ISSN 0971-8508

JOURNAL OF

TECHNICAL AND VOCATIONAL EDUCATION

ISSUE 19

2002

TECHNICAL TEACHERS' TRAINING INSTITUTE

CHENNAI 600113 INDIA

EDITORIAL AND EDITORIAL ADVISORY BOARDS

EDITORIAL

The 19th issue of the journal of Technical and Vocational Education has come up with a variety of articles and research papers and we are happy to bring out this volume in time. We have been trying to get substantial amount of contributions from engineering colleges and technological institutions and in this issue we are able to achieve this objective partially.

We got very good responses from our contributors for this issue also and we register our sincere thanks to our contributors. Further, in this issue we are able to have one article from one of the contributors who has long drawn experience with the Ministry of Human Resource Development, Government of India, and we are honored to publish this article.

Research in Engineering Education by using qualitative method is very rare in India, though substantial research documents have been produced in developed countries in the past decade. Professor Gupta has contributed an excellent work in this area of Technical Education with the guidance of Prof. (Mrs.) Saxena. The research on evolving models of participatory governance and internal management of polytechnics will serve as a model for effective use of qualitative method.

Professor Sudharssanam in his paper on quality assurance in technical education has considered few issues concerning quality of technical education. His discussion is focussed mainly on Empowerment and Involvement, Governance, Academic Motivation and Direction. He has also highlighted very briefly on the role of Government in enhancing quality.

Sri Govindarajan with his long drawn experience in high-tech industry has come up with several experienced based ideas on enhancement of software engineering skill. The emphasis of the paper is on Capability Maturity Model (CMM) based qualitative approach. The author has observed that training is an ongoing process and therefore efforts are required to improve and enhance the software engineering skills of system engineers through quality technical education and training.

Engineering Education and industrial production system are deeply interlinked. Professor Kuruvilla and Professor Mukhopadhyay have described in their article on Engineering Education and industrial production a convergent system approach. They have suggested that it will be a good practice to apply the tools for quality assurance in Engineering Education system. They have made use of fish bone diagram to explain how application of quality assurance tools can be made successful in making the education system also quality oriented like the manufacturing system.

In the present era of high technology, this issue of the journal was further enriched with the contribution of articles from Professor Mandal and Professor Kannan. Dr. Mandal

in his article on outline of Mechatronics Education has given the salient features of Mechatronics Education for special technicians. Professor Kannan in his article has narrated very briefly his experiment on online assignment for business school students.

In a different area altogether, Dr.Madhavan and Dr.Rajendran have contributed their enlighted views on two significant affective domain areas of Organizational Behaviour. These are, intellectual and emotional factors in human behaviour, and motivation training programme for entrepreneurship development. Readers will find lots of interesting inputs in these articles.

The Journal of Technical and Vocational Education has been always enriched with the contribution from the academics of Nigeria. In the present issue Professor Onwuka has attempted to throw more light on magic square. His paper addresses the natural relationship between the real numbers and magic squares through certain types of matrices and symmetric groups.

For this issue we have received a few articles on English for special purposes. We are glad to publish at least one article by Professor Luthar on role of English in Science and Technology. Undoubtedly it will be of great interest to a section of our readers.

Professor Jaiprakash Narain in this issue has contributed his thoughts on strategic planning in technical education institutes in India. He has suggested that in India the MHRD, AICTE, TTTIs, ISTE and State Directorates of Technical Education will have to further strengthen their training and development activities focussing on strategic planning initiative.

The Research Abstract Section of the present volume is enriched with the contributions of Professor Pasupati, Professor Srinivasan and Professor Mandal. These are valuable additions to the present volume.

We sincerely acknowledge the contribution of authors from India and abroad. We welcome research papers and articles for future issues also. The Editorial Board appeals to the academics and readers to come forward and contribute by way of publishing papers, articles and best practices to this journal for the benefit of the Technical-Vocational Education and Training Community. We welcome any suggestions for further improvement of the journal.

We thank Mr. G. Kulanthaivel for going through the proof and discharging other responsibilities for the journal which made it possible to publish the journal in time.

– Editor

CONTENTS

Evolving Models of Participatory Governance and Internal Management of Polytechnics

B.L. GUPTA and M.SAXENA

1. RATIONALE

Maharashtra State Government has granted autonomy to 16 Government and Grant in aid Polytechnics through a Government Resolution in 1994. The governance structure of these polytechnics is suggested in the Government Resolution but it is silent on many points of governance as well as internal management of the autonomous polytechnics.

These polytechnics are being governed and managed on the basis of the Government resolution. The literature in the field of governance and internal management was comprehensively reviewed and found no research study on participative governance and internal management of autonomous polytechnics. Literature in the other related fields also reviewed and found that participatory governance and internal management is the area, which needs to be studied. The objectives of the study are framed on the basis of gaps found in the literature and listed in next section.

2. OBJECTIVES OF THE STUDY

1. To describe the patterns of participative governance in the form of models adopted by Autonomous Polytechnics.
2. To analyse the participative internal management practices and factors responsible for their successful execution in Autonomous Polytechnics.
3. To study the existing model of participatory management adopted in Joint Forestry Management and suggests its suitability in management of Autonomous Polytechnics.
4. To evolve concepts, models, and guidelines of participative patterns in both governance and internal manage.

3. NEED AND IMPORTANCE OF THE STUDY

The study will be useful guidelines to Policy makers, Administrators, Academicians and Researchers for policy making. It will be a base for further exploring the area of participatory governance and internal management of Autonomous Polytechnics in future.

4. DELIMITATION

The study is delimited to autonomous polytechnics of Maharashtra State.

5. LITERATURE REVIEW

The candidate reviewed 15 Research studies, 25 Reports, 25 Books, 5 Articles, 1

paper on Internet, 12 case studies and 28 related documents. The review of literature has been continuously done with purposes of establishing the gap, deciding the objectives of the study, design of methodology, design of research instruments, deciding presentation format and contrasting with findings of other researches.

6. DESIGN OF RESEARCH INSTRUMENTS

The research instruments are designed on the basis of indicators generated through literature review, interaction with the teachers working in the autonomous polytechnics, interaction with the stakeholders and faculty members of the Technical Teachers' Training Institute (T.T.T.I) who are involved in Autonomy Project of Polytechnics of Maharashtra State. These instruments were tried out on teachers and stakeholders of two polytechnics and members of the role set to obtain their comments. They have generously given comments on construction of the instrument as well as content of the instruments. The instruments were further refined on the basis of comments of the respondents and again tested on selected autonomous polytechnic teachers and a few faculty members of the T.T.T.I., Bhopal. Finally the instruments were prepared respondent wise, which contain structured questions, open-ended questions and rating scale.

7. POPULATION AND SAMPLE

All 15 government and grant-in-aid autonomous polytechnics of Maharashtra State constitute the population and stratified random sampling technique was used to select the sample. Approximately 30% members of governing body, governing committee, internal management committee and role set were selected for obtaining data. Forty-six governing body chairmen and members, 171 governing committee members, 213 internal management committee members and members of 45 role set respondents for this study. Principal of each polytechnic, at least two members of each Governing Body, at least two members of each Governing Committee, at least one member of each internal management committee and one member of each role set were selected as a sample.

8. MODE OF DATA COLLECTION

The candidate has personally visited each autonomous polytechnic for a day or two and collected data through administering instruments. He has also personally collected data from Governing Body Chairman and Members, Governing Committee Chairman and members. The role set members of 65 Forest divisions were mailed the instrument out of which 45 have responded. The candidate has also reviewed the documents related to governance and internal management of each autonomous polytechnic.

9. PRESENTATION AND ANALYSIS OF DATA

The data/formation is presented in sequence of the items of instruments and presented in 67 tables and 92 charts. All the tables and charts are produced observing some rules to avoid repetition of information.

10. INTERPRETATION OF DATA

The interpretation of data/information is carried out in the light of each objective and research questions observing some rules. A brief interpretation is described whenever found necessary.

11. RECOMMENDATIONS PARTICIPATORY GOVERNANCE

Concept of participatory governance of autonomous polytechnics: It is recommended that autonomous polytechnics may use the following concept of participatory governance:

The process of setting direction in terms of policies and perspective plans in different areas of institutional functioning for institutional growth and development and seeing that progress is being made accordingly involving stake holders.

Model of participatory governance

Governance structure: It is recommended that governance structure for Autonomous Polytechnics should be created through constituting Governing Body and Governing Teams like; Board of studies, Planning Team, Evaluation Team, Examination Team, Appeal and Grievance Team, Purchase Team and Finance Team.

Composition of Governing Body: It is recommended that there should be representative members from significant stakeholders on Governing Body. There should be one representative each from Technical Examination Board (TEB), Government of India (GOI), Human Resources Development Organisations (HRD) and Supporting Staff, two representatives each from Directorate of Technical Education (DTE), Professional Bodies (PB), Faculty, and Managing Society (MS) in case of grant-in-aid Polytechnics, three representatives from Industries (I) and three more representatives from the State Government (SG), All India Council .of Technical Education, (AICTE), Women, and parents.

Size of the Governing Body: It is recommended that the size of the Governing Body should be between 15-20 members including secretary, chairman and other office bearers.

Criteria for determining the size of the Governing Body: It is recommended to use criteria like; number of programmes, development level of the polytechnic, number of projects, and number of students for determining the size of the Governing Body.

Table Composition of Governing Teams T-Teachers, M-Members of Governing Body, ST-Staff, S-Student, D-DTE, B-BTE, I-Industry, SO-managing Society

S.No.	Composition of teams	Average number								Total
		T	M	ST	S	D	B	I	SO	
1.	Board of studies	3	1	1	1	1	1	2		10
2.	Programme wise team of board of studies	3	1	1			1	2		8.
3.	Planning team	3	1	1	1		1	1		8
4.	Evaluation team	3	1	1		1	1	1		8
5.	Examination team	3	1	1			1	1		7
6.	Appeal and grievance team (other than examination)	2	1	2	3					8
7.	Purchase team	2	1	1		1			2	7
8.	Finance team	2	1	1		1			2	7

Appointing/nominating agency for members to the Governing Body: It is recommended that the Government, Director, and industry should jointly nominate the members to the Governing Body.

Facilities to Governing Body chairman and members: It is recommended to pay token honorarium to Governing Body members for attending meetings. It is also recommended to pay travelling allowance and dearness allowance to outstation members.

Composition of Governing Teams: The recommended composition of each governing team is given in the table.

Size of the Governing Teams: It is recommended that the size of each Governing team should be between 7-10 members.

Functioning

Term of office of Governing Body and Governing Teams: It is recommended that the term of office of Governing Body and Governing Teams should be 5 years.

Frequencey of Governing Body meetings: It is recommended that the frequency of Governing Body meetings should be twice in a year.

Frequency of Governing Team meetings: It is recommended that Board of studies, Planning team, Evaluation Team, Purchase Team and Finance Team should meet six monthly. The Programmes wise team of Board of Studies, examination Team, Appeal and Grievance Team should meet Quarterly.

Nature of preparation to be made before Governing Body meeting: It is recommended to make preparation like; drafting agenda, circulating agenda and notice of the meeting, gathering and compiling information, discussing issues in relevant teams, orienting new members, discussing minutes of the previous meeting before Governing Body meeting.

Preparation made by: It is recommended that preparation should be jointly made by Principal, support team and Autonomy incharge.

Attendance of Governing Body members in its meetings: It is recommended that there should be 80% attendance of members in governing body meetings.

Quorum for decision making: It is recommended that quorum for decision making should be 50% of the total membership.

Methods of decision making: It is recommended that decisions should be made unanimously.

Areas of institutional working in which decisions, policies and perspective plans should be made by Governing Body: It is recommended that Governing Body should make decisions, frame policies, prepare and approve perspective plans in all major areas of institutions working. The proposed areas and sub areas are mentioned below:

Academic Continuing education, learning, resources development, staff development, curriculum development, industry institute interaction, enhancing quality of passouts, starts new programmes and examination.

Administrative: Transfer, promotion and discipline

Managerial: Drafting vision and mission of the institute, new technology trends to be entered, evaluation of the institutes programmes/projects, performance appraisal, incentives, problem solving, modernisation, recruitment, service conditions, student amenities, and community development

Financial: Purchase, financial and financial planning.

Time to be spent on major issues like policy formulation, perspective planning and major decision by Governing Body in its meeting: It is recommended that governing body should spend 60% to 80% time on major issues like; policy formulation, perspective planning and major decision making in its meetings.

To whom Governing Body should be responsible: It is recommended that Governing Body should be responsible to all relevant stakeholders including government.

Functions of Governing Body: It is recommended that governing body should perform all four types of functions i.e. managerial, administrative, academic and financial. It is recommended that governing body should perform following functions in each category:

Managerial

- Decide the policy of the Institute and prepare guidelines for the functioning of various committees.
- Analyse all the issues and provide policy directives for developing the scheme and implementing the same at the Institute level.
- Supporting and evaluating the performance of the Principal
- Providing the vision
- Evolving, endorsing and monitoring perspective plans
- Setting long term objectives
- Setting a good value system
- Evaluating performance of various committees/teams
- Improving and reviewing polytechnic performance
- Establishing, clarifying and monitoring the institution's mission
- Safeguarding the interest of the stakeholders, faculty members, staff members and students.
- Serving as a bridge and buffer between the institution and stakeholders
- Improving and reviewing self-performance

Administrative

- Delegate administrative, financial and additional powers wherever necessary to the Principal and other functionaries of the Institute for its smooth functioning.
- Approve annual reports of the Institute.
- Appoint various committees for Governance and for smooth functioning of the Institute.
- Approve the appointments of visiting faculty, Experts, engaged on contract basis as and when necessary.
- Approve the fees and other charges payable by the students of the

polytechnic on the recommendations of the Board of Studies.

- Regulate and enforce discipline among members of teaching and non-teaching staff in accordance with rules, and procedures laid down in this regard.
- Lay down service conditions, emoluments, travelling allowances for teaching and non-teaching staff of the Institute.
- Lay down procedures for selection, recruitment and transfer of teaching/ non-teaching staff.

Academic

- Approve modifications in present curriculum in order to accommodate the changing demands of the industry, society from time to time.
- Approve new programme of studies leading to Diploma/Post-diploma.
- Approve continuing eduction programmes or similar activities beneficial to the students/community/ Institute.
- Approve intake

Financial

- Approve Annual Budget, Expenditure, Balance Sheet & Appropriation and reappropriation of Funds.
- Institute scholarships fellowships, studentships, Cash prizes and certificates on the recommendations of the Board of Studies.
- Appoint qualified auditor every year
- Ensuring good financial position

Functions of Governing Teams

It is recommended that governing teams should perform following functions:

Functions of Board of Studies

- To examine curriculum developed/revised by programmed wise committees and approve it keeping in view the institutional objectives and the national requirements
- To scrutinize and validate detailed proposals prepared by the programme wise team for starting new programmes in the institute
- To suggest different innovations, reforms and changes those can improve academic effectiveness of the institutions
- To review the progress of various academic programmes offering in the institution
- To resolve academic problems brought to the notice of the committee
- To guide and coordinate research, teaching, extension and other academic activities in the institution
- To create operational policies in academic areas
- To ensure high standards of achievement of students
- To recommend books for various courses of studies

Functions of Programme Wise Team

- To decide philosophy of curriculum design course wise

- To analyse present needs and to identify desirable change, addition, deletions course wise
- To identity training/development needs of teachers and technical supporting staff
- To formulate programme objectives
- To decide contents
- To design student evaluation scheme
- To decide resources required and development thereof
- To decide strategy of implementation
- To evolve mechanism for evaluation of programmes
- To provide feedback on the effectiveness of academic programmes
- Recommend equivalence for granting exemptions
- To design variety of appropriate continuing education programmes, through both formal non-formal modes, to meet diverse target group requirements

Functions of Planning Team

- To formulate system of various activities in the institute
- To identify shortcomings in various areas of functioning like Industry liaison, Sports/Gymkhana, Extra curricular activities, Facilities to students, library, hostel, canteen, mess, girl students and suggest measures to improve.
- To approve academic/activity calendar for the academic year of the institute
- To recommend structure of tuition fees and other fees

Functions of Evaluation Team

- To evaluate the performance of the institute as a whole
- To evaluate the progress of various schemes/activities in the institute
- To evaluate the progress of various projects
- To obtain the feedback regarding implementation of various autonomous scheme and analyse the data so obtained
- To suggest the corrective measures for improvement
- To obtain feedback for the performance of the students supporting and teaching staff and analyse it and to suggest corrective measures

Functions of Examination Team

- To finalise names for appointment of examiners, paper setters, moderators and other relevant expertise
- To call for manuscripts of question papers, moderation of question papers and to plan the timetable of examination
- To ensure the assessment of answer books, declaration of results, etc, and to arrange for reverification cases
- To approve the award of diploma
- To take decisions regarding mal practices and other disputes
- To prepare policy related to examination

Functions of Appeal and Grievance Team

- To entertain complaints and grievance of the staff working in the institute.
- To organise hearings of grievances
- Redressal of the grievance
- Award in writing if necessary
- To suggest measures to reduce grievances
- To recommend serious matters of grievances to Governing Body as and when necessary.

Functions of Purchase Team

- To scrutinise the proposals submitted by the institute and approve it
- To call for quotations/tenders and to finalise the same for placing the orders
- To check the quality of material and pass the bills of the equipment
- To plan for write off the obsolete and worn-out equipments and to suggest the replacement for the same
- To suggest measures to bring improvements in the purchases

Functions of Finance Team

- To scrutinise the budget prepared by the institute and approve it
- To appoint auditors
- To approve the expenditures made by the institution
- To scrutinise the financial policy prepared by the institution
- To suggest ways for properly using the funds

Ensuring agency for implementation of decisions made by Governing Body: It is recommended that principal should ensure the implementation of decisions of Governing Body.

Methods for enhancing participation of Governing Body members in the Governance of the Polytechnic: It is recommended to use methods like; provide essential documents, education of board members, introduction to top campus officials, clarity of roles and responsibilities, recognising the contributions, giving specific assignments, conducting formal orientation programmes, organising formal training programmes to enhance the participation of Governing Body members in the Governance of the Polytechnic.

Strategies to enhance the effectiveness of various Governing teams: It is recommended to use strategies like; imparting need based training, recognising accomplishments of the team openly, providing autonomy to evolve team norms, solving problems timely, making roles and responsibilities clear, providing necessary resources and support timely, encouraging team members, providing autonomy to evolve team norms, imparting training in team working providing all relevant information related to task, providing an opportunity for self assessment, promoting healthy competition, circulating minutes of the meeting, orientation of team members about their task to enhance the effectiveness of various Governing teams

Circumstances under which Governing Body should be dissolved and new Governing Body should be formed: It is recommended that Governing Body should be

dissolved in circumstances like; when members are inactive, when it is ineffective and inefficient, lack of vision, when it has mal intentions, when there is less than 75% attendance in three consecutive meetings, when there is conflict between chairman and member secretary, when there is indecisiveness in the house, when chairman is absent for three consecutive meetings.

Role of the Principal

It is recommended that principal should perform the role given below to enhance the participation of governing body and governing team members:

- Persue all matters personally
- Provide all relevant information when demanded
- Share experiences and problems with the board members
- Show commitment to implement decisions
- Appreciate the contributions made by board members
- Serve all notices well in time
- Invite members on important occasions
- Promote effective communication among Board members
- Invite members to deliver expert talk on topics of interest for institutional members
- Collaborate in projects of mutual benefits
- Orient all Board members

Outcomes

Anticipated gains of Governing Body and Governing Teams: It is recommended to bring outcomes like; quick decisions, qualitative decisions, right directions for the future, enhanced industry institute interaction enhanced satisfaction of institutional members and stakeholders, good inter personal relationship, increased flexibility in working, policy formulation, resolving issues and problems, perspective planning, design innovative work, research work, through functioning of the governing body and governing teams.

Participatory internal management

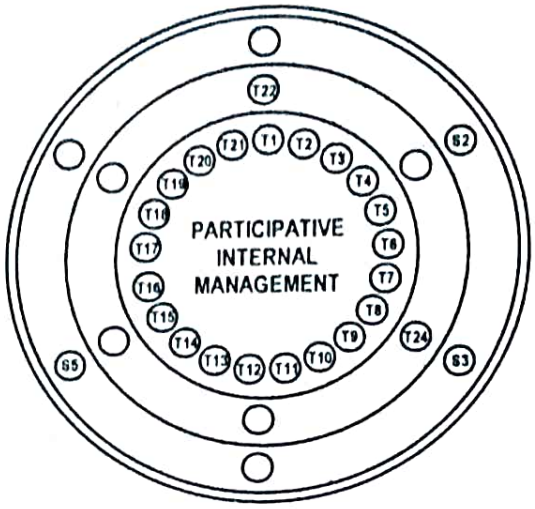
Concepts of participatory internal management of the polytechnic: It is recommended that following concept of participative internal management may be used by autonomous polytechnics.

The process of involving institutional members and empowering them to have sense of ownership and accountability for institutional work. The institutional members implement decisions of governing body for organizational excellence and derive satisfaction out of it.

Model or participatory internal management

Participatory Internal Management Structure: It is recommended to create internal management structure through constituting teams in different areas of institutional working. Voluntarily participation should also be promoted thorough implementing various schemes of voluntarily participation. The proposed internal

PARTICIPATIVE INTERNAL MANAGEMENT STRUCTURE



S1 Quality Circles
S2 Suggestion box
S3 Co-operation & Support
S4 Joint objective setting
S5 Organising cereativity sessions
S6 Exchange of ideas

T1 Curriculum development
T2 Admission of student
T3 Learning Resource Development
T4 Library
T5 Staff Development
T6 Hostel Management
T7 Gymkhana
T8 Cooperative Store
T9 Examination
T10 Guidance & Counselling
T11 Administration & Discipline
T12 Industry Institute Interaction
T13 Continuing Education
T14 Research & Innovation
T15 Consultancy
T16 Community Development
T17 Building construction & maintenance
T18 Purchase
T19 Finance
T20 Internal monitoring
T21 Documentation & Publication
T22 Condemnation of materials
T23 Campus development
T24 Staff appraisal
T25 Evaluation of programmes
T26 Service conditions
T27 Recruitments

management structure is mentioned in the figure.

Composition of internal management teams: It is recommended that all the institutional members should be given an opportunity to participate in internal management of the institution. Teachers, supporting staff members, students and other relevant members should be involved in internal management teams. The following composition of internal management teams should be considered in different areas of functioning of the institution.

Size of internal management teams

It is recommended that the size of internal management team should be kept between 5-10 members.

Criteria for inclusion of members on various internal management teams

It is recommended to use criteria like; ability of members, experience, interest in specific area, willingness of members, institutional priority, training in specific area for inclusion of members in internal management teams.

Constituting agency for internal management teams: It is recommended that internal management teams should be constituted by principal of the polytechnic. He should consult Autonomy incharge, Head of the Department and Chairman to constitute team in specific area.

Functioning

Term of office of internal management teams

it is recommended that term of office of internal management teams should be 3 years.

Functioning of management team

It is recommended that internal management teams should perform following functions:

Functions of staff development team

- To identify the training needs based on the performance appraisal of the employees
- To sponsor the staff for outstation training programmes
- To prepare training plans (in house and out station)
- To receive feedback on training received by various employees
- To conduct in house training programmes with the help of experts
- To monitor and evaluate the effectiveness of such programmes
- To sponsor the staff for outstation training programmes
- To maintain the computerized information related to staff development
- To recommend books related to training and development
- To prepare staff profile

Functions of library team

- To make purchase as per recommendations received from various teams and departments
- To help library users
- To up-keep the library facilities
- To condemn books and magazines which are not useful
- to computerize all records of the library including issuing and receiving of books
- To prepare budget statement for purchasing books and the magazine, journals etc.
- To create a book bank
- To exhibit the new arrivals

Functions of learning resources development team

- To organise training for developing and using learning resources
- To guide teachers and technical supporting staff in developing learning resources
- To procure necessary material and equipment to develop learning resources
- To keep subject wise computerized information of learning resources development centers and learning resource developed by them
- To prepare a list of experts who can guide and help learning resources development activities
- To prepare policy for the institute to develop and use learning resources

Functions of admission team

- To give admission to students
- To receive the filled up forms from students
- To scrutinise the forms as per rules and regulation
- To keep record of information
- To prepare and declare merit list
- To inform relevant agencies about admissions
- To advertise admission schedule
- To attend court cases

Functions of examination team

- To make plans for conducting examination
- To make arrangements for question paper setting from resource persons
- To prepare seating arrangement plans
- To arrange resource as per needs
- To arrange for valuation of answer books
- To compile and declare results
- To distribute mark-sheets
- To keep computerised information of examination system
- To procure necessary material for conducting examination
- To process remuneration bills
- To bring the cases of unfair means to the notice of Principal and relevant empowered team.

Functions of guidance and counselling team

- To guide students to select subject of their interest
- To guide students in further/continuing education
- To organise short training programmes with the help of experts in various areas like leadership, management, entrepreneurship etc.
- To diagnose the learning difficulties of students in different subjects
- To help students in their adjustment to curricular and co-curricular activities
- To provide career information
- To develop interpersonal adjustment attitudes
- To solve personal and academic problems

Functions of Industry Institution Interaction team

- To organise campus interview
- To establish and liaison with industries
- To involve industry experts in instructional process
- To organise industrial training of teachers and technical support staff
- To conduct training programmes for industry personnel
- To improve training, placement and employment for students
- To conduct survey of industries and prepare a directory
- To offer consultancy and testing services

Functions of Gymkhana team

- To organise inter-class, local, district and inter-polytechnic matches
- To organise cultural activities
- To organise competitions

- To encourage students and staff to regularly participate in Gymkhana activities
- To run health club
- To prepare proposals to purchase material for Gymkhana
- To organise different Gymkhana teams

Functions of innovation team

- To gather information related to innovations in the technical field as well as in the field of institutional development
- To introduce the innovations to the institutional members
- To design strategies to implement innovations in the institution
- To implement innovations with the help of institutional members
- To host and administer a full fledged website on the net work
- To train staff and students to use the internet

Functions of administration/discipline team

- To organise get together sessions
- To diagnose discipline related problems and solve them
- To work as a platform for disseminating correct information
- To act as a buffer between management and students/employees
- To implement code of conduct in the institution
- To appoint class monitors

Functions of finance team

- To maintain the accounts regularly
- To arrange for the audit of the accounts at the end of every financial year and submit the report to the Governing Body and other agencies
- To prepare the budget of the institute at the beginning of financial year and get it approved from the finance committee and governing body
- To prepare policy for finance utilisation
- To suggest ways for properly using the funds
- To conduct awareness programmes for institutional members for properly utilising the funds

Functions of community development team

- To organise non formal training for village youth and capable persons in employable and productive trades
- To transfer technology developed by research organisations and laboratories
- To conduct socio-economic and technical survey and need analysis
- To operate extension centers in cluster of villages
- To organise community support services in villages
- To develop a spirit and competence for entrepreneurial ventures
- To maintain management information system on its activities
- To help villagers to start their own enterprise

Functions of building construction and maintenance team

- To make necessary correspondence with various agencies like Public works department, Electricity Board, Municipal

corporation, Architect, Directorate of Technical Education etc. for getting building construction work completed

- To prepare proposals for Building construction as per requirement
- To prepare annual maintenance plans of the building
- To propose different agencies for building maintenance

Functions of curriculum development team

- To monitor the progress of the curriculum implementation
- To identify the needs of the society related to technician programmes
- To develop the curriculum as per needs
- To visit industry to know latest technology and techniques being used
- To review and revise the curriculum as per needs
- To develop new laboratory experiments
- To develop instructional material on new technology and new techniques
- To coordinate various activities related to curriculum development

Functions of purchase team

- To estimate the quantities of material to be purchased at the beginning of every year
- To prepare proposals for the purchase
- To get approval on the proposal
- To purchase the material as per rules
- To maintain inventory of items/material
- To verify the purchased material
- To pass the bill

Functions of continuing education team

- To negotiate with industries and other organisations for conducting short term training programmes
- To identify experts from academic institutions, industries and professional areas for curriculum design and development for continuing education programmes
- To develop curriculum of short term and long term continuing education programmes
- To coordinate with various continuing education organisations
- To implement the curriculum in right spirit
- To conduct staff development programmes for resource persons
- To undertake surveys to identify educational and training needs for technicians, short programmes etc
- To identify most appropriate learning resources for proper implementations of curricular.
- To establish mechanism for review and updating curriculum periodically and implement the same

Functions of documentation and publication team

- To prepare documents and disseminate them timely
- To liaison with various committees and Principal regarding documentation
- To maintain record of various types of documents to be prepared and disseminated to various organisation

- To train employees on document preparation

Functions of time table team

- To prepare the academic calendar of the institute
- To develop the physical resources like space, furniture equipment etc.
- To monitor and review the progress of the academic activities
- To consolidate teaching load of all the years and branches
- To solve overlaps and clashes in time table
- To modify the time table in case of transfer of teacher, change in curriculum etc.

Functions of student chapter

- To organise expert lectures on various topics of interest
- To organise field/industrial visits/ excursion tours.
- To organise student's seminar/workshops by students for students on topics of interest
- To celebrate various occasions
- To publish magazine
- To organise competitions

Functions of students' cooperative

- To sale the articles at cheaper rates
- To maintain account of the money
- To purchase things required by students
- To maintain inventory of the articles
- To run the canteen of the institute and mess of the hostel
- To prepare balance sheet and get the account audited
- To make new members

Functions of consultancy team

- To sale the expertise of the institute to industries and society
- To negotiate with industries and other organisations to bring business
- To keep the account of the revenue generated
- To prepare contract documents
- To complete the consultancy work with the coordination of different departments and sections of the polytechnics
- To prepare a proposal to utilsie the funds

Functions of women empowerment team

- To organise awareness programmes on various topics of general interest with the help of experts
- To organise competitions in various areas related culture, hobby and women right
- To organise entrepreneurial programmes
- To organise workshops for enhancing their participation in industrial activities
- To organise problem solving sessions
- To organise counselling sessions
- To prepare proposals to create facilities for women in the institutions
- To make efforts for employment of women passouts.

Resources and support providing agency for implementing the decisions of the Governing Body

It is recommended that principal should provide resources and support. He should arrange resources from Government, Industries, Professional Bodies and Managing Society in case of grant in aid Polytechincs.

Mode of functioning of internal management teams: It is recommended to use a general model of functioning of internal management teams given in figure.

Mode of communication to communicate the decisions of Governing Body to internal management teams: It is recommended that minutes of the meeting and circulars i.e. written communication mode should be used to communicate the decisions of the governing body to different internal management teams. Verbal mode like face to face meetings and telephonic modes may also be used to support the written mode.

Mode of communication to be used among team members: It is recommended that team members should use face as well as written modes of communication.

Strategies to enhance the effectiveness of internal management teams

It is recommended to use variety of strategies like; promote healthy competition, providing an opportunity to interact with Board members, imparting need based training

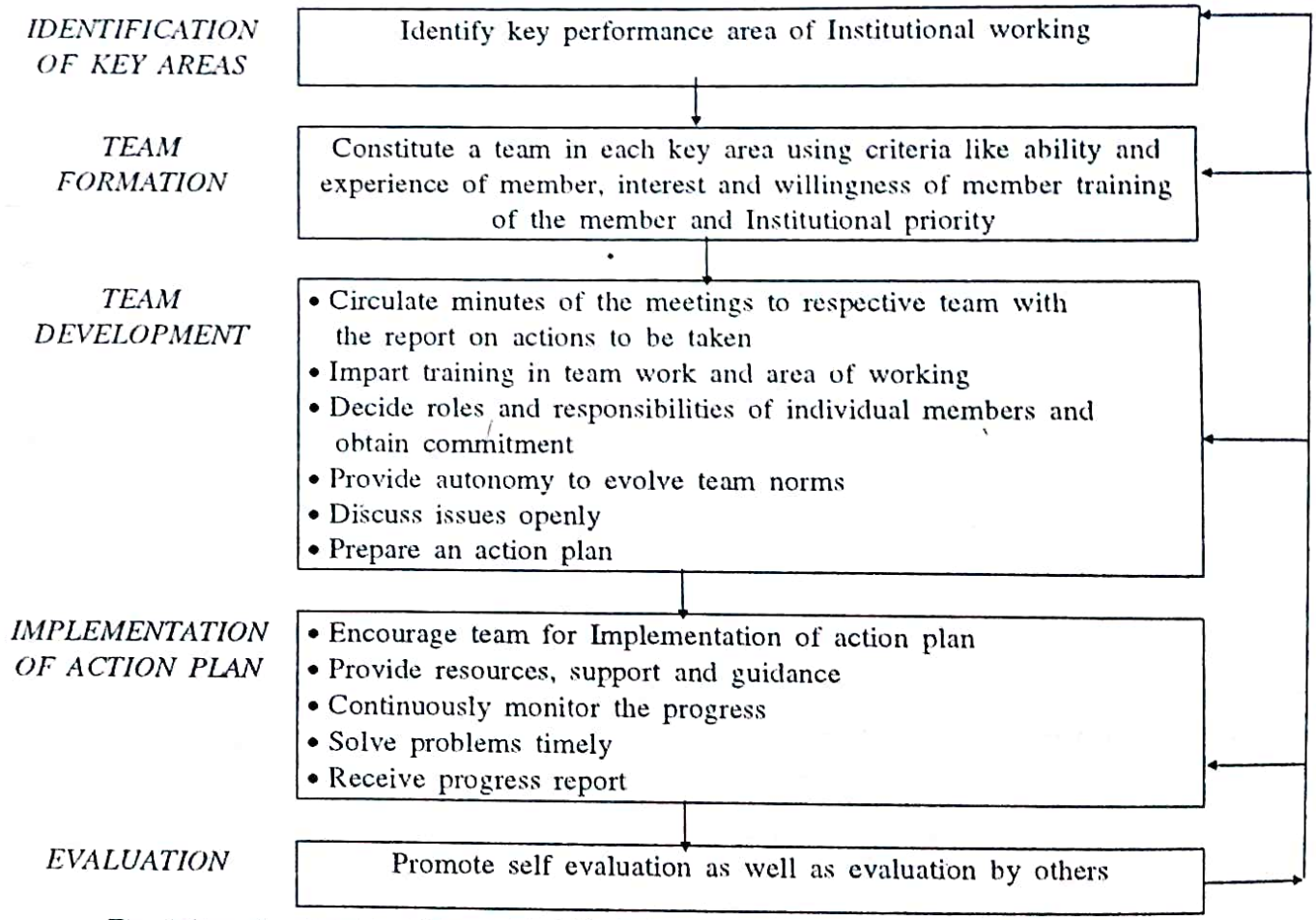


Fig. MODEL FOR FUNCTIONING OF INTERNAL MANAGEMENT TEAMS

solving problems timely, providing necessary resources and support timely, making roles and responsibilities clear, providing autonomy to evolve team norms, providing an opportunity for self assessment, imparting training in team working, orientation of team members about their risk, openly recognising accomplishments of the team to enhance the effectiveness of internal management teams. It is also recommended to implement well designed strategies to avoid problems and barriers, which may occur because of participative internal management practices.

Role of Principal in enhancing the participation of Institutional members in internal management of the Polytechnic: It is recommended that Principal should perform the following role to enhance the participation of the institutional members in internal management of the Polytechnic.

- Provide relevant information timely
- Provide an opportunity to institutional members to become internal management team members
- Use reward techniques instead of punishment techniques
- Appreciate the contributions made by the members
- Promote healthy competition in team members
- Give appropriate feedback to members on their performance
- Promote effective communication
- Create opportunities for members development
- Award autonomy to various teams
- Provide resources timely
- Solve problems timely

Outcomes

Outcomes of participative internal management practices: It is recommended to bring outcomes like: Quick decisions, Enhanced quality of decision, Increased responsibility, Enhanced commitment of members, Enhanced self confidence, Increased transparency in working, Enhanced co-ordination and co-operation among members, Improved quality of work, Time saving, Increased flexibility in working, Training of members, Improved performance, Healthy environment, Creative problem solving, Enhanced trust among members, Shared responsibility, Distributed work, Risk factors lowered down, Ready to face challenges, sustained interest in work, Work does not suffer, Quick implementation of decisions, Less conflicts, Effective utilisation of resources, Effective communication, Good interpersonal relationship, Members satisfaction, Good discipline through participative internal management practices.

Suggestions for further study: During the research study it was felt that following areas should be explored further:

- Identification of training needs, design of training programmes and developing instructional materials for members of the Governing Bodies and Internal management teams.
- Impact of Autonomy in terms of quality of passouts, their employability, satisfaction of employees and institutional members.
- Comparative study of management of Autonomous Polytechnics and non-Autonomous Polytechnics.

*The paper is the excerpt from the first author's Ph.D. work

Quality Assurance in Technical Education

S. SUDHARASSANAM

This paper considers few issues concerning quality of technical education at the delivery end (i.e) institution level (Engg College, Polytechnic etc). Who will assure quality? How to accept the so called quality? Is it dependent on the institution only or is also dependent on the direction (in its entirely) and also the prospective students? In author's opinion, for quality assurance, onus lies on the consumer - students, also. Age 13 to 18 is the adolescence. Will the student know in full what he is needed to equip himself in terms of the degree that he earns at the end of the course or is it the responsibility of teachers to decide what the student needs to know, to be a proficient, professional engineer and not merely a degree holder. It is the creditability of the university to fend for the assured quality of the degree awarded? Do the parents have any accountability and responsibility in this regard or their job is only to remit the fees and what not?

While dealing with financial accounting, audit plays a prominent role to ensure that implementations have been on the rails without any derailment. In this context, pre audit/concurrent audit plays a vital role, to avoid large number of objectionable transactions at the end of the year audit or end of the scheme audit which sometimes serves the purpose of only postmortem. On the above analogy, is there any, concurrent, periodical educational audit (academic, administrative, support services, governance etc) which helps in correcting the deficiencies/distortions as and when they occur, to enable assured end product who is proficient, and employable, commensurate with his qualification. Quality assurance in the context of production scenario is reflected by the rejection of the components, which might be only a meagre percentage. Is such a phenomenon relevant in technical education?

In author's opinion, quality is better monitored, modulated and moderated when the customer, alert clientele, takes active participation, rather than being onlooker or acceptor of what are given. Quality assurance in technical education would be possible when the students as direct beneficiary (stakeholders) participate actively, know what they are needed to equip themselves to face world of work, be demanding, not in the sense of rebellious actions, but yearning to learn. This paper suggests few concurrent audit practices, which could have way for quality education, rather than data oriented quality assurance (like a paper tiger).

As per Philip B. Crosby one of the foremost exponents of quality management "Quality is the entrance fee to the world". As per him,

- Quality means conformance to requirements, not goodness
- Quality comes from prevention, not detection
- The performance standard for quality is Zero Defects, not Acceptable Quality Levels
- Quality is measured by the price of non conformance, not by indexes

How does quality of Technical education relate in terms of above?

A national seminar held in 1997 to discuss "Alarming Failure rates in Technical Institutions - Causes and Remedial Measures", - identified following major causes:

- Admission of poor quality students having no aptitude towards the technical courses
- Insufficient infrastructure in the technical institution, outdated laboratory equipments and absence of committed faculty members
- Lack of adequate library facilities
- Absence of counselling and orientation of students

The seminar also suggested the remedies. Some are:

- Improvement in the quality of input at the first year level itself
- Provision of adequate infrastructure including committed faculty
- periodical modernisation of laboratories
- Improvement of discipline in the matter of attendance in classrooms and labs
- Library facilities must improve
- Analysis of results for remedial measures

Can there be any improvement in quality if these deficiencies are not rectified and remedial measures are not carried out?

Charts at Annexure - I&II depict the growth of technical institutions (degree level & diploma level) in the country. The growth in number of institutions and also approved intake is phenomenal, especially in the last decade. Capacity (intake) in respect of Engineering Colleges has gone up five times in 2001 compared to that in 1985. In respect of polytechnics the growth (intake) is about 2.5 times during the same period. Back bone of technical institution is high quality teachers. First and Foremost is to have full complement of highly qualified, talented and motivated teachers with full commitment to teaching profession. AICTE is certainly looking at this as an important issue. Till a quantum jump improvement, in the present scenario of availability of teachers (quantitatively and qualitatively) is achieved, not much improvement of quality of technical eduction will be visible by taking efforts in all other directions.

Quality of Technical Education has been a topic of discussion in various fora in the last 3 decades. This clearly indicates the decline in quality, sometime from 1970's only. That means quality was at acceptable levels, conforming to the requirements of employers, prior to 1970

Basic responsibility of an educational institution with specific reference to an institution conducting courses/programmes leading to degrees/diplomas in the field of

Technical education, is to inculcate a process, which turns the raw material (a student input) into a value added product. Major aspects that contribute to value addition of a student in technical institution are,

- Motivated student input with aptitude for engineering / technology courses
- High quality, demanding teachers
- State of the art curriculum
- Excellent ambience of an educational institution
- Well equipped class rooms, seminar halls etc
- Well equipped functional laboratories & workshops
- well equipped, dynamic, vibrant library,
- Responsive administration & support services
- Sound governance
- Periodical, continuous evaluation of students, feedback and improvement as a continuous chain
- Evaluation of students though semester end/year end exams
- Active interaction with industries/user agencies, feedback on alumni and feedback from alumni
- Placement of pass outs through campus interview
- Level of employment of pass outs
- Leadership

Do we have a clear bench marked audit of all these at regular intervals to identify deficiencies as and when they occur diagnose and inject corrective steps? Are such audit / evaluation reports of each institution, each department, each laboratory / workshop / library etc. made known to the students, teachers, administrators, governing body members, etc.? Answers are, by and large, a firm 'No'. Quality is not an entity in isolation.

Several authors have formulated bench marking of the connected parameters of quality. As Phil Crosby has put it, ***"QUALITY COMES FROM PREVENTION, NOT DETECTION".***

As of now, do we have any designated mechanism to detect deficiencies, deterioration, etc, within the shortest time of such occurrence, as a concurrent, recurring process? By and large, answer would be a simple "No"

Is SWOT analysis (Strength, Weakness, Opportunities, Threats) being done by every technical institution at regular intervals with proper documentation of efforts to enhance quality and results obtained? Again the answer would be a general "No"

In the absence of all these, results could only be, as the adage goes, "Excuses are only nails to build a house of failure"

Till '70s, students for admission to engineering colleges were selected through interviews by a committee of senior professors, besides marks obtained in qualifying exams. Number of institutions then were, about 12% of the present strength. Through it was not a fool proof, transparent mechanism, calibre of input into an engineering college and the output did not suffer much in terms of quality. By and large graduates of engineering colleges were able to

get placement, (through campus selections or after) commensurate with the qualifications. Now there is a distortion in this scenario like huge underemployment, unemployment an underemployability. Complete eradication of the last syndrome (unemployability) would be the least indicator of improved quality. Barring the outputs from IITs, RECs, Government and grant in aid engineering colleges (Majority of students in these category of institutions get placements), about 50% of the students coming out from other colleges are underemployed, unemployed or unemployable.

EMPOWERMENT & INVOLVEMENT

As per Phil Crosby, "... PERFORMANCE STANDARD FOR QUALITY IS ZERO DEFECTS, NOT ACCEPTABLE QUALITY LEVELS" As the adage goes, "MEDIOCRACY BREEDS MEDIOCRACY". Though zero rejects in real terms could be possible in a production scenario, near zero rejects in output from technical institution is achievable. The additional process needed would be the preaudit/concurrent audit (academic, humanware, hardware, software, infrastructure, support services, administration, management etc) as a continuous chain of processes.

Who will do the audit? Who is entitled to give a feed back? In a commercial scenario, marketing manager knows "Customer is the king". Unlike in marketing scenario, there cannot be any unique, so called, customer, but there are number of stakeholders.

In terms of organizational growth, it is said that organization grows with the growth of the individuals and individuals in the organisation grow, as the organisation grows. Several institutions have contributed for their glorified alumni and the alumni had indeed glorified the alma mater.

Educational audit is not to be done by any external agency. It should be fully internalized. There is a process called annual stock verification in technical institutions. No outside agency is called for. Professor or an academician of dept X will conduct stock verification of laboratory Y, academician of dept/lab Y will conduct stock verification of lab Z and so on. Like wise, concurrent audit for quality has to be through multiple entity, need not be mutually exclusive. It is also imperative that, any one auditing a part of the academic process or hardware or so, will be viewed as a facilitator for improvement of quality, and not as an adversary, nor will he assume a momentous superiority. Equally important is ensuring absence of "I scratch your back, you scratch mine" syndrome. Such syndrome should be shunned. Spirit behind the "EDUCATIONAL AUDIT" is to have a self diagnostic mechanism in the institutions to induct needed correction so that every sub-system functions without any malady. Also, the element of consumerism (with emphasis on accountability) has to take root in the mind of teachers, students, administrators, service personnel etc. Basic concept behind "internalized educational audit" is that everyone in the system has a responsibility to ensure zero defects in the process in the institution.

For instance, let us take the case of laboratory instructions in strength of materials lab in an engineering college. Following possibilities could exist in an institute.

(a) adequately equipped lab with all needed equipment as per standard list experiments, in position

(b) above with all the equipment operational

(c) above with a few or more equipment inoperational

(d) though there are equipment as per requirement, they are not of the up to date, state of the art equipment

(e) inadequate equipment

(f) adequately equipped with all needed equipment of the state of the art, as per standard list of experiments in position, all are operational, plus equipment needed to understand several other theories like beams & bending, deflection etc. through standard / in situ models etc

Who is to ensure that the lab is always fully equipped and all equipment are operational? This should be primarily the responsibility of the concerned head of the department, lab in charge, lab asst, etc, with overall responsibility with the principal. In several institutions this just does not work. Hence empowerment of students is suggested, who is the prime stakeholder, besides others. It is suggested that each lab must have "QUALITY IMPROVEMENT BOOK" (on the lines of complaint books in Railway stations, etc.) A student should be in a position to record about absence of equipment, dysfunctional, malfunctional equipment, lack of adequate consumable for hands on experience etc. in a register to be kept in every lab, workshop, office, library, amenities room toilets, hostels, mess halls etc. Students/teachers/ other officials of the institution, will, as stakeholders/accountable, in the quality of outputs of the institute, shall record deficiencies, difficulties, flaws, lapses etc in the register not with a complaining attitude, but with a bent of mind of improving the quality performance through the particular sub system. These could be also computerized with access to the stakeholders.

There shall be an audit committee, of Professors (a maximum of 3 or 4 in rotation for a period of 2 years or so) who examine the "QUALITY IMPROVEMENT BOOKS" of all labs workshops other service locales, at periodic intervals. (say once a fortnight or so). Basic requirement to enhanced quality is the absence of fear in the minds of the aggrieved or one who detected the flaws. Besides, there should also be a "PERFORMANCE BOOK" for every major equipment to ensure of the equipment in functional, working condition (on the lines of log books). All these QIBs & PBs will be examined by the audit committee at its periodical meetings & forward the report to the Principal of the institution for speedy, necessary action. Report of the audit committee shall be examined by the Principal of the institution for implementing the recommendations of the audit committee. Here the role of audit committee will not end in consolidating and pointing out deficiencies but will have to come up with suggested solutions to rectify the deficiencies. Complainants will be looked at as facilitators for correction and improvement, who should be recognized appropriately. This does not mean, the lab in charge or lab assistant can be indifferent in-proper maintenance of Lab. Role of students / other stakeholders as above is only supplementary. Recognizing a student will indirectly be a blot on the performance of lab in-charge / lab assistant. If this concept is well understood and implemented, alertness and continuous improvement will be the result. This phenomenon should be well publicized

within the institution, so that participation and facilitation (rather than the, "it is not my job" syndrome) in the well being of the institution is institutionalized. A paradigm shift from "why should I" to "why not I" would make all the difference.

Suggestions/complaints in the QIB will be complementary to the efforts of the lab in-charge. At every successive meeting audit committee will review the action taken on earlier recommendation to avoid cumulative bundle of deficiencies. The head of the institute and administrative personnel will be kept away from the affairs of the committee., except for complying with the recommendations of the committee within the needed time frame. This is to ensure bare minimum downtime of various equipment in the labs aimed towards quality delivery of the practical knowledge to the students.

Mahakavi "Subramaniya Bharatiyar" (Tamil Poet, who kindled the spark of patriotism towards freedom struggle) has sung as part of song, which means "if there could be no food even to one citizen, we will destroy the whole world". The spirit behind is that starvation should be a non-existent phenomenon and that there should be no citizen in the world lacking in minimum essential needs for survival and contribute to the society.

There should be such a spirit when we talk of Quality of Education in general and Technical Education in particular. One should not be complacent with a few Eiffel towers, which stand out from the crowd to produce world-class quality engineers, like IITs, IIMs, RECs. and few others. Quality should be understood in a sense that not one pass-out from a technical institution should lead to be a national waste. It is precisely because of lack of such focus, more than 50% of the pass-outs from the technical institutions started in the late one-and-a-half decade of the past century, land up as unemployable or unemployed or underemployed. Hence, this forum has to address itself to throw a punch towards nothing less than high quality Technical Education as seen from the quality of output, notwithstanding the input both qualitatively and quantitatively (students, infrastructure, teachers, other hardware, software and process).

Another example of the need for educational audit is that of library in technical institutions. The author had the fortune of visiting libraries of several polytechnics and engineering colleges in various States in the country. From the visit, the following came to the fore:

1. Gate Registers to note entry into the library are not maintained. This is essential to know as to how many students or teachers or other outsiders have visited the library and made use of the resources therein. In Tamil, there is an adage which transliterates to "even if you throw things into a river (as surplus, unwanted or discards) still a measure must be kept of what is thrown into the river". Hence, data on the utility of the library is a must to infer on the status of utilisation of resources in the library.

2. Library is very poorly staffed. In some cases qualified librarians are not posted and the library is manned by one of the general clerks. For an effective functional library, a qualified librarian

with adequate supporting staff is essential.

3. Neither Card Index Catalogue (old generation methodology!) nor computerized cataloguing is available.

4. Issue Slip/pouch Cards in the books indicate that several of them were never borrowed either by a student or a teacher even once, raising a question mark on the relevance of the books. That means the library is a dumping place of books to only account for the number of titles and volumes to satisfy AICTE's norms.

5. There were instances where the library contained books which were irrelevant to the courses offered or incoherent with the levels of students.

6. Reference Section and a calm reading area were missing.

7. There was no display zone to prompt the teachers and students, of new arrival of books. Library should be a vibrant, dynamic zone, which should inspire and motivate the students to refer to more and more books, rather than staying with the notes given by teachers.

8. Closed Access System is still being followed in several institutions. This is certainly a dissuader from using the library.

9. Absence of adequate technical journals & magazines.

It is possible that one or more of the lacunae enunciated above could be in several of the institutions(s). Hence, as suggested earlier a "QUALITY IMPROVEMENT BOOK" should be kept in the Library, which will be perused by the Audit Committee during its periodical meetings. Unless the Library is made to breathe fresh air and made vibrant, quality of education will remain where it is.

Governance

Governing body of the institute will have to necessarily meet once in 3 months or at least 3 times a year on standardized fixed days, as a perpetual measure. Even though the Governing body's composition shall not include parents, parents could be invited to be special invites for each meeting, on rotation basis. Selection of parents for each meeting will be from among the parents of one of the poorly performing, mediocre & well performing students. Governing body will examine the gist of reports of audit committee and remedies taken.

Governing body at its successive meetings will take appropriate decisions to prevent recurrence of once notified deficiency.

Academia

AICTE has prescribed qualifications and experience for various levels of teaching positions. Highly talented, experienced, demanding teachers are one of the foremost essentials of a technical institution. Certainly, highly qualified, talented, demanding teachers are the back bone of technical institutions. "Extracts of couple of advertisements" are given below.

> EXPERT GUIDANCE
> for B.E. (Computer Science)
> and MCA Students to complete project work!
> Contact XXX
> (The Hindu Date 14-9-98 Page-9)

LIVE PROJECTS
for BE/MCA students
Software Development Training Experience
Contact YYY
(The Hindu Dated 27-2-2000, Page-24)

When we talk of quality assurance, had there been assured quality of teachers, in the institutions, where is the scope for such advertisements? Does it not reveal that certain private individuals are exploiting the situation (rather helping out the students!) of lack of qualified, talented, teachers and facilities in technical institutions to carry out project work, which is meant for stimulating the knowledge of students? Does it not lead to double exploitation of students? On one side, a student has to pay the required fees to the institution and because of lack of teachers (in quality and quantity) and facilities, he has to cough up, to get the project work done outside to enable obtaining the degree by completing the course requirements. These advertisements only reveal the wrong side of the poorly equipped and poorly staffed institution. AICTE has to put in place a clear mechanism that such vaccum never exist.

Then the President of India Shri R. Venkataraman, after distributing National awards to teachers for the year 1989, on the occasion of Teachers day, emphasized:

"We shall require teachers of proven competence and utmost devotion and commitment to their profession. This will depend to a large extent on the professional qualities of those who take to the teaching career, their education attainments, improvements in their professional training ....."

It is after 12 years, above remains a dream in so far as Technical Education is concerned. As prescribed by AICATE every professor and Reader/Assistant Professor in an engineering college should posses Ph.D.degree. A study on "shortfall and Remedies of Engineering Ph.D personnel in India", reveals,

- There are several institutions where no Ph.D. qualified teachers are employed
- Every additional intake of 100 seats in engineering college generates a need of 10 teachers with Ph.D in teaching profession alone
- There are no Ph.D qualified teachers in the area of Information technology, Computer Science & Engg and Electronics Eng. in a very large no of institutions except in IITs, IISc, RECs, few universities and very few other institutions
- The least shortfall of Ph.D. qualified persons in the country shall be of the order of 6000, 15000 and 27000 in the years 2001, 2005 and 2010 respectively

Also a study on "present out turn of Engineering Ph.D. in India 1984-99" reveals a phenomenon of decrease in out turn of Ph.D.

All the above will have adverse effect on quality of technical Education at macro level also.

Motivation

Next important aspect is inspiring and motivating the students. It is more than a fact, students joining technical institutions come from varying academic, social, environmental, and family backgrounds. It is necessary that a

student is well motivated to learn to the best and to understand what he is expected to be, as a *'PROFESSIONAL ENGINEER'* and not merely a degree holder. In the past, it is seen that the process of admission took place over a longer period. Two aspects are very important. One is to conduct a well structured orientation programme after admitting the students. Second is to make them know during the course of studies their expected role as an engineer, manager, administrator, academician and what not, in future career. To this effect during the 2nd year of the course well structured guest lectures on professional practices by professionals/practicing engineers/managers from variety of organizations (for civil engineering branch engineers from PWD, highways, railways, private enterprises Govt. Depts etc) could be arranged. A credit course titled "Glimpses of professional practices" be introduced in 2nd year. This will certainly motivate the students to choose a couple of specific lines of professions. This will also indirectly work like guidance and counseling for the students.

Every technical institution should take pride in ensuring high quality in every endeavour in the institution, since these are for creating future leaders in engineering & technology for the country. As part of the course on "Glimpses of Professional Practices", students should be exposed to several attributes of a future leader like,

- translation of vision into goals
- ability to convert ideas into action plans
- ability to spot opportunities
- excellent communication skills
- time management etc.,

Direction

Education is a concurrent subject. State Government through the Directorates of Technical Education have the responsibility to ensure proper functioning of technical institutions on sound lines and to the expected standards. Charts at Annexure I & II depict the growth of technical institutions in the country. Strengthening the Directorate of Technical Education in the states is of paramount importance in directing and guiding the technical institutions. At present, it seems, not many states have strengthened the directorates towards direction & administration, though in some states increase in number of technical institutions is phenomenal. This is yet another important aspect which will make a positive dent in improved quality of technical institutions.

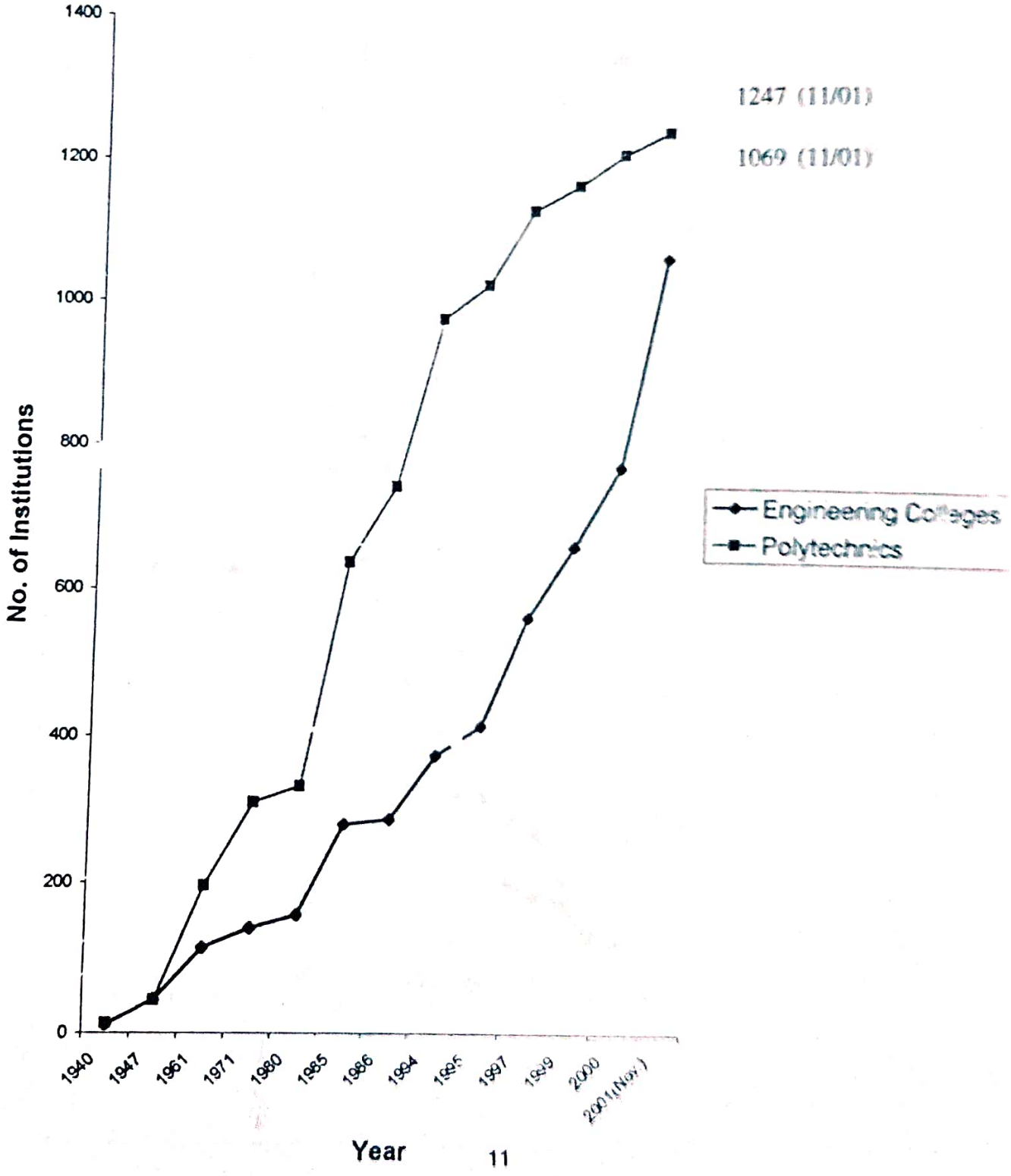
The IIT review committee stated the objectives of IIT as:

"The product has to be excellent in quality, relevant to the technological needs of the country, motivated to give of its best and have a commitment to the country. The goals and tasks of these institutes in their process of development have to relate continuously to significant and notable changes that are taking place in the socio-economic development of the country..." Though these are stated with reference to IIT system, which of these attributes could be deemed as redundant to other class of technical institutions (engineering colleges, polytechnics etc)?

In view of Global WTO regime, there is an urgent need for a thorough look at applying all the concepts for attaining highest quality in technical education. As Phil Crosby puts it, *"ZERO DEFECTS"* shall be endeavour in

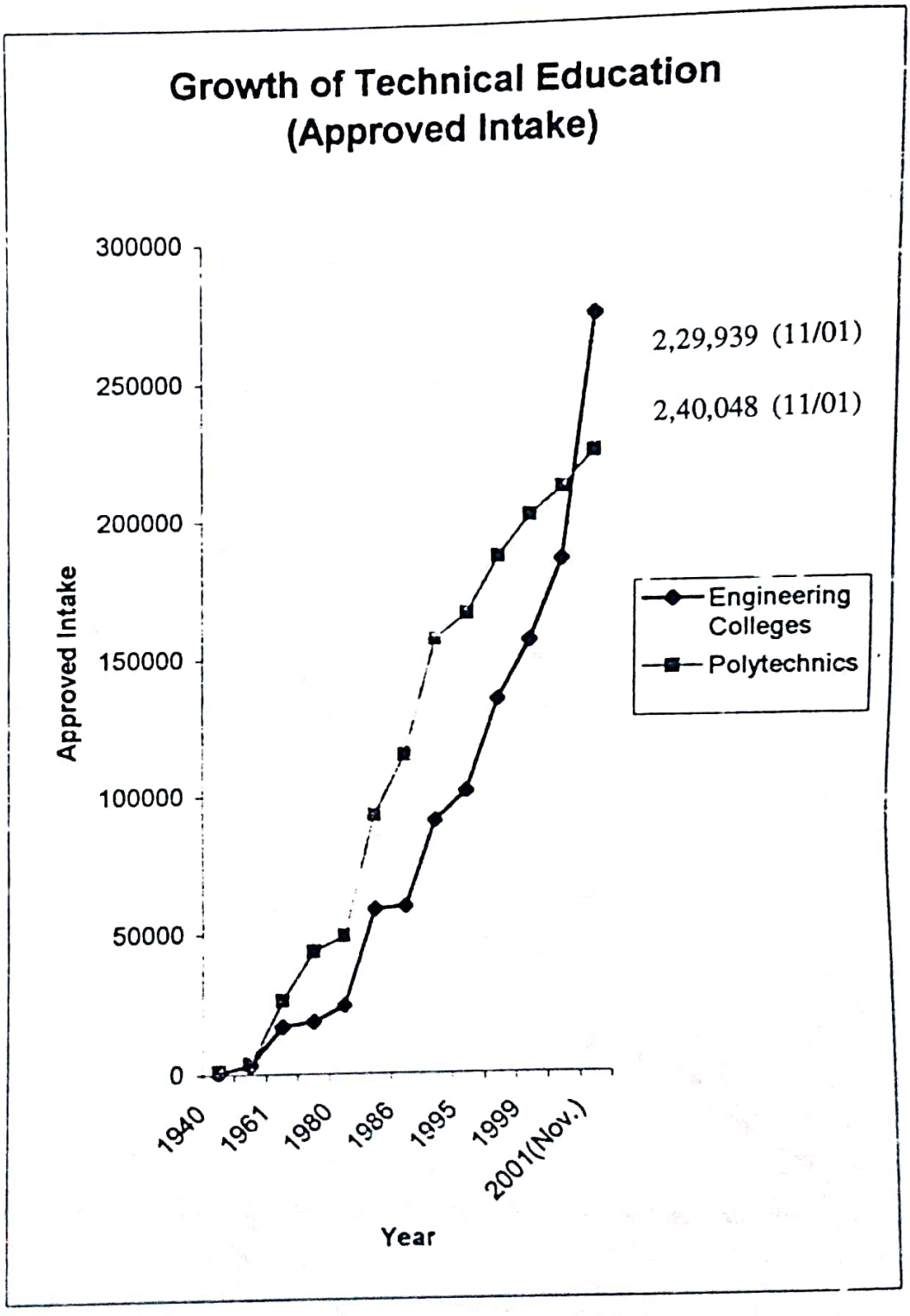
Annexure I

Growth of Technical Education
(No. of Institutions)



Annexure II

Growth of Technical Education
(Approved Intake)



technical education, which, all the stakeholders, including sponsors of technical education, have to make happen.

Conclusion

Empowerment of stakeholders, (students, teachers, etc.) motivation of students including pre-orientation & counselling, concurrent academic audit, governance with involvement of parents, high quality academia (qualitative and quantitative) and improved direction by state Government can steer sustained enhancement of quality in a positive way.

REFERENCES

Technical Education in India Today, Dr. L.S. Chandrakant - 1963

IIT Review Committee Report 1986

An overview of Technical Education India - ISTE May 1988.

National Seminar (ISTE sponsored) on "Alarming failure rates in technical institutions - causes and remedies", 26, 27th November, 1997. (Anjuman Engineering College - Bhatkae Karnataka)

Scientific and technical manpower development in India - Status, need and future strategies - IIT Delhi April 1998.

Motivation in Education Management, Dr.B.Mukhopadhyay, Sterling publishers Private Ltd. - 1994

Present out turn of Engineering Ph.D in India 1984-1990 Dr. J.P.Shrivasthava, Dr. Rakesh Kumar Khare - Indian Journal of Technical Education, October - December 2000.

ISTE HandBooks 1993 to 2001.

Shortfall and Remedies of Engineering Ph.D. Personnel in India (2000-2010) - Dr.J.P.Shrivasthava & Dr. Rakesh Khare - Indian Journal of Technical Education April - June 2001

Software Engineering Skill Enhancements - A CMM based Qualitative Approach

S.GOVINDARAJAN

1.0 CURRENT TREND OF INDIAN SOFTWARE INDUSTRY

In the past few years, the Indian IT Industry has pursued the goal of attaining the highest International Standards of Quality. A World Bank funded study conducted in the year 1992 to discuss Indian Software Strategies had concluded that more and more vendors in the US prefer to get their software developed in India for its Quality and Cost advantage.

Indian players have created a strong value proposition in the IT Software and Services arena. India and it's Educational Institutions, enjoy advantages of people sophistication in terms of a very large pool of English speaking scientific personnel, varied and extensive skill sets in terms of technology enhanced often in tune with changes through training program, and offering services at globally competitive costs. India also boasts vendor sophistication with more than 200 Companies being quality accredited and serving the needs of over 255 Fortune 500 Companies. Today, the World looks towards the Indian IT software and services industry for its good quality and high price performance.

According to Mc Kinsey & Co., India has and will continue to have a growing number of vendors successfully working on complex projects across all areas of software and services, and performing at levels comparable to those of leading global players.

As of 31st March 2002, India had 42 companies at SEI CMM level 5 assessment. The quality maturity of the Indian Software Industry can be measured from the fact that already 316 Indian software companies have acquired quality certifications and more companies are in pipeline to do so.

The other heartening feature has been the growing acceptance and adoption of the newly emerging People-capability Maturity Model (People-CMM) by the Indian software industry. For a country like India, with its large assets in the form of skilled human resources, the relevance of CMM needs no emphasis. A large number of Indian IT software and services companies have been quick to realize this and have either implemented or initiated appropriate training programs.

Indian IT industry is on track to achieve its long term aspirations of US$ 50 billion in export revenues by 2008 and remain the pre-eminent destination for exports. The

Industry has grown at a CAGR of 46 percent since 1999, which is higher than the growth rate required to reach the target set in the first NASSCOM-Mc Kinsey study.

Today, India is undoubtedly the pre-eminent destination for offshore IT services. However, China has the fundamentals to emerge as a credible offshore IT services destination in the medium term.

Sustaining future growth, will call for new capabilities, an expanded business footprint, and radical changes to existing business models through improving the Business Process Re-engineering techniques and impart new concepts of process through trainings. India needs to take several initiatives to sustain its lead in exports of IT services and also explore opportunities to engage with China.

2.0 EMERGING OPPORTUNITIES AND CHALLENGES

Based on location and people attractiveness, ten countries were identified as strong contenders for the global ITES market in 1999 – India, Ireland, UK, Australia, Singapore, Hong Kong, China, Philippines, Netherlands and Mexico. Among these, only two countries, India and Ireland, have created a substantive presence till date.

Today, India and Ireland surpass other competitors in terms of employment, number of companies sourcing ITES as well as spectrum of verticals and services lines. India, in particular, is witnessing rapid growth due to its cost advantages, the early success achieved by the reference lighthouse customers and government initiatives implemented to improve location attractiveness. The ITES industry has grown at more than 70 percent over the last two years and currently employs over 1,00,000 people. India is fast emerging as the "new" leader, especially in traditional services such as call centers, back office processing, etc. India is also the first country to see significant third party activity.

Philippines and China could pose the strongest competition to India and challenge India's supremacy in the medium to long term. Only China and the Philippines, other than India, have a sizeable, low cost talent pool, which could meet global IT manpower needs. Governments in both countries are taking significant steps to improve their attractiveness for the IT industry.

Other countries like Malaysia, the Caribbean, South Africa, Hong Kong, etc. have seen some activities towards development of IT services. However, the small size of their talent pools and lack of reference customers severly constrains their ability to energy as hubs.

The Indian IT services industry is set to move well beyond contact center, low-skilled work driven by the early success of the first movers. Capturing the opportunity will require players to crystallize their business models and develop tailored value propositions.

3.0 OUR STRENGTHS AND WEAKNESSES

India's abundant, high quality and cost effective services and its vast resource of skilled software human power have made it an attractive location for global software clients.

There has been a healthy growth in the number of India's IT professionals over the last decade. From a base of 6,800 knowledge workers in 1985-86, the number increased to 522,000 software and services professionals by the end of 2001-02. It is estimated that out of these 522,000 knowledge workers, almost

170,000 are working in the IT software and services export industry; nearly 1,06,000 are working in the IT enabled services and over 220,000 in user organizations.

3.1 NASSCOM'S MANPOWER RESOURCES SURVEY

3.2 HIGHLIGHTS OF THE SURVEY

- The number of employed IT software and services professionals increased to 522,000 by the end of the year 2001-02 compared to 280,000 employed in the year 1998-99. This figure includes professionals, who are engaged in software, IT services and IT enabled services including professionals engaged in software development units in user organizations.
- The hiring of new IT professionals was highest in South India at 41 percent and lowest in the Eastern region at 6 percent.
- The overall median age of software professionals was about 25.6 years.
- 79 percent of software professionals in software companies were men, whereas 21 percent were women. However, this ratio is likely to be 65 : 35 (male : female) by the year 2005.
- 44 percent of the software professionals or knowledge workers possessed over 3 years of working experience.

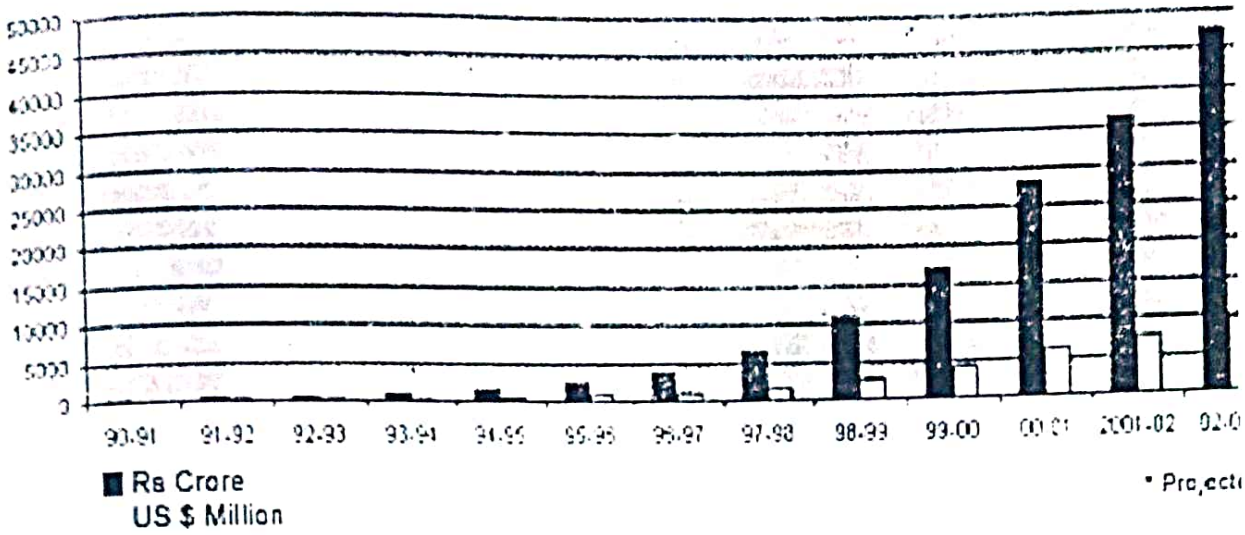
Indian IT Sector: Knowledge Professionals Employed

Category	1990-92	1996-97	1999-00	2000-01	2001-02 E
Software exports sector			110,000	162,000	170,000
Software domestic sector			17,000	20,000	22,000
Software captive in user organizations			115,000	178,114	224,250
IT enabled services			42,000	70,000	106,000
Total	156,000	160,000	284,000	430,114	522,250

India's New IT Labor

Category	2000-01	2001-02	2002-03	2003-04	2004-05
IT Professionals from degree and diploma colleges	74,364	90,867	99,959	110,495	115,533
Non-IT Professionals from degree and diploma colleges	32,025	35,612	38,423	43,261	55,877
IT labour from non-engineering fields	26,597	31,620	34,595	38,439	42,853
New IT labor	132,986	158,099	172,977	192,194	214,263
Total number of Engineering seats	290,088	333,094	361,076	401,791	464,743
IT professionals from degree and diploma colleges as a proportion of Engineering seats	26	27	28	28	25
IT graduates as a proportion of Engineering graduates	33	35	35	35	31

Indian Software Exports 1990 - 2002



- Most companies are increasingly adopting the variable pay concept in order to link pay to revenues, and control costs.

- Higher quality and productivity, faster delivery, lower costs, and better morale.

- It assist organizations in maturing their people, process, and technology assets to improve long-term business performance.

- Each maturity level indicates an acquisition process capability and has several Key Process Areas (KPAs). Each KPA has golas and common features and organizational practices intended to institutionalize common practice.

- It is a model of the practices an organization can use to define, implement, measure, control and improve its software processes.

- Addressing software and disciplines that have an impact on software.

- Providing integrated process improvement reference models.

4.0 WHAT IS CMM?

4.1 ABOUT THE SOFTWARE ENGINEERING INSTITUTE

The Software Engineering Institute (SEI) is a federally funded research and development center sponsored by the U.S. Department of Defense through the Office of the Under Secretary of Defense for Acquisition, Technology and Logistics [OUSD (AT&L)]. The SEI contract was competitively awarded to Carnegie Mellon University in December 1984. The SEI staff has extensive technical and managerial experience from government, industry and academicians.

The U.S. Department of Defense established the Software Engineering Institute to advance the practice of software engineering, as quality software that is produced on schedule and within budget is a critical component of U.S. Defense systems. The SEI mission is to provide leadership in

advancing the state of the practice of software engineering to improve the quality of systems that depends on software.

The SEI accomplishes this mission by promoting the evolution of software engineering from an ad hoc, labor-intensive activity to a discipline that is well managed and supported by technology. Princes Areas of Work.

The SEI carries out its mission through two principal areas of work:

Software Engineering Management Practices

This work focuses on the ability of the organizations to predict the quality control schedule, cost, cycle time and productivity when acquiring, building or enhancing software systems.

4.2 WHY SHOULD CMM METHODOLOGIES TO BE ADOPTED?

CMM (basic concepts) have been developed by the Software Engineering Institute (SEI) at Carnegie Mellon University, started in 1986. Basic ideas published in Watts Humphrey's book "Managing the Software Process" (1987). The CMM term coined and first release of the framework was published in 1991 (release v1.0).

A systems/software engineering framework (model) that sets guidelines and associated metrics to measure the maturity of a Software Development Environment/ Organization e.g., team, group, training-methodologies, company, corporation.

4.3 EVOLUTION OF CMM

- It has been finely tuned ever since its inception, even though the main concepts were not changed.
- This framework (model) is rapidly becoming (if not already is) a standard measure of an organization capability to develop High Quality Software.
- U.S. Government (and its departments, e.g., DoD) uses it aggressively, for at least past half decade to decide on awarding contracts to various bidders.
- Lately, it's being embraced by commercial organization as well, due to an emerging TQM and ISO 9000 type of requirements.
- Software process maturity is the extent to which a specific process is explicitly defined, managed, measured, controlled, and effective. Maturity implies a potential for growth in capability and indicates both the richness of an organization's software process and the consistency with which it is applied in projects across the organization after propagations through training programs.

5.0 CURRENT TREND

In today scenario, there is a phenomenal growth in number of engineering institutions. One of the states in India (Tamil Nadu), which had around 10 colleges 15 years ago, today has over 250 colleges. Most of these colleges offer computer courses in B.E Computer Science, Info Tech., hardware engineering and Post Graduate courses including M.S., M.E., M.Tech and M.Sc. (IT) and therefore more than 2,00,000 engineering graduates per year are produced from a single state like TN or

AP. Leading software companies do their campus recruitment at 10% of these colleges and pick up not even 1 to 2% of the yearly pass-outs. Almost all the passed outs have to look of opportunities along with their earlier batches. Software industries in a lull period recruit less number of trainees/apprentices and look for experienced hands with at least 1-2 years of professional experience. One of the major reasons for unemployment among the fresh graduates in the software industries in HUGE-GAP prevailing in their current curriculum and practical requirements in the software-industries. In fact the Vice Chancellors from number universities, started emphasizing the immediate need to address this HUGE-GAP through proper Industry - Alignment - Programs as part of curriculum. This industry alignment program could be during the last year of their graduation or one year elongated on their final graduate degree (in similar line with Medical Profession). In order to bridge this industry requirement-GAP, every college/institutions should have their Project-tiE-uP (PEP) with different industries within their vicinities. This PEP program could be part of every department including computer science and should be coordinated (or controlled) by placement departments of the respective institutions.

Thus the PEP team of computer science under placement cell would be ideally rendering services to different industries by the way of providing manpower, carrying and project management activities. before carrying out the project execution plan, the PEP team should develop their trainees through methodical training program in order to win more projects with different industries.

Thus the educational institutions should interact with the industries/companies directly and involve/associate themselves with different categories of s/w companies like S/W solution developers, solution implementers, product-makers, maintenance-houses, product testers, version and release controllers, embedded s/w architects, etc. Based on the interactions, educational institutes should classify their students population into different groups in line with the software company categories.

6.0 CMM BASED SKILL ENHANCEMENT METHODOLOGY

We need to choose the right method of training in order ensure that the reach goes to the maximum possible extent within the framework of available resources and other practical limitations. CMM one of popular methodologies in the software industry advocates of covers training activity too under one of it's Key process Activities (popularly known as KPA - under level 3). As per this KPA, the following are the broad stages of training milestones:

6.1 IDENTIFYING TRAINING NEEDS AND ANALYSIS

Purpose and Scope

This procedure describes the collection and consolidation of various skills needed by the organization.

Procedure

Various training needs originate from

- Identification from emerging technologies
- Market trends

- Industry requirements
- Colleges/Institutions requirements
- Feed from alumni
- Obtain skills requirements.

Organizational/Institution Level

Identify the organizational goals, the barriers to achieving these goals, the high leverage areas to investigate for performance improvement. The specific skills needed by the organization and when those skills are needed is identified.

Project Level

Collect the requirements of the projects from industries. These skills requirements will be for existing and future projects.

Individual level

The individual needs are those identified at a staff member level either by the person or by his/her supervisors.

In all the three levels, the following types of training are considered for assessing the training needs:

- Role Based Training
- Software Management Training
- Software Engineering Training
- Application Training
- Support Function Training

Analyzing Collected Data

The general strategy for conducting training needs analysis is to

- Collect and analyze the data using a scale. This calibration is essential to the specification of the training to be later developed or purchased.
- Analyze the data and synthesize training recommendations.
- Identify, categorize and prioritize the various training needs.

Output

Training needs for the quarter.

Training plane calendar creation.

Purpose

To identify, document the objectives of the training program, training needs of the organization/institution, the training to be delivered and the tactical procedures for carrying out the training activities.

Scope

The scope covers preparation of quarterly rolling plan.

Procedure

Based on the identified training needs, a three-month rolling plan is prepared by student (or) Staff Development Coordinator (SDC). A detailed plan is developed for first two months and tentative one for the third month.

The plan is revised and changes are incorporated on monthly basis.

The plan is reviewed with the affected groups at the time of initial release and whenever major changes are made to it.

Availability of training material, internal faculty and resources are considered in priority, before opting for an external training.

If possible, training materials are re-used, with or without revisions, by internal faculty.

Output

Quarterly training plan

6.2 CURRICULUM/TRAINING PRODUCTS DESIGN

Purpose

The purpose of this document is to evolve a procedure for developing and maintaining the training courses.

Scope

The scope of this document is to give a broad framework to be followed when designing a course.

Procedure

The following activities are carried out as part of Training Course material design and development. The following tasks are carried out for internal training.

Determine Requirements

- Determine audience (job level, education, experience, prerequisite knowledge)
- Set educational objectives and map them to organizational objectives.
- Select media and materials (Slides, video-tape, audio-tape, exercises, textbook, case studies, mentoring tools for on the job training etc.)
- Consult subject experts on content and topics to be included and on instructor qualifications.
- Identify constraints (resources, date required, and delivery environment).
- Prepare financial estimates for development, delivery and maintenance.

Create Design

- Build architectural design to map training solution components to educational objectives, delivery medium, and means of learning assessment.
- Build detailed design for each component, the content outline, learning objectives, learning assessment mechanism, bibliography, associated reading and exercises.
- Determine packaging of instructional materials.

Build Product

- Implement design by creating planned instructional material.
- Overhead Transparency should clearly mention the course title, version in the header. In the footer the organization name, location (in abbreviated form) and the page number should be mentioned.
- Conduct a test offering (with participants representative of the intended audience) or a review of the course for consistent quality, general impression, usefulness.
- Evaluate the test offering by summarizing key issues and discrepancies and by assessing student learning.
- Respond to test evaluation by changing the materials, the planned delivery approach as appropriate.

Changes to training course materials are reviewed and authorized. The training course is identified by version control.

Generate Training Product Specification form TP05 is created.

Output

The developed course materials are available.

6.3 NOMINATING PARTICIPANTS

Purpose

The purpose of this exercise is to nominate participants for a training program.

Scope

This procedure describes all the major activities and issues related to nominating participants for a training course to be conducted.

Procedure

Nominations to PDP

- The coordinator will announce the schedule of specific courses, the pre-requisites needed and invite nominations from PM/PL.
- The coordinator will announce the monthly training schedules (and the pre-requisites for each course) on notice boards and invite nominations from staff forwarded through PM/PL.
- The coordinator will finalize listing the participants to attend a program.
- All confirmed participants will be informed before the start of the program, either formally or informally.
- The coordinator may intimate a brief profile of participants nominated to the faculty.

Output

List of Nominees for the training program.

Updated Skill Database

6.4 CONDUCT OF TRAINING AND FEEDBACK COLLECTION

Purpose

The purpose of this exercise is to:

- Organize and conduct training programs.
- Evaluate feedback of the participants and faculty.

Scope

This procedure describes all the activities related to organizing, conducting, evaluating and reporting of the internal programs.

Procedure

- The coordinator will announce the schedule of specific courses, the pre-requisites needed and invite nominations from PM/PL.
- The coordinator will announce the monthly training schedules (and the pre-requisites for each course) on notice boards and invite nominations from staff forwarded through PM/PL.
- The coordinator will finalize listing the participants to attend a program.

- All confirmed participants will be informed before the start of the program, either formally or informally.
- The coordinator may intimate a brief profile of participants nominated to the faculty.

Evaluate Participants' Performance

The faculty will evaluate the participants' performance with regard to their overall learning and fulfillment of the course objectives TP08.

Evaluate Feedback

Student (or) Staff Development Coordinator (SDC) will:

- Compute the summary for each of the factors in the feedback forms (TP08, TP09) and summarize the qualitative component of the feedback.
- Discuss the faculty feedback and the participants' summary feedback with the concerned faculty and identify the follow-up action points.
- For each program, SDC will put together.
  Participants' Attendance (TP06)
  Participants' Feedback (TP08)
  Faculty Feedback (TP09)
  If the training is arranged from an external agency, then the SDC collects the participant's attendance sheet, participant's performance and participants feedback form at the end of the training and prepares the course completion report.

Output

Course Attendance Sheet

Waiver forms if any

Participant's Feedback

Faculty Feedback

6.5 TRAINING EVALUATION AND TRACKING

Effectiveness of the training program in fulfilling its objectives is assessed.

The status of training activities is tracked using training development milestones, course offering dates, budget data staffing profiles etc. The training attendance levels and approved waivers are indicators of the growth and decline of training needed on particular topics which may trigger the relocation and resizing of training resources for future work. These measures may also indicate erosion of management commitment to the training program thus triggering further communication with managers or promotion of the training program.

It is appropriate for the training group at the organizational level to consolidate the status data from other training groups within the organization and report on all training activities to senior management. The training group's mission is to make the efficient delivery of training, eliminate redundancies and present recommendations for improving the training capability of the organization.

Kirkpatrick Model is used for evaluating the quality of the training program. It has 4 levels.

Level 1. Reaction: Participant opinions regarding the training, the processes and outcome to know the level of participant satisfaction. (Participant's Feedback).

Level 2. Learning: The extent to which learning took place during the training. Achievement of skill and knowledge objectives. (Faculty feedback, Participants' performance).

Level 3. Behavior: Changes in actual on-the-job performance. Transfer of learning to work setting. The employees' managers evaluate their effectiveness after training or track the employees' career to make a comparison of those who had the training and those who did not.

Level 4. Results: Positive effects of training on the organization whether training contributed to the organization's making progress towards meeting its strategic goals. Improvement in quantity and/or quality of output, cost savings, profit, etc., is tracked.

Records Maintenance

Purpose

Data related to conduct and effectiveness of the training is collected for maintenance. Attendance and waivers are recorded and analyzed. The maintenance report is kept updated with the information about the training hours, number of participants, start date and faculty for the training, conducted in the month.

Scope

This report summarizes the information about the training courses, seminars conducted during the month and the training courses, seminars planned for the next month and metrics.

Procedure

The coordinator will do the following.

- Consolidation of Training conducted.

Maintenance of the following records for a minimum period of one year

- Training Request Form - TP01
- Training Plan - TP02
- Faculty Evaluation Form - TP03
- Evaluation Report of Training Institute - TP04
- Training Course Specification Form - TP05
- Course Attendance Sheet - TP06
- Participants Feedback Form - TP08
- Faculty Feedback Form - TP09
- Supervisor's Feedback Form - TP10

Output

Training Records

7.0 CONCLUSION

In the last decade, Multinationals (MNC's) have brought-in a revolutionary change in Indian industries including software. MNC's have pushed technology at the pace beyond imagination, changed the game of competition and broken monopolies, introduced new practices, and in short-shaken the Indian market and economy.

Today productivity is the name of the game and productivity measures are changing. Introduction of Technology is bringing the transparency in operations. People are not able to cope up with the pace to Technological advancements, hence causing threats of being obsolete. People are almost becoming desperate about picking up new technology and trends. Technology has definitely

enhanced the efficiency. Technology has built the base for being still more effective among our youngsters. But the technology in particular Software industry has been growing phenomenally. Unless efforts are made to impart knowledge on technological advancements through Organized Training Program, it will be impossible to catch up the fast-growing technologies. The only thing that has become constant is 'Change' and the only way (& perhaps the right way) to achieve 'this' is through proper Training Program.

Training is an ongoing process and therefore continuous efforts are required to improve or enhance the software engineering skills of system engineers through quality technical education and training. It is true at the individual level, companies' level and institutional levels too.

REFERENCES

Dr. APJ.Abdul Kalam - Vision India 2020.

Capability Maturity Model - Software Engineering Institute - TR25 Documents.

Nasscom Reports on Software.

Kirkpatrick Model on effectiveness on training programs.

United States software industry requirements (industry trends for a period of 1 year).

ISO - 9001:9000-2 (Clauses applicable for software industry).

Engineering Education and Industrial Production
A Convergent System Approach

V. JOB KURUVILLA and B.MUKHOPADHYAY

INTRODUCTION

Advent of privatization of higher education in our country has thrown the Engineering Education in a spin. An exclusive domain of a few high academic performers, (hither to nurtured by Government), is becoming mass based and commercially oriented. Affordability is becoming more a criterion for entry, than Aptitude. Quality is secondary to Quantity. The old stigma on Brain drain is no more an impediment, when a globalized job market dominated by MNCs gobbles up our best Engineers from top Institutions like IIT and REC. Our domestic Industry takes it cool because they cannot attract these talents with out substantial investment in Research or Innovative technologies. The Net result is that a large number of fresh Engineers, mostly from the new Private Engineering Colleges find themselves jobless or under employed.

There are three aspects to this problem:

1. Does the Indian Economy need 75,000 Engineers annually?

2. Should the society continue to have a system which produces engineers having better monitory resources than intellectual resources?

3. Is it possible to reduce the erosion of quality of engineering education, even in mass production, so that the engineers are employable?

The first problem is a complex one. Statistics reassures us that the growing Indian economy will need such large numbers of engineers. The second issue regarding poorer section of the society being deprived of the Engineering Education. The answer to this will be based more on our own value judgments, about what is good and what is bad for the society, - a part of Normative Economics. In this paper, we are confining ourselves to the third problem: How quality of engineers can be maintained in a mass production Engineering Education system.

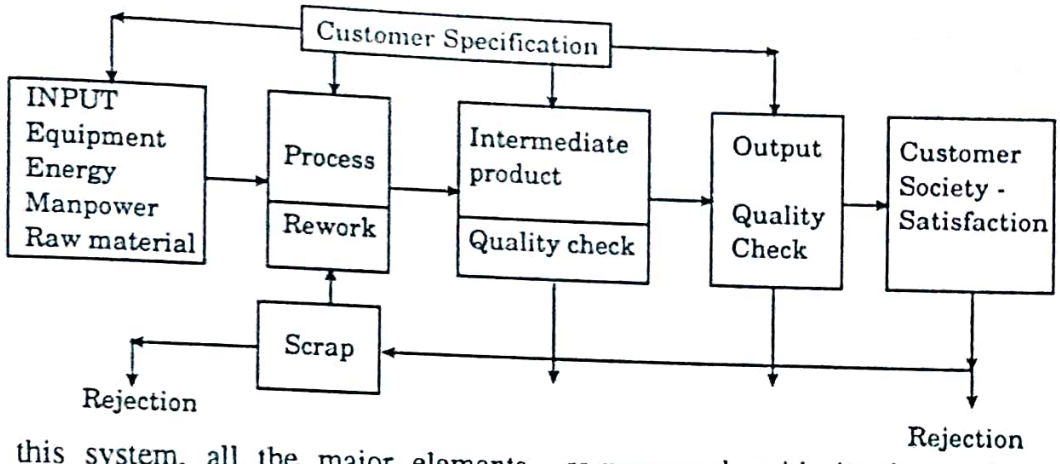
II. ANALOGY BETWEEN MANUFACTURING AND EDUCATION SYSTEMS

It may be pointed out that mass production is a term borrowed from Manufacturing Technology. Henry Ford introduced the concept in 1907, and his assembly line alone threw Americas Industrial revolution into over drive. In mass production, the demand rate and production rates are almost equal. It is the continuous manufacture of identical products, like an automobile. In

modern manufacturing mass production system, the production skill has been transferred from the operator to the machines, with built in Quality assurance devices. Now, the Engineering education is almost similar: A college with almost 2000 to 2500 students, a class room packed with 60 to 90 students, and all students passing over the learning conveyor system, with periodic examinations, filtering for quality standards! Keeping this analogy in mind, a system approach will enable us to understand, the factors that make the mass manufacturing system a success and the Engineering Education system almost a failure.

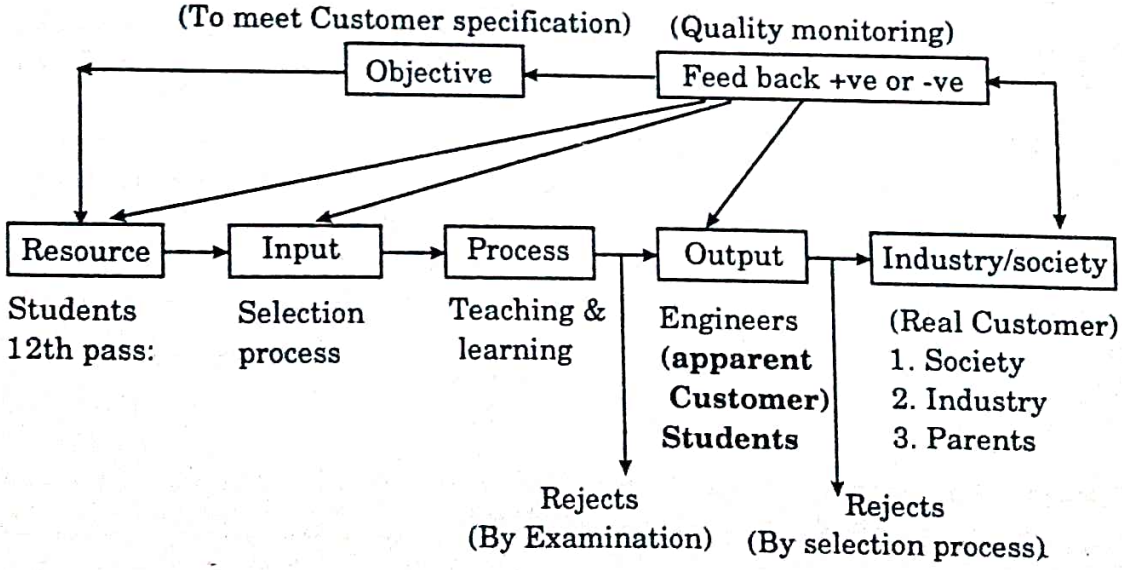
Conceptual ideas of the two systems are bought out in the following diagrams:

A. MANUFACTURING SYSTEM



In this system, all the major elements like input, process, intermediate products, and finally the output are according to predetermined specifications and any out of specification products are either rejected or re-processed, with in the system as per set standards, or by any chance such products reach the customer, and does not satisfy him, he rejects it, by switching over his favor to a competitors product.

B. ENGINEERING EDUCATION SYSTEM



In the above model, resource or raw material is the vast pool of students passing out from 12th standard of various streams, like State Boards, CBSE, ICSE, etc. The real input is based mostly on marks obtained in these examinations and, or, result of a Competitive examination different states adopting different standards. In addition, various types of reservations, based on caste, place of birth, region, backwardness, etc., add on to the selection criterion, mostly to dilute the minimum standards otherwise set. All these factors result in a highly heterogeneous input with which it is difficult to design a common standard of teaching and learning process. The faculty is always confronted with the problem: what should be the bench mark for the teaching and learning process, should it address to the minimum standards of the students in which case the brighter students are pulled down, or should meet the requirements of the higher standards of academically brighter students, in which case others are left out. Often, the standards of the lower layer is taken for the taching process, because, the faculty is evaluated on the examination results and not on Cognition aspects like effective knowledge transfer. Hence, the output of the system is taken as the students themselves, with evaluation standards like pass percentage. In this system, the interest of the actual customer viz., the Industry/society is ignored. And mostly the rejection process happens outside the Education system, by rigorous selection process adopted by the industry and not inside as it should be.

Engineering Education

The table on comparative study of clearly indicates the similarities and

Table : 1 Comparative Study of the Two Systems

Sl. No.	Features	Manufacturing System	Education System	Remark
1.	Resource	Raw material, energy, manpower, etc.	12th std students	Students are of different standards
2.	Input	Based on acceptable, measurable parameters, so homogeneity can be assured	Only min. in qualifying mark, other parameters, like aptitude, mostly ignored	Marks are variable for different sections
3.	Process	Process parameters maintained by built in quality standards	Non-standard teaching and learning methods	Wide variation in staff and student standards
4.	Intermediate product	Quality checking in different stages of production possible	Done semester wise in 4 stages (years), mostly, by written examination, checking min standards	Ineffective quality assurance in education system
5.	Apparent customer	Quality assurance department	Students and parents	Students themselves are not aware what they want
6.	Actual customer	Industry / Society	Industry / Society	National wastage, due to high rejection and training cost of industry
7.	Quality systems	Rigorous, inbuilt, reliable, standardized	Only exam system, highly unreliable	Results in unemployable engineers

differences of the systems. An Industrial product will remain unsold if it does not meet the quality standards, and specification, drawn based on customer requirements. Our Engineering Educational system churns out products, without any drawn out program on quality, decided by the needs of the customer.

Two things are axiomatic: The student is not the ultimate customer in the above model, the end user is the Industry, the activities of which ultimately benefits the society. The Student is one of the Intermediary links. Often we consider the student as the customer, hence most of the evaluation systems in Engineering Education are student oriented. The Examination system is considered as a Bench mark for evaluating the students as well as the teachers performance. We know to colleges, where pass percentage is considered as a major criterion, for staff performance. Hence for improving the performance, faculties force the students to mug up answers of possible university questions so that their performance is excellent. There is also wide disparities between the internal assessment marks between engineering colleges as no standard norms are fixed. So examination results as a Bench mark for evaluation of the education has resulted in distorted quality assessment among the students. Consequently, the industry relay up on their own selection process to weed out the sub standard candidates. Sometimes students with less marks, but with better aptitudes are ignored by the industry because they may not fall within the high cut off marks put up by them for their selection process.

III. A CONVERGENT VIEW OF THE TWO SYSTEMS

With so many factors common to the manufacturing and educational systems, it is possible to take a convergent view of the two systems and explore the possibility of adopting some of the tools successfully employed in manufacturing system for quality improvement of engineering education.

It is well known that in any manufacturing process, where mass production is employed as a means of production, quality assurance is ensured by building into the system, methods of avoiding defects rather than employing inspection as a means of weeding out bad from the good. Remember the postulates of Philips S. Crosby, who pioneered ZERO defects, and proved that Quality comes free. Considering the fact that, an Engineer will be spending nearly Rs. 2.5 lakhs for a 4 year course in Engineering, and if he is disabled to do the job expected out of him, the National wastage in Human Resources can be estimated as Rs. 1250 crores annually, a colossal waste!!. (Assuming 50,00 engineers coming out annually in India are non productive, because of low quality education they receive, and/or they are not competent to take up an engineers job because of their intrinsic professional weakness).

So accepting this as a reality, let us examine whether we can RE-engineer the existing system to meet the requirements of the society, i.e. to produce engineers who can generate wealth for the country, which will take us to a technology driven economy.

IV. APPLICATION OF ENGINEERING QUALITY ASSURANCE TOOL TO EDUCATIONAL SYSTEM

As mentioned earlier, any mass production system should have in built quality assurance methods to ensure that wastage does not occur. Is it possible to incorporate such a system in education? It is a very elaborate subject to deal with. So in this paper only one method, typically employed in Industry for quality assurance is discussed to bring out the relevance of applying such tools, in education. The chosen illustrative method is Fish bone diagram.

CAUSE & EFFECT's DIAGRAMS or ISHIKAWA or FISH BONE DIAGRAM build on Brain Storming, that is, a through dissection on factors which has a direct bearing on observed results. This is a very effective tool in identifying root causes of problems with a systematic approach.

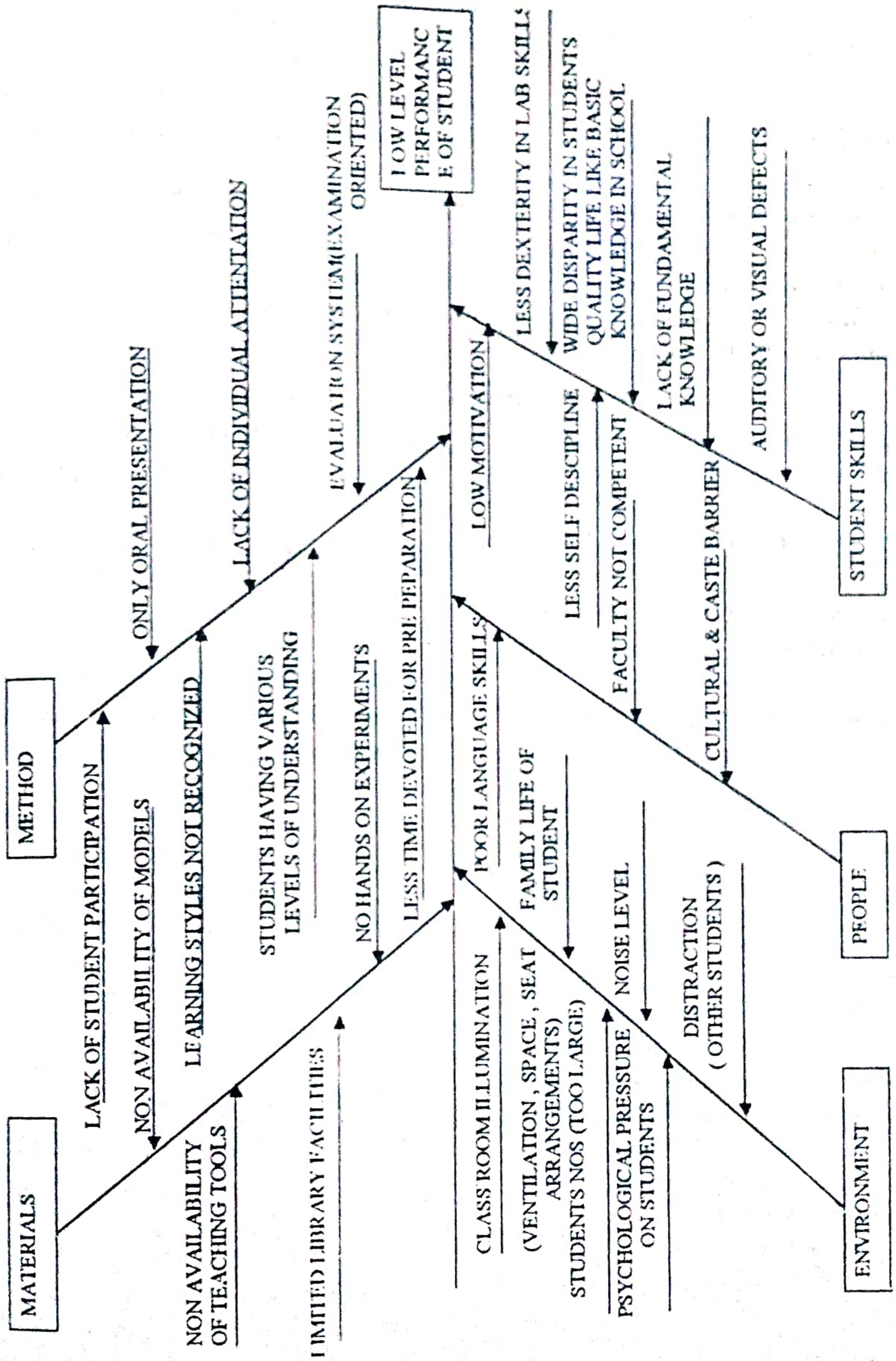
ISO 9000, in Educational Institutions and Accreditation standards have tremendously transformed many of our Institutions to higher levels in terms of infrastructure and faculty standards. But, unfortunately, these steps have not improved the quality of the products to the desirable levels. The main reason is that the teaching and learning methods of these institution have more or less remained unchanged. The teaching is mostly lecture oriented and evaluation systems, examination oriented. Here again the needs of the ultimate customer, viz. the industry is ignored.

V. CONVERGING THE TWO SYSTEMS

Should our technical education curriculum continue to be SERVE ALL type of customers (industry) rather than SERVE only chosen field of CORE AREAS, based on competence?

At present those joining the B.E. course in any particular branch will have to go through the whole array of subjects, prescribed in the syllabus. The number of subjects they study is almost 48, and as the semester progress the complexity of subjects also increase, and mostly so are the arrears. Mathematics is a very typical example, all students go through the drill of studying complex integration, like Cauchy's residue theorem, contour integration, Bounty Value problems for partial differential equations etc. the whole lot most of the engineers never come across in their professional life. May be only a few, who take up research work would use it, but why trouble the majority, who could not digest it, be made to forcibly mug it up, to be forgotten for ever? Can their time be spent on other areas where they have more aptitude and desire to learn? Definitely this is possible. Our Engineering Curriculum should have two streams, one catering to the needs of the research oriented industry where innovative work is considered the basic need, and the other stream good for industries focusing on practical engineering problems. Students having an aptitude for understanding the intricate technology through the looking glass of mathematics can choose the first option, and those with less faculties in mathematics, but better capabilities in logic and reasoning, can choose the second one, one should not be considered superior to the other, but can be streamlined based on the needs of the industry. Then, the engineers will be employable and the industry will not be left with the difficult procedure of choosing people by a selection process which itself may not be fool proof.

Fish Bone Diagram



Engineering education will become more meaningful and satisfying for those students who have taken up engineering, perceiving it as a practicing science.

VI. CONCLUSION

At present, engineers are being mass produced without any stress on quality and customer need, the customer being the industry. Since the manufacturing system has proved its efficacy, by built in quality assurance means, it will be advantageous, if such tools can be modified and used in education system also. It will be a good practice to apply the tools for quality assurance to the education system also to make sure that quality is maintained in production stage itself rather than afterwards. This will reduce the Human Resource wastage considerably. A typical application of fish bone diagram explains how such an approach can be made successful in making the education system also quality oriented like the manufacturing system.

REFERENCES

Jenkins, Lee, 1995 "Improving Student Learning".

Deming, W.E, 1986 "Out of the crisis".

Deming, W.E, 1992 "The New Economics for Industry Education and Government".

Gardner, Howard, 1983 "Frames of Mind : The Theory of Multiple Intelligences".

Hanrad, S., 1987 "Psychological and Cognitive Aspects of Categorical Perception".

BS EN ISO 9000-1 : Selection and use, QA Designs.

Bergman, B and Klefsjo, B, 1994 "Quality from Customer needs to Customer satisfaction".

Outline of Mechatronics Eduction for Technicians

S. MANADAL

1.0 INTRODUCTION

In our everyday life we come across many systems such as autofocus cameras, cars, robots, CNC machine tools, washing machines, etc., which use microprocessors as controllers and have electrical sensors extracting information from the mechanical inputs and outputs via electrical actuators to mechanical systems. The term mechatronics is used for this integration of microprocessor control systems, electrical systems and mechanical systems. These mechatronic system is becoming more complicated day-by-day due to its interdisciplinary nature and aggressive customer demands for additional features. Normally the operation and maintenance of these mechatronic systems are done by high level technicians. As these systems involve knowledge and skills of interdisciplinary nature, the training in conventional engineering disciplines is not sufficient. In the present work an outline of mechatronics education is proposed for special technicians.

2.0 NATURE OF MECHATRONCIS

Mechatronics is the synergistic integration of precision mechanical engineering, electronics, intelligent control, and systems thinking in the design of smart products and processes [Siegwart, 2001]. The key element in mechatronics is the integration of these areas through the design process. With the passage of time the new technologies cannot be partitioned according to conventional disciplines and further that important innovation often stem from the interaction of several previously unconnected streams of scientific and technological activity. The dynamics of research and technology can be explained as a science-push cycle followed by a demand-pull cycle, a process that is non-linear and requires efficient feedback and interaction.

3.0 EVOLUTION OF MECHATRONICS

The term "Mechatronics" was first coined by a Yaskawa electrical engineer in 1968 [Kyura and Oho, 1996]. Trademark rights were granted in 1972, and the term became popular with widespread use. In 1982 Yaskwa released all right pertaining to the trademark. In early part of 1970's mechatronics was defined as the combination of mechanics and electronics. Systems with servo technology such as automatic doors, vending machines, auto focusing cameras, automatic vehicle controls, and so on, were considered mechatronic systems. In the 1980's information technology utilizing database enhanced the capacities of mechatronic systems to develop more sophisticated systems such as NC machines, robots, automotive engine control systems, washing machines etc.

In the 1990's the communication technology brought further development by connecting conventional mechatronic products by a communication network to show higher performance in the global sense.

4.0 MAIN AREAS OF STUDY IN MECHATRONICS

Until recently most engineers have been trained in one very specific discipline. Today's product designers need a more interdisciplinary education and knowledge in systems design. Pure mechanical or electronic products almost do not exist any more. Product design has become much more interdisciplinary, thus interdisciplinary thinking and design has become a key competence for successful engineers and technicians. Emphasis is placed on physical understanding rather than on mathematical formalities. The key mechatronics areas of study are:

(i) mechatronic system design principles

(ii) modeling, analysis, and control of dynamic physical systems

(iii) selection and interfacing of sensors, actuators, and microcontrollers

(vi) analog and digital control electronics

(v) real time programming for control.

5.0 SKILLS NEEDED IN MECHATRONICS

The key to success in mechatronics is a balance between two sets of skills

(a) Modeling (physical and mathematical) analysis (closed form and numerical simulation) and control design (analog and digital) of dynamic physical systems

(b) Experimental validation of model, and analysis and understanding the key issues, in hardware implementation of designs.

6.0 SHORTCOMINGS IN THE PRACTICING TECHNICIAN ENGINEERS

As the engineering systems become larger and more complicated, technicians need insight to see the important role of mechatronics by systems analysis and integration. It is a practice - based technology unlike any other technology. There is a lot of products in the market requiring the modern technology of mechatronics for a higher performance and human friendly interface. Some observations regarding practicing engineers and technicians [Craig, 2001] are as follows.

(i) Control design and implementation is still the domain of the specialist - Most technicians have had never practiced designing and implementing a controls system as part of a design.

(ii) Very few engineers perform any kind of physical and mathematical modeling - Technician engineers are under such pressure to deliver hardware that they do not get time to model and develop physical insight

(iii) Mathematics is a subject that is not viewed as enhancing one's engineering skills but an obstacle to avoid - Technicians use computer programmes without any understanding of the underlying physical and mathematical principles involved because they view

physical and mathematical modeling are not very useful.

(vi) Very few engineers and technicians have balance between analysis and hardware essential for success - Engineering education system cut costs and rely more and more on computers to perform victual experiments.

7.0 FOCUS OF MECHATRONICS CURRICULUM

An excellent understanding of the basic technologies (building blocks) form the foundation for mechatronics education. However, system design and integration, teamwork, and creativity (bonding blocks) are additional, highly important issues for successful product design and innovation. Whereas the educational concept for the basic technologies are already established, the bonding knowledge is probably not all as well understood and not as easy to teach. The typical building block courses of mechatronics curriculum are:

(i) elements of mechatronic systems

(ii) physical effect and its applications in mechatronics

(iii) basic electrical circuits, sensors and actuators

(vi) architecture and design of controller

(v) control and artificial intelligence

(vi) microprocessor systems, real-time digital control.

The bonding blocks should include:

(i) mechatronics design, tools, and approaches

(ii) creativity, innovation

(iii) project management, team work, communication, controlling.

8.0 LEARNING ENVIRONMENT

In the study of mechatronics the focus has to be kept on the role of the key mechatronic areas of study in the overall design process and how these key areas are integrated into a successful methatronic system design. Emphasis should be placed on interactive learning through:

- student-team formation in the lectures and the discussion of design-related issues
- hands-on laboratory exercises, both in class and laboratory, involving industrial, off-the-shelf hardware
- computer-aided design involving the latest electronics simulation and control design software
- the encouragement of critical thinking throughout the courses

The practical training may be given through the following laboratory exercises:

(i) Analog Electronics

(ii) Digital Electronics

(iii) Microcontrollers

(vi) Stepper motor control

(v) Thermal system closed-loop control

(vi) Pneumatic servomechanism

(vii) DC Motor closed-loop control

(viii) Magnetic levitation system.

9.0 CONCLUSION

The basic approach of mechatronics education is experiential learning, in other words, it is "learning by doing". Students should have some basic kits of mechatronics and they should apply their theoretical knowledge to add their own sensors and actuators and by writing "intelligent" real time software, and should design and build autonomous mechatronic system. This process can be further stimulated by organizing contests between different project teams of students. It helps the students to get a deeper understanding of the theory and motivates them to apply knowledge.

REFERENCES

Siegwart, Ronald (2001). "Grasping the Interdisciplinarity of Mechatronics" IEEE Robotics & Automation Magazine, 8, 2, 27-34.

Craig, Kevin (2001). "Is Anything Really New in Mechatronics Education ?" IEEE Robotics & Automation Magazine, 8, 2, 12-19.

Kuyra, Nobuhiro and Oho, Hirosuke (1996). "Mechatronics -An Industrial Perspective" IEEE/ASME Transactions on Mechatronics, 1, 1, 10-15.

Intellectual Vs Emotional Factors in Human Behaviour

B. MADHAVAN

Nowadays there is lot of hype and attention on the "Latest and Dramatic developments" in the field of Organizational Behaviour - viz., the all powerful instrument of "EMOTIONAL INTELLIGENCE" which can predict success at career better than any other "conventional tool". What is this about?

Let us consider the following, simple phenomena in behaviour and try to place them "True of False."

1. Mr.A is an intelligent student; therefore he has to be successful in his career.

2. Mr.B is a very senior judge. Therefore he is free from anger and hatred.

3. All employers assess their subordinates based on work alone.

4. Mr.C is the senior most, super skilled draftsman in the department, who can draw and design precision engineering components - and therefore he should be promoted from his present workman cadre, to become an officer to look after the work of 25 such draftsman. He will be highly successful.

5. The best bosses are those who have only task-oriented, business like relationships with their office colleagues - without any place for personal feelings.

6. Mr.D is a scholarly professor. Therefore he will clarify all the doubts of his students.

On a plain reading of the above, even a commoner will say it is not possible to give clear cut answers of true or false. Even to analyse them on relative terms, it is clear that we require more data. But that's hardly the idea of this paper.

What is more, we don't even seem to have the correct expressions and standards to comprehend - much less debate on such postulations. It appears that a different thinking process is required to gain insight into such questions. Well, there is an underlying concept or principle behind all these, which is required to sit it, so to say and thrash out the issues raised above. This article sets out a simple but profound theory about human nature, which would equip us with a proper orientation while we encounter issues like the ones stated above. That's the idea.

The Theory is certainly not new. It was propounded in its original form, in the 1940s by Sigmund Freud in and is known as the Psycho-Analytical Theory. Freud is a great German psychologist who gave the subject the status of an organized and scientific body of knowledge and is known as the Father of Modern Psychology. Great refinements have

been made to the Theory and continuous research is going on even today. What the Theory means is set out below and for ready understanding, professional jargon is avoided. According to this Theory, the human mind is composed of 3 distinct aspects-

1. The intellectual side
2. The emotional side and
3. The ethical side

Some underlying truths about these are required to be known in order to appreciate the contribution of each one of these blocks to behaviour. For the sake of more convenient perspective, we shall consider only intellectual and emotional sides and leave out the third block.

1. The properties of any one side do not automatically make an impact on the remaining two, most times.

2. In a normal human being, it is the intellectual side that is developed and pampered throughout life. Right from basic Mathematics & English up to knowledge of the latest technologies relating to space, nuclear technology, cyber applications - it is all on the intellectual side. **However it has no direct correlation with the emotional level of the person.**

For e.g Mr.Edward, a Professor, is a great authority in Bio-Medical sciences; but supposing a student argues a differing view point in the class room, how he would handle the situation, is largely determined by his emotional content. No doubt, he has the intellectual inputs to clarify the doubt - but it is also possible that he might simply get angry and dispose of the matter without clarification. That depends not on his intellectual abilities but on his emotional balance.

To quote a more down to earth example, a chronic smoker knows that smoking is injurious to health (knowledge input) but unless he has the emotional strength he won't be able to quit smoking.

To cite yet another example, let us take the case of twin girl children about six years in age who are born and brought up in the same home in the first floor of an apartment structure, growing up in the same environment

Intellectual side	Emotional side	Ethical/Moral
Abilities like	**Feelings like**	**Convictions On**
(i) Intelligence abilities (measured in terms of IQ or intelligence quotient)	(i) Love/Hatred	(i) Sin/Virtue
	(ii) Hope/Despair	(ii) Wrong/Right
	(iii) Courage/Fear	(iii) Bad/Good
(ii) Analytical abilities	(iv) Ambition/Desolation	(iv) Paapa/Punya
(iii) Factual abilities	(v) Faith/suspicion	
(iv) Empirical abilities	(vi) Sympathy/Aner	
(v) All knowledge abilities	(vii) Sensitivity to praise/ criticism	

etc. The parents bought for them similar pair of dresses for the Deepavali. One child came down from the stair-case wearing the dress, and the lady living in the downstairs apartment made a damaging criticism of the dress saying it looked cheap. The child rushed upstairs crying and threw down the dress on the floor and cursed the parents. As the example goes, the second child came down wearing the dress, the jealous lady downstairs made the same remarks and the child responded "OH!.. you think so ... I don't think so !!..." and went out for playing. This portrays the difference in the emotional factors of the two kids-the particular variable involved being, "sensitivity to criticism".

3. The emotional side remains largely unattended from childhood. An average person is left to learn by a series of unplanned moves, some of them could be accidents. A person's emotional content given to him by birth remains largely unchanged. For example, there is no syllabus / class room to make a child any bolder in the face of opposition or any kinder when he sees suffering of others. Only some factors like friends, the school, and the immediate family, turning points in life, mentor, etc make a dent in this area.

4. Intellectual side should be strong to do well in academics but without emotional stability job he will not progress in career.

5. Intelligence is required to earn a job, like ability to earn high scores in tests & interview etc., but emotional strength is required to keep the job.

6. Intelligence is required to earn money (like patenting a new idea or inventing a new product etc.) but emotional composure is required to enjoy that money.

7. The basic point to remember is that the intellectual and emotional sides largely function as independent variables in a man's total personality. They require to be cultivated and developed with specialized efforts catering to each side separately. The same goes true for the ethical side also.

8. The best persons/leaders/ sub-ordinates are those who are well developed in all the three sides. Particularly in work situations it is necessary to blend the intellectual and emotional applications quite well, in order to be successful in career and also have high quality of life on the whole.

The latest trend in many Multi-National Companies is to measure the emotional balance of a person which will reveal many attributes about the ability of the candidate to work successfully. However if the employers were earlier emphasizing on intellectual factors to the total absence of emotional factors, the current trend seems to take for granted EQ (Emotional Quotient) as a "cure-all". Therefore it is necessary to have a proper perspective about these sides of human nature and their relative importance to organizations. Any skewed emphasis on one area to the detriment of the other area could lead to defective results.

Motivation Training Programme for Entrepreneurship Development

R.RAJENDRAN

INTRODUCTION

Entrepreneurship is purposeful activity indulged in initiating, promoting and maintaining economic activities for the production and distribution of wealth.

Also, entrepreneurs performing a vital role in our national economic development using their inner potentialilities such as: knowledge, ability, skills and motivation. The motivation play an important role both the entrepreneurs and the trainers to initiate entrepreneurship. To inculcate the knowledge to the beneficiaries, a large number of EDP trainers called "motivators" are trained significantly to expand the Entrepreneurship Development Programme.

The present study is focussed on the direction towards the motivational aspect of entrepreneurs to initiate and acceptance of the programme. As the human being as an active agent in the process of economic development there is a need to study the drive part of an individual to transform resources into profitable output. The motivated aspect of the entrepreneurs such as: ability to perceive economic opportunities, generating capital, recruits manpower, establishing relations with the suppliers, customers and governmental agencies.

MOTIVATION

Motivation refers to the inner drive that ignites and sustains behaviour to satisfy needs. The human behaviour is goal directed and satisfying bodily and social needs. Motivation implies also an inner state that causes a person to act towards the attainment of goals. It is an inspirational process of steering an individuals inner drives and actions towards attainment of desired goals. It is also an on going process as human needs are never completely satisfied.

Moreover, this motivation can be both positive and negative. Positive motivation occurs when a person is inspired to act for earning some records and benefits. For example, an entrepreneur who sets up an enterprise to gain prestige and power is called "positively motivated". "Negative motivation" arises from fear of failure of frustration. The negative motivation occurs when a person could not success in setting up his own enterprises.

ENTREPRENEURIAL MOTIVATION

It may be defined as a set of motives such as: high need to achieve, moderate need for power and affiliation which reinforce the people to set up and run the enterprises. It is highly imperative of other behavioral dimensions such as: tolerance for ambiguity, problem solving capability and creative potential (divergent thinking).

Motivational Factors Responsible for Entrepreneurs

An exclusive study conducted by Sharma (1987) and the identified the factors to motivate the people to start business enterprises. They are:

Internal Factors:

(a) Academic background of the individual

(b) Total occupational experience

(c) Desirability on using innovative business

(d) Desirability on independent business

(e) Family support and background experience

External Factors

(a) Monetary assistance from the State/Central Government.

(b) Financial support from various agencies/institutions.

(c) Availability and usability of technology.

(d) Availability and usability of raw materials.

(e) Moral support or encouragement from other business units:

(f) Healthy demand for proposed product

Motivational Characteristics of Entrepreneurs

Though the internal factors constitute the personality characteristics of the entrepreneurs, it directly help them to adopt the entrepreneurial activity. In order to fulfil one's own motive. It should be partially supported by the environment (external factors).

In most of the time, the entrepreneurs are uses of their human resources in a creative way to start innovative business. When they introduce a new product in the market, it fulfil their needs and wishes and it directly provide employment opportunities to resourceful young men and women. It improves the economical conditions of the state.

One's own familarily of the products and knowledge of the market helps to improve the motivational level to the aspirants. It is to mention that the strongest motivator is the financial resources. The external factors of this type which include: availability of surplus funds, using sick units available at a cheaper rate, success stories of first generation entrepreneurs, support from friends and relatives etc.

Other motivational factors such as: loss of job, death of family members, dissatisfied with present job etc., can motivate the people to launch their own industries.

Need for Testing Motivational Level

Many research studies have conducted and revealed that everyone cannot be trained to become an entrepreneur. There is a need to assess their motivational level by using various psychological methods such as:

(a) Objective methods

(a) Subjective methods

(a) Protective methods

Apart from these, one should be tested on their cognitive potentials such as: Intellectual and creative abilities. Overall, one can assess the successful entrepreneurs by using effective psychological testing.

Need for Achievement Motive in Entrepreneurs

The essential components of successful entrepreneur is the high need for achievement motivation. Psychologists have reported that

achievement motivation can be developed through an effective training. Moreover, one's own ambition in the life is the lower of all motives to achieve desired outcome (success).

The psychologists are widely used the Thematic Apperception Test (TAT) to assess the need for achievement. The test presented an ambitions picture and trainees are asked to interpret it. The achievement related themes mentioned by the trainee are then counted. The final score indicates the trainee's desire for achievement.

Behavioral Characteristics of Entrepreneur

As the entrepreneurial behaviour is the manifestation of what a person thinks, feels and acts, one should know the behavioral pattern of entrepreneurs:

1. He should be a creative potential
2. Ability to carryout self-actualised needs such as: new product, new sources of raw material, market coverage, etc.
3. To achieve goals, he feels emotionally attached to his work.
4. He should be active and alert
5. He looks for more challenging in his jobs.
6. Effective use of time.
7. Coping with occupational stress.
8. Good communication skills.
9. Good in decision making
10. Good in human relations with others.

Further, the personality studies were evidenced that the distinguished personality traits of entrepreneurs such as:

(a) Self-confidence
(b) Creativity
(c) Persistence
(d) Calculated risk-taking
(e) Need for achievement
(f) Initiativeness
(g) Individuality
(h) Good leadership quality
(i) Optimism
(j) Looking for challenge in their job.

Importance of Achievement Motivation Training (AMT) or Entrepreneurial Motivation Training (EMT)

The motivational training for entrepreneurs is the essential components for entrepreneurship development. In training, a special labs are arranged to asses the achievement motive of the trainee. The labs provide experimental and experiential learning situations which in turn help the trainees to examine their attitude and modify them.

REFERENCES

Gupta, C.B. and S.S Khanta (1996). Entrepreneurship and Small Business Management. Sultan Chand & Sons, Delhi

Morgan Clifford et al. (1993). Introduction to Psychology. Tata Mc-Graw-Hill Publishing Co. Ltd.

Sharma, R.A (1980). Entrepreneurial Change in Indian Industry: Sterling Publishers, New Delhi.

Throwing More Light on Magic Squares

BENJAMINE E. ONWUKA

This paper addresses the natural relationship between the real numbers and magic squares through certain types of matrices and symmetric groups. These matrices are such that when entries are selected once from each row and column and summed, a constant results can be obtained. Three types of such matrices are (i) n^2 consecutive terms of a linear sequence entered serially row wise into an n by n matrix (ii) numbers formed by a matrix of pairs of points in a simple space say of two tosses of a fair retrahedron (iii) a square matrix with differences between all the corresponding entries in any two adjacent rows or column constant. Magic square algorithm can be applied to any of the types in 8 orders based on the vertices of the square matrices. When this is done, an odd order matrix of the 1st and 2nd types yield magic squares in each case. The third type yields a matrix which becomes a magic square after some adjustment of the minor diagonal entries of the resulting matrix. Even order 1st and 2nd types behave similarly but sophiscated adjustment of entries decimal numbers may enter the magic square. The research also showed that (i) Magic squares are complexes of symmetric groups, not sub groups. Closure in possible only under inverse taking rotation and reflection equivalent maps and also under addition, substraction and scaler multiplication (ii) Magic square algorithm applied to $(2n + 1)$ symbols in periodic speeds of length $2n + 1$ invariably yields a latin square for experimental designs. A slightly different algorithm applied to 2n symbols yield even order latin squares also for experimental designs.

INTRODUCTION

Close relationship between games and mathematics has continued to bring about further interest in research on recreational mathematics. The objective is to improve interest and achievement in mathematics. Advances in this field in the last four years include ability to choose

(a) the mean of entries, in the magic square

(b) the range of entries

(c) the smallest entry

(d) the biggest entry and the ability to produce magic blocks which when placed side by side to give rise to bigger magic squares of even number of row and columns. For example if 300 - 25n + nN is the N^{th} term of the n^{th} linear sequence, the first four sequences each of 49 terms can be used to form 4 magic blocks to produce one 14 by 14 magic square. The mean of the entries is 300,

the smallest entry is the 1st term of the 4 th sequence and the biggest entry is the 49th term of the 4th sequence. The sum of each row column or diagonal is

$$\frac{300 \times 196}{14} = 4200$$

This paper dwells on the basic relationship between magic squares and the decimal numbers.

RESEARCH QUESTIONS

To guide the conduct of this research, the following research questions were posed.

1. What relationship if any exists between magic square and latin square?

2. Defining a latin square matrix as a square matrix of real numbers which is such that if entries are selected once from each row and column and added, the sum is a constant, if magic square algorithms is applied to odd order latin square matrix, does a magic squares result?

3. If a magic square algorithm is applied to a 4 by 4 latin square does a magic square result?

4. considering three basic types of latin square matrixes, does each type result in magic square when magic square algorithm is applied to it?

5. Are magic squares images of elements of symmetric groups in n^2 symbols?

6. Is composition of map a well-defined binary operation in the set of magic squares?

7. What binary operations are transformations are valid in the set of magic squares?

RESEARCH METHODOLOGY

The research is essentially basic. Trial and error and logical processes and algorithms were freely used.

RESEARCH PROCEDURE

The odd order magic square algorithm was applied to the five symbols A, B, C, D, E repeating the symbols in periods of five. The matrix produced proved to be a latin square.

The result is shown below:

$$\begin{pmatrix} B & D & A & C & E \\ C & E & B & D & A \\ D & A & C & E & B \\ E & B & D & A & C \\ A & C & E & B & D \end{pmatrix}$$

When this algorithm was applied to the symbols $\alpha, \beta, \gamma, \lambda, \delta$ in reverse order to the symbols A, B, C, D, E the following Graeco-Latin square was produced.

$$\begin{pmatrix} B_\lambda & D_\beta & A_\delta & C_\gamma & E_\alpha \\ C_\gamma & E_\alpha & B_\lambda & D_\beta & A_\beta \\ D_\beta & A_\delta & C_\gamma & E_\alpha & B_\lambda \\ E_\alpha & B_\lambda & D_\delta & A_\delta & C_\gamma \\ A_\delta & C_\gamma & E_\alpha & B_\lambda & D_\delta \end{pmatrix}$$

Thus there is a useful relationship between latin squares and magic squares produced using magic square algorithm.

However, a 4 by 4 magic square applied to the four symbols A, B, C, D failed to produce a latin square. A different algorithm produced the 4 by 4 latinsquare. viz write the

four symbols rowwise in periods of four starting with A at a_{11}, with D ending at a_{14}, A at a_{22} with D ending at a_{21}, A at a_{33} with C and D ending at a_{31} and a_{32} respectively and finally A at a_{44} with B, C, D at a_{41}, a_{42} and a_{43} respectively. the latin square is shown below

$$\begin{pmatrix} A & B & C & D \\ D & A & B & C \\ C & D & A & B \\ B & C & D & A \end{pmatrix}$$

The symbols $\alpha, \beta, \gamma, \lambda$ in reverse order yielded the 4 by 4 Graeco-Latin square

$$\begin{pmatrix} A_\lambda & B_\gamma & C_\beta & D_\alpha \\ D_\alpha & A_\lambda & B_\gamma & C_\beta \\ C_\beta & D_\alpha & A_\lambda & B_\gamma \\ B_\gamma & C_\beta & D_\alpha & A_\lambda \end{pmatrix}$$

Define a latin square matrix of real numbers as a square matrix which is such that entries are selected once from each row and column and summed we obtain a constant.

There are three basic types of such a matrix. The first type is obtained by entering terms of a linear sequence serially rowwise into n by n matrix. An example is shown below:

$$\begin{pmatrix} 8 & 13 & 18 & 23 & 28 \\ 33 & 38 & 43 & 48 & 53 \\ 58 & 63 & 68 & 73 & 78 \\ 83 & 88 & 93 & 98 & 103 \\ 108 & 113 & 118 & 123 & 128 \end{pmatrix}$$

Magic square algorithm is applicable to this latin square matrix in 8 orders namely

(i) row wise starting from the left of top row

(ii) row wise starting from the right of top row

(iii) row wise starting from the left of the bottom row

(iv) row wise starting from the right of the bottom row.

(v) column wise starting from the top of the first column

(vi) column wise starting from the bottom of the first column

(vii) column wise starting from the top of the last column

(viii) column wise starting from the bottom of the last column.

In this way 8 different magic squares were produced of which the first and the fourth were the regular analytic magic squares, based on order of magnitude of entries.

The second type of latin square matrix has row entries as consecutive terms of a linear sequence but the last entry in row k is not consecutive to the first entry in row k + 1. An example of such a latin square matrix is shown below.

$$\begin{pmatrix} 8 & 13 & 18 & 23 & 28 \\ 48 & 53 & 58 & 63 & 68 \\ 88 & 93 & 98 & 103 & 108 \\ 128 & 133 & 138 & 143 & 148 \\ 168 & 173 & 178 & 183 & 188 \end{pmatrix}$$

When magic square algorithm is applied to this type of odd order latin square in 8 orders as enumerated above, a magic square is produced in each case. This result is remarkable since these segments are analogous or equivalent to the type of segments we

obtain in enumerating sample spaces such as throwing two dice.

$$\begin{pmatrix} 11 & 12 & 13 & 14 & 15 & 16 \\ 21 & 22 & 23 & 24 & 25 & 26 \\ 31 & 32 & 33 & 34 & 35 & 36 \\ 41 & 42 & 43 & 44 & 45 & 46 \\ 51 & 52 & 53 & 54 & 55 & 56 \\ 61 & 62 & 63 & 64 & 65 & 66 \end{pmatrix}$$

Eight magic squares obtained from each of the four separate blocks can each form a basis for a Bingo game.

The third type of latin square matrix is formed as follows:

Choose, $8 = a_{11}$ at will, add any four different numbers say 10, 7, 3 and 2 successively to this a_{11} to produce the first column of the matrix thus:

$$\begin{pmatrix} 8 & 23 & 31 & 33 & 34 \\ 18 & 33 & 41 & 43 & 44 \\ 25 & 40 & 48 & 50 & 51 \\ 28 & 43 & 51 & 53 & 54 \\ 30 & 45 & 53 & 55 & 56 \end{pmatrix}$$

Then add any other four numbers say 15, 8, 2 and 1 successively to each first column entry to produce the full latin square matrix shown. When magic square algorithm is applied to this latin square matrix in eight orders enumerated above, we obtain a matrix in such case, which has equal sum for rows, columns and main diagonal but not for the minor diagonal.

To obtain a full magic square, entries in the minor diagonal are adjusted. This adjustment sometimes introduces decimal entries into the magic square. Below is a matrix produced from this latin square in the 4th order in the enumeration. All rows columns and main diagonal adds up to 198 while the minor diagonal adds to 224.

$$\begin{pmatrix} 43 & 54 & 8 & 40 & 53 \\ 51 & 30 & 33 & 51 & 33 \\ 28 & 23 & 48 & 55 & 44 \\ 45 & 41 & 53 & 34 & 25 \\ 31 & 50 & 56 & 18 & 43 \end{pmatrix}$$

To obtain a magic square the researcher used the equation $224 - 5x = 198 - x$, giving $x = 6.5$. subtracting 6.5 from every entry in the minor diagonal, he obtained the magic square below. Thus latin square matrix forms a natural link between matrix squares and the decimal numbers.

$$\begin{pmatrix} 43 & 54 & 8 & 40 & 46.5 \\ 51 & 30 & 33 & 44.5 & 33 \\ 28 & 23 & 41.5 & 55 & 44 \\ 45 & 34.5 & 53 & 34 & 25 \\ 24.5 & 50 & 56 & 18 & 43 \end{pmatrix}$$

FOUR BY FOUR LATIN SQUARE MATRIX

Results obtained above in respect of types 1 and 2 of odd order latin square matrices were also obtained from a 4 by 4 latin square matrix when magic square algorithms were applied to them. With the 4 by 4 latin square matrix of the third type, complex adjustments were applied before a magic square with decimal number entries were obtained. We cut off any 4 by 4 block from the 5 by 5 latin square matrix of the third type to obtain the matrix shown below.

$$\begin{pmatrix} 23 & 31 & 33 & 34 \\ 33 & 41 & 43 & 44 \\ 40 & 48 & 50 & 51 \\ 43 & 51 & 53 & 54 \end{pmatrix}$$

By interchanging a_{11} and a_{44} and a_{14} and a_{41}, a_{22} and a_{33}, a_{23} and a_{32}. We obtain the matrix with row and column sum as shown.

$$\begin{pmatrix} 54 & 31 & 33 & 43 \\ 33 & 50 & 48 & 44 \\ 40 & 43 & 41 & 51 \\ 34 & 51 & 53 & 23 \\ = & = & = & = \\ 161 & 175 & 175 & 161 \end{pmatrix} \begin{matrix} = 161 \\ = 175 \\ = 175 \\ = 161 \end{matrix}$$

A little verification shows that this is not a magic square. Some rows and columns add up to 175 and some to 161. Now $175 - 161 = 14$. We step up 61 to 175 by suitable adjustments to obtain the matrix, shown

$$\begin{pmatrix} 61 & 31 & 33 & 50 \\ 33 & 50 & 48 & 44 \\ 40 & 43 & 41 & 51 \\ 41 & 51 & 53 & 30 \end{pmatrix}$$

With sums of rows and columns equalised, we examine the sums of the two diagonals viz 182 and 182. In this case we equalise the row, column and diagonal sums. Using the equation $182 - 4x = 175 - 2x$ or $7 = 2x$, $x = 3.5$.

We then subtract 3.5 from every diagonal entry. The matrix obtained after adjustment is thus a magic square. In some cases the adjustment results to a magic square with decimal number entries as in the case above.

MAGIC SQUARES AS IMAGES UNDER SYMMETRIC GROUPS

Consider a latin square matrix with entries as the first 25 term of the linear sequence 3, 8, 13, 18, ... 5n - 2.

This is shown below:

$$\begin{pmatrix} 3 & 8 & 13 & 18 & 23 \\ 28 & 33 & 38 & 43 & 48 \\ 53 & 58 & 63 & 68 & 73 \\ 78 & 63 & 88 & 93 & 98 \\ 103 & 108 & 113 & 118 & 123 \end{pmatrix}$$

The eight magic squares from this latin square matrix in eight order are:

(i) $\begin{pmatrix} 83 & 118 & 3 & 83 & 73 \\ 113 & 23 & 33 & 68 & 78 \\ 18 & 28 & 63 & 98 & 108 \\ 48 & 58 & 93 & 103 & 13 \\ 53 & 88 & 123 & 8 & 43 \end{pmatrix}$

(ii) $\begin{pmatrix} 93 & 108 & 23 & 38 & 53 \\ 113 & 3 & 43 & 58 & 98 \\ 8 & 48 & 63 & 78 & 118 \\ 28 & 68 & 83 & 123 & 13 \\ 73 & 88 & 103 & 18 & 33 \end{pmatrix}$

(iii) $\begin{pmatrix} 33 & 18 & 103 & 88 & 73 \\ 13 & 123 & 83 & 68 & 28 \\ 118 & 78 & 63 & 48 & 8 \\ 98 & 58 & 43 & 3 & 113 \\ 53 & 38 & 23 & 108 & 93 \end{pmatrix}$

(iv) $\begin{pmatrix} 43 & 8 & 123 & 88 & 53 \\ 13 & 103 & 93 & 58 & 48 \\ 108 & 98 & 63 & 28 & 18 \\ 78 & 68 & 33 & 23 & 113 \\ 73 & 38 & 3 & 118 & 83 \end{pmatrix}$

(v) $\begin{pmatrix} 43 & 98 & 3 & 58 & 113 \\ 73 & 103 & 33 & 88 & 18 \\ 78 & 8 & 63 & 118 & 48 \\ 108 & 38 & 93 & 23 & 53 \\ 13 & 68 & 123 & 28 & 83 \end{pmatrix}$

(vi) $\begin{pmatrix} 93 & 48 & 103 & 58 & 13 \\ 73 & 3 & 83 & 38 & 118 \\ 28 & 108 & 63 & 18 & 98 \\ 8 & 88 & 43 & 123 & 53 \\ 113 & 68 & 23 & 78 & 33 \end{pmatrix}$

(vii)
$$\begin{pmatrix} 33 & 78 & 23 & 68 & 113 \\ 53 & 123 & 43 & 88 & 8 \\ 98 & 18 & 63 & 108 & 28 \\ 118 & 38 & 83 & 3 & 73 \\ 13 & 58 & 103 & 48 & 93 \end{pmatrix}$$

(viii)
$$\begin{pmatrix} 83 & 28 & 123 & 68 & 13 \\ 53 & 23 & 93 & 38 & 108 \\ 48 & 118 & 63 & 8 & 78 \\ 18 & 88 & 33 & 103 & 73 \\ 113 & 58 & 3 & 98 & 43 \end{pmatrix}$$

The identify map is

$$\begin{pmatrix} 3_1 & 8_2 & 13_3 & 18_4 & 23_5 \\ 28_6 & 33_7 & 38_8 & 43_9 & 48_{10} \\ 53_{11} & 58_{12} & 63_{13} & 68_{14} & 73_{15} \\ 78_{16} & 83_{17} & 88_{18} & 93_{19} & 98_{20} \\ 103_{21} & 108_{22} & 113_{23} & 18_{24} & 123_{25} \end{pmatrix}$$

Thus the eight maps are identified as follows:

(i) $Q_1 = \begin{matrix} 1 & 2 & 3 & 4 & 5 & 6 & 7 & 8 & 9 & 10 & 11 & 12 & 13 & 14 & 15 & 16 & 17 & 18 & 19 & 20 & 21 & 22 & 23 & 24 & 25 \\ \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow \\ 17 & 24 & 1 & 8 & 15 & 23 & 5 & 7 & 14 & 16 & 4 & 6 & 13 & 20 & 22 & 10 & 12 & 19 & 21 & 3 & 11 & 18 & 25 & 2 & 9 \end{matrix}$

(ii) $Q_2 = \begin{matrix} 1 & 2 & 3 & 4 & 5 & 6 & 7 & 10 & 11 & 12 & 13 & 14 & 15 & 16 & 17 & 18 & 19 & 20 & 21 & 22 & 23 & 24 & 25 \\ \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow \\ 19 & 22 & 5 & 8 & 11 & 23 & 12 & 20 & 2 & 10 & 13 & 16 & 24 & 6 & 14 & 17 & 25 & 3 & 15 & 18 & 21 & 4 & 7 \end{matrix}$

(iii) $Q_3 = \begin{matrix} 1 & 2 & 3 & 4 & 5 & 6 & 7 & 8 & 9 & 10 & 11 & 12 & 13 & 14 & 15 & 16 & 17 & 18 & 19 & 20 & 21 & 22 & 23 & 24 & 25 \\ \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow \\ 7 & 4 & 21 & 18 & 15 & 3 & 25 & 17 & 14 & 6 & 24 & 16 & 13 & 10 & 2 & 20 & 12 & 9 & 1 & 23 & 11 & 8 & 5 & 22 & 19 \end{matrix}$

(iv) $Q_4 = \begin{matrix} 1 & 2 & 3 & 4 & 5 & 6 & 7 & 8 & 9 & 10 & 11 & 12 & 13 & 14 & 15 & 16 & 17 & 18 & 19 & 20 & 21 & 22 & 23 & 24 & 25 \\ \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow \\ 9 & 2 & 25 & 18 & 11 & 3 & 25 & 19 & 12 & 10 & 22 & 20 & 13 & 6 & 4 & 16 & 14 & 7 & 5 & 23 & 15 & 8 & 1 & 24 & 17 \end{matrix}$

(v) $Q_5 = \begin{matrix} 1 & 2 & 3 & 4 & 5 & 6 & 7 & 8 & 9 & 10 & 11 & 12 & 13 & 14 & 15 & 16 & 17 & 18 & 19 & 20 & 21 & 22 & 23 & 24 & 25 \\ \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow \\ 9 & 20 & 1 & 12 & 23 & 15 & 21 & 7 & 18 & 4 & 16 & 2 & 13 & 24 & 10 & 22 & 8 & 19 & 5 & 11 & 3 & 14 & 15 & 6 & 17 \end{matrix}$

(vi) $Q_6 = \begin{matrix} 1 & 2 & 3 & 4 & 5 & 6 & 7 & 8 & 9 & 10 & 11 & 12 & 13 & 14 & 15 & 16 & 17 & 18 & 19 & 20 & 21 & 22 & 23 & 24 & 25 \\ \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow \\ 19 & 10 & 21 & 12 & 3 & 15 & 1 & 17 & 8 & 24 & 6 & 22 & 13 & 4 & 20 & 2 & 18 & 9 & 25 & 11 & 23 & 14 & 5 & 16 & 7 \end{matrix}$

(vii) $Q_7 = \begin{matrix} 1 & 2 & 3 & 4 & 5 & 6 & 7 & 8 & 9 & 10 & 11 & 12 & 13 & 14 & 15 & 16 & 17 & 18 & 19 & 20 & 21 & 22 & 23 & 24 & 25 \\ \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow \\ 7 & 16 & 5 & 14 & 23 & 11 & 25 & 9 & 18 & 2 & 20 & 4 & 13 & 22 & 6 & 24 & 8 & 17 & 1 & 15 & 3 & 12 & 25 & 10 & 19 \end{matrix}$

(viii) $Q_8 = \begin{matrix} 1 & 2 & 3 & 4 & 5 & 6 & 7 & 8 & 9 & 10 & 11 & 12 & 13 & 14 & 15 & 16 & 17 & 18 & 19 & 20 & 21 & 22 & 23 & 24 & 25 \\ \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow \\ 17 & 6 & 25 & 14 & 3 & 11 & 5 & 19 & 8 & 22 & 10 & 24 & 13 & 2 & 16 & 4 & 18 & 7 & 21 & 15 & 23 & 12 & 1 & 20 & 9 \end{matrix}$

Now

$$Q_1^{-1} = \begin{matrix} 13 & 118 & 98 & 53 & 33 \\ 58 & 38 & 18 & 123 & 78 \\ 103 & 83 & 63 & 43 & 23 \\ 48 & 3 & 108 & 88 & 68 \\ 93 & 73 & 28 & 8 & 113 \end{matrix}$$

and is a magic square different from any of the eight magic squares. Similarly Q_2^{-1}, Q_3^{-1}, Q_4^{-1}, Q_5^{-1}, Q_6^{-1}, Q_7^{-1}, and Q_8^{-1} are all magic squares.

COMPOSITION OF MAGIC SQUARES

Now $Q_2 \cdot Q_1(x) =$

1	2	3	4	5	6	7	8	9	10
↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
14	4	19	9	24	21	11	1	16	6

11	12	13	14	15	16	17	18	19	20
↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
8	23	13	3	18	20	10	25	15	5

21	22	23	24	25
↓	↓	↓	↓	↓
2	7	7	22	12

$$= \begin{pmatrix} 68 & 18 & 93 & 43 & 118 \\ 103 & 53 & 3 & 78 & 28 \\ 38 & 113 & 63 & 13 & 88 \\ 98 & 48 & 123 & 73 & 23 \\ 8 & 83 & 33 & 108 & 58 \end{pmatrix}$$

Which is certainly not a magic square since row one adds up to 340 while column one adds up to 315. We therefore conclude that the composition of two magic squares is not always a magic square. Given any of the magic squares from the eight orders, other magic squares can be produced by rotating about

(a) the North - South axis through angle180°

(b) the East - West axis through angle180°

(c) the major diagonal axis through angle angle180°

(d) the minor diagonal axis through angle180°

(e) the vertical axis through angle 90°

(f) the vertical axis through angle 180°

(g) the vertical axis through angle 270°.

Other magic squares can also be produced by suitable permutation of symmetrically located rows and columns. With a five by five magic square 4 other such permutation are possible.

These bring to completion all permissible binary operations permissible in a set of magic squares.

A magic square as an element of a symmetric group on n^2 symbols can be represented as a product of disjoint cycles. For example:

$Q_1 = (1, 17, 12, 6, 32, 25, 914, 20, 3, 1)$
$(2, 24)\ (4, 8, 7, 22, 18, 19, 21, 11)\ (10, 16)$

a product of four disjoint cycles.

REFERENCES

Onwuka B.E.: A research work to present Prime Numbers in essential sequences. Journal of Technical and Vocational Education, Issue No. 11, 1994. Technical Teachers Institute Southern Region Taramani P.O. Box 600 113 Madras India.

Onwuka, B.E.: Exploring Avenues for Industrial Uses of Factors and Composite Numbers. Journal of Technical and Vocational Education Issue No. 12 1995. Technical Teachers Institute Southern Region Taramani P.O. Box 600 113 Madras India.

Onwuka, B.E.: Expanding the Scope of Magic Squares. Journal of Technical and Vocational Education, Issue No.12, 1995. Technical Teachers Institute Southern Region Taramani P.O. Box 600 113 Madras India.

Onwuka, B.e.: Factor Tables and Prime List Devices Using a class factory Approach. Journal of Applied Sciences Vol. 3 No.1, 2000.

Leon L and Roberts S. (1983): Game Theory Fund and Wagnalls New Encyclopedia. Vol. II U.S.A.

Scaaf, W.L. Number Games and other mathematical Recreations. The New Encyclopedia Britaincia Untop, Philip W.g. edit Vol. 25 pp. 1-13.

Frank K. Perkins, Bingo, Boston Herald in Encyclopedia Americana Vol. 3 pp. 755-756.

Muguel de Guzman: Games and Mathematics Popularizing Mathematics Book of Reading University of Madrid, Spain.

The Role of English in Science and Technology

D.MARTIN LUTHAR

The manifestation of supremacy of the English language seems to be inevitable in all spheres of knowledge. English language has a tremendous global attraction on it. Further, English has been identified and accepted not only as an ambassador of ideas by all walks of life but it has imposed a great impact upon the Indian Environment in particular.

To retrospect the genesis of the English language in India, it has laid its roots in Indian soil when it was introduced in the nineteenth century by Lord William Bentinck, the then Governor General of India, for imparting Western System of Education. The endeavour was focussed not only at imparting their Educational System, but, primarily to inculcate mental slavery among the Indians. The strategies of the British Empire succeeded but in vain as the language played an unrivalled role to bridge the scattered mass. Thus, it had become a boon to all Indians in driving the British Kingdom out of India.

In the present scenario, it has been perceived by the Indians that the pivotal role of English remains to be an unchallenged one. The language is considered to be the window of the world. The dominance of English has been amounted to greater levels because of the availability of abundant knowledge in all domains - Science, Technology, Space Research, Nuclear Field, Medicine, Engineering etc. Having acquainted with the language, student community strives to access to this vast treasure of knowledge particularly in Science and Technology.

It is not only evaluated on technical skills alone, but also on the image one presents while communicating

(Keith R.Welker, Administrator,
Hughes Air Craft Company, California)

As per the comment exhibited above, the expertise of a candidate depends not only on his competency in the technical field but his efficiency in communication. But for the familiarity in English all the efforts to reach the zenith of knowledge would have become sterile. The English language renders its mission for the process of transmitting facts and information to a desired audience for a specify purpose. Most companies consider the ability of communication to be a unique ingredient for recruitment process. Scientists and engineers may be technically brilliant and creative, but, unless they can convince their clients, their technical skill will be unnoticed, unappreciated and unused. Communication in English has been considered to be the critical tool for success, even, survival in "real world" environment.

No man is an island

As the maxim alludes, every technical person works in organizational settings where team work is essential. The effective communication will lead to reach greater heights of success in a very short span of time. We live in a world that is increasingly diversified and interactive. There is more commerce among more people than even before, and it is cutting across geographical, occupational, cultural and linguistic boundaries everywhere. So, in order to inject out thoughts, it is mandatory to communicate effectively in English.

We are many more and more toward a single Global Economy, an economy based on a glow of information as much as it is on material products. We have entered the "information age". It is very essential to identify the needs of the clients and share the ideas effectively.

The best ideas in the world are useless unless they can be communicated to others. Miscommunication of information not only destroys many great ideas, but causes untold waste in daily business activities

(Richard W. Oliver, Assistant Vice-President, Northern Telecom Limited Nashville, Tennessee.)

The more we influence our clients, the more we benefit from them. Unless the communication skill accepted as a dominant factor, the technical skill will be at a diminishing end. To experience the dream come true, the obstacles should be removed by all means to accumulate better communicative skills in English.

The analysis portrays the magnanimity of English language on all horizons of Science and Technology. As it is a thing of beauty it will be a joy for ever. The Royal pilgrimage of English began even before twenty decades and the journey still continues with full of pomp and pageantry. So it is appropriate to crown the glory of the English language.

Online Assignment : An experiment

K.V.KANNAN

INTRODUCTION

Utilization of computer and internet has become vital for most of our activities in day-to-day life. Without computer and internet, it takes time for everyone to get the things completed. Corporate planning and decision making to certain extent are done online now a days. The chief executives take decisions for worldwide operations, sitting in front of a personal computer by utilizing the internet. Thus, internet has become one of the most important mass media in corporate life.

For a B-school student, the exposure to computer and internet is becoming a must. In order to make the students convenient for corporate communication, planning, decision-making, etc., and to make the student assignment interesting, they can be introduced with online assignments (assignment that has to be done with the help of internet and/or e-mail).

THE METHODOLOGY

(Followed at the Department of M.B.A., K.S.R. College of Arts & Science)

Every student has been given a company website. They are asked to browse the given website and has to identify the important information available in it. The important information can include the company's policy, achievements, HR and marketing practices, financial position, strategies etc. The information thus collected by the student has to be typed and sent to the respective faculty through e-mail within a stipulated period of time.

The faculty will go for a final evaluation and classification if any would be done with the student. The students are asked to make a final seminar presentation about their assignment. The information thus collected has been published in the form of book and has been used as a database for further references. The students make use of the e-mail ID's of companies for communication purposes in order to get project work. The information collected has been used for literature study during the time of project work. If the college has intranet facility the information thus collected can also be published in the intranet so that others can get benefited out of it.

ONLINE ASSIGNMENT AND ACQUISITION OF KNOWLEDGE

The faculties can go for alterations if needed in the online assignment and can be introduced for the students. The students can be asked to go for comparison of financial performance of different companies. Similarly the HR and marketing practices can be compared for various companies and

industries. With the help of search engines like google.com, altavista.com, rediff.com, yahoo.com, etc., the students can gather lot of information about global and national level companies. They can go for further analysis with the information thus gathered. During different semesters / trimesters the faculties can go for different type of online assignments as according to their need. Thus, online assignment plays a major role in acquisition of knowledge.

MERITS OF ONLINE ASSIGNMENT OVER THE TRADITIONAL METHOD OF WRITTEN ASSIGNMENT

1. The level of interest student gets increased when they have been exposed to internet.

2. The assignment can be submitted faster than the written assignment.

3. Student gets exposure to computer, e-mail and internet.

4. Practical knowledge of companies can be gained.

5. The information collected through these assignments can be used as data warehouse for research work and other future references.

6. Creativity of the student can be enhanced based on the analysis which they go for during this assignment.

CONCLUSION

At present, this method of online assignment has been introduced to students of M.B.A of K.S.R College of Arts & Science, Tiruchengode. It has been felt by the students that online assignment is interesting and useful when comparing to the traditional method of written assignments. Knowledge of practical orientation is getting improved through these online assignments. The faculties of other educational institutions can try for this online assignment with some alterations according to their need.

STRATEGIC PLANNING IN TECHNICAL EDUCATION INSTITUTES IN INDIA

G.B.JAIPRAKASH NARAIN

1.0 INTRODUCTION

Strategic Planning has been used by Industries and Business organisations in India for a long time. However the adoption of Strategic Planning process by educational institutions is only of recent origin - i.e., from 1992 onwards.

Traditionally technical education institutes in India viz., (i) Technical Universities and Engineering Colleges, (ii) Polytechnics and (iii) Industrial Training Institutes (which provide vocational training at Craftsmen level) have been carrying out long range operational planning for their various activities.

2.0 LONG RANGE PLAN

The basis for long range operational plan (usually 5 years) was the internal environment of the organisation and its focus was on budgets, goals and objectives. Further it adopted a methodology of linear extrapolation. The planning initiatives followed a *"Top-down"* hierarchical model.

The organisations involved in planning the technical education system of India and the interrelationships between them are depicted in figure 1.

3.0 STRATEGIC PLANNING

The Strategic Planning process takes into consideration the changes in the external environment as well as the interval environment of the organisation. It focuses on issues and **results in new shifts in directions.** It follows a *"Bottom up"* model involving all the internal and external stakeholders of the organisation.

4.0 NEED FOR STRATEGIC PLANNING

The National Policy on Education of Govt. of India formulated in the year 1986 highlights the need for proactively managing change. The section 6.16 of the policy reads as follows: *"In view of the likely emergence of changes in management systems and the need to equip technical education institutions and students with the ability to cope with the changes, effective mechanisms will be deviced to understand the nature and direction of change per se and to develop the important skill of managing change".*

The following changes in the Socio-economic environment of the country necessitate the adoption of Strategic Planning process by technical educational institutions.

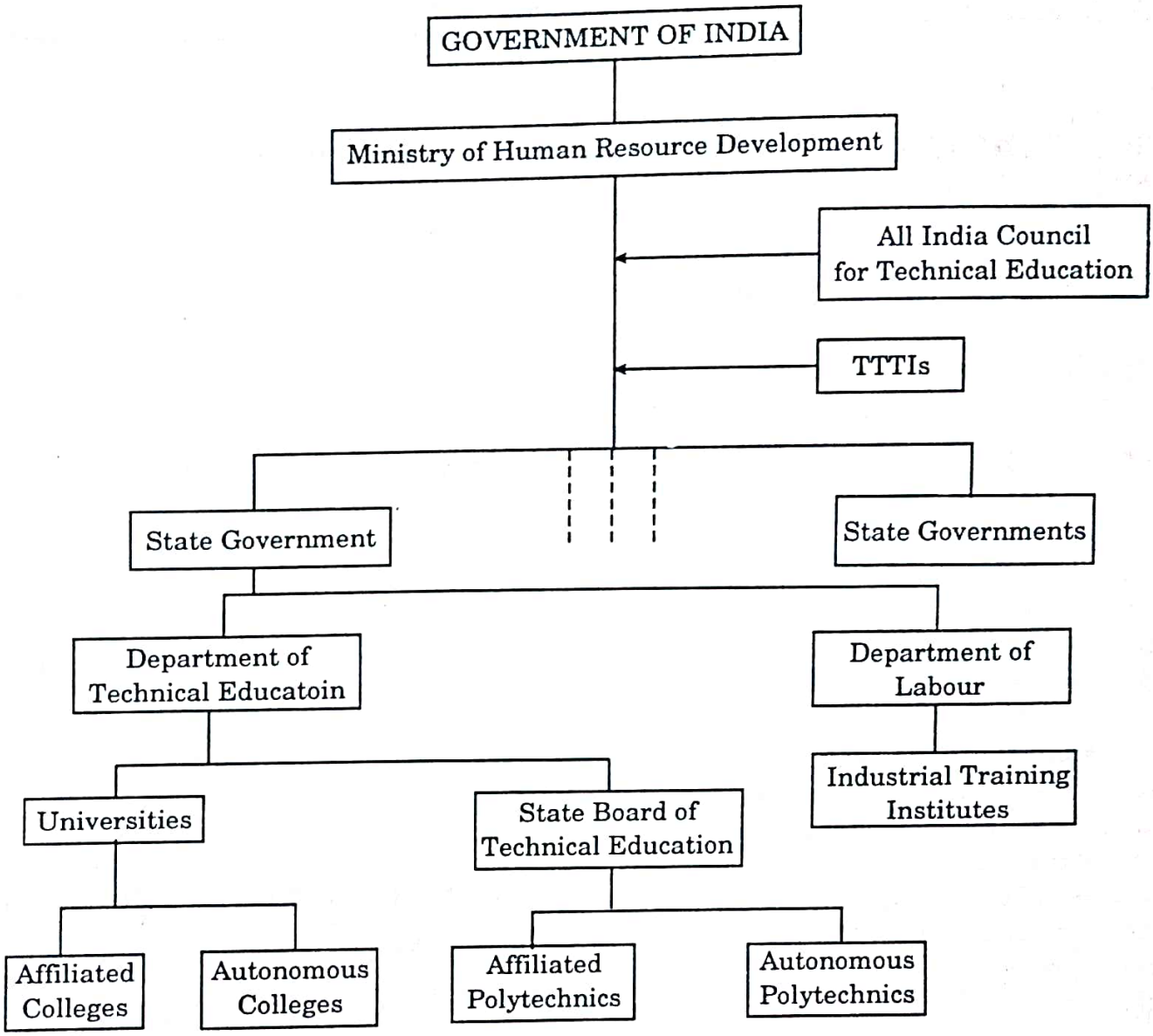


Figure 1: Organisations involved in Planning of technical Education in India

Changes in the External Environment

1. Liberalisation, Privatisation and Globalisation of Indian Economy.
2. Impact of developments in Information and Communication technologies.
3. Concern for quality and relevance of education programmes.
4. Decreasing funding support from Government for technical education
5. Increase in the number of commercial/ private training organisations.
6. Increasing importance assigned to:

- Environment (Preservation of nature-Pollution Control)
- Development of Women
- Development of poor

5.0 PURPOSES OF STRATEGIC PLANNING

1. To proactively anticipate change (external forces.trends), measure the impact and respond effectively with new systems and revised product offerings

2. To follow a Bottom-up Model and ensure the participation of all Stakeholders in the planning process.

3. To enable an organisation to optimally utilize its resources and maximize performance

4. To continually adapt to reality

6.0 STATUS OF STRATEGIC PLANNING INITIATIVES IN INDIA

The Canada India Institutional Co-operation Project (CIICP) which was implemented in India during 1993-99 introduced and facilitated adoption of Strategic Planning process by all the Directorates of Technical Education and selected polytechnics at three states (Karnataka, Kerala and Tamil Nadu) in the Southern Region of India. TTTI, Chennai and the Indian Society for Technical Education (ISTE), New Delhi were the major resource institutes for the implementation of the Project.

Currently a similar project titled "Canada India Industry Institute Linkage Project" is under implementation in the Western Region of India (Maharashtra, Madhya Pradesh, Gujarat, Chattisgarh and Goa). Under this project also all the Directorates of Technical Education and Project Polytechnics have developed Strategic Plans. TTTI, Chennai is helping CIIILP in implementing this initiative.

The Technical Teachers Training Institutes in India and the ISTE have conducted a large number of programmes on Strategic Planning for training the Principals, Heads of Departments and Senior Teachers of Polytechnics and Engineering Colleges.

The percentage (approximate) of different categories of Technical Education institutes which are adopting Strategic Planning process is given below:

I.I.Ts, I.I.Ms, & T.T.T.Is	100%
Technical Universities	100%
Engineering Colleges	25%
Polytechnics	40%
I.T.Is	10%

7.0 FUTURE SCENARIO

"Education service" is one of the twelve economic activities identified under the General Agreement on Trade in Services (GATS). A series of proposals are under consideration of the World Trade Organisation (WTO) to ensure that the process of export and import of higher education is covered under its agreements. This globalisation of education is posing serious threats to the conventional system of higher education (which includes technical education) in all developing countries including India. In the emerging international knowledge market Indian technical education institutes have to compete with the foreign players. This situation forces the education institutions in India to improve the quality of education imparted, so as to make it comparable to international standards. The learner of the 21st Century is becoming increasingly selective in making choices to learn what is relevant to

him or her. Hence, the education institutions have to adopt Strategic Planning in order to redesign their programmes and services so as to make them flexible, cost-effective and relevant to the market economy.

The National Board of Accreditation which accredits the Polytechnics and Engineering Colleges gives credit tot he Strategic Planning practices adopted by the institution. Further as many of the funding agencies also give weighage to the Strategic Planning initiatives of the institution, the number of technical education institutes which are adopting Strategic Planning is increasing.

To facilitate the adoption of Strategic Planning practice by all the technical education institutes in India the MHRD, AICTE, TTTIs, ISTE and State Directorates of Technical Education will have to further strengthen their training and development activities focusing on this initiative.

Status of Technician Education Programmes in Computers in Kerala State - A qualitative Analysis (Abstract of Ph.D.thesis)

T.D. PASUPATHI

INTRODUCTION

Computers made revolution in the early fifties of the twentieth century, owing to the advancement in science and technology. And, computer programming has been introduced as a course of study in all disciplines in polytechnics in 1991 in Kerala State.

From a tracer study, it is found that the technicians who have been trained in computer technology both in hardware and software are not able to get suitable jobs.

Hence this research has been planned to identify the current status of the computer-based technician education programmes in the State of Kerala. Since this technician education provides the manpower for manufacturing, assembling, testing troubleshooting and maintenance of computers and used for various production processes, it is essential to study the programmes at diploma and post-diploma level, their contribution to the utilization and industrial application which will absorb the trained technicians.

OBJECTIVES

1. To critically review the various computer technician curricula of Kerala State.
2. To assess the needs of the computer industries.
3. To evaluate the input and the process adopted in computer technician programmes in Kerela.
4. To generate a model for developing suitable curriculum for computer technician education programmes.
5. To develop dynamic strategies for curriculum implementation.
6. To integrate training and education in technician development programmes in Kerala.

METHODOLOGY

The researcher adopted the descriptive survey methodology, covering all the polytechnics of Kerala State that offer computer programmes in diploma and post-diploma level focusing on the curriculum, resources, faculty, infrastructure, equipment, library sources etc. available in the

polytechnics, for the technician education programmes, For these, the questionnaires have been developed and mailed to all the polytechnics, industries, alumni, heads of sections and the staff and sample industries in Kerala State.

Sample:

The respondents of the study were chosen from the stakeholders. The questionnaire approach was chosen as a means of investigation for several reasons:

(i) responses could be obtained to a reasonable accuracy.

(ii) respondents had the information requested and were free and willing to respond.

(iii) information that are not available from other sources

(iv) administrative costs are lower than that of personnel interviews.

In addition, at random, about 10% of staff and students from various polytechnics were also interviewed and relevant data were collected. All these were collated and analysed to study the curricula of technician programmes in computers.

CONCLUSION

Based on the data from the polytechnics in Kerela, the following conclusions are drawn:

1. The diploma curricular in computer and related fields in Kerela State do not incorporate the advances in the hardware and related software. Also there is great paucity of funds which effects the procurement of needed hardware and software.

2. Another factor that affects the implementation of the curriculum is the paucity of faculty in computer science, engineering science and commerce. The available teacher training programmes are inadequate.

3. There is a great gap between the polytechnics and the industry. This affects the effective interaction, support from the industry for curriculum development and implementation and student placement.

4. There is a dearth of infrastructure which effects of quality of instruction and training.

To overcome all these shortages, an integrated model for developing the diploma and post-diploma curricula has been prepared. This model can be utilized by any State since it considers all stakeholders. It consists of eight stages:

1. Need analysis
2. Programme Planning
3. Curriculum Specification
4. Planning for implementation of the curriculum
5. Pilot trial
6. Evaluation of the pilot trial
7. Implementation of revised / improved curriculum
8. Periodic evaluation, revision and implementation

This model provides strategies to overcome shortages in infrastructure, industrial

partnership, training and staff development. These are possible by:

(i) constituting IT Academy at state level which will consist of IT foundation for providing resources and infrastructure.

(ii) A learning resource development center is to be created as a part of IT Academy to provide learning resources.

All the above innovative contributions will enhance the quality of computer technicians. With the proposed model, the development and revision of various diploma programmes can be undertaken. Computer enabled technicians in each branch of technical education can be developed. Also the appropriate task specific software skills can be introduced. The infrastructure and other needed resources can be procured through the proposed IT Academy which will also provide logistic support for obtaining supports from the IT industry.

The above model could profitably be utilized by any other developing country in the world for modernizing the existing diploma and post-diploma programmes not only in computer related programmes but also in other technology driven programmes.

Utility of Manpower Training under Community Polytechnic Scheme

R.SRINIVASAN

1.0 INTRODUCTION

The Ministry of Human Resource Development in 1978-79 introduced the community polytechnic scheme in 35 polytechnics around the country. Upto March 2001 this scheme was extended to 617 polytechnics in India. Being a direct central assistance scheme this helps mainly the rural community to look for facilities which could improve their socio-economic conditions.

Under this scheme the polytechnics offer free skill based training to identified youth from the poor families in technical / general trades. The training ranges from 1 month to 6 months depending upon the trade and some beneficiaries after a year have equipped them in an additional trade also.

This scheme is implemented in 208 polytechnics in southern region. The present study about collected opinions of institutions and as well beneficiaries about the usefulness of training. This paper presents the views of organizers and beneficiaries collected from a few polytechnics in southern region.

A questionnaire was used to gather opinion from the project staff involved in the scheme and opinions were collected from 32 polytechnic teachers. An interview schedule was used to interview the beneficiaries and 14 persons trained offered their views.

2.0 ANALYSIS OF TEACHERS OPINIONS

The questionnaire used revealed that

1. Among the trades offered
   (i) Housewiring (ii) Radio and TV servicing (iii) Two wheeler servicing (iv) Motor rewinding (v) Data entry operator and (vi) Refrigeration and Air conditioning servicing are popular technical courses.

2. Among the non technical trades
   (i) Tailoring and embroidery for women (ii) Screen printing and book binding (iii) Typewriting (iv) Detergent soap making and (v) Bakery and food processing are viewed as demand driven courses.

3. A few polytechnics also offered Entrepreneurial awareness service towards the end of training to encourage them for self employment as it is one of the objectives of the scheme.

4. The opinions gathered revealed that among women practically there were no drop outs and discontinuing from the course is seen among male students.

5. Though training is also offered at village centres the preference was for getting training in the polytechnic premises.
6. A few institutions also arranged to donate a few sewing machines to poor women from agencies like Rotary club on one or two occasions.
7. Further the project staff said they helped a few women to get bank loans also to procure sewing machines and village women are happy as this training enabled them to earn atleast for themselves.

3.0 OPINIONS OF BENEFICIARIES

The poor youth trained expressed satisfaction and they revealed that

1. The community polytechnic scheme is a boon that it gave a second chance to them to develop their skills and brightened their prospects.
2. The project staff are helpful that they follow up the trained youth and ascertain how much they are able to earn and give them suggestions for improving their services rendered to villagers.
3. A few of the persons trained wanted further support like supplying essential tools at subsidised rate / free of cost to motivate them for entrepreneurial work.
4. A few of them expressed their willingness to work as skilled assistants under the scheme in the polytechnics if offered to them on a consolidated remuneration.

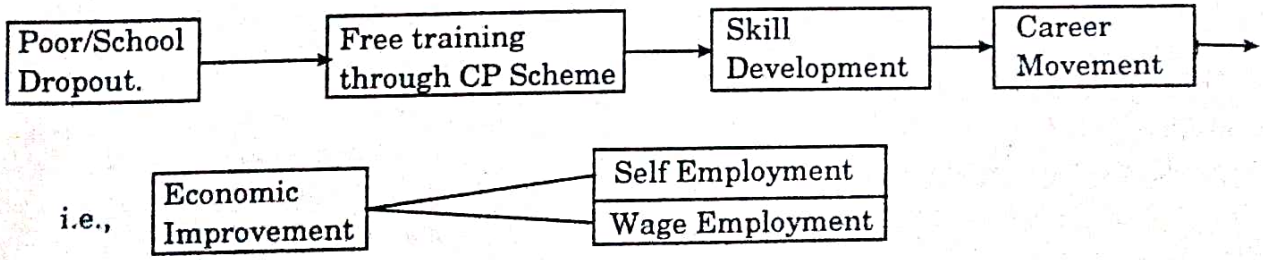
4.0 SUGGESTIONS

Man power training and skill development is the most important activity conducted by the polytechnic. Each polytechnic on an average trains 400 to 500 youths every year through short and long courses not exceeding six months. In order to enhance the effectiveness of the scheme it is suggested that

- the polytechnics could help the pass outs of this non-formal training to get apprenticeship in local industries if available.
- The Apprenticeship Training Act could be amended to make youth trained under Community polytechnic scheme also as eligible to register with Boards of Apprenticeship Training for extending industrial training experience. This could be considered by the Ministry of Human Resource Development. BOAt is also an organisation controlled by the Ministry.

An entrepreneurial cell at each state level for promoting rural entrepreneurship could be considered. This cell could be housed in the Directorate of Technical Education and Training. Through this cell the rural entrepreneurs could be given further training if necessary to help them expand their activity spectrum.

The sequence adopted is as follows:



This scheme over the last two decades has established its ability in the polytechnics. As the unique implementers these technical institutions have also enable community development activities.

It is desirable to offer a few courses to the project staff also on

(i) Motivating trained youths for entrepreneurship.

(ii) Evaluating training schemes.

(iii) Involving industrial support in organizing courses to make the scheme more useful.

Through this endeavour the polytechnics have satisfied the technical manpower needs of their neighbourhood at the lower / skill level.

Some institutions have also set up production cum training centres which have also earned sizeable revenue through sale of finished products. It is suggested that all institutions could think of setting up production cum training centres and in these a few trained youth could be employed which also may satisfy the job requirement of some of them.

Studies on Gas - Liquid Flow through curved Geometries

S.N.MANDAL

Studies on the hydrodynamics of two-phase co-current gas-liquid flow have received extensive treatment during the last few decades because of their widespread application in industry. The co-current gas-liquid flow occurs in boiler tube, distillation columns, oil and gas wells, transportation systems of crudes and refined products, all key pieces of equipment in refineries, petrochemical industries, polymer processing, nuclear engineering and a large number of chemical reactor applications. The extensive research on this topic is still going on. However, no satisfactory method for calculating two-phase pressure drop and hold up has still yet been available.

Research programme has been undertaken to investigate the following aspects

1. Studies on hydrodynamics to gas-Newtonian liquid flow through horizontal pipe.
2. Studies on hydrodynamics to gas-Newtonian liquid flow through bends in the horizontal plane.
3. Studies on hydrodynamics to gas-Newtonian liquid flow through helical coils in vertical orientation.
4. Studies on hydrodynamics to gas-Newtonian liquid flow through helical coils in horizontal orientation.

The thesis has been presented in the following four chapters

Chapter 1: It presents the important applications of two-phase gas liquid flow through curved pipes.

Chapter 2: It consists of the studies on the pressure drop and holdup of gas-Newtonian two-phase flow in horizontal tube. Experiments have been carried out four aqueous solutions of water, water-amyl alcohol (1% by volume), water-glycerin (30% by volume) and water-glycerin (42% by volume) were used as Newtonian liquid and the atmospheric air as the other fluid. The test section consisted of a perspex tube of 0.019 m internal diameter and 7 m long. Sufficient entry length before the test section and exit length after the test section has been provided to ensure undisturbed flow condition in the test section. The air and liquid flow rates as used in the experiments were in the range of 0.33×10^{-4} to 5.57×10^{-4} m^3/s and 2.0×10^{-4} to 6.31×10^{-4} m^3/s respectively. The flow patterns of the two-phase flow were observed on the basis of visual observations. The range of experimental condition was limited within intermittent flow.

For horizontal tube, the following empirical correlation has been developed

$$f_{tplh} = 6.0816 \times 10^{-3}\ Re_l^{-1.0600 \pm 0.0048}\ Re_g^{1.1045 \pm 0.0024}\ N_{pl}^{-0.2029 \pm 0.0017} \quad \ldots (1)$$

The above correlation has been tested statistically. The variance of estimate and correlation coefficient of the above equation are 1.5709×10^{-4} and 0.9998 respectively. The experimental hold up data well agree with the original Lockhart-Martinelli curve.

Chapter 3: It presents the pressure drop studies on gas-Newtonian liquid flow through bends.

Bends are integral part of any pipeline transport process. Even today the data or equations for pressure loss in two-phase gas-Newtonian liquid flow through bends are meager and the present study is an attempt to generate experimental data on pressure drop with respect to certain finite bends in the horizontal plane. The mechanism of flow of fluids through bends is considerably more complex than that of straight tubes.

Since in bends the flow will remain always in developing stage, it is difficult to analyze it theoretically. Hence, the analysis of the experimental data has been carried out by the two-phase friction factor method similar to that of horizontal flow.

Four different types of bends have been used for the experimental study, namely, 45° bend, 90° bend, 135° bend, and 180° bend. These bends are with respect to horizontal axis. Experiments have been carried out same four aqueous solutions mentioned chapter - 2 and the atmospheric air as the other fluid. The experimental studies are conducted in 0.019 m internal diameter mild steel tube. The gas and the liquid flow rates used in the experiments were in the rage of $0.42 \times 10^{-4} - 5.97 \times 10^{-4}$ m^3/s and $2.00 \times 10^{-4} - 5.96 \times 10^{-4}$ m^3/s respectively.

The analysis of the single-phase experimental pressure drop data across the bend is carried out by means of the Fanning friction factor. The following empirical correlation has been developed.

$$f_b - f_h = 10.2075\ Re_l^{-0.2754 \pm 0.0673}\ (R_t/R_c)^{1.6847 \pm 0.1277}\ (\alpha/\Pi)^{-0.7573 \pm 0.0859} \quad \ldots (2)$$

For individual bends,

$$45^\circ \text{ bend}: f_{tplb} = 46.3227\ Re_l^{-0.9626 \pm 0.1255}\ Re_g^{0.6996 \pm 0.0581}\ N_{pl}^{0.0438 \pm 0.0431} \quad \ldots (3)$$

$$90^\circ \text{ bend}: f_{tplb} = 59.5212\ Re_l^{-0.5754 \pm 0.1661}\ Re_g^{0.5908 \pm 0.0804}\ N_{pl}^{0.1585 \pm 0.0565} \quad \ldots (4)$$

$$135^\circ \text{ bend}: f_{tplb} = 0.4211\ Re_l^{-0.8595 \pm 0.1089}\ Re_g^{0.6440 \pm 0.0519}\ N_{pl}^{-0.1299 \pm 0.0408} \quad \ldots (5)$$

$$180^\circ \text{ bend}: f_{tplb} = 0.0683\ Re_l^{-0.6249 \pm 0.0623}\ Re_g^{0.7565 \pm 0.0338}\ N_{pl}^{-0.0433 \pm 0.0229} \quad \ldots (6)$$

The above equations have been tested statistically and the correlation coefficients are 0.9381, 0.8876, 0.8985 and 0.9642 for 45° bend, 90° bend, 135° bend and 180° bend respectively.

The generalized empirical correlation for all the different bends has also been developed

$$f_{tplb} - f_{tplh} = 392.6107\ Re_g^{0.5087 \pm 0.0443}$$

$$Re_l^{-0.5642 \pm 0.0901}\ N_{pl}^{0.1216 \pm 0.0320}$$

$$(R_t/R_c)^{1.8590 \pm 0.0728}\ (\alpha/\pi)^{-0.9660 \pm 0.5070} \quad \ldots (7)$$

The statistical analysis of this equation (18) has also been carried out and the variance of estimate and correlation coefficient of the above equation is 0.1451 and 0.9256 respectively.

Chapter IV: It consists of the studies on the pressure drop and hold up for gas-Newtonian two-phase flow in vertical helical coil. Experiments have been carried out three aqueous solutions of water, water-amyl alcohol (1% by volume), water-glycerin (30% by volume) were used as Newtonian liquid and the atmospheric air as the other fluid. The test section consisted of a PVC pipes with internal diameter of 0.013 m and 0.010 m and total length of 15 m. Four helix angles (0°, 4°, 8° and 12°) were used for experiment. Before the helical coil about 1.5 m long horizontal tube was provided for the mixing of the two-phase flow. The air and liquid flow rates used in the experiments were in the range of 0.15 to 5.25×10^{-4} m^3/s and 3.65 to 14.2×10^{-5} m^3/s respectively. The range of experimental condition was limited within intermittent flow.

Various different methods of analysis available in the literature for gas-Newtonian fluid flow for pressure drop and hold up in the horizontal flow are tested.

The experimental data on the two-phase friction factor have been correlated on the basis of the dimensional analysis with physical, geometric and dynamic variables of the system. The following empirical correlation has been developed.

$$f_{tplc} = 5.8853\ Re_l^{-1.1829 \pm 0.0215}\ Re_g^{0.9520 \pm 0.0142}$$

$$N_{pl}^{0.0220 \pm 0.0086}\ (D_t/D_c)^{-0.2820 \pm 0.0369}, \quad \ldots (8)$$

The above correlation has been tested statistically. The variance of estimate and correlation coefficient of the above equation are 0.0022 and 0.9855 respectively.

Similarly, the experimental data on the holdup have been correlated. The following empirical correlation has been developed.

$$\alpha_l = 0.1723\ Re_l^{0.4620 \pm 0.0077}\ Re_g^{-0.3632 \pm 0.0051}$$

$$N_{pl}^{-0.0068 \pm 0.0030}\ (D_t/D_c)^{0.3712 \pm 0.0142} \quad \ldots (9)$$

The above correlation has been tested statistically. The variance of estimate and correlation coefficient of the above equation are 0.0028 and 0.9976 respectively.

Chapter 5: It consists of the studies on the pressure drop and hold up for gas-Newtonian two-phase flow in vertical helical coil. Experiments have been carried out three aqueous solutions mentioned above Chapter 4 were used as Newtonian liquid and the atmospheric air as the other fluid. The test section consisted of a PVC pipes with internal diameter of 0.013 and 0.010 m and total length of 15 m. Four helix angles (0°, 4°, 8° and 12°) were used for experiment. Before the helical coil about 1.5 m long horizontal tube was provided for the mixing of the two-phase flow. The air and liquid flow rates used in the experiments were in the range of 0.12×10^{-4} to 4.416×10^{-4} m^3/s and 4.15×10^{-5} to 9.5×10^{-5} m^3/s respectively. The range of experimental condition was limited within intermittent flow.

Various different methods of analysis available in the literature for gas-Newtonian

fluid flow for pressure drop and hold up in the horizontal flow are tested.

The experimental data on the two-phase friction factor have been correlated on the basis of the dimensional analysis with physical, geometric and dynamic variables of the system. The following empirical correlation has been developed.

$$f_{tplc} = 2.3958\ Re_l^{-1.1915 \pm 0.0316}\ Re_g^{0.8963 \pm 0.0166}$$

$$N_{pl}^{-0.1787 \pm 0.0097}\ (D_t/D_c)^{0.5149 \pm 0.0116} \quad \ldots (10)$$

The above correlation has been tested statistically. The variance of estimate and correlation coefficient of the above equation are 0.0129 and 0.9900 respectively.

Similarly, the experimental data on the hold up have been correlated. The following empirical correlation has been developed.

$$\alpha_l = 0.1345\ Re_l^{0.3593 \pm 0.0140}\ Re_g^{-0.4172 \pm 0.0074}$$

$$N_{pl}^{-0.0642 \pm 0.0043}\ (D_t/D_c)^{0.3106 \pm 0.0164} \quad \ldots (11)$$

The above correlation has been tested statistically. The variance of estimate and correlation coefficient of the above equation are 0.0026 and 0.9904 respectively.

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This journal is priced as follows:

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Subscription for One Issue	Rs.50/-	10 US $
For Five Issues	Rs.200/-	40 US $
Month of Publication	Every December (Planning to publish two issues in June and December every year)	

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