv) Requisiting approval, (v) Placing order by letters, (vi) confirming oral aggrements, (vii) Responding to the labourers complaints, (viii) Responding to the executives absence, etc.

51. List various auxillary services required from the bridge.

52. Study the project schedule network describing activities till the commissioning stage for the construction activity under reference.

53. Names of design and consultancy organisation which assisted in the completion of the project durng the project implementing stage.

54. Number of the staff of the following categories:-

Manager, Assisstant Manager, Technician, Skilled Un-skilled, laboratory staff.

55. Study of the improvements of roads to facilitate traffic movements.

56. Study the establishments of first aid, telephone facilities, canteen, etc.

57. Study the maintenance of the by-pass roads.

58. From the study of project, describe the various items that go to design the project cost till the stage of commissioning.

59. Any other information related with trainiong and not covered in (1 to 58).