

Curriculum Development for Polytechnics

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Curriculum Development for Polytechnics

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Foreword

Curriculum Development Centre of this Institute was established in 1971 and has since then been very active for providing assistance to the Directorates/Boards of Technical Education in meeting their curriculum development needs. Over the years, the Institute has been instrumental in formulating norms and standards for the polytechnics, conducting competency profile studies of diploma engineers, identification of institutions and programmes, undertaking projects for design/revision of curricula in engineering and technology and other vocational disciplines by using a systematic approach. The Centre has also promoted innovations like introduction of Multi-Point Entry and Credit System in some of the selected polytechnics of the region so as to provide flexibility in programme offering.

There was no appropriate instructional material in the field of curriculum development which may be suitable for technical education system. Keeping this in view, the faculty of curriculum development centre of this institute has brought out this publication to provide basic material for understanding various stages of curriculum development viz design, implementation and evaluation. Every effort has been made to make the text as simple as possible for easy understanding.

It is hoped that this publication will be very useful for the technical teachers and officials of Directorate/Board of Technical Education in the country. Suggestions for improving this publication are most welcome.

January, 1999
Chandigarh

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Preface

This publication has been developed by the faculty of Curriculum Development Centre of Technical Teachers' Training Institute, Chandigarh with a view to:

1. Creating understanding regarding various aspects of curriculum development
2. Creating awareness amongst technical teachers regarding domains of learning for developing desired competencies in the students
3. Appraising the teachers regarding various stage of curriculum development and the role of the institutions in effective curriculum processes viz planning, designing, implementation and evaluation
4. Educating and training the teachers in the process of curriculum development, instructional strategies and evaluation techniques leading to effective curriculum implementation and evaluation
5. Creating awareness regarding networking between the institutions and the world of work for work integrated learning and sharing physical and human resources for effective curriculum processes
6. Creating understanding regarding curriculum evaluation strategies for bringing about modifications in the curriculum
7. Discussing various aspects of academic planning at institute and department levels

This book has been written keeping in view the applied aspects. Effort has been made to use simple language so that teachers are able to derive maximum benefit and make teaching–learning process meaningful. Suggestions for further improvement are most welcome.

The authors are grateful to Professor KB Raina, Professor MM Malhotra, Professor TR Ramanna, and Late Professor AL Jain former professors of Curriculum Development Centre and former Principal, Professor PD Kulkarni for their valuable contribution in the field of curriculum development.

The authors are also grateful to Dr SK Bhattacharya, Principal, TTTI, Chandigarh for his encouragement in bringing out this publication.

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1. Technical Education in India

1.1 Introduction

Technical education is one of the most significant component of the human resource development spectrum with great potential for adding value to products and services, for contributing to the national economy and for improving the quality of life of the people. In recognition of the importance of this sector, successive Five Year Plans laid great emphasis on the development of technical education.

Technical education in India can be considered essentially operating at three levels, namely: Certificate level training in various trades; Diploma level education and training in a variety of engineering/technological and other vocational disciplines; and undergraduate and post–graduate education in a number of engineering/technology disciplines.

The first level of technical education at the certificate level produces skilled workers for industry. Such training is offered by the Industrial Training Institutes (ITIs). The entry to such training is possible after general school education of 10 years in a majority of cases, though in some trades, students who have completed 8 years of schooling are also admitted. This training scheme is looked after by the Ministry of Labour at the Centre and certification is done by the Directorate General of Employment and Training (DGE&T) at the national level. Directorates of industrial training at the state level look after the operation and administration of the scheme.

Certificate level training is also supplemented by +2 vocational courses, under the 10+2 pattern of education. In addition to engineering trades, vocational courses are offered in the major areas of agriculture, business, commerce, health, paramedical, home science and humanities. The National Council for Vocational Training at the national level and the Directorates of Vocational Education at the state level look after the planning and operation of this scheme.

The second level of technical education is the diploma programmes offered at the polytechnics and aimed at producing diploma engineers, who are mainly responsible for managing shop-floor operations. Admission to such programmes is available after 10 years of schooling. Diploma programmes are classified under the following three categories:

- (a) Diploma programmes in engineering and technology like: civil engineering, electrical engineering, mechanical engineering, electronics and communication engineering, production engineering, leather technology, textile technology, plastic technology etc.
- (b) Diploma programmes in other vocational fields like: modern office practice, garment fabrication, beauty culture, library science, medical laboratory technology etc
- (c) Diploma programmes in applied arts/crafts like: interior design, architectural assistantship, commercial practice etc.

The above programmes are offered essentially through one of the following modes:

- Fixed and linear modes (Full time programmes)
- Multipoint Entry and Credit System (MPECS)

Duration of full time programmes is generally three years after 10+. In some cases, like modern office practice, computer engineering etc., All India Council for Technical Education (AICTE) has raised the entry qualification from 10+ to 10+2. Some of the diploma programmes in vocational disciplines are of 2 years duration also.

A few polytechnics offer diploma programmes on sandwich pattern. In sandwich programme, industrial training is interlaced in between academic studies. The duration of these programmes is generally three and half years with two semesters of training in industry.

Some polytechnics situated in industrial belts or big towns offer part time diploma programmes to facilitate continuing education of working craftsmen or for those engaged in industry/field having 10+ qualification. These programmes are of four year duration. Classes are held during evenings for about 15 hours of contact per week. A small percentage of polytechnics also offer post diploma/advanced diploma programmes in specialized areas. The duration of these programmes is one and half years and two years respectively after a diploma programme.

The products of this level are employed in wide ranging functional areas such as drafting, estimating, production, construction, erection, inspection, quality control, marketing and servicing etc. While the planning, promotion and control of this sector of technical education rests with the All India Council for Technical Education and the Bureau of technical education in the Ministry of Human Resource Development at the national level, it is essentially operated at the state level by the Directorates of Technical Education and the State Boards of Technical Education.

The third level of technical education at the under-graduate and post-graduate levels is available in engineering colleges and institutes of technology, producing professional engineers. The programmes offered in broad-based and diversified disciplines at the under-graduate level are of 4 years duration after higher secondary education i.e 10+2 years of schooling. Programmes at this level are affiliated to different universities, which come under the purview of University Grants Commission or are offered by deemed technological universities/institutes.

In addition to the formal system of acquiring certificate, diploma, degree and higher qualifications, a non formal system of education run by professional bodies like Institution of Engineers, Institute of Electronics and Telecommunication Engineering, Computer Society of India etc also provide opportunities to specific target population for acquiring these qualifications.

The technical education system in the country is diagrammatically represented by a skeletal structure which is shown in Figure 1.1

1.2 Organisational Structure

Education is a state subject. It is managed by national and state level bodies for meeting present and future demands of the country and states respectively. According to AICTE, technical education includes areas of engineering and technology, architecture, town and country planning, pharmacy, hotel management and catering technology etc.

The organisational structure of technical education at national and state levels is briefly described below:

1.2.1 At National Level

a) *All India Council for Technical Education (AICTE)*

At the national level, All India Council for Technical Education (AICTE) is the apex body established by the Act of Parliament in 1987 as a statutory body for providing leadership in planning, promoting and regulating technical education in the country. The functions of AICTE are:

- Assessment of technical manpower needs – present and future
- Reconciliation of differing perceptions of needs at different levels
- Providing match between demand and supply
- Coordination and integration of technical and management education development plans at Central/Regional level
- Effective quality improvements through scientific curriculum processes, instructional material development and teacher training
- Formulation and periodic review of norms and standards for programmes, resources, staff etc
- Formulating guidelines for promoting innovation, research and development
- Toning up management structures and granting autonomy to institutions
- Formulating guidelines for grants and funding of priority areas
- Establishing mechanisms for enforcing maintenance of norms and standards
- Accreditation and recognition of institutions and programmes
- Continuous monitoring and evaluation of planned thrusts

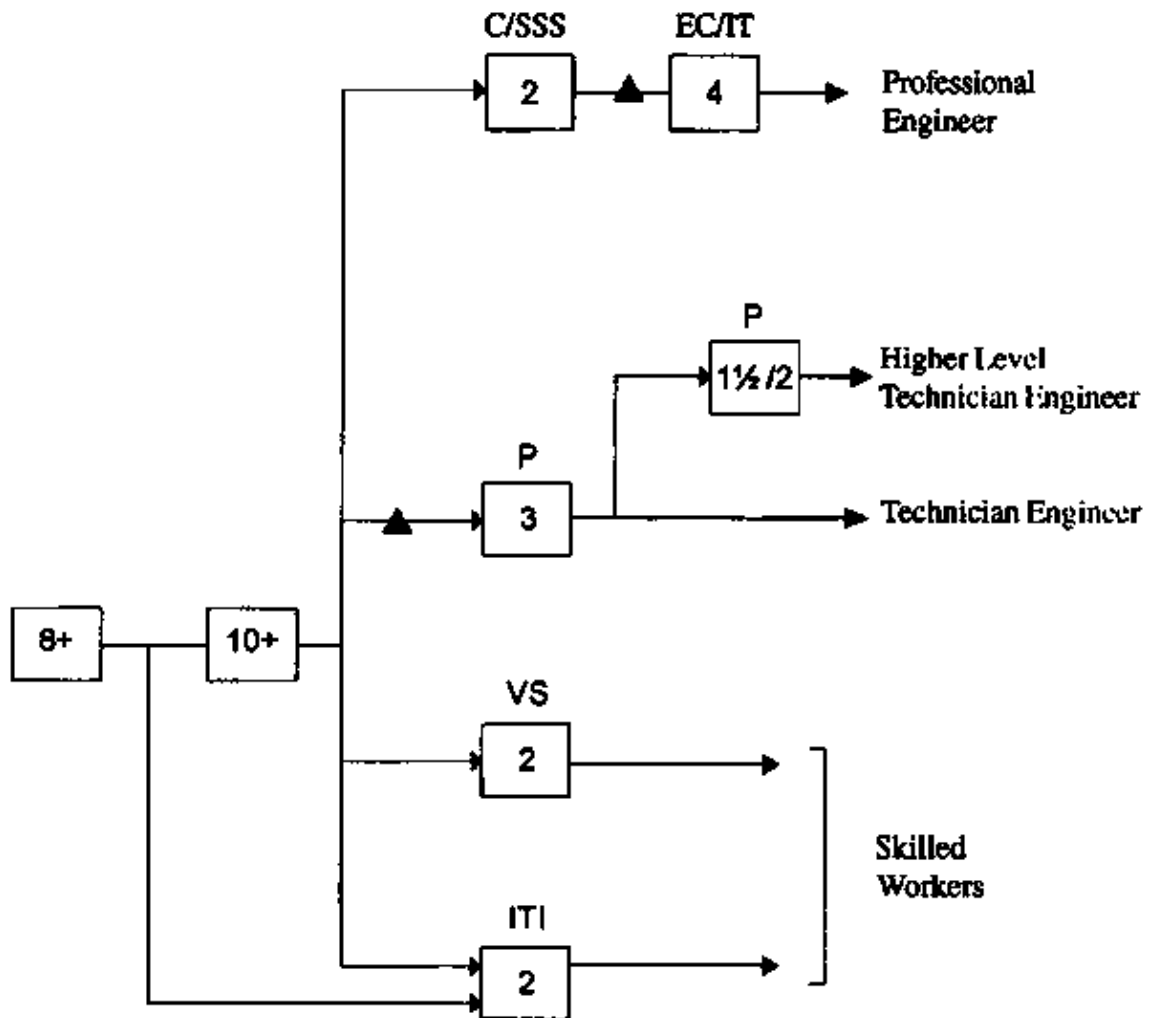


Figure 1.1: Technical Education System in India

- ITI Industrial Training Institute
 VS Vocational School
 P Polytechnic
 C/SSS College/Senior Secondary School
 EC/IT Engineering College/Institute of Technology
 ▲ Entrance Test

The AICTE, assisted by its Boards and Regional Committees have been vested with statutory powers by an Act of Parliament, to ensure pursuance of its policies more vigorously.

b) All India Boards of AICTE

AICTE has presently several All India Boards of Technical Studies. Some of those are listed below:

- All India Board of Architecture Education
- All India Board of Computer Science, Engineering, Technology and Applications
- All India Board of Hotel Management and Catering Technology
- All India Board of Management Studies
- All India Board of Pharmaceutical Education
- All India Board of Technician Education
- All India Board of Under-graduate Studies in Engineering
- All India Board of Post-graduate Education and Research
- All India Board of Town and Country Planning Education
- All India Board of Vocational Education

Each of the above Boards takes care of planning, promoting and regulating education in the respective areas.

The main functions of the respective Boards are:

- Assessment of manpower needs in the country
- Development of educational plans to train manpower in the respective areas
- Preparation of guidelines for states and union territories for improvement and development of respective areas
- Design and periodic review of model curricula in existing and emerging areas
- Formulation and periodic review of norms and standards
- Promotion of quality improvement, innovation, research and development in the respective areas
- Promoting autonomy to institutions
- Identifying priority areas for funding
- Monitoring and evaluation in the respective areas

c) *Coordination Committee/Regional Committee of AICTE:*

AICTE has set up a coordinating committee which acts as executive body of the council and discharges functions on its behalf on urgent and important matters. It has also set up seven regional committees for performing the general functions as assigned to AICTE and to supervise the work of technical institutions in the region in co-operation with state governments. Some of the major functions of regional committees are:

- to survey facilities for technical education in all the states and union territories in the region
- to promote liaison between technical institutions and industry
- to review critically academic aspects of training
- to render advice and guidance to technical institutions within the region in respect of finance and other matters
- to make recommendations to AICTE for the expansion of technical education through provision of facilities in respect of diploma, undergraduate and post graduate courses

As state engineering colleges are affiliated to universities, these institutions follow the norms and standards laid down by the UGC and the AICTE. To coordinate policies for the growth and development of technical education at degree and post-graduate level, UGC accepts the policies of the AICTE for the matters connected with technical education. Chairman UGC is a member of the AICTE.

The National Technical Manpower Information System (NTMIS) at the national level, with its lead centre located at Institute of Applied Manpower Research (IAMR) and nodal centres in the states, supply data needed by the AICTE in manpower assessment and planning.

d) *Bureau of Technical Education*

The Bureau of technical education in the Ministry of Human Resource Development, Government of India has dual role to play. The first and foremost role is of advisory nature regarding proper growth and development of technical education in the country. This department takes care of the policies of Government and financing the AICTE and represents on its various Boards. The other important role is executive in nature and relates to the processing, implementation, monitoring, controlling and evaluation of programmes and projects in central institutes, centrally sponsored schemes.

1.2.2 At State Level

a) *State Departments of Technical Education*

The state departments of technical education are responsible for planning, management, administration and funding of technical education in the state. However, providing policy directions, setting norms and standards, initiating schemes for quality improvement and coordinated integrated development fall under the purview of AICTE/department of technical education.

b) *State Directorates of Technical Education*

Each state has a State Directorate of Technical Education which undertakes the following broad functions:

- Identification of state manpower needs and programmes
- Preparation of plans for starting new programmes under the policies laid down by the AICTE
- Working out resource requirement and planning for infrastructure development
- Development of human, physical and instructional resources
- Introduction of innovations and developments
- Formative and summative evaluation of institutions and programmes

In some of the states, polytechnics and engineering colleges are under the administrative control of State Directorates of Technical Education. Engineering colleges are affiliated to universities for conduct of examinations and award of degrees and polytechnics are affiliated to State Boards of Technical Education.

c) *State Boards of Technical Education*

State Boards of Technical Education are generally functioning as part of state directorates of technical education. Their main functions are:

- Design and review of curricula
- Lay down norms and standards for technical education
- Conduct examinations
- Award for various diploma, post-diploma and advanced –diploma programmes
- Maintenance of quality of education and training imparted in polytechnics

1.3 Examination and Certification

a) For the polytechnics, state boards of technical education lay down curricula, conduct examinations and award diplomas, post-diplomas and advanced diplomas for various programmes offered by the polytechnics.

b) All the state engineering colleges are affiliated to state universities which conduct examinations and award Bachelor's and Post-graduate degrees for various programmes in engineering and technology.

c) Regional engineering colleges (RECs) are affiliated to state universities for the conduct of examinations and award of Bachelor's and post-graduate degrees for various programmes offered by these colleges

d) Indian Institutes of Technology (IITs) are deemed universities. These institutes conduct their own examinations and are empowered by an Act of Parliament to award their own bachelor, post-graduate and doctoral degrees.

In addition to IITs, there are some selected institutions which have the status of deemed university. These institutes conduct their own examinations and award bachelor and post-graduate degrees.

e) ITIs come under the control of the DGE&T. All examinations and certification for ITI trade courses is done by the DGE&T.

1.4 Accreditation

At present, accreditation of institutions and programmes is being done by special committees appointed by AICTE/Regional Committees from time to time. A National Accreditation Board under the AICTE has also been set up for accreditation of institutions and programmes.

After this brief introduction of technical education system, next chapter deals with various aspects of technical education in response to future manpower requirement.

2. Technical Education in Response to Future Manpower Requirements

2.1. Introduction

Every country develops its own system of education taking into account its unique socio-economic and cultural identities and also to meet the challenges of times so as to ensure that the fruits of change reach all sections of society.

The National Policy of Education – 1968 marked a significant step in the history of education in post independent India. It aimed to promote national progress, a sense of common citizenship and culture and to strengthen national integration. It laid stress on the need for a radical reconstruction of education system, to improve the quality at all stages and gave much greater attention to science and technology, the cultivation of moral values and a closer relation between education and the life of people.

National Policy on Education – 1986 laid great emphasis on quality improvement, expansion of technical education facilities in new and emerging areas of technology and making technical education accessible to special sectors of population consisting of rural population, working population, women, handicapped and other weaker sections of society.

Government of India, since 60's initiated number of steps to revamp technical education with a view to make it relevant to the requirements of world of work based on the recommendations of various seminars and symposia at national and state levels and that of task groups set up by the Ministry of Human Resource Development.

Direct central assistance was provided to technical institutes at all levels to remove obsolescence in the equipment and information resources and develop infrastructure in emerging areas of technology not covered under state plans.

Setting up of quality improvement centres in some selected institutions was also a step to promote continuing education of teachers, development of curriculum and production of appropriate instructional resources.

Establishment of Technical Teachers' Training Institutes (TTTIs) with a view to improve the quality of polytechnic education by means of training teachers, designing curricula, preparation of instructional resources, rendering extension and consultancy services and undertaking R&D projects leading to quality improvement in the polytechnics.

In 1994, the Government of India launched the project of strengthening technician education* in India with the assistance of World Bank as important follow up of the National Policy of Education – 1986. The project aimed at:

- a) *Capacity Improvement* – by expanding and diversifying programmes in the polytechnics; establishing continuing education centres, strengthening community polytechnics etc.
- b) *Quality improvement* – through modernizing laboratories and workshops, intensifying teacher training, updating curricula etc.
- c) *Efficiency Improvement* – by way of strengthening structures like Directorates/State Boards of Technical Education, promoting industry-institute interaction, encouraging internal resource generation etc.

* The term technician education is being used for polytechnic education. In the Indian Context, the term technician is generally used for craftsmen. To avoid this confusion and to provide polytechnic passouts a distinct identity, it may be worthwhile to designate such persons as diploma engineers or technician engineers.

With the opening of Indian economy since 1991, multi-nationals and other foreign investors started entering in the industrial scenario leading to changed manpower requirement. Also, the Indian industry and service sector are becoming quality conscious to compete in the national and international market. Hence the manpower requirements at different levels would undergo a tremendous change. Policy formulators related to human resource development have to ponder over again and carefully devise strategies to meet the changing manpower requirements.

2.2 Pattern of Technical Manpower

Technical manpower requirements in terms of number and type is dependent on the state of development in a particular country. This has been shown in figure 2.1 which provides comparative number of different type of manpower required for an under developed, developing and developed countries. An analysis of employment pattern in an underdeveloped country indicates 'Pagoda Shape' structure of technical manpower in which semiskilled, skilled workers, diploma engineers/technician engineers requirement is much larger as compared to graduate engineers and innovators.

In the case of a developing country, cone shaped structure provides an idea of proportionate changes in the type of manpower required. Here innovators, engineers and technician engineers proportion is comparatively larger than underdeveloped countries.

While in a developed country, number of innovators, managers and technician engineers is still greater as compared to developing country.

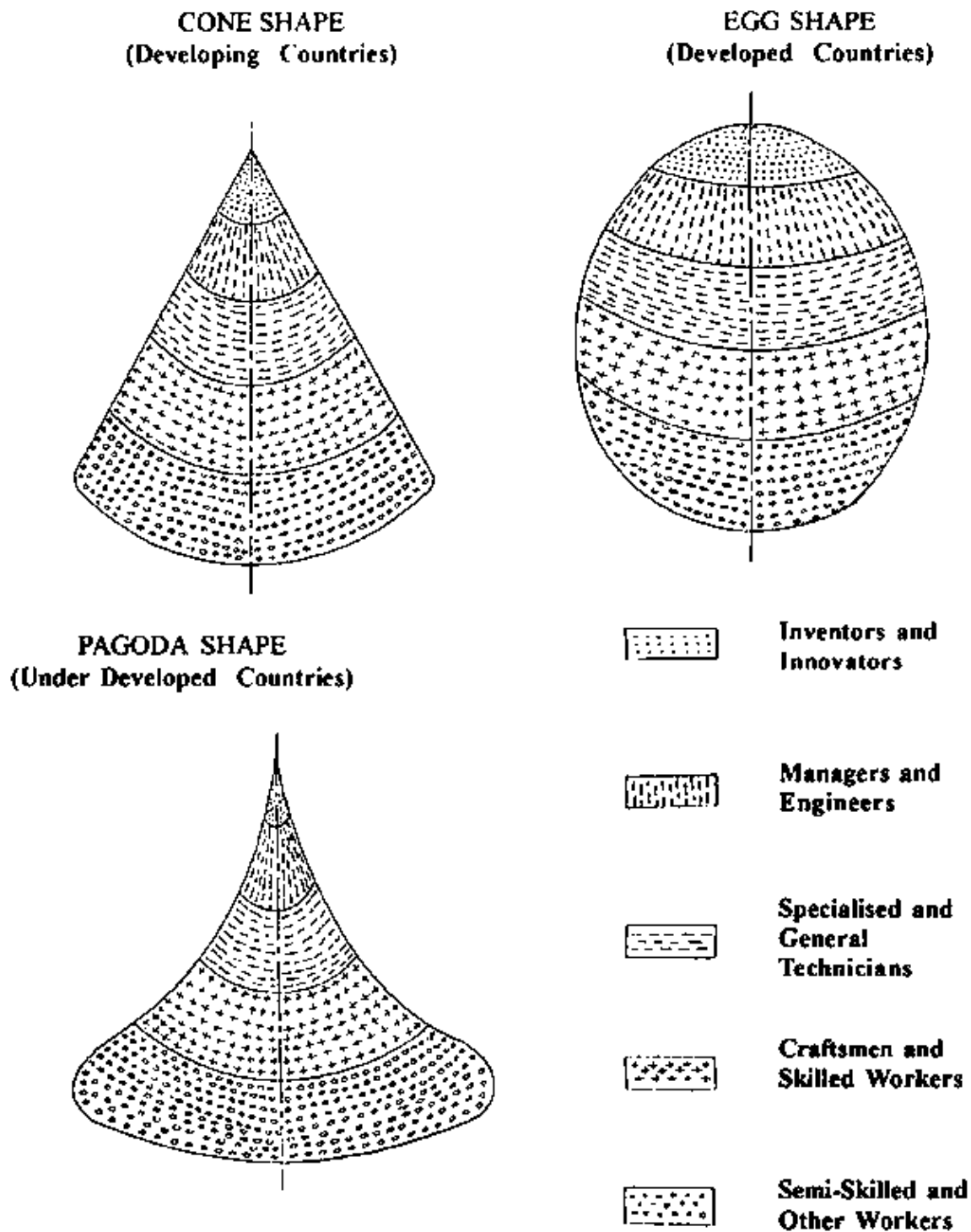


Figure 3.1: Structure of Technical Manpower

In India, we are at an intermediary stage between a developed and developing country. Hence the technical manpower requirement can be predicted in the following proportion:

– Innovators	9 to 10 percent
– Engineers	12 to 15 percent
– Technician Engineers/Diploma Engineers	20 to 25 percent
– Skilled and semi skilled workers	40 to 50 percent

In industrial restructuring, technology advancement is one of the major dimensions. It helps in increasing production efficiency and at the same time help in generating new technology and industry.

In order to achieve this, technologies are to be acquired, utilised, diffused, adapted, improved and developed. For doing this, appropriate human resources with the required capabilities* are to be made available. For human resource development, these capabilities can be identified as:

a) Acquisitive Capability

The capability to acquire technologies depends on the ability to search for, assess and transfer technologies for effective functioning in various functional areas like: R&D, design and drawing, planning, shop-floor management, quality control operations, repair and maintenance, marketing and sales etc.

b) Adaptive Capability

This relates to the ability to modify existing production process or product design so that the process is better adapted to local factors and the product reflects local market preferences.

c) Operative Capability

This involves production know how, knowledge of codes and standards production management, production engineering, diagnostic skills, communication techniques and interpersonal skills.

d) Innovative Capability

This involves the ability to anticipate future demands and to develop new designs, processes and technologies.

* Abstract from "Study in Human Resource Development – Its Technological Dimensions" – Economic and Social Commission for Asia and the Pacific Inter-Government meeting report – 1986. (Figure 2.1 has also been taken from this study).

In future, a strong R&D infrastructure, development of high quality scientists and engineers to undertake R&D work for promoting innovations and new technologies will be required.

The category of technical manpower is also dependent on the nature of technology involved. Some technologies will need a strong base of sciences. In the case of some other technologies, the requirement may be a strong practice base.

In order to achieve competitiveness with advanced countries, human resource development policies have to be changed. The curricula are to be made dynamic to take into account changes in technologies by introducing electives. Development of learning-to-learn skills, problem – solving skills, interpersonal and communication skills, competency in making use of computers for various engineering applications will be called for.

The basic formal education acquired by an individual in any category of manpower spectrum will become obsolete over a period of time due to changes in technologies. Continuing education for all categories of manpower will be required, if industrial restructuring is to be successful. This would mean that institutions should have to offer courses on short term and long term, formal and informal basis to update the available work force.

The new technologies of significance to industrial restructuring have close association with basic scientific knowledge and cognitive abilities. In other words, the adoption and development of such technologies will require greater generic skills which are normally acquired through higher levels of formal education.

In future, knowledge-skill profile of technical manpower will change; greater number of appropriately trained manpower will be required for infrastructure and service sector and information technology.

The capabilities such as innovative, acquisitive, adaptive and operative will be needed in the top, middle and operative levels of manpower.

2.3 Education and Training Needs

In order to boost up economic development and improve productivity, India, like many other developing countries has adopted the policy of globalisation. The new policy is expected to create a congenial environment, which will lead to setting up of new industries both by foreign and domestic investors. It has been assumed that the open market policy will also compel the existing Indian industry to take steps to modernize their infrastructure and improve productivity so that they can survive in the competitive market. The new industries and modernization of existing industry will invariably use new technology based on micro electronics and will need technical human resource to possess knowledge of handling computer softwares, information technology tools and ability to handle sophisticated equipment like robotics, computer aided design and manufacturing techniques and high order cognitive abilities for reasoning and innovation.

2.3.1 Training Needs for Organised Sector

Keeping in view high degree of competition in the national and international market due to dual criteria of cost and quality, it is imperative that high degree of automation has got to be adopted on the shop floor. The technical manpower at different level has to be well versed with information technology tools like MS Office, MS Project, Auto CAD, CAD–CAM Packages in addition to the use of Fax, modem and scanners etc. Therefore, technical manpower at different level will have to undergo sufficient training in electronics and computer applications so as to face the challenge of technology upgradation on the shop floor.

It will also be desirable to have strong foundation for applied sciences, engineering sciences and mathematical tools, so that technical human resource is able to adopt, adapt and innovate technologies for industrial development.

For organised sector, it will be essential to offer broad based programmes, so that technical human resource at different levels can be made to work in any functional areas, may it be R&D, design, planning, manufacturing, quality control operation, maintenance, marketing and sales and general administration.

It should be understood that this sector of employment will require technical human resource of all categories with different capabilities as stated in section 2.2

2.3.2 Training Needs for Un-organised Sector

Unorganised sector primarily deals with serving the community to provide repair and maintenance and other services as per felt needs, may these be repair of auto vehicles, electronic equipment, electrical gadgets, dress making, reprographic services, house keeping, photography/videography, shoe making, plumbing and allied services and building services.

Indian educational system so far has been planned and organised primarily to cater to the needs of organised sector. It mainly provides wage employment opportunities. Though efforts are on to promote vocational education to cater to the needs of unorganised sector and provide opportunities of self employment. India is fast developing and the hand skill are being replaced by machines. Also, the society has already started demanding high quality services. In the times to come, India will need highly skilled work force as well as technician engineers, who have diagnostic capabilities and are able to provide repair and maintenance services of first order to the community. For this purpose, the existing paper pencil type of training will be changed to. more skill oriented training making use of sophisticated equipment and machines, aided by computer know how to discharge above functions. In fact, in the times to come, these technically trained people will have much greater demand than those required in the organised sector.

2.4 Planning Considerations

The whole exercise of manpower planning is dependent on the demand and supply of technical manpower possessing specific knowledge, skills and other competencies to meet the short and long term employment needs.

While ascertaining manpower needs, the focus is generally on manufacturing sector, which provides only a part of employment opportunities. In the times to come, plenty of jobs will be available in the tertiary sector i.e. service sector which primarily deals with repair and maintenance; construction, commercial, transportation, banking, defence, education and social sectors of employment.

If the requirement of manpower in a particular occupation is quite large, then starting full time programmes may be viable. When the employment opportunities are of short range nature, then including such technologies in the existing programmes or offering continuing education programmes to upgrade knowledge and skills of working people can be another viable proposition.

Before proposing new institution and the programmes, it is essential to look into feasibility considerations which include availability of financial resources, societal requirements for growth and development, climatic conditions, availability of technically qualified persons for recruitment as faculty and Conducive environment for networking and sharing resources.

Another factor which should be considered is the optimum utilisation of resources so that infrastructure created is usable for implementing various programmes and the faculty should also have opportunities of horizontal and vertical mobility from one department to another by offering programmes in a flexible multi–point entry and credit system.

2.5 Educational Implications

Following are some of the implications of future technical manpower development:

(1) Offering Programmes on Cooperative Education Basis

In the fast changing technological scenario at work places, it would be practically impossible to keep pace with the developments of technology by adding more and more infrastructure in the technical institutes. It would be desirable that in the times to come, specific group of industries will be called upon to collaborate with a technical institute in the design of curriculum and its implementation. A plan of mutual collaboration has got to be worked out for sharing physical, human and informational resources for mutual benefit. Involvement of students to undertake minor and major project assignments in cooperative organizations should form essential component of curricula without increasing the duration of programmes.

(2) Flexibility in Programme Offering

Keeping in view varied requirement of technical manpower development through formal and non–formal programme, the design of the programmes will have to be flexible to provide entry of students from different streams and levels of education. To accommodate different pace of learning, vertical and horizontal mobility of manpower, multipoint entry and credit system will have to be introduced. Electives will have to be offered in last two semesters to take care of technology upgradation.

(3) Teaching–Learning Process and Preparation of Learning Resources

The present system of teaching–learning in the majority of technical institutions is highly teacher centred. The shift must take place to make teaching – learning process more student centred by way of tutorial assignments, well planned laboratory and workshop experiences and learning through project assignments. This will indeed require extensive training of teachers. Preparation of appropriate learning resources will be an important educational implication.

(4) Training the Faculty

Because of high degree of automation on the shop–floor, use of computer in productivity, automation and management has become essential. Teachers are supposed to be computer friendly for making use of computer software packages like CAD–CAM, Auto CAD, MS Office, MS Project, use of Fax, Modem, Scanners etc. A deliberate Scanners, Modem programme of action to train teachers in computer applications will be the need of the day. In addition to above, industrial training of teachers in emerging areas of technology, educational

technology, curriculum development, entrepreneurship development will be called for.

(5) Examination System

Teaching–learning process in any institute will depend on the type of examination System. The thrust of today's examination system is primarily on memory oriented learning. Examination of students should focus on development of competencies. The present paper and pencil type examination may have to be substituted by well organized objective type questions, short answer questions, project oriented examination followed by viva voce examination by experts from industry and faculty of technical institute.

To conclude, there is need to revamp technical education at different levels for meeting the challenges of technology development at work places.

3. Curriculum – An Overview

3.1 Introduction

In the history of technical education, development of curriculum on scientific basis is relatively new. There are a few countries in which curriculum development activity for technical and vocational education is carried out systematically on regular basis. There is need to look curriculum development in the context of socio–economic developments in a particular country, which keep on changing from time to time. Thus, curriculum development needs a scientific approach for taking into account present and future socio–technological development scenario.

It has been experienced the term 'curriculum' is not understood properly by majority of teachers and administrators. Mostly, the term curriculum and syllabus are used interchangeably. Hence, it is important to define both the terms, for facilitating clear understanding between the two.

3.2 Concept of Curriculum

Many authors have defined curriculum in varying contexts. A review of literature produced by various writers reveals marked differences in the way each perceives and defines the term curriculum.

Taba Hilda (1962) stated that a curriculum usually contains a statement of aims and objectives, it indicates some selection and organization of content, it either implies or manifests certain pattern of learning and teaching, because the objectives demand them or because the content organization requires them. Finally, it includes a programme of evaluation of the outcomes.

Saylor (1966) stated that curriculum encompasses all learning opportunities provided by the school.

Johnson (1967) described the term curriculum as "structured series of intended learning outcomes".

Burns and Brooks (1970) stated that a curriculum is a plan for arrangement of information and experiences which educator consider necessary for children to cope successfully in life. It is further stated that curriculum is defined as everything that is planned to happen to a learner with a view to enhancing, investigating or modifying predetermined behaviour.

Jenkins David et. al., (1976) expressed that a curriculum is the formation and implementation of an educational proposal, to be taught and learned within a school or other institution, accepts responsibility at three levels, its rationale, its actual implementation and its effects.

Rubin (1977) stated curriculum to encompass the total impact of the school environment on the learner.

Lawton Danis et. al., (1978) defined curriculum as all the learning which is planned and guided by the school, whether it is carried out in groups or individually, inside or outside the school. He divides the curriculum into four aspects: curriculum objectives; knowledge; learning experiences; and curriculum evaluation.

Doll (1978) expressed that curriculum emphasizes guided, pre-selected experiences to which children and youth should be exposed; plans for learning; ends and outcomes of being educated and system for achieving educational production.

Harris et. al., (1978) stated that the term curriculum is used in a broad sense to include the totality of what is to be taught in school, the relationship between subjects, teaching materials, teaching methods, technological and other aids and organization of teaching learning.

Tanner Daniel (1980) stated that curriculum is planned action for instruction.

Burshoff (1981) stated that curriculum is an education project defining goals, aims and objectives of an educational action; ways, means, activities employed to achieve these goals; method and instruments required to evaluate the success of the action.

According to UNESCO, curriculum is an organized programme of both theoretical and practical studies, the successful completion of which is considered necessary to achieve specified educational goals corresponding to different levels of knowledge and qualification.

A publication of CPSC (1982) stated that curriculum of a course has been defined as an educational programme designed and implemented to achieve specified educational objectives.

Choate, Joyce (1987) stated that the curriculum is that set of courses and instructional experiences afforded to students.

Taking above into consideration, curriculum is viewed as a plan of intents about the learning outcomes, the processes (instructional and managerial) and resources in terms of physical, human, financial, informational etc. designed and implemented to attain the specified goals of an educational programme for specified learners.

In other words we can say that curriculum is a written document of an educational programme which states educational objectives, details out integrated sequence of curriculum areas(subjects) and detailed contents, recommends learning experiences to be given to students and methodology of student evaluation for achieving the objectives in a stipulated period for a specific group of learners.

The term 'syllabus' is only a part of curriculum which means what is to be taught i.e. detailed contents comprising of concepts, principles, procedures and practices to be taught to students, where as curriculum is a broad term which not only contains syllabus but the complete plan of action of teaching-learning, including student evaluation directed to achieve defined objectives in a stipulated time frame.

From above, it is clear that curriculum of a programme is an important document based on which entire teaching-learning process is planned to prepare suitable technical human resource. Curriculum is important for the learner to understand the scope of study; for the teacher to know what and how to teach and select appropriate learning experiences to be given to student for developing desired competencies in them, industry to understand the type of manpower and competencies possessed by the pass outs from a programme and to facilitate Universities/State governments/Directorate of Technical Education for planning physical, human, informational and financial resources for effective implementation of the curriculum. It also facilitates the Universities/State Board of Technical Education to conduct examinations as per laid table of specifications for achieving desired levels of competencies.

3.3 Characteristics of Curriculum for Technical Education Programmes

The curriculum for technical education has some special characteristics. These are briefly described below:

a) Data Based

The curriculum for technical education should be based on long and short range manpower requirement. Decisions about whether or not to offer a curriculum should be based upon related data. Curriculum contents can not be worked out until the characteristics of students and the nature of occupation for which they are trained is clearly known.

Hence, for taking appropriate curriculum decisions, following type of information will be quite useful:

- Employment opportunities
- Present and future technology development trends
- Activity/competency profile of specific target group
- Existing facilities of technical education
- Availability of appropriate environment for effective implementation of curriculum
- Availability of appropriate human resources and instructional resources etc

b) Dynamic

The curriculum of technical education has to keep pace with technology development at work places. Hence, curriculum for technical programme should be dynamic, making provisions for bringing modifications from time to time.

c) Fully Articulated

It is essential that there should be integrated sequence of organized learning experiences to be given in a logical and chronological order of learning so as to achieve desired objectives in stipulated time for a specific target group of learner.

Curriculum articulation may involve the resolution of content conflicts across different areas or development of a logical instructional flow from one semester to other. Articulation may extend to determine the ways and means the co-curricular activities lend support to the rest of curriculum.

d) Realistic

The curriculum of technical education cannot operate in vacuum. If the students are to be prepared for employment, the curriculum should focus on development of job related competencies. Contents should clearly specify knowledge and skill profile of technical human resource so as to enable the teachers to provide appropriate learning experiences to students. Hands on experiences in laboratory, workshop or in industry provide the student with a relevant means of transferring knowledge, skills and attitudes to the world of work. Curriculum should be realistic so that it is possible to implement in a given situation.

e) Student Oriented

The aim of technical education curriculum is to develop specific competencies for gainful employment and hence students are required to learn by doing practical work in laboratories, workshops and in the industry. It is therefore, essential that curriculum should emphasize on student centred learning approaches.

f) Explicit Outcome

Not only the curriculum for technical education be relevant to the world of work, it must be able to communicate the desired outcome to both the teachers and students. Broadly stated goals are an important part of curriculum. Although, it is recognised that it is difficult to state all curricular outcomes in specific measurable terms, many of these outcomes may be written down in such a manner that broad curricular goals are made more quantifiable. This is perhaps the most commanding reason for ensuring that the curriculum outcomes are clear and precise.

g) Future Oriented

Technical educators particularly are very much concerned about the future. What technological changes might affect the students? What type of laboratories will be needed twenty years from now? What sort of continuing education will be needed by the students undergoing education now? These and other questions which are often raised by technical teachers who think in futuristic terms. Persons responsible for contemporary technical

curriculum need to ensure that ongoing curricula are considered in relation to what will or may occur in the future. As decisions are being made about curriculum content and structure, thought should be given to the future results that might come from those decisions. Any curriculum that hopes to be relevant tomorrow must be relevant to tomorrow's as well as today's needs. The extent to which a curriculum is successful in the times to come will be largely dependent upon the future-oriented perspective associated with it.

3.4 Curriculum Development Stages

After understanding the characteristics of curriculum it is important to know the stages of curriculum development process. Curriculum development comprises of the following four stages.

- a) Need analysis stage
- b) Curriculum design stage
- c) Curriculum implementation stage
- d) Curriculum evaluation stage

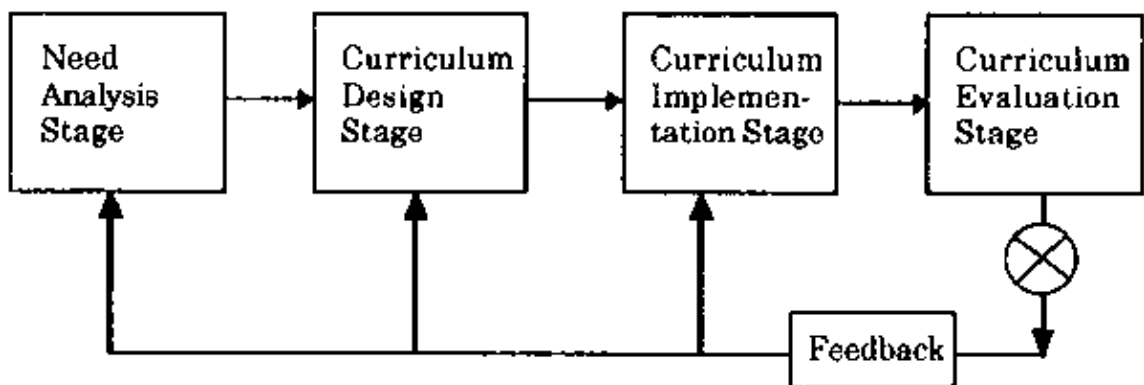


Figure 3.1: Stages of Curriculum Development

A brief description of the scope of each of above stages is given below:

a) Need Analysis Stage

This stage deals with diagnosis of needs which involves conducting market surveys for determining employment opportunities for specific target group, technology development at work places and competency profile of technical manpower, keeping in view the present and future employment trends. This also includes determination of the strengths and weaknesses of the system of technical education.

b) Curriculum Design Stage

The curriculum design stage involves devising or planning the intents of the curriculum. At this stage, decisions regarding curriculum objectives for specified target group are spelled out. From these objectives, curriculum areas (subjects) are identified. Detailed contents are worked out to match the competency profile of specific target group. After working out time requirement for imparting desired knowledge, skills and attitudes, study and evaluation scheme is worked out, selection of appropriate methods and media for various curriculum areas is also detailed out. At this stage resources required (i.e. physical, human and informational) for effective implementation of curriculum are also spelled out.

c) Curriculum Implementation Stage

Once the curriculum document is ready it will call for development of appropriate resources for the successful implementation of curriculum. This stage deals with harnessing of resources and their utilisation for providing appropriate learning experiences to students for developing desired competencies in them.

Networking with industry and other organizations for sharing resources is one of the important considerations for effective implementation of curriculum.

d) Curriculum Evaluation Stage

Evaluation is considered in two stages. The first stage is monitoring during implementation stage. During this stage, corrective measures are taken to improve teaching–learning process. Once the system has undergone corrective process for some time and got improved, a summative evaluation is undertaken for making changes at different stages for increasing the effectiveness and bringing improvement in the curriculum and the processes at different stages.

In the over view only a brief description of each of curriculum development stages has been given. Each of the above stages are discussed in detail in the chapters to follow.

4. Need Analysis Stage

4.1 Introduction

First stage in curriculum development process is the need analysis stage. At this stage, the need and demand of manpower and their profile is determined. Need ascertains the requirement of industry and service sector for manpower in the occupation under consideration and the demand gives idea about the probable response of the people to the programme. Programmes with long term demand should be generally initiated. The survey of industry helps to provide parameters or information on employment opportunities and activity profile of technical manpower which forms the basis to determine the boundaries of knowledge and skills to be imparted.

Therefore, need analysis is done with a view to determine:

- long range and short range employment opportunities for a specific target group
- technology development at work places
- competency profile of technical manpower, keeping in view the present and future employment trends

4.2 Focus of Conducting Need Analysis Surveys

It has been experienced that surveys are generally focused on manufacturing sector, which indeed form a small part of employment opportunities of technical manpower. It would be worthwhile to take into account technical manpower requirement in primary, secondary and tertiary sectors of economy.

Primary sector deals with mineral and mines, agriculture and agro–based products.

Secondary sector deals with manufacturing/construction industry which include boards and corporations; construction industry: mechanical, electrical, textile, electronics, computer, leather and leather goods, chemicals, plastics and other process industry.

Tertiary sector deals with repair and maintenance services, health and paramedical services, commercial services, communication services, transportation services, educational services, travel and tourism, defence services etc.

Depending on the type of programme, above sectors of employment, on selective basis, be explored for determining employment potential, present and future technology development trends and competency profile of manpower.

Literature search from various agencies like: Five year plan documents at national and state levels, information available with National Technical Manpower Information System and State Industrial Policy documents can also serve a useful guide for providing projections about future manpower requirements.

While exploring world of work, it is essential to take care of manpower development requirement in different functional areas like: design and drawing, planning, shop–floor/production, quality control, repair and

maintenance, inventory control, marketing and sales etc., so that the product of technical and vocational education is prepared to perform these function after little training.

Further, technical manpower at different levels has to possess different types of competencies in terms of knowledge, skills and attitudes. It is important to understand various domains of learning viz. occupational/vocational preparation, continued learning, human relations and personal development for ascertaining competency profile of such manpower. A brief description of each of these domains is given below:

a) Occupational/Vocational Preparation Domain

This domain deals with imparting appropriate of knowledge, skills and attitudes for meeting the present and future technological requirement of different functional areas in the world of work.

Imparting appropriate knowledge and skills will vary from level of programme being offered. This domain will include following broad aspects:

- Skills of reading and interpreting drawing
- Estimating and costing skills
- Knowledge of materials, specifications and testing procedure
- Knowledge of construction/manufacture/erection installation techniques
- Knowledge of national and international codes
- Diagnostic/repair and maintenance skills
- Competency of using computers for various engineering applications
- Marketing and sales techniques
- Basic management skills
- Knowledge of important provisions concerning industrial legislation
- Stress management, time management, safety management, pollution control, labour management techniques, etc.

b) Continued Learning Domain

This domain includes developing life long learning abilities such as independent study skills, information storage and retrieval skills, generic skills of problem–solving.

c) Human Relations Domain

A technical person has to work in a team. He/she has to understand the importance of working in a team; dealing with seniors; peers and juniors; values and attitudes; helping in distress; listening skills; verbal and written communication skills; report writing skills; motivational skills; initiative and leadership qualities etc. Curriculum should contain learning experience through curricular and co–curricular activities for developing interpersonal and communication skills, which are so essential component of technical human resources development.

d) Personal Development Domain

This domain includes personality traits like: physique, proper attitudes, values, discipline, commitment, dignity of labour, communication, self expression, sense of responsibility, coping with stress, time management and associated skills. It will be worthwhile to include development of such skills in the curriculum.

It should be well understood that all categories of technical manpower do need education and training in all the four domains but extent of coverage will vary for different levels of manpower and functional expectation.

4.3 Identifying Emerging Areas of Employment

The curriculum planner must be able to project into the future regarding employment trends. Although any long range projections have the risk of being inaccurate, efforts must still be made to identify emerging occupations. Furthermore, the development of vocational and technical programmes should not be based solely upon the current employment opportunities, since the time span between the original programme concept and the first student graduate may take three to four years or more.

Even with future uncertainties, selected elements of socio-economic areas can be studied to help predict employment opportunities. For example, if the population is on the increase, certain services like hospitals, utilities, food services, housing services will expand, which may generate increased employment opportunities. Close contact with confederation of industry, chambers of commerce and industry etc. be maintained, since one of their efforts focuses upon attracting new business to the community. Other people to maintain contact can be business leaders and those individuals holding leadership positions.

In addition to identifying emerging areas of employment, one must also be alert to the areas that are tending to experience a decrease in employment.

4.4 Assessing Current and Future Manpower Needs

A curriculum planner must be open-minded in undertaking job of assessing manpower supply and demand. The first problem faced by curriculum planners is that accurate and guaranteed approaches in projecting precise labour demands do not exist. Demands projected beyond four to five years may often lead to inaccurate decision making and will result in developing inappropriate curricula. However, this situation should not stop curriculum planners from assessing future technical and vocational manpower demands as best as they can with the information that is available.

4.5 Approaches of Manpower Forecasts:

Some of the important approaches include: employer surveys, extrapolation, the econometric approach and job vacancy which may be of great help in taking decisions regarding manpower forecasting. These approaches are briefly discussed below:

(1) Employer Survey Approach

Probably the most widely used approaches in assessing labour demand data is through what many educators refer to as employer surveys. This approach basically involves contacting the employer in order to assess the current and projected manpower needs. The strength of this approach is in the collection of meaningful data.

Curriculum planners using the employer survey approach must also be aware of certain limitations. Employers may be reluctant to share employment data with strangers. Thus, when using this approach, it is helpful to contact employers before the actual personal interview to make them aware of why information is needed and how it will be used. Industrial associations/chambers can also be helpful in obtaining desired information. Data should be collected regarding current and projected manpower needs and the instrument used should accomplish both purposes. Several approaches may be used in the collection of data from employers. Mailed questionnaires, personal interviews, observations etc. constitute most common approaches.

(2) Extrapolation Approach

This approach of projecting future manpower needs is based on the assumption that past and current trends will give an indication as to what will happen in the future. The strength of this approach is that it is relatively easy to perform and can be done in a short time. Additionally, the cost of extrapolation is quite low.

(3) The Econometric Approach

The econometric approach of manpower forecasting appears to be the most sophisticated approached for manpower forecasting in use. The projections are developed in a series of five steps, each of which is based on separate model. These are as follows:

- (a) Labour force projection: based on future age, sex, racial composition and migration of population
- (b) Aggregate economic projections: projects the Gross National Product (GNP) and major categories of demand and income
- (c) Industry output projection: Industry output projections are estimated using input output data associated with the expected GNP
- (d) Industry employment projections: given the final output expected from the identified industrial sectors, estimates are then made of the occupational structures needed in the industries required to produce that output
- (e) Occupational employment projections: an industry – occupational matrix is developed showing the distribution of employment, which will be helpful to project the manpower needs

Curriculum planners may find implications for using this approach at the local level because some of the data may be available at the state and regional levels. As with other labour demand forecasts, the econometric technique has several limitations. Among the major drawbacks are that economic activity fluctuates widely and can greatly influence the manpower needs, thus projections can be inaccurate. Other limitation centres around the unpredictable rate of technological advances and the attempt to predict the educational requirements for occupations that now are few in number but in future may represent a sizeable share of workforce.

(4) Job Vacancy Approach

This approach to manpower forecasting is based on current job vacancies. Job vacancy approach depends heavily upon information obtained and compiled by employment exchanges. The strength of this approach is that immediate needs of an area can be quickly ascertained. Furthermore, curriculum planners can easily rank job vacancies by priority of importance of number of vacancies. Job vacancy as a means of forecasting manpower needs does have some limitations. First, are the vacancies of long range nature or seasonal jobs? Curriculum planner must take above aspect into consideration. When a particular vacancy remains vacant for quite some time, it is essential to enquire the type of qualification and experience desired for the fulfilment of such vacancies.

The above manpower demand approaches may help curriculum planners to choose one or more approaches for collecting relevant information. The selection of approach depends upon the purpose, resources and the time available to the planner. All four approaches have distinct advantages and limitations.

4.6 Tools Used for Conducting Need Analysis Surveys

Different tools and techniques are used for collecting information regarding employment opportunities, competency profile and type of present and future technology trends etc. The conventional tools used for collecting such information are questionnaire, conducting interviews and observation.

a) Using a Questionnaire

A questionnaire is used when factual information is desired. Questionnaires administered personally to groups of individuals have number of advantages. It provides an opportunity to establish rapport, explain the purpose of the study and explain the meaning of items that may not be clear. Availability of high number of respondents in one place makes possible an economy in time and expense and provides a high proportion of viable responses. However, when desired information cannot always be collected personally, in such cases, mailed questionnaire may be useful. It should be understood that filling out lengthy questionnaires takes great deal of time and effort, results in low response. Poor quality of questionnaires also is one of the reason for small feedback.

Unless one is dealing with a group of respondents who have a genuine interest in the problem under investigation, know the sender, or have some common bond of loyalty, the rate of return is generally disappointing and provides a flimsy basis for generalization.

But still, properly constructed questionnaire has unique advantages and serves as a most appropriate and useful data gathering device.

Questionnaire can be:

- Closed form
- Open form

Questionnaires that call for short, check–mark responses are known as the restricted or closed form type. Here respondents mark a yes or no, write a short response, or check an item from a list of suggested responses. For certain type of information the closed–form questionnaire is entirely satisfactory. It is easy to fill out, takes little time, keeps the respondent on the subject, is relatively objective, and is fairly easy to tabulate and analyse.

The open form or unrestricted questionnaire calls for a free response in the respondent's own words.

For Example:

Why did you choose to join the polytechnic?

Not that no clues are given. The open form probably provides for greater depth of response. But because it requires greater effort on the part of the respondent, returns are often meagre. Also, the open form item can sometimes be difficult to interpret, tabulate and summarize.

Many questionnaires include both open and closed type items. Each type has its merits and limitations and the researcher must decide which type is more likely to supply the wanted information.

b) Guidelines for Constructing a Questionnaire

Following guidelines may help in better understanding of the questionnaire and greater response:

- i) Define or qualify terms that could easily be misinterpreted
- ii) Be careful in using descriptive objectives and adverbs that have no agreed upon meaning. Words like frequently, occasionally, rarely etc. do not have same meaning to different persons
- iii) Avoid using double negatives
- iv) Be careful of inadequate alternatives
- v) Avoid the double barrelled questions, make only one query in a statement
- vi) Underline a word if you wish to indicate special emphasis
- vii) When asking for ratings or comparisons, a point of reference is necessary
- viii) Avoid unwanted assumptions
- ix) Phrase questions so that they are appropriate for all respondents
- x) Design questionnaire that will give a complete response
- xi) Provide for the systematic quantification of responses

c) Characteristics of a Good Questionnaire

- i) It deals with a significant topic, one the respondent will recognize as important enough to warrant spending his or her time on. The significance should be clearly and carefully stated

on the questionnaire, or in the letter that accompanies it.

- ii) It seeks only that information which cannot be obtained from other sources.
- iii) It is as short as possible, and only long enough to get the essential data. Long questionnaires frequently find their way into the waste-basket.
- iv) It is attractive in appearance, neatly arranged, and clearly duplicated or printed.
- v) Directions for a good questionnaire are clear and complete. Important terms are defined. Each question deals with a single idea and is worded as simply and clearly as possible. The categories provide an opportunity for easy, accurate, and unambiguous responses.
- vi) The questions are objective with no leading suggestions as to the responses desired.
- vii) Questions are presented in good psychological order, proceeding from general to more specific responses. This order helps respondents to organize their own thinking so that their answers are logical and objective. It may be proper to present questions that create a favourable attitude before proceeding to those that may be a bit delicate or intimate. If possible, annoying or embarrassing questions should be avoided.
- viii) It is easy to tabulate and interpret. It is advisable to pre-construct a tabulation sheet, anticipating how the data will be tabulated and interpreted, before the final form of the questionnaire is decided upon. This working backward from a visualization of the final analysis of data is an important step for avoiding ambiguity in questionnaire form. If the computer tabulation is to be used, it is important to designate code numbers for all possible responses to permit easy transference to a computer format.

d) Validity and Reliability of the Questionnaire

All too rarely do questionnaire designers deal consciously with the degree of validity or reliability of their instrument. Perhaps this is one reason why so many questionnaires are lacking in these qualities. It must be recognized, however, that questionnaires, unlike psychological tests and inventories, have a very limited purpose. They are often one-time data-gathering devices with a very short life, administered to a limited population. There are, however, ways to improve both validity and reliability of questionnaires.

Basic to the validity of a questionnaire is asking the right questions, phrased in the least ambiguous way. In other words, do the items sample a significant aspect of the purpose of the investigation?

The meaning of all terms must be clearly defined so that they have the same meaning to all respondents. Researchers need all the help they can get; suggestions from colleagues and experts in the field of inquiry may reveal ambiguities that can be removed or items that do not contribute to a questionnaire's purpose. The panel of experts may rate the instrument in terms of how effectively it samples significant aspects of its purpose, providing estimates of content validity.

It is possible to estimate the predictive validity of some types of questionnaires by follow-up observations of respondent behaviour at the present time or at some time in the future. In some situations, overt behaviour can be observed without invading the privacy of respondents. A comparison of questionnaire responses with voting data on a campus or community election may provide a basis for estimating predictive validity.

Reliability of questionnaires may be inferred by a second administration of the instrument, comparing the responses with those of the first. Reliability may also be estimated by comparing responses of an alternate form with the original form.

4.7 Conducting an Interview

The interview is in a sense an oral questionnaire. Instead of writing the response, the subject or interviewee gives the needed information orally and face-to-face.

With a skilful interviewer, the interview is often superior to other data-gathering devices. One reason is that people are usually more willing to talk than to write. After the interviewer gains rapport or establishes a

friendly, secure relationship with the subject, certain types of confidential information may be obtained that an individual might be reluctant to put in writing.

Another advantage of interviewing is that the interviewer can explain more explicitly the investigation's purpose and just what information he or she wants. If the subject misinterprets the question, the interviewer may follow it with a clarifying question. At the same time, he or she may evaluate the sincerity and insight of the interviewee. It is also possible to seek the same information in several ways at various stages of the interview, thus checking the truthfulness of the responses. Through the interview technique, the researcher may stimulate the subject's insight into his or her own experiences, thereby exploring significant areas not anticipated in the original plan of investigation.

Preparation for the interview is a critical step in the procedure. Interviewers must have a clear conception of just what information they need. They must clearly outline the best sequence of questions and stimulating comments that will systematically bring out the desired responses. A written outline, schedule, or checklist will provide a set plan for the interview, precluding the possibility that the interviewer will fail to get important and needed data.

An open-form question, in which the subject is encouraged to answer in his or her own words at some length, is likely to provide greater depth of response. In fact, this penetration exploits the advantage of the interview in getting beneath-the-surface reactions. However, distilling the essence of the reaction is difficult, and interviewer bias may be a hazard. The closed-form question (in the pattern of a multiple-choice response) is easier to record but may yield more superficial information.

The relationship between interviewer and subject requires an expertness and sensitivity that might well be called an art. The initial task of securing the confidence and cooperation of the subject is crucial. Talking in a friendly way about a topic of interest to the subject will often dispel hostility or suspicion, and before he or she realizes it, the subject is freely giving the desired information. As in the use of the questionnaire, the interviewer must be able to assure the subject that responses will be held in strict confidence. When interviews are not tape recorded, it is necessary for the interviewer to take written notes, either during the interview or immediately thereafter. The actual wording of the responses should be retained. It is advisable to make the interpretation later, separating this phase of analysis from the actual recording of responses.

Recording interviews on tape is preferred because they are convenient and inexpensive and obviate the necessity of writing during the interview, which may be distracting to both interviewer and subject. Interviews recorded on tape may be replayed as often as necessary for complete and objective analysis at a later time. In addition to the words, the tone of voice and emotional impact of the response are preserved by the tapes. It is unethical to record interviews without the knowledge and permission of the subject.

In order to obtain reliable and objective data, interviewers must be carefully trained. This training should include skills in developing rapport, asking probing questions, preparing for the interview, and a host of other details.

4.8 Observation

Observation has been the prevailing method of enquiry since early times. As a data gathering device, direct observation may be very useful in seeing the people in action. The size and scale of operations, type of technology in use, activities/job profile of technical manpower, working environment etc. can be better understood by making observations in the actual world of work. Only thing is that the observer must know what to look for. He or she must be able to distinguish between the significant and insignificant aspects of the situation. Sometimes, instruments such as the stopwatch, mechanical counter, camera, audiometer, audio and video recording and other devices make possible observations that are more precise than mere sense observations.

Observations as research data-gathering process demands rigorous adherence to the spirit of scientific inquiry. The following standards should characterize observers and their observations:

- Observation is carefully planned, systematic and perceptive. Observers should know what they are looking for and what is irrelevant in a situation.
- Observers should be aware of the wholeness of what is observed

- Observers should be objective
- Observers should separate the facts from the interpretation of the facts. They should observe the facts and make their interpretation at a later time.
- Observations should be checked and verified, whenever possible, by repetition.
- Observations should be carefully and expertly recorded
- Observations should be collected in such a way as to make sure that they are valid and reliable

After conducting need analysis surveys, data is analysed to arrive at the following conclusions:

- i) Type of employment opportunities in different functional areas.
- ii) Type of activities of technical manpower in different functional areas.
- iii) Type of knowledge and skills which should be imparted to students for developing desired competencies in them.
- iv) Future technology trends

Above information will help in taking appropriate decisions at curriculum design stage.

5. Curriculum Design

5.1 Introduction

The National Policy of Education – 1986 has emphasized the need for making programmes for technical human resource development effective and efficient. It has laid considerable stress on improving the programmes continuously in the context of the changing needs of technical manpower in the context of changes in technology.

The aim of any educational programme is to develop certain knowledge, skills and attitudes in the students to enable them to function effectively in the chosen discipline and for becoming responsible citizens who are able to serve the society and the world of work with the objectives for which they are technically trained. The system of technical education would be deemed effective if the product of the system matches with the requirements of the situation for which they are being trained.

It has been experienced that majority of teachers do not have clear understanding regarding the terms 'syllabus' and 'curriculum'. The term 'syllabus' is only a part of curriculum, which contains concepts, principles and procedures to be taught to the students. Whereas 'curriculum' is a broad term which not only contains the syllabus but refers to complete plan of action of teaching–learning and student evaluation, directed to achieve defined objectives, in a stipulated time frame. Therefore, curriculum of a programme has been defined as an educational programme designed and implemented to achieve specified educational objectives, for a specific target group. The advantage of such a definition is that it takes into account the fact that:

- a) Education is purposeful and has objectives
- b) It implies that there is an organised plan of action
- c) Such a plan is translated into action through appropriate strategy of implementation
- d) It is meant for a specific target population

The programme should therefore:

- a) Be relevant to the needs
- b) Be feasible for working environment
- c) Adequately communicate the intents and purpose
- d) Guide planning strategies for implementation
- e) Be capable of being used as a basis for improvement

Curriculum must be changed from time to time for making it compatible with the change in the environment. This makes curriculum development as a dynamic process.

Preparation of curriculum document is an important activity and need a systematic procedure for arriving at various elements of knowledge, skill and attitudes to be developed in the students.

5.2 Expectations of World of Work from Technical Manpower

Though it is not possible to produce tailor made human resources, what is possible is to develop understanding of basic concepts, principles, procedures and practices in the chosen field coupled with skills of data collection and information gathering; reading and interpreting drawings; estimating and costings; precise measurement; testing and report writing; diagnostic skills for failure analysis, fault analysis and causes of low productivity and low quality; communication skills; interpersonal and leadership skills; problem-solving abilities related to different functional areas; positive attitude and concern for time and money, optimum utilisation of resources, and pollution control techniques.

Stress should be on development of professional knowledge, problem-solving and entrepreneurial skills. Providing project oriented learning experiences will prove useful in acquiring the desired level of competencies. Student must be able to make use of computer software for various engineering applications.

As indicated in Chapter 1, there are three categories of technical manpower.

The first category comprises of engineering graduates. Their main function include research and development, planning and management.

The second category is that of diploma engineers, who are primarily engaged in production, erection/installation, testing, quality control, repair and maintenance, marketing and sales etc.

The third category consists of skilled workers/craftsmen who should possess specific manual and machining skills. They are engaged in direct production and repair and maintenance functions.

It has been experienced that above technical manpower find employment in all sectors of economy namely: primary, secondary and tertiary. They are placed for employment in various functional areas like R&D; Design and Drawing; Planning; Shop-floor Operations; Quality Control; Repair and Maintenance; Sales and After Sales Services etc

Further, there are over hundred disciplines of engineering/technology in which above technical manpower is being trained. It is beyond the scope of this book to provide manpower profile for all the disciplines. What is being attempted here is to provide the general competency profile of above categories of manpower to guide curriculum planner to investigate the extent of knowledge and skills required for designing appropriate curriculum for different categories of manpower in a specified discipline/area.

It is important to mention that besides developing appropriate competencies related to profession, it is important to develop interpersonal skills, communication skills, learning-to-learn skills and generic skills of problem solving in above manpower. The extent of the above skills will vary as per functional requirement of various categories of manpower and their position in the organisations.

- Curriculum for degree programmes may lay greater emphasis on imparting broad based knowledge and associated skills, developing analytical abilities and skills towards R&D, management, planning and budgeting
- Curriculum for diploma programmes may lay high emphasis on shop-floor operations; supervisory skills; estimating and costing; measurement and testing; diagnostic and marketing skills
- Curriculum for craftsmen should lay high emphasis on manual and machining skills; measurement skills; repair and maintenance skills

Table 5.1 presents the general competency profile of different categories of technical manpower:

5.3 Curriculum Design Models

According to Taba (1962) "curriculum design is a statement which identifies the elements of the curriculum, states their relationships to each other, indicates the principles of organisation and the requirement of that organisation for the administrative conditions • under which it is to operate" This concept of curriculum design has gained wide acceptance. For example, opinions differ regarding what elements should be included in the curriculum. Some suggest that the curriculum document should include lesson plans, teaching strategies etc. where as other suggests that a list of objectives only are needed, leaving other aspects to the instructional system.

Table 5.1 General Competency Profile of Technical Manpower

Graduate Engineers	Diploma Engineers/Technician Engineers	Skilled Workers/Craftsmen
Knowledge and Associated Skills pertaining to:	Knowledge & Associated Skills pertaining to:	Knowledge Associated Skills pertaining to:
1. Materials, specifications and manufacturing processes/practices (including CAD–CAM process control, automation etc.	1. Materials, specifications and processes	1. Operation of machines, plant and equipment
2. National and International standards	2. Awareness of National and International standards and quality control operations.	2. Measurement and testing skills
3. Indian Economy and thrust areas	3. Innovations pertaining to shop floor/field operations	3. Skills in reading drawings
4. Design & development of new products, technologies and systems	4. Reading & interpreting drawings	4. Diagnostic and repair and maintenance skills
5. Proto–type development	5. Estimation and costing	5. Construction and installation skills
6. Quality Engineering and Total Quality Management	6. Supervision techniques	
7. Futuristic Planning	7. Work–study techniques	
8. Budgeting and Financial Management	8. Erection/installation techniques	
9. Management of Physical, Human & Financial resources leading to optimization of resources and efficiency	9. Measurement and testing skills	
10. Generic skills of problem–solving, time management, stress management, managing change etc	10. Diagnostic skills	
11. Interpersonal and communication skills	11. Pollution control and safety at work places	
	12. Management skills	
	13. Interpersonal and communication skills	

However, the level at which the curriculum is being offered (whether at certificate, diploma and degree levels) will determine the extent to which details should be provided in the curriculum.

The most frequently quoted curriculum rationale is that proposed by Ralph Tyler (1950). It is based on four basic questions:

- (1) What educational purposes should an institute seek to attain?
- (2) What educational experiences can be provided that are likely to attain the purposes?
- (3) How can these educational experiences be effectively organised?
- (4) How can we determine whether these purposes are being attained?

This rationale has been further developed by Taba (1962) in proposing an orderly procedure for curriculum development. The steps suggested in that procedure are:

- (a) Diagnosis of needs
- (b) Formulation of objectives
- (c) Selection of content
- (d) Organisation of content
- (e) Selection of learning experiences
- (f) Organisation of learning experiences
- (g) Determination of what to evaluate and the way and means of doing it. The steps proposed are not linear but cyclic in nature.

It is important to understand that curriculum design is the organizational pattern or structure of a curriculum. It is determined by decisions made at two different levels of development; a broad level which involves the technical planning and implementation of curriculum elements. At the broader level of decision making, curriculum design is influenced by the choice of the data source or sources, historically, have been used as bases for choices in making curricular decisions: Organized subject matter, the student who are to experience the curriculum and society (Tyler 1950). The curricular elements usually referred to in a discussion of a design are: i) objective, ii) content, iii) learning activities and iv) evaluation procedures (Zain 1976). Some authors also include; v) learning materials and resources, vi) time, vii) space and environment, viii) grouping and ix) teaching strategies as curricular elements. These nine elements can be treated in different ways when developing curricula and through these different treatments, a variety of designs can be created (Good Lad 1979). Thus, at this technical level to development, a specific curriculum design is created by the ways in which the elements are treated and the inter-relationships which occur among them. The challenge to curriculum developers is to make the necessary decisions so that the curriculum which is created has a high degree of internal consistency (Hunkins 1980).

If the decisions made about each of the data sources and curricular elements are compatible, the curriculum will have internal consistency and it will have a greater potential for having the desired impact upon the students. Designs created on a theoretical level rarely exist in practice in a pure form (Zais 1976). The realities of schooling force change and require compromises. Thus, conducting research to determine the best curriculum design to use is not feasible. Evaluation studies can be and have been conducted to determine the impact of a particular curriculum upon the students. These studies, however, are not intended to help make decisions about other curricular designs which are created for different learning goals and purposes. Curriculum designs created, by devoting major or exclusive emphasis to each of the three primary data sources for decisions making, organized subject matter, the student and the society, have their own merits and demerits.

According to CPSC Publication (1982), effective curriculum design starts with the values held by the society and reflected in the educational system. These values determine the objectives, or goals or purposes which the system strives to achieve. The scheme next suggests that the important issues of what the content should be and what method should be used are guided by the three sources given below. These sources are widely accepted as the sources for important curriculum decision. Expressed in slightly different terms, the primary sources for curriculum are:

- (a) Needs of the individuals learner (individual needs approach)
- (b) Structure of the organised body of knowledge (subject – specialisation approach)
- (c) Needs of the society (social demand and job analysis approach)

All the three must be used for deriving the objectives and the content. These different models are thus available for arriving at curriculum decisions.

Individual Needs Approach

In this model, the education is considered to be for the development and growth of an individual to the fullest extent. The students are compared with budding flowers and the teachers are expected to handle these according to their interests and needs. The steps adopted in this model are given below:

- (1) Identify needs and interest of the students
- (2) Group the students according to similarity of interests and needs
- (3) Select appropriate content/learning experiences from different fields relevant to the needs and interest of the group
- (4) Organise teaching – learning process and implement the programme
- (5) Evaluate the success of the programme.

Subject Specialization Approach

According to Foshay (1962) any discipline has three main elements:

- (a) It has domains – the phenomena or aspects of life for which it takes responsibility
- (b) It has methods and rules according to which the scholar in the discipline seeks out and handles the data given in the domain and according to which the quality of the generalisation he/she may be judged
- (c) Any discipline has a history or a tradition, which enters into the decision on both the domains and the rules according to which it proceeds as a field of learning

Typical steps used in developing a curriculum are given below:

- (1) Interpret or formulate goals and policies
- (2) Setup curriculum committees consisting of professionals/experienced scholars in the discipline
- (3) Analyse discipline for its structures, logic methods
- (4) Organise content which brings out the logical structure and relationships of the discipline.
- (5) Prepare instructional resources
- (6) Implement on pilot basis in selected institutions
- (7) Collect data from the field and identify gaps
- (8) Take corrective steps to prepare the final document for full scale implementation.

Social Demand and Job Analysis Approach

The philosophy underlying this approach is to satisfy the needs of the society and should be relevant to those needs. Education is treated as preparation for life. Life consists of performance of specific activities which can be analysed in terms of knowledge and skills for preparing the teaching plan. These objectives then form the objectives of the curriculum. When seen in this context, the approach could be better called as an Activity or Job Analysis Approach for curriculum design. Steps of this model are:

- (1) Conduct feasibility study, occupational analysis and form job clusters.
- (2) Analyse jobs clusters i.e. activities; knowledge, skills, equipment etc.
- (3) Develop Training objectives
- (4) Develop Instructional packages
- (5) Orient and train teachers for effective implementation of curriculum

(6) Finalise instructional package for wider dissemination

None of the models presented above may be wholly adequate for any specific system of technical education, but all may contain ideas which could be fruitfully adapted.

5.4 Curriculum Design Process

Kulkarni PD and Malhotra MM (1974) developed a model for developing technician curriculum which is based on systems approach. This model identifies three stages of curriculum development viz. design stage, development stage and evaluation stage. The model proposes following steps for undertaking curriculum design process:

- (i) Stating constraints
- (ii) Determining educational objectives
- (iii) Conducting job/market social service and listing activities
- (iv) Determining course objectives
- (v) Analysing activities into knowledge and skills
- (vi) Assessing entry behaviour
- (vii) Determining curriculum areas and subject
- (viii) Determining scope and contents of subjects
- (ix) Working out time requirement for learning
- (x) Preparing horizontal and vertical organisation curriculum
- (xi) Preparing teaching and evaluation scheme
- (xii) Working out resource requirement

Schematic representation of various stages of this model is given in Figure 5.1. The model proved very useful in designing curricula at different levels.

Taba (1962) proposed a procedure for curriculum design as follows:

- i) Diagnosis of needs
- ii) Formulation of objectives
- iii) Selection of contents
- iv) Selection of learning experiences
- v) Organization of learning experiences
- vi) Determining of what to evaluate and the ways and means of doing it

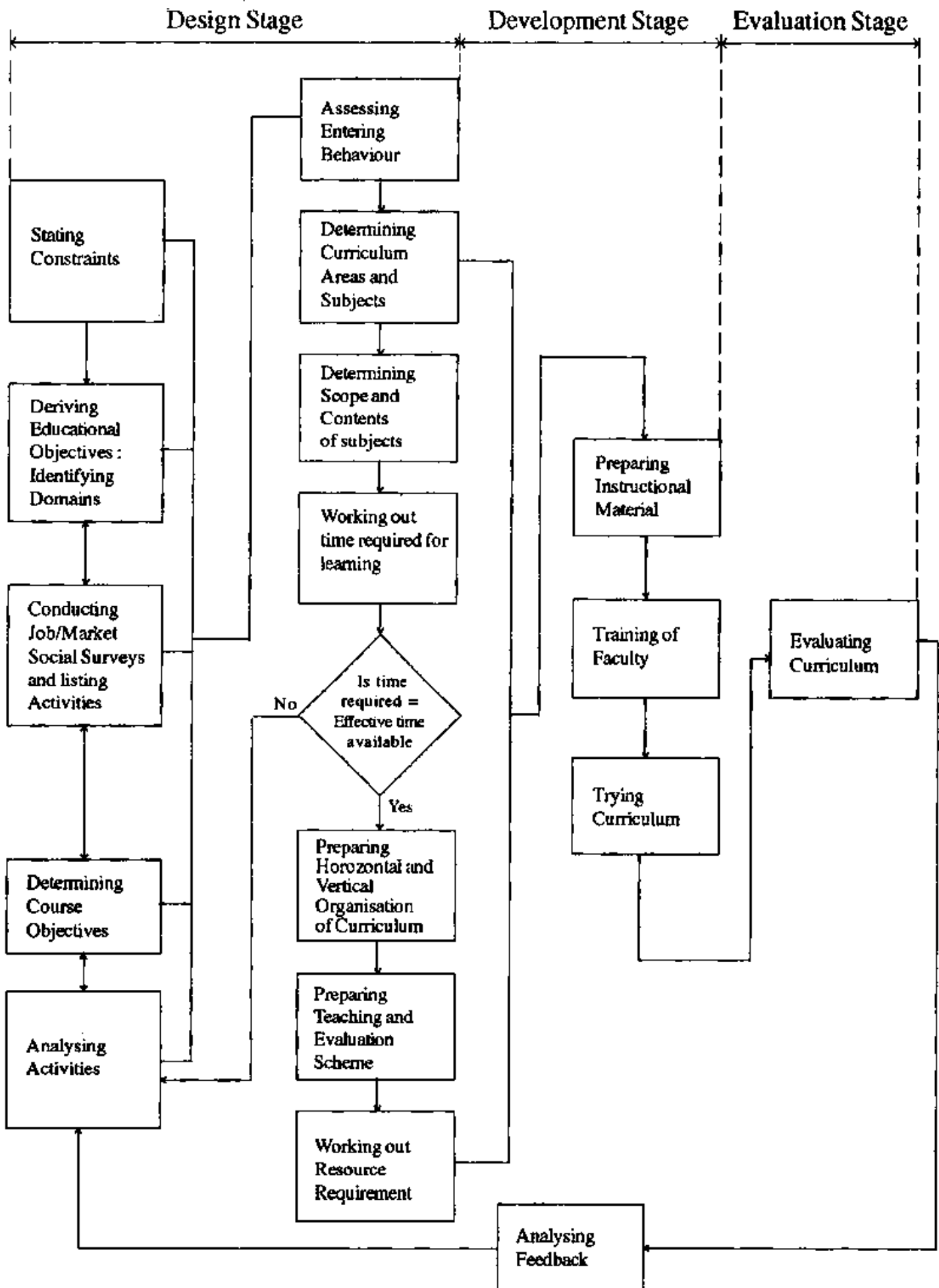


Figure 5.1: Schematic Representation of various Stages in Curriculum Development

Based on the models developed by Kulkarni and Malhotra and that to Taba, the authors based on their experiences, modified the schematic diagram of curriculum design process to provide better clarity. For details, see figure 5.2. It will be observed from the figure that after conducting need analyses, which primarily focuses on exploring long range employment opportunity; activity/job profile of technical manpower and exploring present and future technological developments. Above exploration will provide a data base for undertaking curricular decision. The schematic diagram provides ten steps for designing a curriculum. Brief description of each of these steps is given in pages to follow:

Step 1

Stating Constraints:

Before undertaking design of a curriculum, it is essential to ascertain the constraints so that realistic curriculum decisions are taken. Constraints are the factors which cannot be changed by the curriculum designer. Some of the important constraints which would impose limitations on the design work may be:

- a) Duration of the programme
- b) Programme pattern – regular, sandwich, part time etc.
- c) Entrance qualification
- d) Teaching and evaluation system – annual, semester, trimester etc.
- e) Constraints of resources, media, culture and location

Step 2

Activity Analysis:

After stating the constraints, the next step is to conduct activity analysis. Each activity identified through need analysis survey(s) can be analysed in terms of knowledge, skills and attitudes to be developed in the students for effective functioning. This analysis provides the curriculum designer necessary data to design a suitable educational programme. An example of such an analysis is given below:

Activity	Requirement		
	Knowledge	Skills	Attitudes
Supervises production activities	<ul style="list-style-type: none"> – Manufacturing processes – Tools and tooling – Scheduling men, material and machines – Codes and standards – Quality Control 	<ul style="list-style-type: none"> – Planning – Organizing – Interpersonal Skills – Skills of reading drawing – Leadership 	<ul style="list-style-type: none"> – Waste–minimization – Good housekeeping – Precision – Leadership

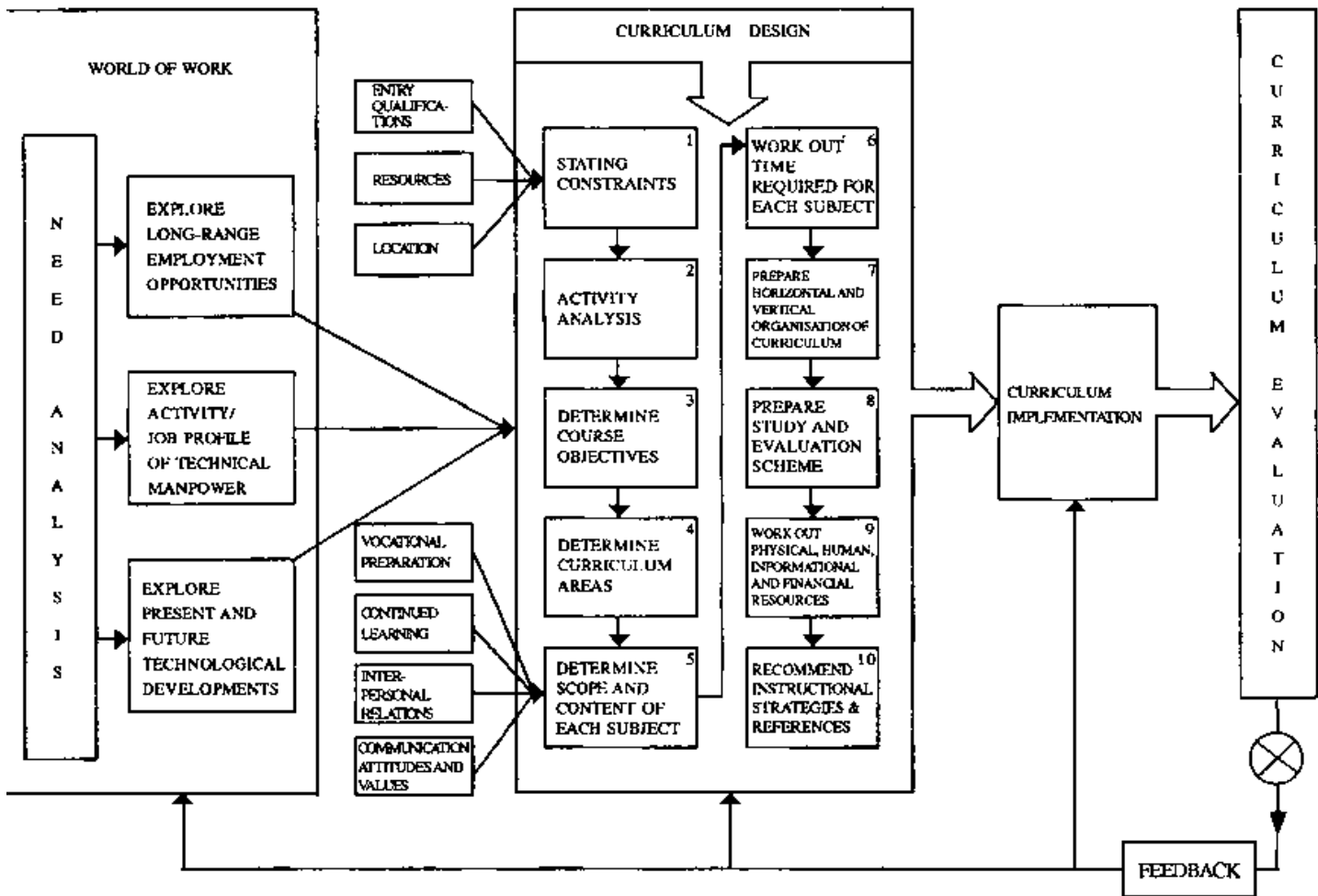


Figure 5.2: Schematic Diagram of Curriculum Design Process

It is not necessary to list the attitudes under each category. These should be considered as an integral part of every learning experience to be laid down in the curriculum.

When all the activities are analysed, there are bound to be repetitions. The repetitions should be carefully marked, because at a later stage these will help the curriculum designer in assigning appropriate weightage to knowledge, skills and attitudes, so that when constraints like time do not allow all objectives to be incorporated in the curriculum, the objectives with less weightage may be omitted.

Step 3

Determining curriculum goals and objectives:

Curriculum goals and objectives will depend upon the level of a particular programme i.e. whether the programme is at certificate, diploma or degree level and the type of competencies which are to be developed in the students. The development of meaningful outcomes for the curriculum is indeed very important because this will have direct bearing on the course contents.

There are some outcomes which are more measurable. Measurable outcomes in technical education can take many forms; for example, a student should be able to read and interpret civil engineering drawing pertaining to building, roads, public health works, drainage works and identify gap if any in terms of specifications, missing dimensions, views etc. In reality, measurable outcomes represent those results that can be assessed in an objective manner.

The other extreme represents outcomes that tend to be unmeasurable. For example, a student will develop an appreciation of the value of work in society or develops the ability to use leisure time wisely etc. represent important aspects of technical education.

Therefore, any curriculum in the field of technical education will have both measurable and unmeasurable outcomes. A basic rule to be followed by curriculum developer(s) is that sufficient number of measurable outcomes be identified in order to assure student competence in critical areas.

It is also important for curriculum developers to understand the difference between goals and objectives. Goals are broad (unmeasurable) aims or purposes of a total educational programme/curriculum. The purpose of each goal is to give direction and provide a basis for the development of more detailed general and specific objectives. An example of goal statement may be:

"Polytechnics shall be the institutions for producing world class diploma engineers consistent with the needs of the industry, community and other sectors of employment".

Objectives can be general objectives and specific objectives. General objectives are similar to goals. In reality, goals and general objectives are some times interchanged to the point where a clear distinction between the two is not possible.

Specific objectives, on the other hand are precise, measurable statements of particular behaviour to be exhibited by a learner under specified conditions. These are also termed as performance objectives.

While defining objectives for a curriculum, the attempt is to summarise the entire knowledge and skills arrived through need analysis exercise into different clusters. While summarising, objectives are written in order of their weightage. While writing objectives, one should keep in mind various domains of learning and weightage to be given to each domain. This means that a student should not only be taught to possess the necessary skills and techniques to perform jobs, but also be equipped to deal with situations arising out of future changes in technology, managing the system and dealing with people working in the system. For

- i) Students should be imparted fundamental concepts of building planning, building bye-laws and be able to apply them for planning and designing of a building
- ii) Students should have conceptual skills of reading and interpreting engineering drawings
- iii) Students should have appreciation of interpersonal and communication skills in professional life

Step 4

Deriving Curriculum Areas i.e. Subjects from Course Objectives:

Once the curriculum objectives are spelled out, the next step is to derive curriculum areas/subjects of study from these objectives. For example, the subjects which can be derived from curriculum objectives spelled in Step 3 are:

- i) Building planning and bye laws
- ii) Engineering drawing
- iii) Interpersonal and communication skills

It should be kept in mind that curriculum areas/subjects derived from curriculum objectives may not spell out any courses in basic sciences and applied sciences which are so important to provide a foundation and pre-requisite to understand technology (vocational) subjects. Hence, depending upon the type of a programme, courses in applied sciences and engineering sciences should be spelled out so on to facilitate learning of technical/vocational courses, as also to take care of continued learning of students.

Step 5

Determine Scope and Content of each Curriculum Area:

After arriving at curriculum areas, next step is to workout detailed contents of each subject.

Determining curriculum contents are directly linked with competency profile of technical manpower and entry qualification of students to a particular programme.

Selection of content should be based on the need analysis, which takes into account technological developments – present and future and other domains stated above. It should focus on the competencies desired to be acquired in these areas. Selection of content should also take into consideration the entry level knowledge and skill of the students.

One of the most important concern of the curriculum designer is with strategies that may actually be used to determine curriculum content. The two most widely used strategies i.e. Dacum approach and Delphi technique are briefly discussed below:

(a) **The DACUM Approach**

DACUM (Developing a Curriculum) approach relies on experts employed in a specific occupational area to determine curriculum content by following a systematic process.

In this approach, suitable experts representing different sectors of employment and functional areas are identified and asked to participate in a workshop to select the contents for a particular programme based on the objectives of the curriculum.

The Dacum workshop group functions collectively with all the developmental activities taking place when the members are together. Time required to complete a Dacum profile will vary from level of the curriculum (whether at certificate, diploma or degree level). Curriculum expert is the coordinator of the group to facilitate the development process and to guide the group in taking appropriate decisions by adopting the following procedure:

- i) Reviewing the employment opportunities
- ii) Reviewing the activity profile
- iii) Reviewing the goals and objectives
- iv) Reviewing the appropriateness of curriculum areas
- v) Identifying components of knowledge and skills required for developing desired competencies
- vi) Structuring knowledge and skills into meaningful learning sequence
- vii) Workout time required for instruction

(b) **Delphi Technique**

Delphi technique consists of series of interrogations with selected individual experts by means of mailed questionnaire. The focus is on some curricular content area in which each individual is knowledgeable. Since respondents never meet face to face, the group is not biased by one individual's outlook. Anonymity enables each respondent to be more thoughtful and creative. Information is sought again and again till the consensus on the content, is reached.

Although the Delphi technique can provide much meaningful information, the entire process consumes a considerable amount of time and relies on participants who have a great deal of commitment and stamina.

It should be understood that involvement of experienced professionals and academicians, their selection and the background of curriculum coordinator (in terms of his/her knowledge and skills pertaining to educational technology and human resource development, leadership qualities) are the key factors in designing appropriate curriculum.

Step 6

Work out Time Required for Teaching:

While working out time for instruction, following factors should be considered:

- a) Level and duration of programme offering
- b) Number of abstract concepts to be taught
- c) Types of skills to be developed
- d) Bulk of content
- e) Entry behaviour of students

After allotting time to the various subjects on the basis of factors listed above, the total time thus required to the courses is checked against the constraint of effective time available. In the case of mismatch, the designer must revise the contents, deleting less important ones, so that time required for teaching may match with effective time available.

Step 7

Preparation of Horizontal and Vertical Organisation of Curriculum:

After working out time requirement for each subject, the next step is to prepare horizontal and vertical organisation of various subjects over the whole duration of the programme. The basic philosophy for this is to lead the student from concrete to abstract, from simple to complex and from known to unknown. Whereas some subjects can be taught simultaneously, it is educationally necessary to teach certain subjects in a chronological manner because the knowledge of one is necessary for the understanding of the other. This logical and chronological arrangement of the various subjects of a curriculum is called horizontal and vertical organization of the curriculum.

Though the time requirement for each subject has already been worked out, but it must now be checked that when the various subjects are horizontally and vertically placed, the total time required within each horizontal band is still within available time for that band. If not, design must be modified. As an example, horizontal and vertical organisation of a curriculum for diploma programme in Civil Engineering is shown in Table 5.2.

The number of working hours in the institution per week, the number of subjects that are taught during one block time (say a semester or a year) will depend on the norms provided by All India Council for Technical Education.

Step 8

Prepare Study and Evaluation Scheme:

Guidance must be provided to teachers in respect of continuous assessment (i.e. formative evaluation) and end term examination (i.e. summative evaluation) of students.

The distribution of time for each subject may include the following:

- Class room instruction
- Tutorial work
- Laboratory/workshop/drawing practice
- Industrial/field visits
- Industrial experience

The basic philosophy of evaluation should be to assist and assess the learning outcomes consistent with the objectives of curriculum. Formative evaluation can be done by continuously recording the students progress by means of class tests, tutorial assignments, home assignment, project work etc. Summative evaluation is done by administering comprehensive examination at the end of a block. The weightage of each subject depends on the relative contribution made by the subject to meet the total objectives of the curriculum. Summative evaluation for theory papers should include:

- Objective type questions
- Short answer questions
- Descriptive/application type questions

Table 5.2 Horizontal and Vertical Organisation of Various Subjects for Diploma programme in Civil Engineering

Subjects	Time Distribution in hours/week					
	I	II	III	IV	V	VI
Communication Skills I & II	4	4	–	–	–	–
Applied Mathematics I & II	4	4	–	–	–	–
Applied Chemistry I & II	6	6	–	–	–	–
Applied Physics I & II	6	6	–	–	–	–
Engineering Drawing I & II	8	8	–	–	–	–
Workshop Practice I & II	8	8	–	–	–	–
Computer Applications I & II	–	–	6	–	–	4
Applied Mechanics	–	–	6	–	–	–
Hydraulics	–	–	5	–	–	–
General Engineering	–	–	4	–	–	–
Construction Materials	–	–	5	–	–	–
Building Construction	–	–	6	–	–	–
Structural Mechanics	–	–	–	5	–	–
Civil Engg. Drawing I & II, III & IV	–	–	4	8	6	6
Concrete Technology	–	–	–	6	–	–
Surveying I & II	–	–	–	8	9	–
Irrigation Engineering	–	–	–	3	–	–
Water Supply and Sanitary Engineering	–	–	–	6	–	–
Soil and Foundation Engineering	–	–	–	–	5	–
Elements of RCC Design	–	–	–	–	4	–
Elements of Steel Structural Design	–	–	–	–	–	4
Transportation Engineering	–	–	–	–	6	–
Estimating and Costing I & II	–	–	–	–	–	5
Construction Management	–	–	–	–	–	5
Project Work (Minor & Major)	–	–	–	–	6	12
Students Centred Activities	4	4	4	4	4	4
	40	40	40	40	40	40

While examining students for practical work, lot of stress should be given on process part, measurement skills, analytical skills of interpreting test results. A format of study and evaluation scheme is given in Table 5.3 as an example.

Table 5.3 Format for Study and Evaluation Scheme for Diploma Programme in Civil Engineering

Sr. No.	Subject	Study Scheme (Hrs/Week)	Evaluation Scheme			Total Marks
						External Assessment

					Internal Assessment						
		L	T	P	Theory	Practicals	Written Paper		Practicals		
					Max. marks	Max. marks	Max. marks	Hr	Max. marks	Hrs	
Third Semester											
3.1	Applied Mechanics	3	–	2	15	10	75	3	25	3	125
3.2	Hydraulics	3	–	2	15	10	75	3	25	3	125
3.3	Construction	4	–	2	10	10	75	3	25	3	125
	Materials										
3.4	Building Construction	4	–	2	15	10	75	3	25	3	125
3.5	General Engineering	2	–	2	15	10	75	3	25	3	125
3.6	Civil Engineering Drawing – I	–	–	4	–	25	75	4	–	–	100
3.7	Computer Applications–I	2	–	4	15	10	75	3	25	3	125
	+ Student Centred Activities	–	–	4	–	25	–	–	–	–	25
	Total	18	–	22							875

+ Student centred activities will include: Extension Lectures, Field Visits, Seminars, Debates, Hobby Clubs, Library Studies, Ecology and Environmental Awareness, Energy Conservation (Electricity and Fuel), Social Service Camps and other co-curricular activities including games. Advance planning for each semester has got to be made.

Step 9

Determining Resource Requirement:

The resources can be divided into:

- Human resources (i.e. faculty, staff etc.)
- Physical resources (i.e. space, building, equipment, raw material etc.)
- Informational resources
- Financial resources (i.e. recurring and non-recurring etc.)

The human resources will depend on:

- Student intake
- Programme duration
- Programme structure
- Periodicity of admissions
- Grouping of students in various learning situations
- Work load norms for different categories of staff

The physical resources required for implementation of the curriculum include land and buildings, equipment and furniture.

The resources need to be worked out for their optimum utilisation; All India Council for Technical Education (AICTE) has provided norms for deciding physical and human resources, which should be followed to recommend such resources. See section 5.7 for details.

The financial resources comprise of non-recurring and recurring expenditure. Nonrecurring expenditure primarily addresses itself to the capital investment on buildings, equipment, furniture and other fixed assets of the institute. Recurring expenditure deals with expenditure on salaries, consumables, water and electricity bills, maintenance costs and other contingent expenditure.

It will be worth-while to phase building of resources in a phased manner. Curriculum document should provide information on such phasing.

Step 10

Recommending instructional strategies:

The informational resources constitute: instructional material (print and non-print) and curriculum document. The curriculum development team has to prepare a list of instructional resources for teachers and students for effective implementation of curriculum. An institute is supposed to procure enough instructional resources to meet the requirement. of teachers and students.

It will also be worthwhile to make suggestions on instructional strategies or types of learning experiences to be provided to students for developing desired competencies.

It will also be worthwhile to make suggestions on instructional strategies or types of learning experiences to provided to students for developing desired competencies.

5.5 Curriculum Structure

Curriculum structures refer to various sub-components of curriculum i.e. percentage time allotted to applied sciences, engineering sciences, humanities and applied engineering/technology courses. Weightage of these sub-components will vary from the level of programme offering.

In order to develop appropriate competencies following are the sub components of engineering and technology curricula of the curriculum. The percentage time allotted for each sub component will vary from level of a programme offering. For designing a diploma programmes in engineering and technology, AICTE has made following recommendations for the curriculum structure. These percentages are however, not rigid stipulations and may be altered according to the functional requirement of the discipline:

– Applied Sciences	10 to 15 percent
– Basic Engineering Sciences	20 to 25 percent
– Humanities, Communication and Management Studies	10 to 15 percent
– Applied Engineering/Technology Studies	50 to 60 percent

The ratio between theory and practice for a diploma programme may generally be kept. as 50:50.

The role of applied sciences is primarily to develop scientific temper, basic understanding of concepts and principles of science so as to give a good foundation for learning the course of studies and also help in developing continued learning skills.

Basic engineering sciences aims at imparting basic knowledge and skills which aid the students in better understanding of applied engineering/technology subjects.

The role of humanities and management studies aims at developing interpersonal skills, communication skills and basic skills of management for effective functioning in the profession. It also aims at developing personality of students to play their role in profession and society.

The role of applied engineering/technology studies is to impart desired vocational competencies related to employment opportunities.

5.6 Introducing Flexibility in Programme Offerings with Specific Reference to Polytechnic Education

5.6.1 Introduction

The existing technical institutions system offers straight jacketed* programmes in various disciplines in a fixed and linear mode which are primarily designed for students with matriculation intake. One of the major complexities faced by the polytechnic education system is the variety of level of students intake, namely 10+, 10 + 2, 10 + ITI, etc., all of whom, in different proportions join these programmes. Students with higher entry qualifications such as 10+2 etc., who enter the system also undergo the same courses as. 10+ students even though they have already studied some of the subjects at +2 stage.

* Programme means a diploma in a particular discipline

Presently, the system has a single entry and exist point and there is no provision for students to pursue the course of studies according to their own pace and capacity.

Rapid developments in technology demand different clusters of competencies in each discipline. Present programmes do not offer any choice to students to select** courses/electives in emerging areas of technology as per their interest. Also, the existing system does not provide any opportunity for working people to update and upgrade their knowledge and skills for effective functioning in the world of work.

** Course and subject have same meaning

Multipoint entry and credit system (MPECS) allows students with different backgrounds and qualifications to enter the programmes of studies at different levels and pursue the same at their own capability and pace of learning.

5.6.2 Objectives of The Scheme

The scheme will:

- allow appropriate level of entry to students entering the polytechnic with different qualifications
- allow students to pursue programme of studies at their own pace, convenience and capacity
- provide flexibility to students in selection of certain courses/subjects as per their interest and need
- develop mechanism in the polytechnic for incorporating changes in the curricula as per needs of the world of work by way of offering elective courses
- make the course of studies field oriented and practice based
- provide opportunities for lateral and vertical mobility of students
- provide greater opportunities to teachers for carrying out innovations in curriculum development, instructional processes and student assessment procedures
- provide opportunities to working personnel for upgrading their knowledge and skills

5.6.3 Basic Concepts of MPECS

Following are some of the basic concepts involved in the scheme of Multipoint Entry and Credit Systems.

a) Credits and Credit System

In the credit system, certain number of credits are allotted to each course/subject. These are primarily based

on the number of contact hour/week spread over a term. Normally one credit is given for one theory/lecture hour and half credit for one practical/tutorial hour per week per term. While this will be the major factor, some times other factors such as the nature and importance of a subject, non-contact hours spent by students in learning the subject also influence the number of credits allotted to a particular course/subject.

For instance in a course/subject having one hour theory or two hours of practical work (tutorial, laboratory, workshop, drawing, survey practicals, field/industrial training) per week in a term will be designated as one credit. For example, a course/subject having three hours of theory and two hours of practicals per week in a particular term will have $3 + 1 = 4$ credits. In case total credits for a subject results in 3.5 or 4.5, it will be rounded off to 4 and 5 credits respectively.

b) *Multipoint Entry*

The national norms pertaining to entry qualifications and duration for most of the diploma programmes is matriculation and 3 years respectively. A large number of students who seek admission to polytechnics are with higher qualifications i.e. 10 + 2 etc. At present, students having different levels and backgrounds have to undergo the same curriculum as applicable to 10+ students. Secondly, admission of students is permitted once a year in first year i.e. in the first term.

In multipoint entry and credit system, the entry of students with different qualifications can be at different points on a credit scale. Based on the entry qualifications, appropriate credit exemptions are given to the students having higher qualifications. Depending upon their previous academic achievements students with higher qualifications can be exempted from the study of few subjects. For example, in the case of a diploma programme, students with 10+2 qualification (science stream) can be given exemption in the following subjects:

- a) English and Communication Techniques
- b) Applied Physics
- c) Applied Mathematics
- d) Applied Chemistry

5.6.4 Salient Features of the Scheme

Following are some of the salient features of the scheme:

(1) *Credits Earned*

A student is said to have earned credits of a course/subject, if he/she completes the relevant study of a course/subject (as per prescribed curriculum both in theory and practicals independently) with requisite and prescribed attendance and qualify the condition of assessment and passing end term examination in the course/subject as approved by State Board of Technical Education.

(2) *Criteria for Exemption*

Students admitted to various diploma programmes with higher qualifications will be granted exemption in the relevant course(s)/subject(s) already studied by them at the time of admission as may be decided and notified by the Board from time to time. It is proposed that the subjects to be exempted should have been covered by the student upto the extent of atleast 75% of the contents of the subject for which exemption is being sought and the pass percentage in the subject for exemption should be the same as that for passing diploma examinations.

(3) *Completion of Diploma at Different Timings*

In this system, the students may be allowed to complete the diploma programme at their own pace. Bright students are able to complete the programme in shorter time by taking up more number of subjects/courses (credits) than taken up by a normal student. Similarly, comparatively weaker students can take more time to complete the diploma programme by opting for lesser number of subjects/courses (credits)

Duration for completion of the diploma programme by a student is also dependent on his/her initial qualifications. The students exempted from certain credits on the basis of higher qualifications than the 'minimum prescribed' may be able to complete the programme in shorter time.

(4) Maximum and Minimum Credits

A student may be allowed to register for a maximum of 20 percent credits and minimum of 10 percent credits per term of the total credits assigned for award of diploma programme.

(5) Provision for. Continuing Education, Specialisation and Diploma in Other Disciplines

Working diploma holders may register themselves for study in subjects/courses of their interest for upgrading their knowledge and skills. This will provide opportunity to them to rejoin the polytechnic for doing specialisation in other areas for the same discipline or specialise in other allied disciplines thus providing horizontal and vertical mobility to such personnel. The students may be allowed to do this, subject to the availability of seats

(6) Audit Subjects

Any student may take up study of one additional subject in a term in addition to the prescribed diploma requirements. The marks obtained in such a subject will not be counted towards the award of diploma. The student may however, be issued a separate certificate of having qualified specified audit subject(s).

(7) Replacing Label of Pass/Fail

The students earn credits in a subject/course after qualifying laid criteria in respect of attendance, sessional marks and end term examination. Those who are unable to qualify these, do not earn the credits.

(8) Admission

The admission of diploma programmes will be governed by the guidelines laid down by the State Directorate/Board of Technical Education.

(9) Migration

Migration from conventional diploma courses to diploma course under MPECS scheme and vice-versa may be allowed. The equivalence of credits for the subjects passed against conventional stream may be worked out.

(10) Award of Diploma

Diploma will be awarded to a student after he/she acquires total number of credits as approved by the State Boards of Technical Education.

5.6.5 Registration

It is necessary to provide **guidance and counselling** to the students to enable them to register for courses in a term. The students will be asked to register themselves for maximum of 20 percent credits and not less than 10 percent credits of the total number of credits required for qualifying a diploma programme, at the beginning of each term.

a) Rules for Registration

The selection of the courses (subjects) in a particular term will be based on;

- Entry qualification of students
- Horizontal and vertical organisation of curriculum areas

- Pre-requisites required for the study of course(s)/subject(s)
- Maximum and minimum number of credits which a student can take according to his/her pace of learning
- Course(s)/Subject(s) for which the student has earned credits during the previous terms or through exemption(s)
- Subject(s) offered for study by the institution during a particular term

b) *Certification*

For arriving at the final grade of a student, all the subjects in which a student has appeared in the examinations will be considered except for audit course(s) in which the student has been granted exemption. The commulative performance of the student will be calculated as per the formula given below:

$$\text{C.P.A. (int \%age)} = \frac{\sum(\%age \text{ of marks obtained} \times \text{No. of credits for a subject})}{\sum(\text{No. of credits})}$$

After knowing the calculated CPA (Commulative Performance Average) in terms of percentage, the student can be awarded the class/division as per Examination Rules.

5.6.6 Organizational Setup

For implementation of the scheme of MPECS existing organizational structure in the polytechnic has to be strengthened. The major activities for implementing MPECS are: admissions, registration, examination, curriculum development etc. For managing these activities, a coordination cell at the polytechnic level may be established. This cell will have a core staff consisting of a full time coordinator, an office assistant, stenographer and data entry/computer operator. A person of the level of Head of Department (separately) will act as coordinator and will manage all these activities. He will be responsible for policy planning, organising, directing, controlling, coordinating and evaluation of different aspects of the scheme under the guidance of the Principal.

For providing guidance and support to MPECS unit at the polytechnic, an Advisory Committee will be set up. The committee will constitute persons from: Industry; Technical Teachers' Training Institute; Directorate; Board of Technical Education; representatives from the polytechnic and other technical institutions/organisations. The Advisory Committee will meet at least twice in a term to monitor the system.

The Coordinator of MPECS should be given assistance by all the departments at the time of admission, registration, examination etc., for guiding students in making right decisions regarding selection of subjects and in other academic/non-academic matters

Each faculty member of the polytechnic should act as a tutor for a group of students throughout their stay in the polytechnic for providing guidance and counseling.

5.6.7 Functions of Coordination Cell

Following are the functions of co-ordination cell:

a) *Admission, Registration and Counselling*

This will include:

- Preparing prospectus and advertisement details
- Carrying out admission of students
- Carrying out registration process

- Conducting induction programmes for new entrants (teachers) about the structure and operation of MPECS
- Deciding the subjects to be offered in a term
- Guiding entrants (teachers/students) for first/as well as subsequent registration, keeping in view already decided subject routes and exemptions
- Displaying the list in which students want to withdraw/change subjects already registered
- Collecting profile of students at the time of registering of student for subsequent term and supply to concerned personnel
- Preparing final list of students registered and send it to the State Board of Technical Education

b) Examination

- Preparing subject-wise list of students appearing in various examination
- Supplying guidelines to teachers for class tests
- Declaring of results of sessional tests in each course/subject
- Preparing students up-to-date record of results in different subjects
- Sending up-to-date record of results to the State Board of Technical Education
- Providing feedback to teachers based on analysis of results

c) Curriculum

- Collecting feedback from students and teachers for improving teaching-learning process and performance in the examination
- Providing information for additions and deletions to be made in the curriculum
- Deciding about new courses/electives to be included in the curriculum

5.6.8 Monitoring and Reviewing

Monitoring of the implementation of MPECS should be done both internally (at the institute level) and externally (by Advisory Committee).

For internal monitoring a committee comprising of Principal, Coordinator MPECS and all Heads of Department of the institution should regularly meet to see the progress of the scheme, assess its effectiveness and solve problems therein.

The external advisory committee may meet twice in a term preferably at the beginning and towards the end of each term. Coordinator MPECS, who is also the Secretary of this advisory committee will get their academic and administrative advice on various matters.

5.6.9 Important Considerations for introducing the Scheme

Recurring and non-recurring expenditure for each polytechnic offering diploma programmes on MPECS will vary. Following may be considered for this purpose:

- (a) It will be desirable to provide some functional autonomy to polytechnics for effective implementation of MPECS
- (b) Admissions, registration and declaration of results are required to be carried out as per plan prepared well in advance
- (c) It will be necessary to provide computer facilities for information storage and retrieval for implementing the scheme

- (d) A space of around 50 sq.m will be required for an academic cell required for introducing the scheme
- (e) Some additional faculty support is required for effective implementation of scheme as per recommendations made in respective curriculum documents
- (f) Provision of recruiting part time faculty will have to be made for offering specialised courses/electives
- (g) An office assistant, stenographer, data entry/computer operator etc will be required for implementing the scheme
- (h) Provision of appropriate recurring expenditure will have to be made towards payment of TA/DA, consumables, honorarium to experts invited for extension lectures for implementing the scheme
- (i) Some additional furniture items and other infrastructural facilities may have to be provided for the effective management of MPECS

Depending upon the availability of existing infrastructure, each polytechnic have to. workout additional recurring and non–recurring expenditures for implementing the scheme.

5.7 Norms And Standards

Technical Institutions in the country offer various types of programmes in the field of engineering and technology and other occupational areas. In order to produce manpower of desired quality and standards, it is essential to provide appropriate learning experiences to the students. All India Council for Technical Education (AICTE) has laid down norms and standards for achieving uniform standards through out the country. Norms also help in proper planning of institutions and preparation of proposals for starting new programmes and institutions. In addition, norms and standards are also essential for accreditation of the programmes.

The abstract of important norms and standards for polytechnics as for polytechnics as laid down by the AICTE is given in the following sections:

5.7.1 Teaching Staff Norms

In a technical institution/polytechnic, following categories of teaching staff is existing:

- Principal
- Head of Department, Workshop Superintendent, Training and Placement Officer
- Senior Lecturer
- Lecturer
- Workshop Staff

Staff structure of an institution will depend on factors which primarily include curriculum structure, work schedules (weekly, semester/annual), student intake, disciplines offered, instructional methods and media employed, student contact hours, group and class sizes, co–curricular and extra–curricular activities.

a) Weekly Work Schedule

Following weekly work schedule is proposed by the AICTE:

- | | |
|---|------------------|
| – Total institution hours per week | 40 hours |
| – Student contact hours in formal learning | 33 – 36
hours |
| – Student centered activities (Library studies, guidance and counseling, seminars, etc. | 04 – 06
hours |

b) Group and Class Size	Students	Teacher
– Theory/lecture class	40 – 60	1
– Tutorials	20	1
– Laboratory Practice/workshop/drawing work	20	1
– Project work	5	1

c) Work Load Distribution

Teachers of polytechnics have to perform a variety of tasks which include formal instruction in class rooms, tutorial classes, laboratories and workshops, preparation of instruction, assessment and evaluation of student's work, counseling and guidance of students and other developmental activities. Any prescription for precise distribution of work and working hours for each type of activity could be counter productive. Each institution has to deploy personnel and allocate work, considering accomplishment of institutional goals and objectives and meeting as far as possible individual competence, preferences and interest. The breakdown of workloads specified below has therefore to be treated as a guideline with scope for flexibility.

Average Work-load Distribution

Sr. No.	Activity	Hours Per Week		
		Principal	HOD	Lecturer and Sr. Lecturer
1.	Contact Hours (Instruction)	4	12	16–20
2.	Preparation, Assessment, Evaluation	3	6	12
3.	Administration, Research, Guidance and Counselling, Development activities etc.	29–33	18–22	8
	Total	36–40	36–40	36–40

Above norms are based on AICTE norms and Standards, 1995

d) Student – Staff (Teacher) Ratio

The student – staff ratio will depend on

- i) teacher time required for formal instruction requiring student contact
- ii) Student time devoted to formal learning requiring teacher contact and
- iii) Class sizes for different forms of instruction.

The student – staff ratio will have to be worked out for specific curricula. The teaching load may be such that it should not be allowed to rise beyond 16:1. However, desirable ratio is 11:1.

5.7.2 Norms For Infrastructure

I. Space Norms

Norms for space have been determined, based on the functional requirements. To effectively meet such requirements, institutions should comply with the minimum norms prescribed. Provisions less than the minimum would have adverse effects on instructional and administrative functions, amenities and services and other essential co curricular activities

In the planning of new institutions or expansion of existing institutions, the desirable norms should be adopted. This would facilitate marginal adjustments in intake in future and add to flexibility.

Building space requirements are classified into instructional, administrative, amenities and residential areas:

(1) Instructional area includes: class-rooms, tutorial rooms, drawing halls, laboratories including computer centre, workshops, library, instructional learning resource utilization centre and examination hall/auditorium

(2) Administrative area comprises Principal's room, staff rooms, office, stores, conference room/seminar room, confidential room, estate office and reception lounge

(3) Amenities include: student and staff common rooms, indoor games, sports and recreation centre, NCC, NSS, canteen, cooperative stores, hobby centre, dispensary and alumni association.

(4) Residential area includes student hostels, staff quarters and guest house

Instructional area

The requirements for instruction of different type – class rooms, tutorial rooms, drawing halls, would depend on the curriculum structure. The break-down of the curriculum in terms of the instructional time for each type of instructional activity has therefore, to be determined initially.

The number of rooms required for each type of instructional activity is calculated by applying the following relationship:

$$N = (Ns/Cs) \times (H/Hw) \times (1/fu), \text{ where}$$

N = Number of rooms required for each type (where N may be Nc, Nt or Nd depending on type of activity)

Nc = Number of classrooms for lecture

Nt = Number of rooms for tutorial

Nd = Number of drawing halls

Ns = Total number of students in all years/semesters/disciplines taking instruction in the specified class size (Cs)

Cs = Class size (Number of students)

H = Number of hours per week of classroom lecture, tutorial or drawing, as the case may be (Hc, Ht, Hd)

Hw = Number of working hours per week (usually 36)

fu = Utilization factor– (taken as 0.75 – in educational institutions, the maximum attainable utilisation factor can be improved by making use of working time spread over long periods)

i) Classrooms and Drawing halls

The unit area to be provided could be stated on a room wise basis – rooms for bigger class size requiring a smaller unit area and rooms for smaller class size, a higher unit area. Following are the minimum norms:

Class rooms for	Norms in Sqm/student (minimum)
15 – 20 students	1.20
30 – 40 students	1.10
Above 60 students	1.00
Drawing Halls	2.5 (4*) +

* For Halls with drafting machines

+ In the times to come, drawing work will be done by using Auto CAD packages and hence the concept of drawing halls will have to be changed.

ii) Laboratories

Laboratories are used for demonstrating, experimenting, investing, discussing, measuring, testing etc. by students

The space requirements of laboratories will vary from one laboratory to another. The major determinates are the number of students working at a time (batch size) and the size of the equipment. In some cases, the first factor is the basis and in others, in which the equipment are large size of equipment is the deciding factor. Norms would vary from 4 to 8 Sq.m per student. There could however be exceptional cases where the size of equipment/machinery like textile technology, printing, etc. heavy machines may dictate areas higher than 8 Sq.m per student which should be decided on a case to case basis

iii) Workshops

Workshops are used for demonstrating shop–floor activities related to skill–learning, assembling, dismantling, fabricating, erecting etc. by students

4 Sq.m per student for workshops requiring work–benches and small–scale machinery/equipment is recommended.

Note:

In the case of small number of students, the total area for laboratories and workshops may be worked out on the basis of actual equipment/machinery/apparatus to be provided.

iv) Library

Library is used for acquiring, storing, cataloguing, indexing, issuing and returning of books, periodicals and non–print instructional material and providing reader services.

Minimum

150 Sq.m for first 500 students
+0.20 sq.m for every additional student

Desirable

200 sq.m for first 500 students
+0.30 sq.m for every additional student

No. of Readers:

10% of students +25% of staff strength

15% of students + 50% of staff strength

v) Educational Technology Centre:

Learning Resource Utilization Centre (LRUC)

The purpose of LRUCs are:

a) Utilisation of media resources like print material, workbooks, transparencies, video programmes etc.

b) Receiving and stocking of media resources like: Over–Head Projector, VCRs, slide projectors, transparency markers etc.

Area of LRUC = 60 sq.m for 180 intake or less, and also upto additional 30 intake.

Learning Resources Development Centre (LRDC)

The purpose of LRDCs are:

a) Development and acquisition of media resources like over–head projector transparencies, slides, workbooks, learning packages

b) Distribution of media resources to LRUCs in state polytechnics

Area of LRDC = 100 sq.m to 150 sq.m depending on media resources to be developed and including photographic, printing, reprographic storing and packing facilities, model making etc.

c) Normally there would be LRUCs in every polytechnic. LRDCs are to be established in a few selected polytechnics in a state.

Administrative Area

Following norms are recommended in this respect:

<u>Particulars</u>	<u>Norms</u>
– Principal's room	30 sq.m.
– Confidential room	15 sq.m.
– Reception lounge	25 sq.m.
– Head of Department/Sr. Lecturer/	15 sq.m.
– Lecturer (Selection grade)	
– Lecturer	10 sqm.
– Main Office (including record room)	0.1 sq.m. per student subject to a minimum of 200 sq.m
– Departmental Offices	20 sq.m. per department

(Training and placement cell will also be considered as a department for this purpose)

Stores (Central Departmental) = $100 + (0.1 \times \text{student population})$ sq.m

Desirable

– Conference room/two seminar rooms	75 sq.m
– Confidential office for examination work	5 sq.m.
– Estate office (Security, campus, services)	5 sq.m.

Amenities

Purpose of amenities is to promote extramural/co-curricular activities (indoor games, NCC, NSS, social, cultural activities etc) of students and staff, health care, physical education, catering and other commercial services.

<u>Particulars</u>	<u>Norms</u>
Girls common room for 20% of strength of girl students	2 sq.m. per student Minimum 50 sq.m
Staff common room for 50% of staff strength	2 sq.m. per person Minimum 50 sq.m
Student common room for 10% of students	2 sq.m. per student Minimum 50 sq.m

Desirable:

NCC, NSS, Indoor games, recreation centre, hobby centre, physical education (gymnasium), alumni centre

Capacity: 1/3 student strength

i) Dispensary	75 sq.m.
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ii) Canteen, cooperative stores, bank, extension centre, postal services etc (0.3) × student strength sqm. Minimum 150 sq.m

iii) Playgrounds

As the availability of land varies from place to place, the norms for playgrounds depend on the place

In cities, where land is scarce and where playground facilities are available elsewhere and accessible to students 2500 sq.m. to provide basketball, volley ball, badminton courts, etc

Where availability of land is not a serious problem 25000 sq.m. to provide athletic track, cricket field, foot-ball, hockey fields, basket ball, volley ball, badminton and tennis courts

iv) Auditorium/Multipurpose hall

Purpose of the auditorium and multipurpose hall is to conduct conferences, seminars, extension lectures, functions, could also be used for examinations and social activities

Norms:

Capacity equal to annual intake; Area 3 sq.m. per student. (This includes space for stage, dressing room, projection room etc). Minimum area: 600 sq.m.

iv) Open-air-theater

The open air theatre is generally used for assembly of all students and staff, social and cultural functions

Norms:

Capacity for all students and staff: Area 1.5 sq.m. per student (Plinth area)

Residential Area

(a) Student hostels (Desirable)

50% of total boy students to be provided hostel accommodation. 100 % of girl students to be provided hostel accommodation in a separate block. However, hostel accommodation provision can be reduced in case of high proportion of local admissions.

<u>Type of Room</u>	<u>Area</u>
Single room	9 sq.m
Double bedded rooms	15 sq.m
Three bedded rooms	20 sq.m
Dinning hall	1.5 sq.m. per student

Capacity: Half the number of hostel inmates (inmates of each block to dine in two shifts) Minimum 150 sq.m.

Kitchen stores:

1.5 sq.m per student based on half the number and common room: inmates, Minimum 150 sq.m.

It is expected that each hostel block will accommodate 120 to 150 students and will have a separate warden, provided with a warden's quarter. Accommodation will be provided for hostel superintendent/caretaker, kitchen and mess staff as well.

Plinth area of warden's quarter	85 sq.m. each
Office	15 sq.m. 100 sq.m. each
Hostel superintendent/care taker	60 sq.m.
Kitchen and mess staff	45 sq.m.

b) Guest House (Desirable)

For visiting faculty, experts. 100 sq.m. with 2 guest rooms and service facilities.

c) Staff residences

i) Minimum accommodation that should exist in the campus or very near the campus, should be as follows:

- Principal's residence
- Residences for all Heads of Department
- Residences for 4 essential staff (caretaker, electrician, driver, plumber)

ii) Desirable

Acute problem of scarcity of teaching staff has necessitated many efforts. One such major effort stipulated in the programme of action of National Policy is the provision of residential accommodation which could facilitate attracting and retaining of competent personnel. The norms are:

- a) Accommodation for 50% faculty and supporting staff
- b) In highly urbanized and industrialised areas, where housing is an acute problem accommodation is to be provided for 100% of faculty and staff

The provision of housing could be accomplished in the following ways:

- a) Constructing houses in the campus and/or
- b) Leasing houses in the vicinity and/or
- c) providing liberal house building loans to enable faculty to construct their own houses

	Plinth areas
- Principal	140 sq.m
- Head of Department/Sr. Lecturer/ Lecturer (Selection grade)/T&PO/WS	100 sq.m
- Lecturer/or equivalent	80 sq.m
- Technical Supporting staff	30 sq.m
- Class D staff	20 sq.m

Note: Plinth areas for residential accommodation be provided as per state norms where such norms exists

II. Miscellaneous Items

- a) Cycle stand 1 sq.m./cycle for 25% students
- b) Scooter stand 3 sq.m./per scooter for 25% students
- c) Car garage 15 sq.m./car
- d) Bus garage 55 sq.m./bus

III. Norms for Conversion from Carpet Area to Total Floor Area

The carpet area is normally usable floor area in any floor. In addition there would be corridors, stairs, toilets, lockers, stores, etc. For estimation purposes, the following approach may be adopted:

$$\text{Total Plinth area} = \text{Carpet Area} \times 1.4$$

IV. Allowance for Future Expansion

Allowance for future expansion will vary depending on the expansion foreseen and availability of land. Where land is scarce, this provision has to be limited to a minimum equal to the plinth area of the buildings. In other cases the allowance be increased upto 3 times the plinth area of buildings. Where the provision of land for expansion is very much restricted (e.g. large cities where land cost is high and availability is scarce) provision should be made for vertical expansion in the design of buildings.

V. Norms for Land

The land area required for the buildings will depend on the prevailing building bye-laws as well as the building design—single storey or multi—storey. However, adequate space has to be available for roads, pathways, gardens, etc. Hence the land area to accommodate the buildings alone will vary from a minimum of twice the plinth area to thrice the plinth area.

Land requirement

i) Land required to construct buildings	2 to 3 times the plinth area as governed by the prevailing bye-laws
ii) Play-grounds	2500 to 25000 sq.m. with 1500 sq.m applicable to large towns and metropolitan cities
iii) Land for future expansion	1 to 3 times the plinth area
Total land = i + ii + iii	

VI. Cost Estimation

Unit cost for construction will vary from place to place. In preparing estimates, provision should be made for cost escalation also.

VII. Development Cost

Development costs would include roads, pathways, lighting, drainage, water supply, compound wall, gates, security check posts, landscaping, etc. and would depend on the topography of the land. An average provision of 16% is suggested. No separate costs are provided for playgrounds assuming that the same could be accommodated within the development costs. However, depending on the topography, if additional costs are required, the same may be provided for.

5.7.3 Equipment Norms

The norms for equipment will vary from programme to programme. However, following factors are to be considered in identifying the equipment for the laboratories and workshops:

- i) Type of skills to be developed
- ii) Utilization and cost consideration
- iii) Grouping of students

iv) Developmental activities at the institute level

The number of students for practical work in any batch may not be, usually, more than 20. Each batch of 15–20 students may be divided into smaller groups. The number of students in each group may not exceed the following:

- a) Experiments/tasks involving verification of laws, principles and theories – 2
- b) Exercises in basic workshops and manufacturing skills –2
- c) Measurement and testing skills – 2
- d) Field measurements, fabrication, erection etc – 5

Considering the utilization of various tools/equipment/apparatus and their cost, the following norms may be followed:

Category of Equipment	Minimum Quantity
<i>Common Measuring Instruments</i>	
i) High use rate	one each for two students
ii) Low use rate	one each for five students
<i>Special Measuring Instruments:</i>	
Laboratory/workshop measurements	
i) High use rate	one each for two students
ii) Low use rate	one each for five students
Field Measurements:	
i) High use rate	one each for three students
ii) Low use rate	one each for five students
<i>Manufacturing/Fabricating/Erecting/Installing Equipments:</i>	
i) High use rate	one each for three students
*ii) Low use rate	one each for the batch
<i>Testing Equipment:</i>	
i) High use rate	one each for three students
*ii) Low use rate	one each for the batch
<i>Equipment/Apparatus for Basic Sciences</i>	
i) High use rate	one each for three students
ii) Low use rate	one each for the batch
<i>Audio–Visual, Drawing Office and Reprographic Equipment</i>	
i) OHP, 35 mm slide–cum–filmstrip projector, cassette tape recorder	one each for each department
ii) Coloured TV and VCR	one each for the polytechnic
iii) 3 5 mm still photography camera for production of slides and filmstrips and photographs with appropriate dark room equipment	one set for the polytechnic
iv) PC with printer	one set for each department
v) Typewriters and duplicating machines	

	one typewriter for each department, library and workshop and two duplicating machines for the polytechnic
vi) Set of drawing instruments, stencils and drafting table	one each for the department, depending on need
vii) Photocopier with enlargement and reduction facilities	one (desirable two)
viii) Other miscellaneous equipment like stitching and binding machine etc	one each for the department, depending on need
* In case of low use rate of any equipment, networking with industry and other organisations may be considered.	

Note:

Any instrument/equipment/apparatus used for more than 50% of the practical exercises/tests/jobs/experiments is considered as "high use rate" and that with less than 50% is considered as low use rate.

While diversifying existing programmes into new ones, effort should be made to fully utilize the available equipment in the new programmes.

Miscellaneous facilities

Appropriate provision may be made for communications (internal and external telephone) and office equipment. The following minimum norms are suggested:

- a) One external telephone for the Principal with STD facility (both at the polytechnic and residence)
- b) One external telephone (paying booth) in the institution
- c) An internal communication set to match with the number of teaching staff members, office, hostel, community services area etc
- d) One external telephone (paying booth) in the hostel building
- e) Two typewriters, calculators and other office equipment totaling machine, one weighing machine for the office
- f) Sufficient computer facilities are to be provided in each polytechnic for teaching of the students.
- g) Provision should be made for a diesel generating set, kitchen and service equipment in the hostel, depending on local conditions
- h) It is suggested that to either purchase a vehicle or instead recurring grant may be provided to hire the vehicle as and when necessary

Note:

- Directorates may prepare detailed list of equipment for different programmes.
- Networking for sharing resources with other institutions and industry should be kept in mind while planning for purchase of equipment
- Duplication of equipment in different departments may be avoided

Furniture

Since the requirements of furniture in the laboratory, workshop, class room, auditorium etc., will depend on the type of programmes offered and location Of institutions, it is therefore, left with respective institution to equip the polytechnics with adequate facilities and furnitures.

5.7.4 Library Books and Periodicals

A library needs to be properly established in each polytechnic. The teachers and students should view the library as a centre of learning. With proper environment created in the library, the students as well as teachers would spend more time referring to the books, periodicals and research papers etc

The library should have books related to the areas of programme offering, books related to basic and engineering sciences, books on communication skills and management, good books for general reading and periodicals related with science and technology. The library should also have multimedia learning packages, audio visual aids like films, charts, slides etc. The library should also have facility for photocopying.

<u>Particulars</u>	<u>Number of Books and Periodical etc.</u>
i) Engineering and Technology Books/other disciplines offered by the respective polytechnic	1500 × number of disciplines
ii) Basic Sciences and Engineering Science	400 x number of discipline
iii) Books on communication skills, Management and standard general reading	75 per discipline
iv) Periodicals	10 – 15 per discipline

Note: For 1 to 3 above, 10% books may be added annually to the library

Immediately after the design of curriculum, development of instructional resources, orientation/training of teachers, establishment of new laboratories and workshops become imperative. Further for effective implementation of curriculum, appropriate learning experiences should be provided. These aspects have been dealt in the next Chapter.

6. Curriculum Implementation

6.1 Concept

As indicated earlier in Chapter – 3, curriculum development process involves four stages namely: Need analysis; Design and Development; Implementation and Evaluation. Once; curriculum design is completed and document is ready, careful attention must be paid for its successful implementation.

Curriculum implementation is a major area of concern for all those concerned with technical education. Implementation as a phase in the curriculum development process has too often, in the past, been interpreted as the process of handing over to the target groups the curriculum document that has been designed. Most seemingly, good curriculum designed with utmost care tends to get into disarray at the implementation stage.

It has been experienced that after designing the curriculum not much attention is paid to employment opportunities and developing appropriate competencies for gainful employment by providing appropriate learning experiences, providing meaningful tutorial and home assignments, selection of appropriate project assignment, proper planning and implementation of industrial/practical training of students, using appropriate tools for assessing students performance etc.

It is aptly said that an "average curriculum" if implemented properly will give better results in terms of quality of passouts. On the other hand a "well designed curriculum" if not implemented in the right spirit shall fail to achieve desired objectives.

The responsibility of implementing the curriculum lies with respective institutions for which it has been designed. Looking at the different states in the country or at different institutions in a state, it is observed that

degree of effectiveness for implementation of the curriculum varies. If the quality of curriculum implementation is marked on a scale as excellent, very good, good, average, fair, we will have institutes in each category of the scale.

Many factors influence the quality of curriculum implementation. Some of them are:

- Availability of appropriate resources i.e., physical, human and informational
- Leadership qualities possessed by the Principal and the Head of departments
- Motivation and competence of teachers
- Institute–Industry cooperation
- Traditions or culture of the institute
- Student discipline etc.

Weaknesses/bottlenecks in each of above areas need to be studied and corrective action taken will result in achieving desired results.

Many tasks need to be performed to introduce a curriculum change successfully or implement new curricula effectively. These tasks need to be performed by identified staff, either individually or in teams at the appropriate times using relevant and adequate resources. To achieve this, institutions need to plan the various aspects of implementing the proposed changes in the curriculum in advance and in a systematic way.

6.2 Advantages of Adopting Systematic Approach for Curriculum Implementation

The adoption of a systematic methodology for affecting curriculum change/or implementing a revised/new curriculum has many advantages. Some of these are listed below:

(1) It enables the Head of Institution/Head of Department, having responsibility of implementing the curriculum, to become more convinced about the value of the new curriculum. They own this and are able to give answers to the following questions asked by the teachers:

- a) What is the difference between the existing curriculum and the new curriculum?
- b) What extra resources in terms of space, building equipment, staff etc. are required for implementing the curriculum?
- c) Does the new curriculum cost more than the old to implement? If yes, then how much is the extra amount required?
- d) Are organisational changes implicit in the new curriculum? If yes, then what are those and how these will be brought into the system?
- e) What type of learning experiences and behavioural changes are expected in the students? How these changes will be brought about?

(2) It helps to obtain the commitment of all the people involved with the implementation. This may involve alteration in leadership style and decision making process. Active participation of the faculty members in all stages of decision making process is one strategy. Delegation of responsibilities and redistribution of resources is another strategy. Provision of incentives for innovative efforts in the form of recognition, additional responsibilities for development activities and financial and career prospects etc is yet another strategy. The individual must feel that they have been benefited by their involvement in implementation, then the motivation of individuals will be high.

(3) It will be possible to identify and provide training to staff to acquire new knowledge, abilities and skills needed for implementing the change, thus improving their competence.

(4) A mode of continuous monitoring the change due to implementation of a new curriculum can be agreed and the criteria established with the consent of the teachers.

(5) It serves as a basis for identifying and providing the essential resources needed for implementation of change at the times when they are required. The most important of these are: materials, reprographic facilities, technician help, library facilities and computer centre facilities.

(6) It guides the Principal/Head of Department to provide a conducive organisational climate for facilitating innovations and changes.

6.3 Guidelines for the Implementation Phase

During the implementation phase, the new/revised curriculum is put into practice. For effective implementation of the curriculum, the teaching staff must be made fully aware of the intent and content of the curriculum, the resources to be harnessed, types of learning experiences to be provided and the techniques to be adopted for evaluating performance of students. The steps involved in curriculum implementation are:

- (1) Analysis of new curriculum with a view to determine changes in the detailed • contents, additional resource requirement (in terms of physical, human and informational) etc
- (2) Orientation of faculty and staff for highlighting important feature of new/revised curriculum so as to cause its effective implementation
- (3) Organisation of resources in a phased manner
- (4) Training of faculty in new and emerging areas as stipulated in the curriculum
- (5) Preparation of appropriate instructional resources (print and non–print) for effective instruction
- (6) Monitoring teaching–learning process

A systematic methodology for implementing curriculum changes present in revised curriculum may consist of the following steps:

- (1) Identification of the main objectives and thrust of revised curriculum and the key effectiveness areas that require the attention of the institution for their accomplishment
- (2) Identification of relevant tasks in these key effectiveness areas, priorities and targets following consideration of time, resources, expertise and urgency
- (3) Giving responsibility to different persons for the key effectiveness areas, and other relevant tasks based upon their experience, interests and the requirement of the institution
- (4) Synthesizing the details worked out in the earlier steps and preparing an operational plan for the institution indicating the key areas, their sequencing and period for completion with a brief description of each of the main tasks
- (5) Actual implementation of the operational plan

These five steps will provide a feasible way in which the curricula may be implemented. Depending upon the particular situation, some variations may be necessary.

Table 6.1 provides details of main objectives at implementation stage and relevant key effectiveness areas.

Table 6.1 Objectives of Implementation Stage and Key Areas

Sr. No.	Main Objectives of Implementation	Relevant Key Effectiveness Areas
1.	To orient the staff with the objectives of new curriculum, changes in courses and contents, study and evaluation scheme	– Orientation programme for faculty and staff by the Head of Department

2.	To design and develop appropriate learning resources (where gaps exist) and procure new instructional resources for effective curriculum implementation	<ul style="list-style-type: none"> – Preparation of print and non–print instructional resources by respective subject teachers. – Procurement of new instructional resources by Principal/HODs
3.	To up grade the knowledge and skills of faculty in emerging areas/new additions for effective instruction	<ul style="list-style-type: none"> – Planning of faculty development programme by Principal and HODs – For newly recruited faculty induction programme – Curriculum processes, educational and institutional management for HODs & principals
4.	To plan, procedure and utilize resources in most economical and effective manner	<ul style="list-style-type: none"> – Identification of gaps in physical resources (Buildings, equipment and furniture etc) and their procurement in a phased manner by DTEs/Principals and HODs – Items needing sharing of resources with industry and other institutions/organisations by HODs
5.	To orient the faculty regarding type of learning experiences to be provided to students	<ul style="list-style-type: none"> – Orientation programme for faculty on instructional strategies by Principal/HODs in collaboration with development agencies like TTTIs
6.	To implement the curriculum and monitor the progress	<ul style="list-style-type: none"> – Design tools for monitoring curriculum implementation by HOD and development agencies
7.	To make improvement in curriculum process	<ul style="list-style-type: none"> – Appropriateness of curriculum; teaching–learning process; student evaluation – Employability of students by an internal or external team

Staff responsible for key effectiveness areas for curriculum implementation are given in Table 6.2

Table 6.2 Staff Responsible for Key Effectiveness Areas

Sr. No.	Relevant Key Effectiveness Areas	Persons Responsible For Action	Remarks
1.1	Staff Development/orientation	Respective Heads of department	The responsibilities for the key effectiveness
1.2	Norms and Standards for physical, human and informational resources as stipulated in the new curriculum.	Respective Heads of department	<p>Areas has been assigned by considering the following aspect:</p> <ul style="list-style-type: none"> – The responsibilities and areas of work of the faculty member (on the basis of specifications of the job)
2.1		Faculty of respective subjects	

	Development of Learning Resources (Print)		– The degree of specialization of the faculty, their status, competencies and attitudes
2.2	Development of Learning Resources	Respective subject expert/Media expert	
2.3	Assessment of Material	Heads of Department	– Coordination warranted with other department or within department
2.4	Procurement of instructional resources print and non–print	Heads of Department assisted by the faculty	– Uniform distribution of Working among as many faculty members as possible
3.	Identify training needs and organise training programme for the faculty	Heads of Department Principal DTEs	– Vertical mobility of the individual in the near future
4.1	Plan Buildings (Workshops, laboratories, etc.)	Principals, Heads of Department	
4.2	Construct building	Principals, Heads of Department	
4.3	Furnish building, purchase equipment		
4.4.	Select Faculty	Principal/DTE	
4.5	Other resources	Principal/DTE	
5.1	Implementation of curriculum with emphasis on the instructional process	Heads of Department and faculty	
5.2	Organisational design including duties and procedures	Principal and HODs	
5.3	Guidance and Counselling	HODs and selected trained teachers	
5.4	Training and Placement	Training and placement officer, HOD and faculty	
5.5	Industry–Institute Cooperation	Principal/Training Officer/HOD	
5.6	Industry–Institute gathering feedback/data	Heads of Department	
6.1	Evaluation of curriculum at institute level	Heads of department, for faculty	
6.2	Curriculum revision, design and development	External team: curriculum development experts, industrial experts, selected faculty	

6.4 Faculty Development for Effective Curriculum Implementation

The quality of technical manpower, is directly dependent on the quality of teachers, who manage the entire instructional process and provide varied learning experiences to the students for developing desired

competencies for gainful employment. Any institution will have new teachers, teachers with experience and managers of the system at the department, institute and state levels. A deliberate planning has got to be done for keeping the entire faculty abreast with the technology development, development in educational technology, techniques of student's assessment and institutional management.

The role of the principal of an institution is the management of physical, human, informational and financial resources at the institute level for effective curriculum implementation, leading to gainful employment of polytechnic passouts.

Therefore, the important areas of knowledge and skills required at the Principal's level include the following:

- (a) Knowledge of principles and practices of institutional management.
- (b) Knowledge of optimum utilization of resources, total quality management and motivational techniques.
- (c) Knowledge of various stages of curriculum and the processes involved at each stage
- (d) Knowledge of norms and standards for planning the resources
- (e) Information concerning administrative procedures for managing human resources and making purchases etc
- (f) Linkage with industry and industrial associations for effective curriculum implementation and placement of students

Similarly the role of Head of departments is to manage physical, human, informational and financial resources at the department level for effective curriculum processes.

Therefore, the important areas of knowledge and skill at the Head of department level include the following:

- (a) Knowledge of basic principles of managing the resources and particularly training of faculty.
- (b) Knowledge norms and standards, optimum utilization of resources and networking for resource sharing.
- (c) Knowledge of instructional strategies and types of learning experiences required to be provided to students for developing desired competencies.
- (d) Knowledge of curriculum implementation and evaluation strategies.
- (e) Knowledge of student evaluation techniques
- (f) Action research techniques for improving the functioning of the department

Teacher is the manager of instruction. He/she is supposed to have mastery over the subject and has sufficient knowledge and skills pertaining to the subject(s) being taught by him/her and is good at communication skills, well-versed in principles of pedagogy/educational technology and instructional resources development, good at using a chalk board. In addition he has the ability to use different approaches and media for creating motivation amongst students for learning and promoting innovations and development, knowledge of student assessment techniques, etc.

It is amply clear from the above that faculty development is not a single shot process. This will change as a person move from one position to another. Training and re-training is a life long process. Faculty development for effective curriculum implementation may have following three essential components:

- (i) Induction or initial training
- (ii) Training for professional development or job related training
- (iii) Training for horizontal and vertical mobility

Induction training is required for developing essential capabilities needed of a teacher when he/she begins the career. Such a training may comprise of exposing the teacher to industrial/field practices, up-gradation of technological knowledge and skills in the chosen field and pedagogical skills. Such a training should be compulsory for all technical teachers.

Training for professional development is aimed at keeping the teachers current in the knowledge and skills about the development in technology, industrial/field practices, educational technology through short term or refresher courses. Such programmes of training can be off-the-job and on-the-job.

Training for horizontal and vertical mobility is aimed at enrichment of the knowledge and skills and acquire competencies/qualifications which will make a teacher eligible for promotion to the next higher cadre. Structured programmes that meet the requirements of different job positions should be designed and offered. Technical Teachers' Training Institutes/Quality Improvement Centres should design and offer such programmes for the benefit of teachers and managers of technical education system.

In the present context of globalization and breaking of the trade barriers, it is necessary that industry is able to compete the world market. Besides competitiveness, other factors are need for quality manufacturing/services due to increased consumer awareness; short lead times and short product lives; complexity and variety in products/services and uncertainty in demand made it increasingly important for the industry to initiate automation steps to achieve all these. Because of its merits, like great speed; accuracy; consistency and efficiency in storage, retrieval, computation and analysis; cost-effectiveness; versatility and compactness, computers have formed a permanent niche in every walk of life whether it is complex system of office administration and management; education/training/research and development; banking/commercial/accounting activities; business/industry; communication/information/network; legal; medicine/health care; meteorology; power, transportation; tourism; defence; agriculture; art/music/sports; space/nuclear research; mining operation or it is a system of as simple as house-keeping.

Computers have a long association with business and industry in all sectors whether it is primary (agriculture/mining), secondary (manufacturing) or tertiary (service) sector. Its applications in the industry start right from accounts/management; raw material management; production planning, control and scheduling; marketing to project management through network planning. In planning large projects where large number of related activities having strict precedence relationships, i.e. some activities cannot start unless some other activities are first completed and whereas some other activities can go in parallel, can be computerized by making use of modern project planning and scheduling methods like Critical Path Method (CPM); Programme Evaluation and Review Techniques (PERT) and Graphical Evaluation and Review Techniques (GERT), to improve the efficiency in handling the projects. Computer-Aided Design (CAD)/

Computer-Aided Manufacturing (CAM), Computer Numerical Control (CNC), Direct Numerical Control (DNC), Robot Technology, Computer-Aided Process Planning (CAPP), Group Technology (GT), Computer-Aided Quality Control (CAQC) and Computer Integrated Manufacturing System (CIMS) are now a reality in most of the large, medium and small scale industries in India.

Computer integrated manufacturing system (CIMS) is concerned with providing computer assistance, control and high level integrated automation at all levels of manufacturing industries, by linking islands of automation into a distributed processing system. Technical institutions should set up micro factory in an institutional training environment so that this facility can become an incubating chamber of training students in CIMS and experimenting with various alternatives in advanced manufacturing systems. Once micro-factory environment for advance manufacturing/services is created, it will also lead to offering consultancy services to industry.

Virtual laboratory (VL), which is an offshoot of computer-aided-learning/computer-aided instruction (CAL/CAI) allows the learner to perform all types of experiments, play with variables, draw graphics, verify laws and develop conceptual and analytical abilities. In the times to come, VL will replace existing laboratories requiring more space and investment.

The curricula of various disciplines/programmes being offered by technical institutions, will have to integrate these "Advanced Manufacturing/Services" systems to remain relevant with the industry so that the manpower being developed and produced in these institutions fit into the job requirements of present industrial scenario. Further the applications of computer and multimedia have a great potential to give educational technology a "technology push" by which a "teacher-leading instructional" style can be replaced with "student-leading learning" style in the technical institutions

Somewhere a misunderstanding among the teachers and other stakeholders of technical education seems to exist that by providing just one or two programmers/computer professionals and by creating an isolated computer engineering/science department with some hardware resources these gaps can be bridged. In fact developing and using any application/educational computer software require a team work consisting of computer professionals, subject experts and personnel dealing with pedagogy. In order to fill-up the existing gaps and to remain relevant to the present day rapid automation in the industry, an integrated approach consisting of following components will have to be followed if some tangible impact is to be realized:

- Inclusion of contents of computer applications appropriate to various courses/subjects in all the programmes/disciplines being offered by the Technical Institutes and integration of computerization in the 'core-curricula'
- Teacher being the key to success of any educational project/programme, both inservice and preservice teachers, irrespective of type of course(s) he/she is teaching whether the course(s) are in applied sciences; drawing; engineering/technology sciences; engineering/technology applications, humanities or management. He/she should be trained and re-trained in relevant hardware and software packages being used in the field to enable him/her "teach with and teach about" various industrial applications of computers including applications of computers in teaching-learning process
- Specially designed, through the involvement of concerned teachers, flexible and appropriate CAL/CAI packages should be made available to every teacher in the technical institutes
- Development of computer, multi-media and other infrastructure to create an environment to practice softwares/systems like CAD/CAM/CNC/DNC/CIM/CAL/CAI/VR/VL etc., in the technical institutes setup
- Autonomy to polytechnic to develop interface between higher level institutions/organizations and industries to exchange expertise and offer consultancy services to make the system self-supporting
- Setting up 'micro-factory' environment in the technician level institutions to create situations where students and teachers can get a feel of practices being following in the world of work.
- Organized effort in the development of VR/VL course-ware is the need of the hour, considering that not much laboratory and workshop facilities exist in technician level institutions, to improve teaching-learning process.
- Efforts have to be made to train all technical teachers in making use of computer soft-wares for various engineering applications in a phased manner for effective. curriculum implementation.

6.5 Appropriate Instructional Material for Effective Curriculum Implementation

Curriculum material are resources that, if used properly, can assist a teacher in bringing about desirable behavioural changes in the students. These materials must not be confused with teaching techniques/methods. One way to consider the difference between the two is that curriculum materials are tangible resources used by the teacher and for students, where as teaching techniques are mainly approaches to teaching where success depends heavily upon the professional skill of the teacher. In general, curriculum material may be classified into three categories: printed material (text books, laboratory manuals, standards, study guides etc.), audiovisual material (Films, pictures, posters, transparencies, chart etc), and manipulative aids (puzzles, games, models, learning kits, simulators).

A good teacher must make use of all potential resources when planning for and conducting instruction. It is important to understand that curriculum materials can make teaching more effective for a learner. It may not be feasible to develop entire curriculum material by the curriculum team due to time, expertise and resource constraints. It is therefore, essential that curriculum material available in the market is assessed for its coverage and quality and be procured/recommended for purchase in the institute library and by the students. In some cases, a teacher may not find desirable instructional material from commercial resources and thus may rely upon developmental efforts by searching appropriate instructional resources.

Appropriateness of instructional material is judged by the type of language used, the diagrams/visuals used, and the level of content in relation to the target group. Also the concern is the relevance of content to the total subject matter area.

When the appropriate instructional resources are not available, curriculum planner may use team approach for the development of instructional resources. Selection of appropriate team member is indeed a difficult task but it can be attempted by looking into the biography of individuals, their previous publication, experience and interest. Development of instructional material will involve following stages:

- (a) Identify the type of instructional resources to be developed
- (b) Determine terminal and enabling objectives
- (c) Review the existing literature
- (d) Obtain relevant references and resources
- (e) Prepare a first draft of the materials
- (f) Edit the first draft
- (g) Prepare a second draft
- (h) Conduct pilot testing and prepare the third draft
- (i) Field testing of third draft and prepare final draft
- (j) Duplicate/print the material

6.6 Appropriate Instructional Strategy

Instructional strategy i.e. providing appropriate learning experiences to students plays an important role in technical manpower development. Generally, stress is laid on lecture work or passing information by verbal mode, which is, by and large, forgotten after students qualify a written examination which is generally conducted at the end of the semester. The role of the teacher is to motivate students for learning or to be independent learner. Graded tutorial exercises, well planned laboratory and workshop experiences, structured and supervised industrial/field training, computer aided learning etc. are all relevant learning experiences to train technical human resources, planning for which has got to be made at the department level as well as at the teachers level.

It has also been experienced that while doing practical work in the laboratories, only one experiment is operative. This results in recording some observations by a group of 15–20 students. Performing all the experiments in a consolidated time may prove beneficial. Another strategy which is being utilized by some of the institutions is providing for two and a half days theoretical work and remaining two and a half days of the week for practical work. This has proved quite useful in developing appropriate competencies in the students.

Providing appropriate learning experiences will differ from type of manpower being developed but the fundamental aspect is involvement of students in teaching – learning process or in other words, making instructional process student centred.

6.7 Student Evaluation

6.7.1 Introduction

Evaluation plays an important role in the total teaching–learning process. One of the major objectives before any educational institute is to endeavour for promoting the development of a well integrated person, capable of exercising responsibilities in the world of work. If the purpose of education is to promote the development of a well integrated person, teachers/trainers must start their teaching/training with certain objectives which may bring about a certain change in the behaviour of the students/learners. There, normally, are many individual differences in the students/learners and in order to meet the educational/training objectives effectively and efficiently, the teacher's functions include measurement and evaluation of curricula, teaching methods, teaching materials and students at different stages in every aspect of educational/training activity to address the basic questions such as "what is being done?", "How successfully it is being done?" and "How it can be done in a better way?" To cause optimal learning of students, a number of activities are undertaken by the educational/training institutions such as guiding students towards instructional objectives, diagnosing their individual differences and learning difficulties, determining their readiness to learn new areas, placing them in special activities in individual or groups under supervision or independently, judging their performance in task-oriented and problems-solving abilities and preparing reports of the students' progress and

accomplishments for parents/guardians, employers, higher level institutions and others. In all these activities evaluative judgments and decisions are required to be taken and the effectiveness of teaching–learning depends, to a large extent, on the degree of accuracy in taking these judgments and decisions.

An understanding of the principles and procedures of student evaluation will aid in accomplishing the task of developing desired learning outcomes and effective curriculum implementation. Informal classroom observations guide many instructional decisions and although these observations are informal and unsystematic, they play an indispensable role in effective teaching. Tests and other procedures of measuring learning outcomes complement and supplement the teachers' informal methods of obtaining feedback from the students in which teachers still remain observer and decision maker but measurements and evaluation procedures provide more comprehensive, systematic and objective evidence on which to base instructional decisions.

Evaluation is a much more comprehensive and inclusive term than measurement. The term measurement is limited to quantitative descriptions of students; that is, the results of measurement are always expressed in numbers (e.g. Rajesh correctly solved 40 of the 50 Mathematical problems). It does not include qualitative descriptions (e.g. Rajesh's work was neat) nor does it imply judgments concerning the worth or value of the obtained results. Evaluation, on the other hand, may include both quantitative descriptions (measurement) and qualitative descriptions (non–measurement) of students. In addition, evaluation always includes value judgments concerning the desirability of the results.

The Figure 6.1 shows the comprehensive nature of evaluation and the role of 'measurement techniques' and 'non–measurement techniques' in the evaluation process. As noted in the diagram, evaluation may or may not be based on measurement and when it is, it goes beyond the simple quantitative description.

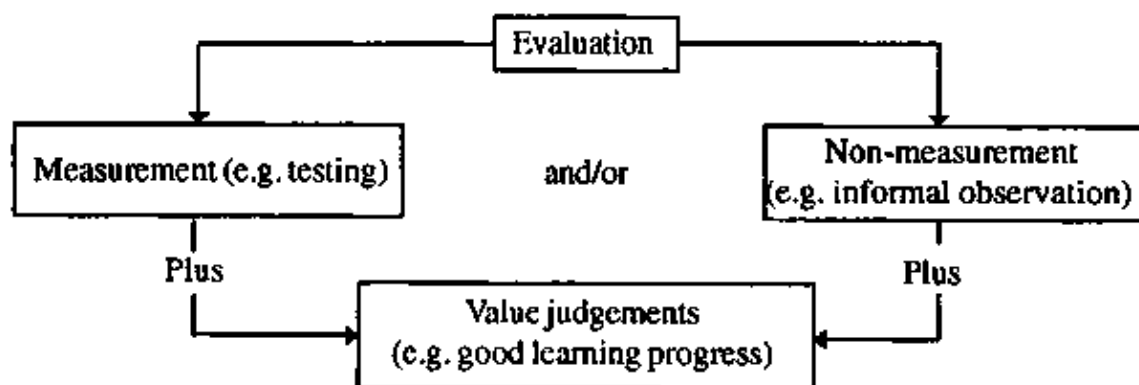


Figure 6.1: The Role of Evaluation Techniques and Value Judgements in Evaluation

6.7.2 Purpose of Evaluation

Numerous decisions are taken by the teacher that require them to supplement their informal observations of students with more systematic measures of achievements, aptitudes, and personal development. Effectiveness of the instruction depends on the nature and quality of the information on which the decisions to enhance students' learning are based. The purposes of student evaluation appear as below:

- To provide information regarding the extent to which a student has achieved mastery over a set of tasks included in a programme/course so as to provide information regarding the comparative achievement of students in relation to the objectives of educational/training programme
- To provide information to the teacher regarding the adequacy of the methods of instruction employed by him/her
- To provide information to the teacher for taking instructional decisions related to planning for teaching, grouping of students for learning, learning difficulties, student counselling and guidance etc.
- To provide information to the students regarding the nature and level of his/her performance
- To provide data for curriculum evaluation

- To provide information for use in institutional administration such as placement, grouping, promotion of students, in-service training of teachers and provision of facilities etc.

In addition to the above, the following are some of the major instructional decisions, which teachers are likely to encounter during the course of their teaching where evaluation systems might be most helpful:

- How realistic are my teaching plans for this particular group of students?
- How should the students be grouped for more effective learning?
- To what extent are the students ready for the next learning experience?
- To what extent are students attaining the minimum essential of the course?
- To what extent are students progressing beyond the minimum essentials?
- At what point would a review be most beneficial?
- What types of learning difficulties the students are encountering?
- Which students are underachievers?
- Which students should be referred to counselling, special classes, or remedial programmes?
- Which pupils have poor self-understanding?
- Which distinction should be assigned to each student?
- How effective was my teaching?

6.7.3 Types of Evaluation Systems

In order to meet various purposes of evaluation, a wide variety of evaluation procedures have been devised. These may be classified and described in many ways, depending on the frame of reference used. Three broad classifications are given below:

a) Nature of Measurement

- Maximum performance evaluation
- Typical performance evaluation

b) Functional roles in classroom instruction

- Placement evaluation
- Formative evaluation
- Diagnostic evaluation
- Summative evaluation

c) Method of interpretation of results

- Norms-referenced measurement
- Criterion – referenced measurement

a) ***Nature of Measurement***

Cronback labeled tests and other evaluation procedures in the following two broad categories on the basis of the nature of the measurement:

Maximum performance evaluation

In this category, those procedures of evaluation are included which determine a student's abilities and are concerned with how well an individual performs when he/she is motivated to obtain as high score as possible. Aptitude and achievement tests are included in this category.

Typical performance evaluation

In this category, those procedures of evaluation are included which reflect a student's typical behaviour and are concerned with what individuals will do rather than what they can do. Methods designed to evaluate interests, attitudes, adjustment, and various personality traits are included in this category and the emphasis is on obtaining representative responses

rather than high scores. Use of interviews, questionnaires, records, ratings, and various other self-report observational techniques are included in this category. Combined results of a number of them, rather than one of them, enables the teacher to make fairly accurate judgments concerning pupil progress and changes required in different areas

b) Functional Roles in classroom instruction

One such classification system follows the sequence in which evaluation procedures are likely to be used in the classroom. Airasian P.W and Madaus G.J in "Functional Types of Student Evaluation", classified the evaluation of student's performance in the following manner:

- Placement evaluation
- Formative evaluation
- Diagnostic evaluation
- Summative evaluation

Placement evaluation

Placement evaluation is concerned with the learner's entry performance and typically focuses on questions such as (i) Does the learner possess the knowledge and skills needed to begin the planned instruction? For example, does the beginner/reader have the necessary reading and readiness skills, or does the beginner of algebra student have a sufficient command of computational skills? (ii) To what extent has the learner already mastered the objectives of the planned instruction? Sufficient mastery might indicate the desirability of skipping certain units or of being placed in a more advanced course (iii) To what extent do the learner's interests, work habits, and personality characteristics indicate that one mode of instruction might be better than another (e.g. group instruction versus independent study). Answers to questions like these require the use of a variety of techniques: readiness tests, aptitude tests, pretests on course objectives, self-report inventories, observational techniques, and so on. The goal of placement evaluation is to determine the position in the instructional sequence and the mode of instruction that is most beneficial for each student.

Formative evaluation

Formative evaluation is used to monitor learner's progress during instruction. Its purpose is to provide continuous feedback to both learner and teacher concerning learning successes and failures. Feedback to learners provides reinforcement of successful learning and identifies the specific learning errors that are in need of correction. Feedback to the teacher provides information for modifying instruction and for prescribing group and individual remedial measures. Formative evaluation depends heavily on specially prepared tests for each segment of instruction (e.g. unit, chapter). These are usually mastery tests that provide direct measures of the intended learning outcomes of the segment. Prescriptions for alternative or remedial instruction can be keyed to each item in the test or to each set of items measuring a separate skill. Tests used for formative evaluation are most frequently teacher made, but customized tests made by various publishers can also serve this function. Observational techniques are, of course, also useful in monitoring learner's progress and identifying learning errors. Since formative evaluation is directed toward improving learning and instruction, the results are typically not used for assigning course grades.

Diagnostic evaluation

Diagnostic evaluation is a highly specialized procedure. It is concerned with the persistent or recurring learning difficulties that are left unresolved by the standard corrective prescriptions of formative evaluation. If a learner continues to experience failure in reading, mathematics, or other subject(s), despite the use of prescribed alternate method(s) of instruction (e.g. programmed materials, visual aids), then a more detailed diagnosis is indicated. To use a medical analogy, formative evaluation provides first-aid treatment for simple learning problems and diagnostic evaluation searches for the "underlying causes" of those problems that do not respond to "first-aid treatment". Thus, diagnostic evaluation is much more comprehensive and detailed. It involves the use of specially prepared diagnostic tests as well as various observational techniques. The main aim of diagnostic evaluation is to determine the causes of persistent learning problems and to formulate a plan for remedial action.

Summative evaluation

Summative evaluation typically comes at the end of a course (or unit) of instruction. It is designed to determine the extent to which the instructional objectives have been achieved and is used primarily for assigning course grades or for certifying learners mastery of the intended learning outcomes. The techniques used in summative evaluation are determined by the instructional objectives, but they typically include teacher-made achievement tests, ratings on various types of performance (e.g. laboratory, oral/written report), and evaluations of products (e.g. themes, drawings, research reports). Although the main purpose of summative evaluation is grading, or the certification of student achievement, it also provides information for judging the appropriateness of the course objectives and the effectiveness of the instruction.

C) Method of Interpreting the Results

How the results of tests and other evaluation procedures are interpreted also provides a method of classifying these instruments. There are two basic ways of interpreting student performance:

Norm Referenced

It describes student performance in terms of relative position held in some known group. These interpretations might base on a local, state or national group, depending on the use of results to be made.

Criterion Referenced

In many cases we care not so much how the person stands relative to other persons but whether or not he/she has mastered a given subject or area of knowledge.

Thus the idea of "criterion referencing" or "criterion-referenced testing" term first proposed by Glasses (1963) use as their frame of reference a special domain to content rather than a comparative group of individual.

Criterion referenced test can be defined as a test used to ascertain an individual's status with respect to a well defined behaviour domain (Hambleton, Swaminathan, Algine and Coulson, 1978). In most cases the concept of a "well defined behaviour domain" applies to some area of knowledge, skills, or competency, and criterion referenced tests are used to assess the individuals degree of knowledge, skill, or competency with respect to that domain. It describes students performance in terms of clearly defined and delimited domain of learning tasks. It enable to describe what an individual can do, without reference to the performance of others. Criterion referenced interpretations can be made in various ways:

For example:

- Describe the specific learning tasks a student is able to perform
- Indicate the percentage of tasks a student performs correctly
- Compare the test performance to a set standard and make a mastery – non mastery decision

6.7.4 Planning the Test

Main goal in testing the students is to obtain valid, reliable and useful information concerning student achievement. This means determining what is to be measured and then defining it so precisely that test items can be constructed that evoke the desired performance. Following steps should be followed to prepare valid, reliable and useful test:

- Determining the purpose of testing
- Developing the test specifications
- Selecting appropriate item types
- Preparing relevant test items
- Assembling the test

- Administering the test
- Appraising the test
- Use the result

6.7.5 Purpose of Test

Tests can be used for variety of instructional purposes in terms of location in the instruction process.

Pretesting is done at the beginning of an instructional segment to determine:

- (a) whether learners have the pre-requisite knowledge and skills needed for the instruction (determine readiness)
- (b) to what extent pupils have already achieved the objectives of planned instruction (placement or modification of instruction)

Monitoring is done during instruction (formative test) to be used to monitor learning progress, detect learning errors and provide feedback to students and teacher. Persistent learning difficulties may require the use of diagnostic tests.

End-of-Instruction Testing is done at the end of course or unit of course to measure the extent to which the intended learning outcomes have been achieved (Summative tests)

6.7.6 Some Possible Barriers to Test Items

- Ambiguous statement
- Excessive co-ordinates
- Difficult vocabulary
- Complex sentence structure
- Unclear instruction
- Unclear illustrative material
- Race, ethnic, and sex bias

6.7.7 Characteristics of a Good Test

Quality of an achievement test can be evaluated by considering factors like:

- relevance
- balance
- efficiency
- specificity
- difficulty
- discrimination
- variability
- reliability
- Validity

Though some of these characteristics are evaluated with different criteria for criterion-referenced or norm referenced measures, each characteristic is important to consider, depending on the score interpretations the test is intended to furnish.

(a) **Relevance and Balance**

Relevance indicate the extent to which the test items reflects the test specifications and contribute to achieving the staled purpose of testing. Relevance is judged by an item by item review of test content directed to the following criteria:

- *Content appropriateness*: Does the item content fit as an element of the domain definition? Does the item content match a specific instructional objective?

– *Taxonomic level*: Are the items written at the appropriate intellectual level? Are the abilities required by each item either too far beyond or well short of the cognitive demands on which instruction was focused?

– *Extraneous Abilities*: To what extent does each item require knowledge, skills or abilities outside the content domain of interest? Does vocabulary level, reading ability or creativity play too much of a role? How much specialized background knowledge, outside the domain of instruction, must the examinee call upon to answer the item?

An assessment of test **Balance** is simply a judgment of the extent to which the ideal specifications were achieved in terms of both content representativeness and cognitive abilities. For achieving this the table of specifications developed in the planning stage is intended to be a guide for choosing items for the test. There are two aspects to the assessment of the balance of a test:

i) Do the weight assigned to content sub-domains in the test specifications seem appropriate?

ii) How well were the intentions of table of specification carried out? Would an independent judgment of the requirements of each item result in content and abilities distributions like those in the table of specifications abilities?

(b) **Efficiency and Specificity**

Efficiency relates to maximizing the amount of information about achievement that can be obtained in a specified time period. A test can also be less or more efficient to develop or score. Essay tests are usually more efficient to build than objective tests because they require fewer items, but they are less efficient to score. But in view of the limited amount of instructional time ordinarily devoted to summative evaluation, the most critical aspect of efficiency relates to obtaining the largest number of independently scorable responses for hour of testing.

A test shows high **Specificity** if a test item noted in the subject matter achieves a score near the chance level on the best. This shows that test measures content specific to the objectives of instruction rather than general information. To the degree that any achievement test is a test of reading or writing ability, or general intelligence, it suffers in specificity. The most useful evidence for assessing specificity is obtained from the responses of proficient test takers who do not have competence in the field covered by the test.

(c) **Difficulty and Discrimination**

Difficulty of a test depends on the purpose for testing and the kind of score interpretation desired. For norm-referenced purposes, tests that are too easy or too difficult for the group tested will produce score distributions that make it hard to identify reliable inter-individual-differences. Under such circumstances use items that will produce moderate difficulty – a mean score that is about halfway between a perfect score and the mean chance score.

In criterion referenced tests, the elements of the domain to be measured are made explicit by the domain definition, the notion of difficulty is built into the test specifications. In this case the item writer is not free to manipulate item content to influence difficulty directly. With manipulation of difficulty, relevance may suffer. The ability of a norm referenced test to discriminate between high and low achieving students is a function of the ability of each item to do just that.

Discrimination items that are too difficult or too easy are not as capable of discriminating between high and low achievers as items of moderate difficulty. Because the purpose of criterion referenced test is not to differentiate examinees, items that fail to discriminate are not regarded as poor items.

d) **Variability and Reliability**

Variability If the differences in student learning exist and the purpose for teaching is to identify them, the test scores should exhibit high variability. Tests composed of items of moderate difficulty stand the best chance of discriminating between levels of achievement and producing high score variability.

Criterion referenced test need not produce score variability. In norm-referenced score interpretations, the reliability of the scores obtained i.e. the most important statistical indicator of their quality and of course

reliability, means very little if relevance has not been established: the user may have succeeded in measuring some irrelevant abilities quite accurately. The goals of high score variability, high item discrimination, and moderate item difficulty all contribute to major aim of obtaining high score reliability.

Reliability The first requirement for a high quality, or "good" test is that the test possesses what is called "reliability". Synonymous of the word reliability include terms such as consistency, stability, replicability and repeatability. Reliability involves the extent to which we are meaning some attribute in a systematic and therefore repeatable way.

e) **Validity**

While reliability indicates the degree to which a test is measuring some attributes in a consistent manner, it does not provide evidence that we are measuring what we intend to measure. The term **Validity** refers to the extent to which the test we are using actually measures the characteristics or dimension we intend to measure. For example, a researcher measures Mr A's height several time and finds that it is reliable measure – that Mr A is six feet tall each time he is measured. However, in trying to relate height to other indices of intelligence. The researcher finds that height is unrelated to these variable. Thus height is a reliable, but not valid measure of intelligence.

The characteristics discussed above are important in evaluating the quality of an achievement test. No matter what our primary testing purpose is the evaluation of each characteristic can provide clues regarding the ways in which the test items might be revised and improved for future use.

6.7.8 Techniques of Assessment

There is a considerable range of techniques by which the abilities and acquired skills of learners can be tested and the process of selecting the most appropriate technique must be governed by a number of important considerations which may include:

- Purpose of assessment
- Learning outcomes
- Time
- Resources available
- Age and ability of learner etc.

Each technique has it is own advantages and disadvantages. But using a variety of techniques can avoid or reduce the disadvantages embodied in a single technique. The most commonly used techniques of assessment include:

(a) Written Tests

- Essay Questions
- Short answer type items
- Objective type items
- Open book examination

(b) Observational Techniques

- check–lists
- Rating scales
- Anecdotal records and behaviour journals

(c) Oral Questioning

- Self Report Inventories
- Socio metric tests

While assessing the students, it is essential in most cases, to use a combination of different techniques. However following definitions and discussions are useful to decide the choice of technique(s), keeping the characteristics of a good test in mind:

Tests: Tests are the mean by which we measure people and environment for the purpose of understanding, explaining and predicting behaviour.

Subjectivity: Subjectivity is a measurement or evaluation to the extent to which the results depend on who is doing the evaluation rather than on what is being evaluated. The extent to which a measurement or evaluation is subjective is the degree to which it is variable to personal bias and prejudice.

Objectivity: If a rating remain constant irrespective of the rater, the rating is said to be objective.

(I) Functions of Tests

a) Instructional functions

- The process of constructing a test encourages the clarification of meaningful course objective (Stay on course – relevance of teaching)
- Tests provide a mean of feedback to the instruction and the student (self assessment/improvement)
- Properly constructed tests can motivate learning (competition)
- Tests can facilitate learning (students priorities)
- Test are useful means of over learning

b) Administrative function

- Test provide a mechanism of quality control
- Test facilitate better classification and placement decisions
- Tests can increase the quality of selection decision
- Tests can be useful means of accreditation, mastery or certification

c) Research and evaluation function

Tests are useful for programme evaluation and research

d) Guidance function

Tests can be of value in diagnosing an individual's special aptitudes and abilities

(II) Aptitude Test and Achievement Test

A distinction between these two types of tests is commonly made in terms of the use of the results rather than of qualities of the tests themselves. Since some tests may be used for both purposes, however, it is obvious that the difference is mainly a matter of emphasis e.g. an algebra test designed to measure achievement at the end of the course may also be used to predict success in future mathematical courses.

Aptitude Test is primarily designed to predict success in some "future learning activity."

Achievement Test is designed to indicate degree of success in some "past learning activity".

6.7.9 Instructional Objectives (Bloom's taxonomy) and Evaluation Verbs

Bloom et al classified instructional objectives into three major groups: cognitive domains, psychomotor domain and affective domain as indicated in the Table 6.3 given below. The evaluation technique and test items must correspond to whether the particular ability or abilities intended to be developed in the students has been developed or not.

Table: 6.3 Schematic layout of Taxonomies proposed by Bloom et. al. and R.H. Dave

Domain	Refer To	Level	Action Verb For Evaluation
Cognitive	Intellectual	Knowledge	Define, describe, identify, label, list, match, name, outline, select, state tell, underline, write etc.
	Outcomes	Comprehension	Convert, calculate, compare, defend, distinguish, discuss, draw, devise, estimate, explain, extend, evaluate, generalize, give example, infer, interpret, paraphrase, predict, re-write, summarize, translate, solve etc.
	Knowledge	Application	Change, compute, derive, determine, demonstrate, discover, justify, manipulate, modify, operate, predict, prepare, produce, relate, show, solve, use etc.
	Understanding	Analysis	Break down, conclude, contrast, diagram, differentiate, discriminate, distinguish, identify, illustrate, infer, outline, point out, relate, select, separate, subdivide, support etc.
	Problem-Solving	Synthesis and Evaluation	Appraises, categorize, combine, compile, design criticizes, compose, create, Plans, solve etc.
Psycho-motor	Emphasis on Motor Skill Development Handwriting Drawing Typewriting Operating	Imitation Manipulation Precision Articulation Naturalization	Assembles, builds, calibrates, changes, cleans, clears, composes, connects, constructs, corrects, creates, designs, dismantles, drills, fastens, fixes, follows, grinds, hammers locates, makes, manipulates, mends, mixes, nails, paints, sands, saws, sharpens, sets, sews, sketches, starts, stirs, type-writes, uses, weighs, wraps, drives, navigates, pulls, pushes, scraps, welds, weight, writes etc.
Affective	Attitudes	Receiving	Ask, choose, describe, follow, give, hold, identify, locate, name, point to, reply, select, sit erect, use etc.
	Interests	Responding	Answer, assist, complete, comply, conform, demonstrate, describe, differentiate, discuss, explain, follow, form, greet, help, initiate, invite, join, justify, label, perform, practice, present, propose, read, recognize, report, respond, select, share, study, tell, values, work, write, etc.
	Feelings	Organization	Organize, adhere, alter, arrange, combine, compare, complete,

			defend, explain, generalize, identify, integrate, modify, order, prepare, relate, synthesize etc.
	Emotions	Characterisations	Value or value complex act, display, influence, listen, modify, perform practice, propose, qualify question, revise, serve, solve, use, verify, etc.

6.7.10 General Suggestions for Writing Test Items

The following general rules are listed for preparing test item:

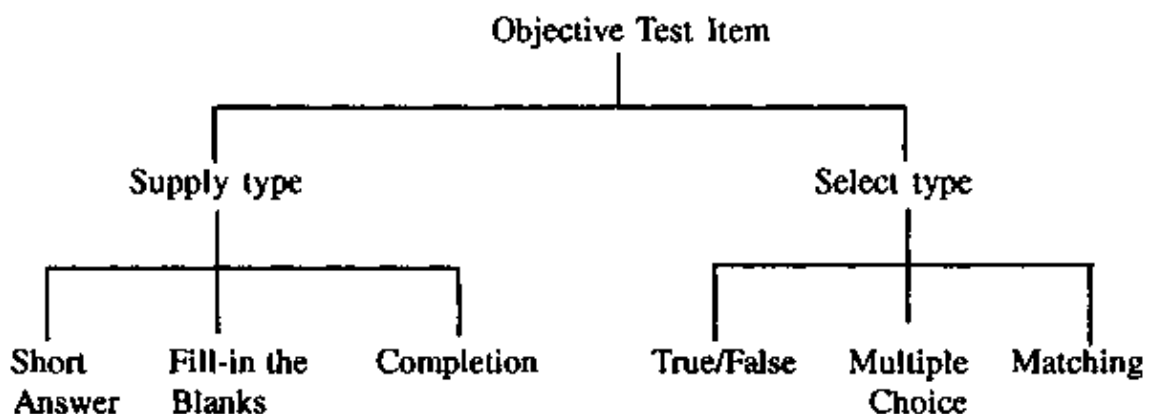
- Use your test specification as a guide to an item writing
- Write more test items than needed
- Write the test items well in advance of testing date
- Write each test item so that it calls forth the performance described in the intended learning outcome
- Write each test item so that the task to be performed is clearly defined
- Write each test item at an appropriate reading level
- Write each test item so that it does not provide help in answering other items in the test
- Write each test item so that the answer is one that would be agreed upon by experts
- Write each test item so that it is at the proper level of difficulty
- Whenever a test item is revised, recheck its relevance

6.7.10.1 Selecting Appropriate Item Types

The items used in tests are typically divided into two general categories (a) objective item (questions) (b) Essay item (questions) which permits the students to select, organise and present the answer in essay form. Each type should be used where it is most appropriate with respect to learning outcomes to be measured.

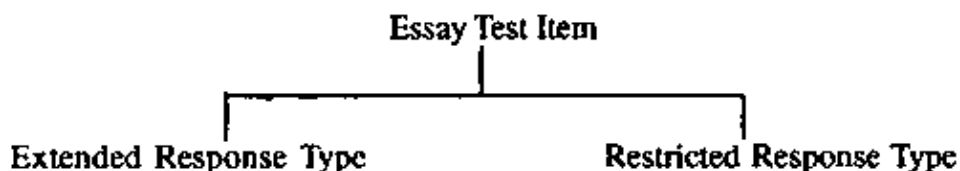
a) Objective test item

The objective item include a variety of different types but can be classified as those which require the students to supply the answer/select the answer. These can be further classified as under:



b) Essay test item

The essay item is commonly viewed as a single item type. A useful classification however, is one based on the amount of freedom of response allowed to the students as under:



Comparison of Test Item Types:

A comparison of the two item types, with regard to a number of important characteristics is presented in the following table.

Table 6.4 Comparative Advantages of Objective and Essay Tests

	Objective Test	Essay Test
Learning outcomes measured	Is efficient for measuring knowledge of facts. Some types (e.g. multiple-choice) can also measure understanding, thinking skills, and other complex outcomes. Insufficient or inappropriate for measuring ability to select and organize ideas, writing abilities, and some types of problem-solving skills	Is inefficient for measuring knowledge of facts. Can measure understanding, thinking skills, and other complex learning outcomes (especially useful where originality of response is desired). Appropriate for measuring ability to select and organize ideas, writing abilities, and problem-solving skills requiring originality
Preparation of questions	Relatively large number of questions are needed for a test. Preparation is difficult and time consuming	Only a few questions are needed for a test. Preparation is relatively easy (but more difficult than generally assumed)
Sampling of course content	Provides an extensive sampling of course content because of the large number of questions that can be included in a test	Sampling of course content is usually limited because of the small number of questions that can be included in a test
Control of learner's response	Complete structuring of task limits learner to type of response called for. Prevents bluffing and avoids influence of writing skill, though selection-type items are subject to guessing	Freedom to respond in own words enable bluffing and writing skill to influence the score, though guessing is minimized
Scoring	Objective scoring is quick, easy, and consistent	Subjective scoring is slow, difficult, and inconsistent
Influence on learning	Usually encourages learner to develop a comprehensive knowledge of specific facts and the ability to make fine discriminations among them. Can encourage the development of understanding, thinking skills, and other complex outcomes if properly constructed	Encourages learner to concentrate on larger units of subject matter, with special emphasis on the ability to organize, integrate, and express ideas effectively. May encourage poor writing habits if time pressure is a factor (it almost always is)
Reliability	High reliability is possible and is typically obtained with well-constructed tests	Reliability is typically low, primarily because of inconsistent scoring

6.7.10.2 Constructing Objective Test Items

The construction of good test item is an art. Needed are a thorough grasp of subject matter, a clear conception of the desired learning outcomes, a psychological understanding of the students, sound judgment, persistence and a touch of creativity. The objective test item can be of the following types:

- a) Short answers items
- b) True-False items
- c) Matching exercises item
- d) Multiple choice form item

a) Short Answers Items

The short answer, fill-in the blanks and completion items are supply type items that can be answered by a word, phrase, number or symbol etc. Categories of problem in arithmetic, mathematics, science, technology and other areas, where solution must be supplied by the students are included in this category. Following outcomes can be measured using short answer item:

- Knowledge of terminology
- Knowledge of specific facts
- Knowledge of principles
- Knowledge of method/procedure
- Simple interpretation of data
- Ability to solve numerical problems
- Skill to manipulate mathematical symbols
- Ability to complete and balance chemical equation etc.

Suggestions for constructing short answer items:

- Word the item so that the required answer is both brief and specific
- Don't take statements directly from text books to use as a basis for short answer items
- A direct question is generally more desirable than incomplete statement
- If the answer is to be expressed in numerical units indicate the type of answer wanted
- Blanks for answers should be equal in length and in a column to the right of the question
- When completion items are used, don't include too many blanks

b) True-False or Alternate Response Item

The following abilities can be measured using the selecting test item of true-false item type:

- Ability to identify correctness of statements of fact, definitions of terms, statements of principles and like
- Ability to distinguish fact from opinion
- Knowledge concerning the beliefs held by an individual or the values supported by an organization or institution
- Ability to recognize cause-and-effect relationships
- Measures some simple aspects of logic

Suggestions for constructing True/False Item

- Avoid broad general statements if they are to be judged true or false
- Avoid trivial statements
- Avoid the use of negative statements, especially double negatives
- Avoid long, complex sentences
- Avoid including two ideas in one statement, unless cause-and-effect relationships are being measured
- True statements and false Statements should be approximately equal in length
- The number of true statements and false statements should be approximately equal

c) Matching Exercises

In this two parallel columns with word, phrase number or symbol in one column is being matched to a word, sentence, phrase or symbol in the other column. The item in the column for which match is sought is called "premises" and the items in the column from which selection is made are called "responses". Following abilities can be measured using matching exercise:

- Ability to identify the relationship between two things
- Ability to relate two things that have some logical basis for association

Suggestions for constructing Matching Type

- Use only homogeneous material in a single matching exercise
- Include an unequal number of responses and premises, and instruct the pupil that responses may be used once, more than once, or not at all
- Keep the list of items to be matched brief, and place the shorter responses on the right
- Arrange the list of responses in logical order
- Indicate in the directions, the basis, for matching the responses and premises
- Place all of the items for one matching exercise on the same page

d) Multiple–Choice Form

A multiple–choice item consists of a problem and a list of suggested solutions. The problem may be stated as a direct question or an incomplete statement and is called the "stem" of the item. The list of suggested solutions may include words, numbers, symbols, or phrases and are called "alternatives" (also called choice or options). The correct alternative in each item is called merely the "answer", and the remaining alternatives are called "distracters" (also called decoys or foils). Multiple choice forms can measure following abilities very effectively:

- Measuring knowledge outcomes
- Knowledge of terminology
- Knowledge of specific facts
- Knowledge of principles
- Knowledge of methods and procedures
- Ability to identify application of facts and principles
- Ability to interpret cause–and–effect relationships
- Ability to justify methods and procedures

Suggestions for constructing Multiple–Choice items

- The stem of the item should be meaningful by itself and should present a definite problem
- The item stem should include only as minimum of the item as possible and should be free from irrelevant material
- Use a negatively stated item stem only when significant learning outcomes require it
- All of the alternatives should be grammatically consistent with the stem of the item
- An item should contain only one correct or clearly best answer
- Items used to measure understanding should contain some novelty, but beware of too much
- All distracters should be plausible
- Verbal association between the stem and the correct answer should be avoided
- The relative length of the alternatives should not provide a clue to the answer
- The correct answer should appear in each of the alternative positions—an approximately equal numbers of times but in random order
- Use sparingly special alternatives such as "none of the above" or "all of the above"
- Don't use multiple–choice items when other item types are more appropriate

- Break any of these rules when you have a good reason for doing so

6.7.10.3 Constructing Essay Test Items

Despite wide applicability of objective item type, there remain significant instructional outcomes for which no satisfactory objective measurements have been devised. These include ability to recall, organize, and integrate ideas, express oneself in writing and the ability to supply rather than merely identifying interpretations and application of data. Such outcomes require less structuring of response than that imposed by objective test. The following abilities can be measured using: (a) Restricted response essay questions and (b) Extended response essay questions.

a) *Restricted response essay questions* measure the ability to:

- Explain cause–and–effect relationships
- Describe applications of principles
- Present relevant arguments
- Formulate valid conclusions
- State necessary assumptions
- Describe the limitations of data
- Explain methods and procedures (and similar out–comes based on the learner's ability to supply the answers)

b) *Extended response essay question* measure the ability to:

- Produce, organize and express ideas
- Integrate learning in different areas
- Create original forms e.g. designing an experiment
- Evaluate the worth of an idea

Suggestions for constructing Essay Test Items

- Restrict the use of essay questions to those learning outcomes that cannot be satisfactorily measured by objective items
- Formulate questions that will call forth the behaviour specified in the learning outcomes
- Phrase each question so that the student's task is clearly indicated
- Indicate an approximate time limit for each question
- Avoid the use of optional question

6.7.11 Design For Internal Assessment

Internal assessment, if taken as an integral part of teaching – learning process, can influence student's learning to a large extent. It can help in monitoring students' progress and providing feedback to them as well as to other stakeholders.

Salient Features of Design for Internal Assessment of Students

To facilitate design the scheme of internal assessment of students, the courses/subjects of study in any engineering degree or diploma programme can be grouped under three categories namely: Theory, Theory–cum–Practical and Practical. Considerations to be made for internal assessment in these courses of study are discussed below:

a) Theory subjects

Study of theory subjects (e.g. Theory of machines, Industrial management, Theory of structures, Material science etc) aims at building knowledge and developing an understanding of concepts, principles and procedures related to the subject of study as well as in the application of this knowledge to problem-solving. "Class tests" (open or closed book) could be used as a preferred technique for assessing the above capabilities. As they help in testing a number of cognitive abilities such as the ability to recall, translate or extrapolate, organize and synthesize, application of knowledge to new situations etc. The frequency of class tests can vary depending upon the nature of the subject. It should, however, be more at the beginning of the (term/semester/year) so as to facilitate students' learning. The major thrust is on diagnosing students' performance with respect to their achievement of instructional objectives and providing them feedback to facilitate learning. Only a few of these class tests say two or three, could be earmarked for the purpose of grading, the rest being used to serve the formative purpose.

For subjects, that require large proportion of information acquisition, practical application or innovative work on the part of students (e.g. Electrical engineering materials etc.) an alternative technique of "Assigning Term Paper" to students could be used. Such a techniques of assessment will promote skills of information processing, communication and make the students more resourceful and creative. Teacher can give an independent assignment to the students that may involve collection, organization and presentation of information related to a particular topic or topics.

In theory subjects, which involve considerable practice in learning the application of mathematical rules and theorems for solving problems (e.g. Mathematics, Strength of materials etc), students may be assigned Tutorial (class work) and Homework. The purpose is to provide opportunities to practice and facilitate learning through providing corrective feedback. These alignments should not be used for grading students.

b) Practical Work

Practical work in laboratories, workshops or field aims at providing opportunities for direct experiences that facilitates development of cognitive as well as psychomotor skills. At the same time, these experiences help in the development of desirable work behaviour (Tamir, 1985). The nature of the practical work may vary from introducing, developing and reinforcing theoretical concepts to development of practical skills related to a discipline. Assessment of practical work will help generate the learning environment essential for the development of desirable skills and attitudes. Some of the assessment techniques for practical work include:

- (i) observing performance on task/job (process evaluation) to evaluate abilities in students to interpret drawings, follow correct procedures, manipulating skills, observe safety precautions, ingenuity in the use of materials and timely completion of job
- (ii) judging quality and precision of job (product evaluation) to evaluate the abilities in the students to observe specific dimension, shape, finish and tolerance limits while completing the job
- (iii) observing general behaviour (e.g. punctuality, care of tools and equipment, safety considerations, care of working spaces) like material, time and space and orderliness/cleanliness at work places, team spirit, responsibility and independent thinking etc
- (iv) conducting viva-voce to judge the students understanding about various processes, operations and related concepts, principles and procedures
- (v) providing feedback to individual students on their skills and attitude profile.

It is important that each and every practical exercise is assessed and the students are provided with feedback on the various process, product and behavioural elements. This would require maintaining a profile of students on the various process and behavioural elements. The above assessment of practical work is primarily carried out to facilitate student learning and developing the desired competencies and attitudes. However, a few of these exercises, say two or three, which are comprehensive, could be earmarked for grading students.

c) Project Work

Project work promotes development of 'creativity', 'job commitment', 'problem-solving' and 'learning to learn skills' apart from learning the 'technical skills' needed for undertaking specific technical project. It also facilitates cooperation among students and provides opportunities for improving communication skills (Hewton, 1985). The assessment of project work should, therefore, include appraisal of all the capabilities it is designed to promote. For this the assessment of project work need to be spread over all its stages beginning from identification of the problem for the project to design and planning of the project work, conduct/execution of the project, additional factors such as group/general behaviour, quality of work, report writing and presentation of the project report.

It is important that feedback is provided to students during each stage of completion of the project so as to facilitate development of essential capabilities in them. Only the final product of the project, the presentation of the project report or/and oral viva could be considered for external end team grading the students' performance.

6.8 Strategies for Improving the Curriculum During Implementation Stage

A strategy is a comprehensive plan for achieving a result. As curriculum coordinators think of what should be done to improve the curriculum implementation over a period of years, they attempt to find strategies. The strategies they choose should fit in a particular situation.

One of the strategies of effective implementation of curriculum is careful planning at a central place. In some states curriculum development centres have been established to plan for the whole state. These centres monitor curriculum planning and bring about improvements.

A second strategy requires shifting the focus of attention from large scale, centralized planning to planning at institute level. The leaders immediately involved in this strategy are usually the principals and Head of Departments. An official from curriculum development centre/coordinator from the State coordinate the planning in number of institutes, as well as its implementation. The purpose is to ensure adherence to norms and standards for promoting uniformity.

Many curriculum leaders prefer to adopt a third strategy. This is based on the belief that the effective curriculum implementation cannot take place until the faculty is well versed with the developments and possess desired knowledge and skills to be imparted to students. They emphasize on training and re-training of faculty. The third strategy is, therefore, involves comprehensive in-service faculty development programmes.

Large number of principals believe that the curriculum improves when organisational conditions in institutions make improvement possible. Accordingly, they emphasize the need to make changes in the organizational structure of institute.

Some of the curriculum coordinators have felt that one of the way of improving the curriculum is involving teachers and other institute personnel in conducting sensible experiments and in undertaking action research.

Principal/Head of the Department/Curriculum Coordinators may adopt two or more strategies at a given time and for overlapping periods of time. Each strategy obviously has its own contribution to make.

In nutshell, Principal and Head of Departments are primarily responsible for managing, physical, human and informational resources for curriculum implementation. They should be pro-active in promoting innovations and developments. They should have clear vision about their institute, transfer these visions into goals and expectation, establish meaningful linkages with the world of work and other organisations, establish a progressive climate in the institute, monitor the programme on regular basis and provide support and guidance to the faculty and staff.

It has been seen from above description that curriculum implementation is to harness physical, human and information resources to provide appropriate learning experiences to the students for developing desired competencies in them leading to their gainful employment. Planning at institute, department and at teachers' level go a long way in effective implementation of curriculum. Monitoring the instructional process at the department level is also essential to solve bottle-neck(s) and plays a vital role in improving the teaching-learning process.

7. Industry – Institute Interaction

7.1 Introduction

The topic of education – work linkage, though of older origin, but has recently attracted the attention of national planners and educationists.

It is interesting to note that if there is any one recommendation on which every commission, committee or seminar has unanimously agreed, it is the need for education – work linkage. If one reviews the history of growth of technical and vocational education, one would find strong recommendations on education–work linkage. The Abott Wood report of 1937 recommended to survey the needs of industry and commerce and accordingly framing the instruction; the Sargent Commission of 1944 suggested that technical instruction must form a link between education and industry; the Working Group on Technical Education 1959 recommended engineering colleges and polytechnics to be located near the industry for sharing physical and human resources; the Education Commission, 1964 suggested that practical training in industry should form an integral part of various courses by offering courses on sandwich pattern; the Special Committee for Reorganisation and Development of Polytechnic Education, 1971 recommended partnership between polytechnics and industry in curriculum design and its implementation, undertaking joint research work and training of teachers in industry; the Working Group on Technical Education, 1978 suggested adoption of polytechnics by industry. However, as pointed out by the Government of India document "Challenges of Education" which was a precursor of the National Policy of Education, 1986, the issue of education–work linkage in India still eludes national educational planners and administrators.

In spite of all the above recommendations, education – work linkages is generally at a slow pace. As per information tabulated from the regional reports on physical facilities for technical education, about 87 to 90 percent of technical institutions offer degree and diploma programmes without having meaningful linkage with the world of work i.e. producing professional and technician engineers without having any kind of professional experience during the course of their studies. This is one of the serious lacuna of the system of technical education in the country.

Chandrakant, LS in a study indicated that technical education in India whether at the college or polytechnic level has developed under university perspective with little or no interaction with the world of work and has become a closed social system. The people within the system have cultivated the same attitudes and values as are usually seen in the universities. The concern about quality and standards has largely centred around issues like: structures, courses of study and their duration, examination, award of degrees and diploma etc. Rarely has the concern extended to more crucial issues like: goals and objectives, planning and management of the system, development of job related abilities in the students, teaching–learning process, interaction with the world of work, employability of students, efficiency and effectiveness of the total system.

Studies reveal that the people working in the system consider education–work linkages as an important aspect but when asked to implement, many questions are raised like:

- will it be possible to provide training facilities for entire student population?
- From where to bring time for industrial training? Should a part of knowledge be deleted from the curriculum?
- who will plan, implement and supervise the industrial training component?
- will industry cooperate in curriculum development, implementation and evaluation?

On the other side, a survey of industries indicates that industry is accelerating the pace of modernization in order to increase productivity, realise higher levels of production and to remain competitive on the basis of dual criteria of cost and quality. This is being accomplished by a quantum leap in technology by way of introducing automation, use of new materials and processes.

This calls for a continuous interaction of technical institutions with the world of work so as to keep pace with industrial developments and to train human resources as per need of the industry.

7.2 Present Practices of Education – Work Linkages

A study conducted in 1992 reveals the following:

Apprenticeship training scheme though initiated to induct graduates/diploma engineers to work in job situations after completion of their course of studies as per requirements of the organisations but in actual practice, in majority of cases, industrial organisations do provide training seats under Apprenticeship Act. The scheme has not become popular, as the scheme is not a part of regular course of studies and teachers are not involved in its planning and execution, the scheme has not brought any improvement in teaching–learning process in the technical institutions.

– Sandwich programmes are very helpful in exposing the students to industrial/field environment, size and scale of operations, industrial practices and procedures. It has been experienced that barring a few institutions, remaining institutions just send students to industry with minimal supervision and that too by Training and Placement Officer (T&PO). Teachers teaching various courses have nothing to do with the training of students. Also students spent one year extra to undergo sandwich programmes

– Industrial/field visits are organised in a limited way. These visits are generally not planned well in advance and ultimately take the shape of excursions. In majority of cases, objective of industrial visit is neither clear to the students nor to the teachers.

– It has been experienced that teachers in the past were not attracted to the scheme of industrial training of teachers under Quality Improvement Programme launched by Government of India, Ministry of Human Resource Development due to meagre financial incentives. Further, there was no coordinator to promote industrial training of teachers either at state level or at institute level.

– Exchange of persons from industry to technical institutions appear to be a theoretical proposition and is by and large, not feasible. A few percentage of institutions do invite professionals from the world of work to speak on general topics. This has not brought much pedagogical reform in the system.

– In late seventies, realising the importance of industrial training, a few percentage of technical institutions ask students to manage (themselves) their industrial training during summer vacations. Some large scale industrial houses, who have established their own training centres, do entertain request of students to provide summer training. During this training, students are provided a general exposure by rotating them to various departments/sections of the organization. Students at the end of training are given a certificate of having undergone such a training. As the teachers are not associated in planning and supervision of such training, teaching–learning process still remains bookish.

It can be observed from above mentioned practices that education–work linkage of the type explained above does not lead to improvement in teaching–learning process in the institutions. Neither industry nor students/teachers have any stake in the above kind of interaction. Therefore, the question arises as to what should be the methodology of linking technical institutions with industry?

7.3 Suggestions for Establishing Desired Linkages

7.3.1 Training of Teachers in Industry

Majority of teachers in technical institutions do not have industrial/field experience. This is one of the major reason that the instructions in majority of technical institutions are theoretical. Industrial experience of 2 to 3 months for newly recruited technical teachers can help great deal in improving the quality of instruction. Undertaking industrial consultancy should be encouraged to make teachers familiar with industrial/field problems. Involvement of technical teachers with industry on a continuous basis is an essential requirement of technical education.

7.3.2 Organisation of Structured Visits of Students to Industry/Field at Subject Level

Organisation of structured industrial/field visit of students at subject level is essential for exposing students to industrial environment for familiarizing them with various materials, processes and products, creating awareness regarding quality control techniques; size and scale of operations in industry/field etc. These visits should not be considered as excursions. Each visit should be planned and structured and should be organised at the subject level and not at the institute/departmental level. It is suggested that for each subject, topics for field/industrial visits are identified so as to fulfil curricular objectives. The State Governments should provide transport facility and recurring expenditure to the institutes for this purpose.

7.3.3 Organization of Extension Lectures by Experts from Industry/Field

It is considered essential that each department of a technical institute should identify areas in which experts from industry/field should be invited to deliver lectures on specialised topics. This will bring industrial/field experts in contact with an institute. Besides providing up-to-date information/knowledge to students in the specialised areas, these extension lectures will be helpful in building a rapport between the institutes and the industry. State Governments may provide financial assistance as recurring expenditure to each institute for organisation of such lectures.

7.3.4 Conducting Cooperative Education Programmes in Selected Institutions

(A) Concept

Cooperative Education is a partnership between the student, the industry and the educational institution in which they all have responsibilities and they all gain by participation in the programmes.

'Cooperative education' is a structured academic programme, developed and supervised by an educational institution in collaboration with selected industrial/field/commercial organisations. The programme structure is composed of education (academic) and work terms. The phasing of academic terms and work terms will vary from programme to programme and the level at which the programme is offered. During academic term, the focus should be on imparting knowledge and basic skills pertaining to applied sciences, engineering sciences and discipline specific courses including management aspects. During work term, the focus should be on the development of observation skills; understanding of industrial/field practices and procedures; problem-solving skills; application of codes and standards; development of interpersonal and communication skills, proper attitudes and values etc.

In cooperative programme, during work term, productive work* is chosen to distinguish it from simple observation by the student. The term productive work is intended to indicate that student takes responsibility for work during practical experience or work term in the same way as any other paid employee. Whether the work done is paid directly by the employer or by way of allowances paid by the government to the student is immaterial; what is important is that student should obtain worth-while work experience related to his/her educational objectives and of direct relevance to the industry. The academic terms and work terms are so sequenced that during work term, student is able to apply the knowledge and skills gained during academic term in doing productive work.

* Productive work include: data collection, report writing, performance of defined tasks, problem-solving, productivity improvement, innovations and developments, managing processes and system etc.

During work term, the student is given an opportunity:

- To learn
 - the discipline of work
 - how to work with people?
 - the financial skills needed on the job
- To improve
 - the attitudes, skills and desired abilities
 - the knowledge of the discipline to other professions
- To broaden
 - the student's horizon and understanding of the world of business and industry

To motivate – the student to recognize the challenges of a professional career

To develop – the communication skills needed by all professionals
– the ability of problem solving
– the right attitudes and values

To measure – the understanding, skills and abilities developed during work term

To enable – the student for exploring employment potential

Cooperative Education programmes are not the same as sandwich courses in which industry plays a passive and secondary role. In cooperative education, industry is an equal partner in the whole process of education including planning, execution and evaluation. In cooperative education, learning is not merely a matter of acquiring qualifications but a more important matter of developing the desired competencies in the students.

(B) Suggested steps for implementation

- i) Identification of institutions for offering cooperative education programmes
- ii) Establishment of an industrial advisory committee for providing guidance in the selection of courses and implementing cooperative education programmes.
- iii) Establishment of industrial/liaison/training and placement cells in the selected institutions
- iv) Identification of programmes and collaborating industries for planning and designing cooperative education programmes by properly phasing academic and work terms
- v) Working out details of responsibilities of the technical institutes, students and industry
- vi) Implementing the programme

(C) Responsibilities

i) At State Level

- Establishment of Industrial Advisory Committee
- Identification of institutions for cooperative education programmes
- Establishment of industrial liaison cells/training and placement cell in the selected institutions
- Providing functional autonomy to selected institutions
- Identification of programmes and cooperative employers
- Designing cooperative education programmes⁺ and provision of resources

ii) At Institution Level

- Assistance in the identification of programmes and collaborating industries
- Visit of the faculty to collaborating industries/potential employers and study the profile of technical manpower, degree of knowledge and skills to be imparted and type of activities/facilities for providing appropriate learning experiences which students will perform during work term
- Participation of faculty in curriculum design activity
- Implementing the curriculum–supervision of students during work term, providing knowledge and skills to students during work term to help them in completing the identified tasks/assignments and evaluation of students.
- Plan for faculty development on a continuous basis

+ It will be desirable to involve professionals from Curriculum Development Centres of TTTIs in designing programmes on

cooperative education basis.

iii) **Industry**

Adopting the selected institutions for:

- identification of programmes and design of curriculum by making available the expertise of practising engineers
- identification of tasks/problems/activities of students for each work term
- decide and provide pocket allowances to students for productive work done by them during work term
- arrange on a systematic and regular basis specialised lectures on identified topics to students by senior technical staff of the industries
- provide facility of industrial experience to students during work term
- provide facility of training teachers from time to time to time
- develop more direct and much more definite participation in the running and working of adopted institution
- help in the evaluation of students
- help in the placement of students after completing their programmes

iv) **TTTTI**

TTTTI can render assistance in planning, designing, implementing and evaluation of cooperative education programme including training of teachers to implement cooperative programmes

(D) A proposed model of cooperative education

The model of cooperative education has to be developed by industries, technical institutions and TTTIs. The model will consist of academic terms and work terms suitably, sequenced to achieve curricular objectives. A suggestive model of cooperative education for diploma level programmes in engineering and technology is given in Figure 7.1.

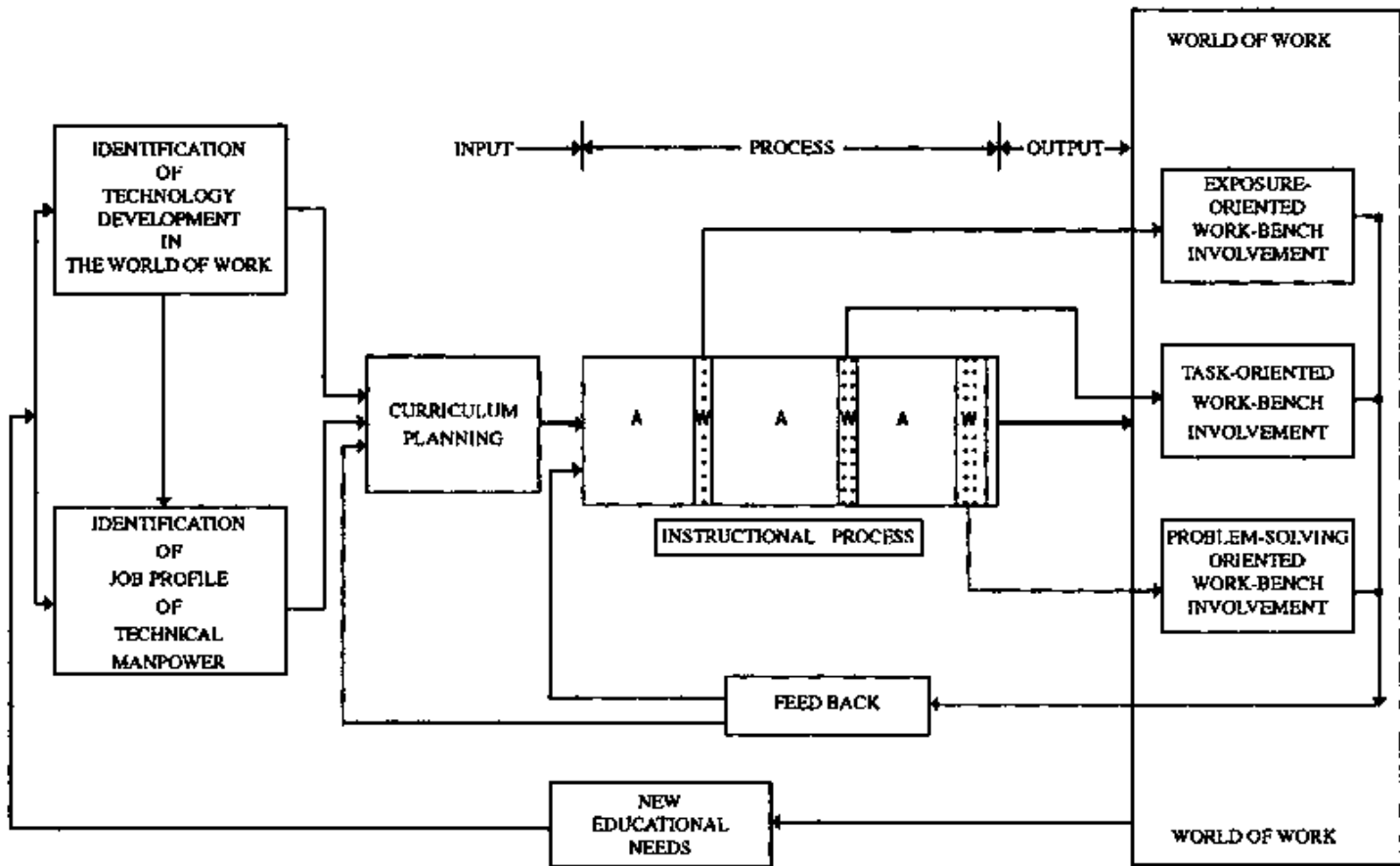


Figure 7.1: Education – Work Linkage for Effective Curriculum Processes

A – Academic Term
W – Work Term

Structured and supervised exposure oriented work bench involvement of students

This type of general exposure, of about 2 to 3 weeks, if provided to students, in the early stages of their courses of studies, will develop understanding in the students regarding the size and scale of operations, industrial environment, functioning and discipline of the world of work. This general exposure can be planned as data collection/information gathering type of experiences in all the functional areas of an industrial setting in which they find employment later. By organizing such an exposure, students will develop communication abilities relevant to their profession. Further, this exposure is likely to motivate the students for better learning and performance in subsequent years.

Structured and supervised, branch specific, task oriented industrial/field experience

Next to general exposure is the involvement of students on day to day task oriented situation in an industrial setting. This type of 4 weeks of work–bench involvement will create confidence in the students in applying the knowledge and skills gained in previous semesters and will motivate them for tackling open–ended problems. This type of experience is helpful if provided in the middle of programmes.

Problem solving oriented workbench involvement

In view of the diversity of industries and the wide range of job requirements, it is almost impossible to produce tailor–made technical human resource considering the prohibitive nature of costs involved and the complexities of curriculum design and implementation. What is possible is to develop problem solving abilities in students by attaching them (for a period of about 8 weeks) with industrial/field organization and providing them with opportunities of tackling practical problems of direct concern/interest to host organization(s) under the guidance of their teachers. This type of problem–solving can be linked with existing project work course. Besides developing problem solving abilities in students, this will open employment avenues as by–product.

Planning and implementation consideration

For the success of an educational design of education–work linkage, involvement of teachers and advance planning are important contributing factors. Selection of proper work benches, selection of appropriate tasks/problems, matching students with tasks/problems to be handled by them, supervision and guidance provided to students by teachers, assessment of students at work–benches etc. are important planning and implementation considerations.

If the system of technical education has to survive and deliver goods, the authors are of the view that professional involvement of teachers is very essential.

It has to be understood that teaching of subject is not complete until the students are placed in a work situation so that they apply the knowledge and skills gained in the class room in the solution of open ended problem(s). Each teacher has to establish linkage with the world of work and see that his/her students are placed in problem–solving situation.

This is possible by proper time tabling, making it possible to provided for practical experience at the end of each semester. Of course, teachers will require financial assistance for visiting the industry.

It has been experienced that industry at present is passive. Industry is also required to be proactive. If each industry identifies its training potential and link the same with its manpower requirements, lot many problems of education – work linkage will be solved. If each industry identifies suitable tasks/problems, place aside some financial resources which can be given to students as incentives for problem solving, it can contribute considerably in technical human resource development, with ultimate advantage to industry.

7.3.5 Providing Career Opportunity Guidance

Technical institutions should invite potential employers to their institutions atleast once in three years. During such interaction sessions, students and teachers should be exposed to the needs of industry, competencies desired, career opportunities available etc. Such type of activities will strengthen the links between the institutions and the industry.

7.3.6 Organisation of Placement Services

Majority of technical institutions do not provide any placement services to the students after they qualify. One of the reason for not providing this service is the absence of appropriate mechanism in the form of industrial liaison cell with adequate infrastructure. It is essential that each technical institution should make itself known to the world of work by means of circulating a small news letter/leaflet/brochure etc. indicating the type of programmes being conducted, facilities available etc., and invite industry to hold campus interviews for selection of students for employment.

7.3.7 Offering Continuing Education Programmes for Industrial Personnel

Each technical institute is expected to identify continuing education needs of personnel working in the near by industry. Based on their strength, each institute should offer continuing education programmes for upgrading the knowledge and skills of working people. This will bring the technical institute in close contact with the world of work.

7.3.8 Introducing R and D and Consultancy Services

Each technical institute should identify industrial/field problems in the industries/field organisations. These problems can be taken up as project work in the technical institute. By this way, institutes and industry will drive benefit for each other.

The suggestions for establishing industry –institute linkage which have been made above are all important aspects. It is possible that each institute may not be able to implement all the suggestions immediately. It is, therefore, suggested that each institute may prepare a plan of action for promoting industry–institute interaction and should implement the same. Each technical institute may implement those activities which suit their environment out of the suggestions made in Section 7.3.1 to 7.3.8.

7.4 Mechanism for Promoting Industry–Institute Interaction

7.4.1 Mechanism at State Level

At the state level, a steering group should be established. This steering group will provide guidance and support for industry–institute interaction. The members of this group may be:

- Secretary Technical Education and Industrial Training
- Director Technical Education and Industrial Training
- Four representatives from CII/PHDCCI
- Representative from TTTI
- Two Principals of Technical institutes

7.4.2 Mechanism at Institute Level

a) Industrial advisory committee at institute level

Industrial advisory committee should be established at the institute level. This committee will advise the institute on the assistance that the industry can render to the institutes and undertaking collaborative projects and programmes. The members of this committee may be:

- 4 to 5 leading industrial executives
- Principal of the Institute
- Heads of Department/Group Instructors
- Training and Placement Officer

b) Industrial Liaison Cell

Selected institutions will have industrial liaison cell at the institute level. This cell will coordinate interaction between various departments of the institute and with the industry on a planned, on–going basis.

To coordinate the activities of the cell, one of the Head of Department will be designated as Chief Coordinator. If possible a new post may be created as Chief Coordinator, industrial liaison. The cell should be provided with necessary infrastructure in terms of physical, human and financial resources for effective functioning.

7.4.3 Functional Autonomy to the Institutes

Selected institutions should be given functional autonomy for:

- i) Undertaking collaborative projects for improvement in teaching–learning
- ii) Deputing staff members for short courses/training in industry
- iii) Making purchase of equipment, library, books, consumables etc. through a purchase committee of the institute
- iv) Making adhoc appointments
- v) Making publicity of the institute for placement of students for employment
- vi) Making payment of TA/DA to staff
- vii) Undertaking R and D and Consultancy Projects

7.4.4 Memorandum of Understanding

Memorandum of Understanding (MoU) should be prepared jointly by Technical institutions and CII/PHDCCI/Industrial Associations. This MoU should clearly spell out the areas of mutual collaboration.

As can be seen from above, it is creating an opportunity for work place based learning activity in the curriculum, which is assessed. One may extend this a little further and many say that such activity might result into a work output of direct interest of the work place as a by product. Without elaborating this point further, it may be mentioned that the traditional system of curriculum development and teaching–learning process, therefore, needs to be questioned?

The central task would be thus to develop a technical human resource which has problem–solving abilities and entrepreneurial culture. If the above were to be possible, one has to look at curriculum development or teaching–learning process with in the framework wherein education incorporates principles of concept of use in education i.e. transfer of knowledge and skills learnt in the class room to solve open–ended problems of the world of work. Level of problem–solving will very depending on the level of programme offering.

It may be mentioned that such structuring of education while on one hand reduces overheads at all levels of education and also industry, thereby reducing costs on the other hand and it introduces new inputs in the domain of teaching–learning and also production, so as to ensure demands of synthesis and modernization, be it a learning or a production situation.

8. Curriculum Evaluation

8.1 Introduction

Teaching–learning process in any educational institution depends on curriculum document. The curriculum document contains aims and objectives of the programme, states the detailed contents comprising of concepts, principles, procedures and applications of a specific field to be taught to the students for achieving desired objectives. It also provides guidance to teachers for using appropriate methods, media and learning experiences for developing desired competencies in students in the light of course objectives. Guidance in respect of student evaluation forms an integral part of the curriculum. This document also provides guidelines regarding creating/procuring appropriate resources, which may be physical resources in terms of space, building, equipment and furniture etc.; human resources, i.e., teaching, supporting and administrative staff; and informational resources, both print and non–print media. It also provides an estimate of recurring and non–recurring financial resources required for setting up infrastructure and running the programme.

It is through curriculum document that students know about the type of competencies required of them and what syllabus i.e., detailed contents, they have to undergo. A teacher will use it for getting an insight of what to teach, how to teach, and how to evaluate students towards fulfilment of programme objectives. It is useful for the administrators, i.e., Heads of Department, Principals and Government to plan infrastructure and resources for its effective implementation. The curriculum document also provides an overview to the employer regarding the type and the level of programme and the type of competencies that will be developed in the students.

In view of the changing needs of society – individual, economical and cultural, it is necessary that curriculum document is kept in tune with the rapid developments taking place in all the spheres. Therefore, curriculum needs to be dynamic, i.e., changing with time and should be under constant review. It should be more so in technical education system since the changes in technology and the consequent changing demands from industry are much more rapid. Thus, there should be a mechanism at the institute, state and national level to obtain information regarding developments taking place in above areas and to keep the curriculum in tune and updated.

Curriculum evaluation is a complex task. It will involve evaluation of objectives, selection methods of students, physical facilities, contents, teaching–learning methods, resources, performance of teachers and performance of students etc.

Information has to be collected from various sources both from inside the institution (from teachers, administrators, students etc.) and outside the institution (from employed graduates, employers, examination boards etc.) and also from different documents like time table, learning resources and assessment plans. Different kinds of instruments like questionnaire, check lists, interviews and observations are to be used for collecting information.

8.2 Concept of Curriculum Evaluation

All those concerned with the management and funding of technical education and training programmes are interested to see that the programmes are effective and efficient in the context of changing occupational, individual and social needs as well as the changes occurring in communication technology and in the field of pedagogy and andragogy. Curriculum of any education and training programme cannot, therefore, afford to remain static. It must change so as to be compatible with the changes in its environment. This makes curriculum development a dynamic process.

Doll (1974) defines the term evaluation as a means to assess the worth of something.

Jenkins (1976) states that evaluation is the process of delineating, obtaining and providing useful information for judging decision alternatives.

Stufflebeam (1971) also agrees with the definition provided by Jenkins.

There is not necessarily a connection between evaluation and decision making but an emphasis on decision-making in evaluation does shift the focus from the method/techniques of data collection to its use in making choices from amongst the available alternatives in a problematic situation.

Evaluation is not for quality control but aims at process or programme improvement.

Evaluation is a judgement process (Scriven 1967). Measurement on the other hand, is simply the gathering of information. Measurements of various kinds are often involved in evaluation, but they are not evaluation themselves.

As opinions are value laden, the same set of measurements may not always lead to the same evaluation conclusions. Different evaluators may make judgements, based on quite different views as to what constitute acceptable program performance. Evaluators differ regarding what should be judged, when it should be judged and by whom it should be judged.

Thus, curriculum evaluation is the process of delineating, obtaining and providing information to assess the work of the various aspects of curriculum against some criteria for judging decision alternatives pertaining to curriculum changes.

The aims of curriculum evaluation are

- to improve educational processes and programmes
- to identify problem areas by diagnosing difficulties while implementing an educational programme (curriculum)
- to evolve new approaches of teaching-learning for achieving the objectives
- to improve the ability of administrators and teachers to plan and affect the necessary changes

The literature survey reveals that there are many models in use for curriculum evaluation such as: Tyler's Evaluation Model available to measure students' progress; Stake's Countenance Model to report the ways different people see the curriculum; Stufflebeam's Model to facilitate rationale and continuing decision making; Taba's Social Studies Evaluation Model to seek simple but enduring explanation of what works; and Scriven's Goal Free Evaluation Model to assess the effects of a programme.

Curriculum evaluation as perceived in most models described above does not lead towards integrated approach for arriving at decision making for various aspect of curriculum. To visualise curriculum evaluation as an integrated process, the model proposed by Stufflebeam, comprising of context, input, process and product evaluation, is the one which appears to be quite suitable for evaluating an educational programme.

8.3 Models for Curriculum Evaluation

Researches have proposed various models for curriculum evaluation. Some of the models are briefly explained as follows:

(1) Tyler's Objective Model of Evaluation

Tyler (1949) visualised curriculum evaluation as the process of determining to what extent the educational objectives are achieved by the programme of instruction. Various steps involves in this model are:

- a. Formulate objectives or aims of the curriculum
- b. Express the objectives in terms of learner behaviours
- c. Devise and provide experiences that will enable the learners to behave in a desired way
- d. Assess the performance of learners against the objectives
- e. Vary the experience to be provided until learner behaviour matches with the educational objectives

Major drawback of this model is that it does not lay emphasis on assessing the inputs and processes.

(2) Stake's Model

According to Stake (1969), curriculum evaluation implies identification of intents of the programme in terms of antecedents, transactions and outcomes. The term antecedents denotes the aspects of situation in which, curriculum is taught, e.g., time available, resources provided. Transaction' refers to the activities of teachers and learners during teaching–learning process, while outcome implies the achievement of learners.

This model is unique in the sense that it lays emphasis on collecting judgemental data.

(3) Scriven's Goal Free Model

According to Scriven (1973), an evaluator should not evaluate a programme on the basis of specific objectives. The effects of a programme could be intended and unintended. If evaluation is done based on intended programme objectives, then the outcome of un–intended objectives will be ignored. The check list used in this model does prescribe minimum levels to be achieved by a programme.

(4) Taba's Social Studies Model

This model stresses on the cause and effect relationship in the curriculum process. According to this model, there is cause and effect relationship between experimental control over the study material and its effects on the achievement of the learners. The evaluator prepares study material in different sets with each set having some variation from others. These sets are given to different groups of learners and then curriculum is evaluated. The set of material which gives the best results will be advocated for designing and developing new programme.

(5) CIPP Model for Curriculum Evaluation

Stufflebeam (1971) developed a four part model that has been widely used as basis for educational evaluation. This model includes (i) Context evaluation; (ii) Input evaluation; (iii) Process evaluation; and (iv) Product evaluation. This is popularly known as the CIPP model for evaluation. This model seems to be the model which can be used to evaluate a programme in totality. Each of its components are discussed below:

Context Evaluation

In the CIPP model, context evaluation has been included out of recognition that planning decisions that precede implementation of an instructional programme (curriculum) have implications for its success or failure. For example, if a programme (curriculum) is directed at goals that are inappropriate for the learners, even the best teachers will have difficulty in making the programme work.

In the context evaluation, consistency of curriculum aims with present needs of industry, society and individual are evaluated. In addition, appropriateness of aims for future technological development needs and further education and mobility of the students undergoing the programme are evaluated.

Input Evaluation

Once the evaluator is satisfied with the base established to guide development of an instructional programme, it needs to look at the means proposed to meet these goals.

An input evaluation attempts to validate the adequacy of the curriculum, which comprise of adequacy of entry behaviour of students, curriculum objectives, detailed contents, methods and media for instruction, competencies of teaching staff, appropriateness of teaching/learning resources, and appropriateness of physical resources etc.

Process Evaluation

Process evaluation occurs when an instructional programme is being implemented. The idea is to monitor instruction so as to ensure that the programme is being delivered as desired. This is an especially critical activity in a programme involving many teachers and instructors.

Process evaluation requires feedback at frequent intervals from those who are implementing the curriculum.

However, process evaluation has functions that go beyond providing feedback to teachers and instructors. It also provides insight regarding adequacy of the teaching faculty who are delivering the programme. Information from process evaluation can suggest needed modification in the training of teachers. Therefore, process evaluation aims at collecting feedback to judge the effectiveness of teaching–learning methods, utilisation of physical facilities, utilisation of teaching–learning resources, effectiveness of system of evaluation of student's performance, efficiency of overall management of curriculum implementation process and integration of theory with practice.

Product Evaluation

Product evaluation is that component of evaluation process that answers the question regarding achievement of objectives of curriculum. This phase of evaluation occurs at the conclusion of the planned instructional programme. Data from product evaluation may be used as a basis for modifying the designed curriculum. The product evaluation is sometimes extended to do tracer studies in respect of consistency of learning outcomes with the stated objectives, employability of technician engineers, social status of technician engineers, comparability of wage and salary structures, and job adaptability and mobility.

8.4 Methodology of Curriculum Evaluation

The methodology of curriculum evaluation comprises of following steps:

8.4.1 Defining Objectives of Curriculum Evaluation

Before attempting curriculum evaluation on a large scale, it is essential to identify or specify the objectives of undertaking curriculum evaluation so as to limit the scope. Is it the context or the input or process or product or these together to be taken care in curriculum evaluation? It is possible that entry behaviour of student may not be conducive to comprehend the course content. It is also possible that the curriculum document is not having desired relevance with the requirements of industry/field organisations. May be that the teaching–learning process or learning experiences provided to students are not appropriate. It may be that adequate resources in terms of physical, human and informational are not made available. Also the graduates of the programme may not able to find wage or self employment. In addition to above, there can be many more aspects to be taken care while evaluating a curriculum.

Defining the objectives of curriculum evaluation will focus the attention of the evaluator on critical areas.

8.4.2 Strategy to be Followed

In any curriculum evaluation, six determining factors which can be easily identified are found by asking following questions:

- (1) Evaluation of what?
- (2) Evaluation of whom?
- (3) Evaluation for what purpose?
- (4) Evaluation by whom?
- (5) Where of Evaluation?
- (6) Evaluation for whom?

The curriculum evaluation has to decide the strategy to be adopted in the light of defined objectives. This strategy includes the following steps:

- a) Decisions regarding persons to be involved in curriculum evaluation process
- b) Identification of target group from whom information has to be collected
- c) Deciding about the type of information to be collected from different target groups
- d) Decisions regarding type of tools to be used for collection of information
- e) Preparation of tools
- f) Method of collection of information
- g) Analysis of information received from different target groups
- h) Identification of problem areas
- i) Discussing problem with the concerned authorities for taking suitable remedial measures

The above strategy for curriculum evaluation is diagrammatically represented in Figure 8.1.

8.4.3 Persons Involved in Curriculum Evaluation Process

Curriculum evaluation is not one person's responsibility. Depending upon the scope of evaluation and its objectives, the evaluation team may comprise of representatives from administration, faculty of the institute which implemented the curriculum, experts from industry, experts from curriculum development centre and representatives of society/community. Further based on the scope of curriculum evaluation, there can be an internal team or a combination of internal and external team or in some cases an external team.

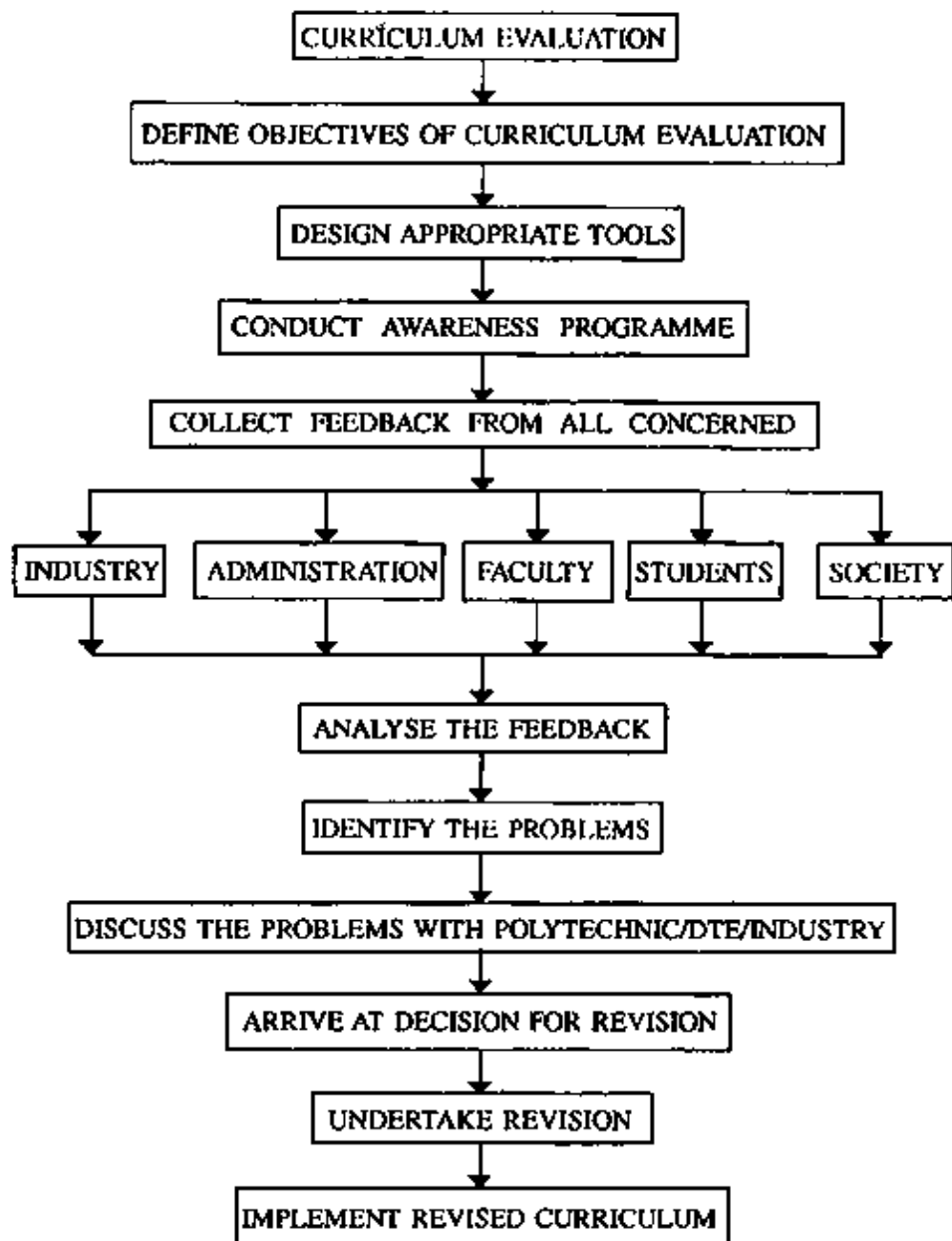


Figure 8.1: Strategy for Curriculum Evaluation

8.4.4 Target Group from whom Information has to be collected

Keeping in view, the Stufflebeam model, information will be collected from the target group which is shown in the following table.

Table 8.1 Information Sources for Different Evaluation Stages

Sr. No.	Evaluation Stage	Target group for obtaining information
1.	CONTEXT	<ul style="list-style-type: none"> – Industry – Society – Working technician engineers – AICTE
2.	INPUT	<ul style="list-style-type: none"> – Students – Teachers – Head of department – Principal – State curriculum development centre

3.	PROCESS	<ul style="list-style-type: none"> – Students – Teachers – Head of department – Principal
4.	PRODUCT	<ul style="list-style-type: none"> – Industry – Teacher/Head of department – State Board of Technical Education

8.4.5 Types of information

In order to have systematic procedure for collecting required information for different target groups, it is essential to identify type of information to be collected at each stage of curriculum evaluation. Table 8.2 provides brief guidance about this information:

Table 8.2 Information to be Collected

Stages of Evaluation	Information to be Collected	Target Group
1. CONTEXT	– Consistency of curriculum aims with the needs of industry, society and individuals.	– Industry
	– Appropriateness of aims for future technological development needs	– Society
	– Appropriateness of aims for further education and mobility of technicians engineers	– Employed Technician
2. INPUT	– Adequacy of entry behaviour of students	– Students
	– Availability of physical facilities like workshops, laboratories, class rooms equipment, library etc.	– Teacher
	– Availability of teaching–learning resources	– Head of Department
	– Adequacy of competencies of teaching staff	– Principal
	– Relevance, sufficient clarity and feasibility of curriculum	– Industry
3. PROCESS	– Understanding of the curriculum objectives and detailed contents	– Teachers – Head of Department
	– Effectiveness of teaching–learning process	– Students – Teachers
	– Appropriateness of learning experiences provided to students	– Students
	– Appropriateness of availability of physical, human and information resources	– Students – Teachers – Head of Department Principal
	– Extent of linkage with the world of work	– Industry – Teachers – Students
	– Effectiveness of system of students evaluation	– Teachers – Students
	– Deployment, utilisation and management of resources	– Teachers – Head of

		Departments
	– Relevance, sufficient clarity and feasibility of curriculum	– Teacher – Head of Department
	– Extent of desired climate for implementing curriculum	– Teacher – Head of Department
4. PRODUCT	– Consistency of outcomes with stated curriculum objectives	– Student – Teacher
	– Employ ability of pass out students	– Industry – Head of Department
	– Comparability of wage and salary structure	– Industry
	– Job adaptability and mobility	– Industry
	– Performance on job	– Industry
	– Extent of further training given to technicians for handling jobs independently	– Industry
	– Extent of coping with the latest developments	– Industry

8.4.6 Summary of Information to be Collected

a) From Employers

The following information can be obtained from employers:

- (1) Consistency of curriculum aims with the needs of industry (present and future)
- (2) Employability of students and their training requirements
- (3) Functions of technicians (present and future)
- (4) Job adaptability and mobility
- (5) Wages and salaries of technician engineers
- (6) Future promotional avenues
- (7) Industry–institute collaboration

b) From Students

The following information can be obtained from students:

- (1) Clarity and coverage of detailed contents
- (2) Appropriateness of teaching learning methods
- (3) Development of competencies and difficulties faced during teaching–learning process
- (4) Competencies of teachers
- (5) Organisation of classroom instructions, laboratory and workshop/drawing sessions
- (6) Adequacy of physical facilities
- (7) Environment in the institute
- (8) Sports and co–curricular facilities
- (9) Motivation and incentives
- (10) Involvement of industry

c) From employed Engineers/Technician Engineers

Technician engineer will be helpful in providing information on the following:

- (1) Employability
- (2) Functions
- (3) Consistency of curriculum with the needs of industry

- (4) Wages and salaries
- (5) Job adaptability and mobility

d) From Faculty

Following information can be obtained from the faculty:

- (1) Curriculum document: consistency with needs, appropriateness with future technological developments, entry behaviour of students, clarity and feasibility of detailed contents in implementation
- (2) Integration of theory with practice
- (3) Involvement of industry
- (4) Training needs
- (5) Effectiveness of teaching–learning methods
- (6) Provision and utilisation of physical facilities and resources
- (7) Administrative support
- (8) Incentives
- (9) Flexibility and adaptability

e) From Principals and Heads of Department

Principals/HODs can provide following information:

- (1) Staff recruitment and vacancies
- (2) Provision of physical facilities/resources
- (3) Financial inputs
- (4) Purchase procedures
- (5) Faculty competencies and training needs
- (6) Training and placement of students
- (7) Involvement of industries
- (8) Environment

f) From Directorate of Technical Education

Following information can be collected from Directorate of Technical Education

- (1) Conduct of examinations and difficulty experienced
- (2) Staff recruitment, training and promotions
- (3) Results and records
- (4) Employability and collaboration with industries
- (5) Financial inputs

g) From Community (An option only)

Following information can be obtained from community:

- (1) Expenditure on education and training
- (2) Status, employability, wages and salaries
- (3) Job prospects

After deciding about the information to be collected from different target groups, the consolidation of information required for curriculum evaluation is done. At this stage, before going for preparation of tools, one has to decide whether evaluation is to be done at (a) Formative level or (b) Summative level or both.

At formative level, consideration is given to what actually happens in practice as the course is being implemented. As the course proceeds; formative evaluation is carried out using questionnaire and observational reporting techniques.

Summative evaluation takes place after the completion of the curriculum. At this stage, attempts are made to assess what has been achieved by students at the end of programme. In the summative evaluation, the tests used are related to what has been finally mastered and achieved as a result of the whole course.

In collection of relevant information, it is essential to identify a representative sample of respondents. There are a number of techniques which are in use for selecting a sample. Generally 20 percent sample of total target group is recommended for collection of information.

In order to have the required written response, one has to send reminders and express the necessity of collection of information from the target group. Mailing the questionnaire only one time will result in poor response.

The response received through questionnaire is validated. Generally 10 to 20 percent of total target group is recommended for conducting interviews and for on the spot observations.

8.4.7 Identification of Problem Areas

The analysis of information will provide feedback on the areas, which need improvement. Curriculum evaluation is only useful to the extent that results have a positive impact on the curriculum. Although it may be necessary on occasions to conduct an evaluation to comply with certain external mandate, the real strength of evaluation lies in its potential to affect educational improvement. Whether concern is with a total curriculum or instructional material; it is essential that evaluation results serve as a basis for determining, if and when appropriate educational changes can be made.

An evaluation that focuses on the educational process is not going to produce as much meaningful data as the one that deals directly with context, input, process and product. Context evaluation data may be used to help in improving the educational environment and redefine goal and objectives. Input evaluation data can assist in determining which resources and strategies have the greatest potential as well as how content might be arranged. Process evaluation data may be utilised to focus on improving both teaching and learning, where as product evaluation can aid in determining which programmes are more useful in producing appropriate human resources.

8.4.8 Discussion with Concerned Authorities about Problem Areas

Once the problem areas are identified, it is essential to hold discussions with the appropriate persons/authority to provide them feedback and alternative solutions. It should be left to the concerned persons/authorities to take suitable action for improvement.

A plan/report of curriculum evaluation should be prepared and submitted to concerned authorities for further action at the end of curriculum evaluation. The framework of this should be prepared before starting the evaluation. It may contain the following elements:

a) Overview

- Need for evaluation
- Evaluation approach
- Benefits derived from the evaluation
- Evaluation objectives

b) Curriculum description

- Curriculum objectives
- Philosophy and contents
- Curriculum procedures
- Student population

c) Evaluation design

- Constraints
- Evaluation model for framework
- Appropriateness of evaluation design
- Determination of achievement of objectives
- Sources of information
- Information collection methods
- Analysis procedures
- Schedule of events
- Proposed budget

d) Description of the evaluation report

8.5 Problems in Curriculum Evaluation

The following problems are visualised in effective curriculum evaluation:

- a) Technician curriculum are still not designed to provide clear specifications of the end product and teaching–learning strategies to achieve the same
- b) Staff at Directorate of Technical Education and senior faculty at polytechnics are not generally trained in the principles of curriculum development
- c) The persons from industry involved in the process of curriculum design and evaluation are normally not the same who provide feedback for curriculum improvement
- d) The users of curriculum (teachers and administrators) by and large are not aware of the collection and supply of feedback systems
- e) Appropriate tools and infrastructural facilities for evaluation are not available

8.6 Essential Requirements for Conducting Curriculum Evaluation

In order to perform curriculum evaluation on scientific lines, following are the prerequisite:

(1) Establishing curriculum development centre/cell at the state level

The purpose of this centre is to follow a systematic procedure for design and review of curriculum on a continuous basis in tune with the requirements of world of work

(2) Training the staff of curriculum development centre

This is required to professionalise staff of curriculum development centre so that they understand various stages of curriculum development and provide a scientific basis for undertaking various jobs. Training is also required in the process of data analysis and preparation of evaluation report.

(3) Designing appropriate curriculum

Most of curriculum documents do not clearly spell out curriculum objectives, competencies to be developed in the students, detailed contents, strategy for instruction, suitable methods and media, guidelines for evaluation and resources etc. In the absence of above, it is not possible to evaluate various aspects of curriculum included in different stages, namely: context, input, process and product. Therefore, it is desirable to get these details spelled out.

(4) Training of senior faculty of polytechnics in curriculum evaluation process

Knowledge and skills in curriculum evaluation process is to be imparted to senior faculty of polytechnic for enabling them to collect feedback for different stages namely: context, input,

process and product, on regular basis and analyse it for the purpose of bringing improvement

(5) Design of curriculum evaluation tools

One of the reason that curriculum evaluation is not being carried out on continuous basis is the non availability of standard tools for collecting information from various target groups. Design of appropriate tools is an essential requirement for system of curriculum evaluation.

(6) Coordination between institute and directorate

For effective curriculum evaluation process, it is essential that there should be proper coordination between the institutes and the directorates in collection of information, its storage and retrieval.

(7) Policy and financial support

Curriculum improvement is an on-going process to be carried out at the state and institute levels. It should be a state policy to revise every curriculum at least once in five years. For this purpose, it is essential to fix up responsibilities at the state and institute levels to collect relevant information from different sources, regularly for facilitating decision making.

Financial resources are required for carrying out curriculum evaluation. A provision, thus, has to be made in the state budget for effective curriculum evaluation.

8.7 Time Frame for Curriculum Evaluation

The time required for curriculum evaluation is dependent on the scope and purpose of curriculum evaluation. It can be related to context, input, process or product or all these stages together. For overall evaluation of curriculum including all stages, the tentative time frame required is given below:

(A) Initial Preparation Time	
– Design appropriate questionnaire for different target groups	1 week
– Typing the questionnaire, tryout, modification and printing the questionnaire	1 week
– Conduct of awareness programme in curriculum evaluation	1 week
Total (A)	3 weeks
(B) Evaluation Time	
– Collection of feedback from students and technicians	2 weeks
– Collection of feedback from teachers and administrators	3 weeks
– Collection of feedback from employers and community	3 weeks
Total (B)	8 weeks
(C) Analysis of Feedback	
– Students	1 week
– Teachers and administrators	1 week
– Employers and society	1 week
Total (C)	3 Weeks
(D) Decision Making	
– Determination of problem areas	1 week

– Appraisal including final decisions for curriculum revision	1 week
Total (D)	2 weeks
(E) Curriculum Revision through Workshop	
– Conduct of workshop for curriculum revision for each programme	2 weeks
– Preparation of draft report	3 weeks
– Preparation of final report	3 weeks
Total (E)	8 weeks
Total Time Required = A + B + C + D + E = 24 weeks	

Monitoring curriculum implementation on regular basis will result in solving majority of problems. However, feedback mechanism at each institute is required to be designed for ascertaining problem areas, which can be taken up during curriculum evaluation stage

9. Organizing Curriculum Development Activities

9.1 Introduction

For effective planning, promoting and regulating polytechnic education system, it is essential to collect information at different levels which can help in appropriate decision making regarding identification of institutions, programmes, course development and provision of infrastructural support (physical, human and informational) for effective curriculum processes. With above in view, this chapter details out the roles and functions to be performed at different levels of management. Besides highlighting the functions at above levels, this chapter also provides information regarding the type and sources of information required for effective curriculum processes in an integrated manner for quantitative and qualitative improvement of technical education in a state.

It has been experienced that many a times decisions regarding starting new institutions and designing/revising various programmes are taken without appropriate data base. This results in considerable mismatch between supply and demand, quality of technical manpower and unbalanced growth of institutions and programmes. Thus, there is a need for establishing information resource system(s)/data base for collecting relevant information in order to take appropriate decisions, by all those involved in policy formation, planning, administration and management of technical education.

9.2 Users of Information

Information is required to be collected at state, institute and teachers level for making curriculum process more effective. Such information will greatly benefit decision making at different levels:

- i) State departments of technical education for planning, management, administration and funding of technical education in the state
- ii) Technical institutes for effective implementation of curriculum at programme and course levels i.e. education and training programmes for technical manpower development
- iii) Directorates/Board of Technical Education which are responsible for examination, certification and accreditation of institutions
- iv) Technical Teachers' Training Institutes for planning curriculum development activities, education and training programs, instructional material development etc.
- v) Bureau of Technical Education in the Ministry of Human Resource Development for providing administrative and financial support to states

vi) All India Council for Technical Education for planning, promoting and regulating technical education in the country

In the light of above, next section deals with different types of functions to be performed at state, institute and teacher's level and types of information required for effective curriculum processes.

9.3 Data Base to be Generated at Different Levels

9.3.1 At State Level

Functions	Types of Information Required	Sources of Information
1. Preparation of Directory of Technical Education Facilities in the State	<ul style="list-style-type: none"> – Name of the technical institutions – Year of establishment – Types of disciplines offered, their duration and entry qualification – Discipline wise intake and out–turn – Location of institutions 	<ul style="list-style-type: none"> – Technical Institutions in the State – State Directorate/State Board of Technical Education
2. Ascertaining technical manpower requirements	<ul style="list-style-type: none"> – Emerging economic and technology development trends – Shortage of technical manpower – Long range technical manpower requirements 	<ul style="list-style-type: none"> – IAMR – State Planning Department – State Directorate of Industries – Leading Industrial Associations like CII, PHDCCI – Discipline specific Industries – State Employment Exchange
3. Identification of viable disciplines, their intake and location	<ul style="list-style-type: none"> – Availability of existing facilities – Areas where imbalances exist – Area specific requirement of starting new disciplines – Technical manpower profiles in emerging area 	<ul style="list-style-type: none"> – IAMR – State Planning Department – State Directorate of Industries – Leading Industrial Associations like CII, PHDDCCI – Discipline specific Industries – State Employment Exchange
4. Preparation of Database regarding availability of expertise from academic institutions and industry who can help in the design of curriculum	Discipline specific list of experts covering various functional areas like: R&D, design and drawing, production planning, shop–floor, inventory management etc.	<ul style="list-style-type: none"> – technical institutions – Engineering Colleges – Industrial Associations – Individual Industries
5. Collection of Important documents related to technical education	<ul style="list-style-type: none"> – Norms and Standards – National Policy of Education – State Policy of Education – 10+ and 10+2 syllabi – UNESCO documents pertaining to technical and vocational education – Curricula offered by different states 	<ul style="list-style-type: none"> – AICTE – State Ministry of Education/Technical Education – Board of Education/CBSE/NCERT – UNESCO

6. Preparation of Operational Plan/Action plan for growth and development of the technical education	Same as that mentioned under function 1 to 5	<ul style="list-style-type: none"> – Same as that mentioned 1 to 5 – TTTIs
7. Designing Curricula of programmes keeping in view professional development, development of learning to learn skills, interpersonal skills and personality aspects in the light of State Action Plan	<p>Existing curriculum (if available)</p> <ul style="list-style-type: none"> – Competency profile of specific diploma holding manpower – Strategies of curriculum design including case – Literature concerning equipment, standards/codes, print and non-print instructional resources – List of potential industries/employers 	<ul style="list-style-type: none"> – State Boards of Technical Education; other Institutions – TTTI – Specific Manufacturers – Industries/Industrial Associations. studies
8. Planning and development of physical, human and informational resources (where gaps exist) keeping in view optimum utilization of resources and resource sharing for effective implementation of curricula	<ul style="list-style-type: none"> – Existing infrastructure/resources in a specific polytechnic(s) – Potential Industries/organisations/institutions for sharing resources 	<ul style="list-style-type: none"> – Technical institutions – Industries/Industrial Associations – Resource Institutions
9. Follow-up of developmental activities concerning effective curriculum implementation and providing necessary support to the polytechnics	<ul style="list-style-type: none"> – Information in respect of availability and gaps in resources 	<ul style="list-style-type: none"> – Technical institutions
10. Promotion of networking of institutions with world of work/institutions for resource sharing and greater employability of students	<ul style="list-style-type: none"> – Types of industries, institutions for sharing resources – Case study/reports of success stories in curriculum research 	<ul style="list-style-type: none"> – Industries/Industrial Associations – TTTIs and other Institutes
11. Promotion of innovations and developments in teaching-learning process, instructional resource development, system improvement etc.	<ul style="list-style-type: none"> – Indicators of excellence – Case studies and success stories – Research studies 	<ul style="list-style-type: none"> – TTTIs – ISTE
12 Identification of problem areas concerning effective curriculum implementation and ensuring necessary follow-up action/remedial measures for bringing desired improvement in curriculum processes	<ul style="list-style-type: none"> – Relevance of course contents and its coverage in stipulated time – Appropriateness of resources for carrying out teaching-learning process – Appropriateness of teaching-learning process and student evaluation – Networking with world of work – Employability of students 	<ul style="list-style-type: none"> Technical institutions

9.3.2 At Institution Level

Functions	Types of Information Required	Sources of Information
1. Preparation of brochure of the institute highlighting its salient features and strengths	<ul style="list-style-type: none"> – Background of institution – Types of courses being offered – Faculty details – Availability of important infrastructure 	<ul style="list-style-type: none"> – Respective institute

	<ul style="list-style-type: none"> – Significant achievements, rewards and recognitions earned – Linkage with world of work – Future growth scenario 	
2. Preparation of directory of potential employers for different disciplines offered by the institutes	<ul style="list-style-type: none"> – Name and address of organisations, their telephone and Fax No. – Products of manufacture/services rendered – Name of chief executives – Names of experienced engineers and their areas of specialization 	<ul style="list-style-type: none"> – Industrial Associations – Specific industries
3. Collection of information regarding technology development at work–place in respective disciplines	<ul style="list-style-type: none"> – Technology Development – New materials and processes – Change in profile of technical manpower – Research reports 	<ul style="list-style-type: none"> – Industries/Industrial Associations – Journals of institutions of Engineers/other professional bodies – Recommendations of seminars – Manufacturers and suppliers of equipment – R&D Centres
4. Preparation of database of expertise in the respective disciplines	Name, qualification experience and specialisation of experts from academic institutions and industry	<ul style="list-style-type: none"> – Institute departments – Other technical institutions – Industries
5. Collection of information/feedback from industrial/field organisations regarding relevance of existing curriculum in the respective disciplines	<ul style="list-style-type: none"> – Relevance of curriculum objectives – Reactions/feedback on course structure – Feedback on detailed contents and suggestions for additions and deletions in the light of technology 	<ul style="list-style-type: none"> – Industrial executives and experienced diploma holders in the the respective disciplines development at work places – Feedback on employment opportunities
6. Planning and development of physical, human and informational resources in a phased manner in the respective discipline	<ul style="list-style-type: none"> – Status of existing resources – Identification of training needs of faculty and staff – Identification of gaps in physical and informational resources 	<ul style="list-style-type: none"> – Specific departments of the institute
7. Networking with industrial/field organizations and institutions for sharing physical, human and informational resources	<ul style="list-style-type: none"> – Gaps in physical, human and informational resources needing networking with other organizations – Identification of organisations for networking 	<ul style="list-style-type: none"> – Institute faculty in the respective departments
8. Promotion of innovations in teaching – learning processes, instructional material development, student evaluation and systems improvement	<ul style="list-style-type: none"> – Case studies and success stories – Research studies 	<ul style="list-style-type: none"> – TTTIs and other resource institutes – Journals dealing with engineering education
9. Collection of feedback concerning implementation of curriculum, identification of problem areas,	<ul style="list-style-type: none"> – Gaps in resources – Relevance of curriculum – Additions and deletions in the 	<ul style="list-style-type: none"> – Faculty of respective departments – Industry

remedial measures to be initiated at institute level and providing feedback	light of developments – Adequacy of time for coverage of course content – Identification of disciplines where meager employment opportunities exist	
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9.3.3 At Teachers' Level

Functions	Types of Information Required	Sources of Information
1. Establishment of linkages with industrial/field organizations in the respective curriculum areas	<ul style="list-style-type: none"> – Relevance of detailed contents in the specific curriculum area(s) with industrial/field processes – Advances in technology in the specific curriculum area(s) which needs inclusion in the curriculum – Obsolete knowledge and skills needing deletion from a specific curriculum area – Latest equipment/instruments in use at work places 	<ul style="list-style-type: none"> – Curriculum area specific industrial/field organisations in public and private sector.
2. Developing rapport with professionals concerning specific curriculum area(s)	<ul style="list-style-type: none"> – Name, qualification, experience and address of experienced professionals 	<ul style="list-style-type: none"> – Industry – Academic institutions
3. Collection of information related to equipment and instructional resources concerning specific curriculum area(s)	<ul style="list-style-type: none"> – List of important manufacturers/suppliers of equipment/instruments – Information regarding relevant codes/standards – Print and non–print instructional resources 	<ul style="list-style-type: none"> – Industrial Directories – Catalogues – BIS
4. Development of instructional resources where gaps exist	<ul style="list-style-type: none"> – Relevant instructional resources 	<ul style="list-style-type: none"> – Library – Resource persons in the specific disciplines – Regional Curriculum Development Centres at TTTI – R&D Organisations
5. Collecting of feedback from students regarding comprehensiveness of knowledge and skills imparted	<ul style="list-style-type: none"> – Area(s) which are difficult to conceptualize and understand – Area(s) needing more laboratory and workshop session for developing necessary skills 	<ul style="list-style-type: none"> – Feedback from students

For organising curriculum development activities at the state and institute levels, there should be a mechanism or a cell at the state level which will look after the state level functions. At the institute level, each head of department will perform the identified functions for their respective discipline.

10. Academic Planning

10.1 Introduction

Planning is the process of deciding in detail how to do something before one actually start to do it. There are a large number of activities to be performed at the institute level for achieving its objectives.

Principals, Heads of Departments and teachers are primarily responsible for managing various activities relating to curriculum implementation for producing right type of technical manpower.

Principal of an institute is responsible to manage physical, human, informational and financial resources for effective implementation of curricula leading to gainful employment of students. This means that the resources are to be optimally utilised. Networking with industrial and other organisations need to be established for sharing resources and to see that students are provided varied learning experiences, so that they acquire relevant competencies and are acceptable to the world of work. Establishing linkage with industry/field organisations is one of the most important role of the Principal.

Similarly, Heads of Departments are responsible for managing the resources at the department level for providing appropriate learning experiences to the students leading to the development of professional competencies in them for gainful employment.

Teachers are primarily responsible to manage the instruction in theory and practice to develop appropriate competencies as per the requirements of the world of work.

Academic planning is thus called for, in managing various activities at the institute, department and class room levels. It calls for setting objectives, fixing responsibilities and targets and monitoring programmes and activities for achieving desired results.

Academic planning is concerned with planning annual cycle of activities related to improvement in teaching–learning process, curricular and other co–curricular activities. A detailed format to plan various activities to be undertaken by an institute is given in the next section.

10.2 Aspects of Academic Planning

10.2.1 Improvement of Teaching–Learning Process

a) Faculty development

Faculty is the king pin for providing appropriate learning experiences to the students to impart necessary knowledge skills and attitudes in them. This is possible only if faculty is well versed with technology development at work places, their subject matter competency and understanding of basic principles of educational technology. This requires training and re–training of faculty in a phased manner for which advance planning should be made. There are teachers with varied qualifications and experience. Their professional development and career growth should be linked in such a manner that the teaching–learning process leads to producing competent technical human resources.

There will be some newly recruited teachers who should be given an induction programme in educational technology, exposure to industry and awareness concerning technical manpower development. Teachers with some experience should undergo training programmes in subject matter updating, project oriented industrial/field training, exposure to curriculum development stages and related processes. Also programmes for vertical mobility should be thought for such teachers.

Principal and Heads of Department need to undergo programmes in institutional management, curriculum development, entrepreneurship development

It is expected that every institute should identify training needs of faculty well in advance for planning faculty development programmes offered by various organisation/quality improvement centre etc.

b) Linkage with Industry

It is essential that the teaching–learning process should be linked with industrial/field practices. For this to happen, deliberate planning is required at the institute and department levels. The planning in this respect may include activities like:

- identification of areas/topics which need inviting experts from industry/field to deliver extension lectures

- identification of industrial/field organisations for exposing students to industrial environment, size and scale of operations, technology in use etc
- identification of industrial/field organisations for sending students for task-oriented or project oriented industrial training under the supervision of their teachers
- identification of problems from industry which can be given to students as project work
- areas in which the institute can provide consultancy to industry etc. It is essential to prepare an action plan for achieving the desired targets

c) Development of Infrastructure for Effective Implementation of Curricula

It is essential to identify gaps in physical resources and yearly operational plan be prepared in a phased manner for procurement and establishment of desired infrastructure. Such a plan may include items like:

- establishment of new laboratories and workshop and the type of equipment to be procured
- procurement of machinery, equipment and raw materials
- modernisation of classrooms
- procurement of audio-visual aids
- networking with industry and other institutions for sharing resources for effective curriculum implementation etc.

d) Development of Instructional Material

It is essential to identify gaps in the availability of appropriate instructional material. This may include text books, laboratory manuals, data books etc.

It may also be essential to prepare work books for effective instruction in drawing, well graded tutorial exercises, well thought out home assignments etc.

Planning in developing such resources will go a long way in producing such material

e) Curriculum Improvement

It is possible that some institutions may take a leading role towards improvement of the curriculum by

- collecting feedback from teachers, students and industry for bringing necessary improvements in the curriculum document
- undertaking studies for finding out emerging areas of technology and starting new programmes or offering electives in the existing programmes
- undertaking a study for effective implementation of curriculum, student evaluation etc

Planning for undertaking activities/projects in above fields will go a long way in motivating some teachers to arrive at useful findings leading to improvement in teaching-learning process

f) Entrepreneurship Development

Development of entrepreneurship is an important area for technical human resource development. Organisation of entrepreneurial awareness camps; extension lectures on entrepreneurship development; lectures by successful entrepreneurs; providing project work(s) leading to starting small scale enterprises by students are all meaningful activities, which need to be planned for achieving the desired targets in a year

g) Offering Continuing Education Programmes

Fast technology development necessitate working people to possess desired knowledge and skills. Some technical institutes might like to conduct a study on determining continuing education needs of working technical manpower and may like to offer some programmes based on the expertise and facilities available in a particular institute, planning for which is again desired

h) **Environment Education**

This may include activities like:

- making an institute green by way of planting trees, flower plants and upkeep of lawns, playgrounds etc
- cleaning week
- organising debates/contexts/seminars/extension lectures on the subject

An operational plan in the respect can help a great deal in achieving the targets

i) **Community Development**

Based on expertise and infrastructure in a technical institute, it can serve the community by way of:

- Organising education and training programmes
- Transfer of technology
- Development of appropriate technologies
- Technical and technical support services to be provided to community
- Dissemination of information and promotion of environmental awareness in community etc
- Undertaking community need based projects

j) **Conduct of Meetings**

A progressive institute prepares a schedule for organising meetings with the Head of Department and faculty for improvement of climate and teaching–learning process which also requires advance planning.

10.2.2 Co–Curricular Activities

A progressive institute may like to plan each and every activity. Co–curricular activities have their own place in development of technical human resource. Planning of various functions, games, alumni association etc can be very helpful in improving the climate of the institute.

a) **Functions**

Sr. No.	Name of Activity	Date	Incharge
1.	Celebration of Republic Day		
2.	Celebration of Independence Day		
3.	Institute Annual Day		
4.	Sports meet/Annual athletic meet		
5.	Cultural programmes		
6.	Debates/Declamation contests		
7.	Exhibitions		
8.	Social Welfare Campus		
9.	Educational Tours		
10.	Any other activity like Blood		

	Donation Camp etc		
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b) Various games and their incharges like:

Any specific activity to be initiated during the year like: starting new games, preparation of play grounds, purchase of sports materials etc

c) Various committees and their coordinators like:

Discipline committee, student welfare committee

d) Alumini Association

Any activity during the year like: collection of information through parents regarding posting of passed out students, correspondence with passed out students, presentation of mementos on annual day to well placed students etc.

e) Improvement of Core Facilities at the Institute Level

Student amenities, hostels, library, media centre, dispensary etc forms the core facility of the institute. Depending upon the gaps, it will be worthwhile to prepare year-wise action plan for bridging the gap.

It will be helpful if each institute prepare a calendar by using A-4 size drawing sheet. This calendar should be available with the Principal and Head of Departments for monitoring the progress of various activities

11. Glossary of Terms Used

Following is the glossary of terms used in this book. This will also help the readers in clearly understanding the meaning of different terms:

1) Aims

A term used for general statement of intent of a course, programme etc.

2) Analysis

A term used for a cognitive process that involves breaking down an idea, system, process etc. into its component parts and examining relationship between these parts.

3) Application

A cognitive process in which a learner, given a new problem, will be able to make use of the appropriate concepts, principles and procedures needed to tackle it.

4) Aptitude

Indicative of an individual's ability to learn or develop proficiency in some particular area. It can also be referred to as special ability of an individual.

5) Assessment

The process by which one attempts to measure the quality and quantity of learning and teaching using various assessment techniques.

6) Behaviour

Any observable act or a response to stimulus.

7) Closed System

A system that has no interaction with its environment.

8) **Communication Skills**

Term used for skills of oral, written, non-verbal or pictorial form of communications.

9) **Cognitive**

A generic term used for the rational processes of perception, discovery, recognition, imagining, judging, memorizing, learning and thinking through which an individual obtains knowledge and conceptual understanding.

10) **Concepts of Use**

Application of knowledge and skills gained to practice in real life situation.

11) **Continuing Education**

This term is used for offering course on part-time, full time or courses of short duration for enhancement of knowledge and skills of working people.

12) **Cooperative Education**

A term used for an educational process that formally integrates a student's academic study with work experience (in cooperating employer organisations) related to the student's field of study.

13) **Correlation**

Shows relationship between two sets of scores.

14) **Curriculum**

Term used to denote a systematic sequence of organised courses and materials of instruction (total learning experiences) offered to pupils to achieve the desired objectives in a stipulated time

15) **Curriculum Development**

The process of planning, validating, implementing and evaluating new curricula

16) **Curriculum Design** is the process of determining needs, specifying objectives, structuring the educational programme, working out detailed contents, and implementation process for their relevance and effectiveness

17) **Curriculum Evaluation** is the collection and provision of evidence on the basis of which decisions can be taken about the feasibility, effectiveness and educational value of curriculum.

18) **Diagnosis**

This term is used to determine strengths and weaknesses for purposes of providing corrective or remedial measures.

19) **Employment**

Any remunerative work, whether for an employer or a self-employed person.

20) **Entrepreneurial Culture**

This term has been used to create a culture in teaching-learning process where by the students are allowed to think, search for relevant information, process and arrive at a practical solution to a problem of interest to someone within the constraint of time, money and manpower, while it being of curricular interest of students.

21) **Environment**

For a given system of interest, the environment consists of the set of all objects, events and ideas lying outside the boundary, the change in attributes of which affect the system behaviour and who are themselves changed by the behaviour of the system.

22) **Experiential Learning**

This term is used for learning through direct experience or involvement with the problems or issues of real life.

23) **Formative Evaluation**

Formative evaluation is carried out during the course in order to know the comprehension of knowledge and skills by the students. It is also termed as continuous assessment during a course.

24) **Goal**

This term is used for ultimate outcomes and is usually phrased in general or global terms.

25) **Hypothesis**

Untested assertion put forward to explain some observed phenomenon which is then tested by experiment.

26) **Industry**

A generic term used for any organisation concerned with productive and economic activity.

27) **Input to System**

Input to the system is that aspect which is fed to the system for being transformed into a new form.

28) **Instructional Objectives**

The term has been used to write the objectives of instruction in behavioural terms helping the teachers to plan steps or strategies necessary to achieve them, helping students to know what is expected of them and helping teachers, administrators and industry to assess the product of the system.

29) **Interaction** is the term which has been used for a dialogue between the institute and the industry. Interaction may be one way, though it can be two ways also.

30) **Interactive Networking** is the term used for both way interaction between polytechnic and industry for curriculum improvement, curriculum implementation and sharing of human, physical and informational resources of both sides for their mutual benefit. It will have different meaning at state, polytechnic and class room levels.

31) **Job**

The term refers to the particular occupational function or the specific work engaged in.

32) **Learner**

One who acquires knowledge, skills and attitudes in a field through instruction, experience or training.

33) **Learning**

A term used for any change in behaviour as a result of experience and training or a process of acquiring and integrating through a systematized process of instruction or organised experience varying forms of knowledge, skills and understanding that the learner may use or apply in later situations and under conditions different from those of instruction.

34) **Learning Experiences**

A term is used to provide appropriate situations to a learner whereby experiencing such situations, learning takes place.

35) **Learning to Learn**

It is a concept which covers ability to identify problem systematic searching of information sources, learning relevant information, storing and retrieving the information, reorganizing new knowledge to find solution to the problem being faced, i.e., development of independent learning skills.

36) **Motivation**

An external or internal influence inciting a person to action.

37) **Objective** is a clear specification of intent for learning, which often includes the performance and the conditions under which that performance will be expected.

38) **Occupation**

A broad term denoting any distinct type of manual or non-manual work which can provide a means of livelihood, whether undertaken for an employer or as to self-employed person. The term 'trade', 'craft' and 'artisan trade' are often used synonymously with respect to manual occupation.

39) **Off-the-job-training**

Training under the auspices of an undertaking which has been either arranged off the premises or, if given on the premises, organised in an area (training workshop, classroom etc.) specially equipped for training purposes.

40) **On-the-job-training**

The supervision and other supportive instruction that is given to a trainee or a beginner in a particular job or position within the actual factory, plant etc. at which he/she works.

41) **Open ended**

A term applied to a question, test, examination, exercise, project etc. in which many acceptable answers or outcomes are possible rather than just one single solution or outcome.

42) **Output of the System**

The goals of the system are set by the environment in the form of production of say trained manpower or new information etc. which is termed as output of the system.

43) **Pedagogy**

The method and practice of teaching, especially as an academic subject or theoretical concept.

44) **Pilot Study**

A small scale research study carried out prior to larger study in order to test logistics etc.

45) **Polytechnic** is a term presently used for a technical institution offering courses and programmes in the field of engineering and technology at diploma and post-diploma levels for producing technicians.

46) **Practice**

This term has been used to apply the knowledge and skills gained in the solution of practical problems of industry/field.

47) **Problem-solving**

The term has been used to apply the knowledge and skills gained in the solution of open ended problems by using the process of analysis, synthesis and evaluation.

48) **Process**

Mechanism for transforming input (material, people, or information) into an output (equipment, people with modified behaviour or processed information) into an output (equipment, people with modified behaviour or processed information). Process has built in interaction between human, physical and informational resources.

49) Profile

A set of measures of different characteristics of an individual or group which give an overall picture of the ability, performance, achievement or potential of the individual or group.

50) Project

A significant unit of practical or scholarly activity, generally involving detailed investigation of some sort or the detailed study of a particular topic, issue or areas.

51) Psychomotor

Relating to the coordination of mind and body in carrying out some physical (motor) action or set of actions.

52) Questionnaire

A form with written questions to elicit specific information from a number of persons, generally on a space provided for responses.

53) Reliability

Term used to indicate how consistent a test is measuring what it is supposed to measure.

54) Structured and Supervised

A preplanned activity which provides specific guidance to the learners under the direct supervision of the teacher.

55) Summative Evaluation

Evaluation that is carried out at the completion of a course in order to provide data for product evaluation or to determine the overall effectiveness of a course.

56) System is the organisation of a process consisting of inter-related parts (consisting of man/machine unit, team, sub-system etc) designed to transform a certain input from its environment into an output desired by the environment.

57) Technician Engineer

A highly skilled semi-professional worker who works below the level of a professional but above the level of a skilled worker.

58) Technology

The creative application of science to industrial or any practical purposes.

59) Training

Activities which aim at providing the skills, knowledge, and attitudes required for employment in a particular occupation or for exercising a function in any field of economic activity.

60) Transfer

A term used in behavioural psychology to denote the effects of previous experience or learning on later learning.

61) Work Bench

Interpreted narrowly, the term means an industry, but in this book allows a generic interpretation of the work–bench as any organisation concerned with productive and economic activity.

62) World of Work

Also a generic term used for any work–place where productive and economic activities are taking place.

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