Centre for Innovation in Engineering Education

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I. Rationale for the centre for innovation in Engineering Education

Introduction

Engineering colleges and polytechnics belong to the formal education subsector :— "professional higher education" .The theme of this article is that **Professional Higher education needs to be professionalized** , because the present Engineering Education system operates on the assumption that educational functions like learning, teaching , curriculum design and development , institutional level, state level and national level educational policy making and management need skills which can be learned on the job through observation and imitation. This assumption is not valid in light of the new findings of educational sciences.

Following are some of the **major factors** which today and also in future will influence the functioning the Higher Education system. The system in future can survive only when HE brings professionalism in its functioning ((**Kettering, Marshall and Fry 2000; Fry Kettering , Marshall 2004)**

Emergence of new Knowledge and Disciplines

Over the last 50 years, a new discipline is emerging every year. HE now exposed to market force has to include new subjects or modify curricula more frequently than before. Degree courses are being diversified to take differently named degree awards. Universities have stared Vocational courses.

Knowledge based economy (Symes, C. & McIntyre2000)

Intellectual capital today drives both economy and social development. .Knowledge gets importance, because of the spread of ICT, brain technology, bio-technology, robotics. and electronics. These disciplines increase the knowledge content of the products and processes in practice also. To progress in life, acquisition of knowledge, and skills and ability for continuous learning are considered today as critical assets. National governments are looking to higher education for delivery of public policy. For solving economic and social problems, all professionals today need to employ scientific knowledge developed in universities, professional knowledge produced by practitioners of professions, and working knowledge developed by teams working at work places. Thus

every graduate coming out of colleges should be aware other ways of knowledge formation in situations outside classroom situations.(Bowden and Marton 1998)

Work based knowledge (Symes, C. & McIntyre 2000)

Advances in technology is creating enormous changes in workplace practices, causing routine work to be done by machines and requiring

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workers at the workplace to take decisions on the site. Operations of such intelligent machines have increased the content of knowledge at the workplaces and require continuous education of front line workers. Many enterprises have started making specific arrangements for learning in the workplace itself. Professional colleges will have to be integral part of such practice based learning

Importance of Key skills (Fellows and Stevens 2000)

Fresh Graduates take three years to get adjusted to the industrial set up.on employment. Also employees have often have to shift from large enterprises to service in medium and small enterprises or think about starting their own business

Something more than the knowledge a student gets in the traditional universities is required. In this contexts educationists and industrialists have started talking about " generic skills" Educationists have identified management of self, management of others, management of information and management of tasks and finally learning to learn skills as generic skills as they can be used in a range of domains Personal, social, employment and continued learning.

Staff in professional colleges.

Staff in the universities is increasingly subjected to increased workload, continuous performance review, pressure to change traditional way of teaching to learner focused teaching, pressures to adopt variety of research methodologies to solve practice based problems. At the same time his working conditions are worsening, because they are required to work on lower pay. Teachers need to improve productivity by understanding the nature of learning, use of technology to reduce barriers of time and space to learning, formative techniques of assessment to accelerate student's learning and so on.

Life long learning (Ormrod 1999)

New knowledge is being created not only in universities but also in professions and workplaces. A professional has to continue to learn even beyond his initial graduate education to keep updating his knowledge .Today's life demands that a graduate is not only is functional in his employment, but also as a member capable of taking care of his personal development, as member of his family as well as act as a good citizen. Higher education now needs to take into consideration that learning has become a lifelong activity. Learning to learn has become the most important generic skill. that needs to be incorporated in the curriculum design of all higher education courses.

National development and its impact on Institutional practices (Fry, Ketterig, Marshall, 2000)

In addition to international pressures, there are pressures created by national government policies aimed at improving access to majority of student population aspiring to take higher education... Government also tries to regulate funding patterns to in order to modify institutional practices to fit into the national framework. Other regulating agencies like AICTE, UGC, State boards have quality improvement frameworks to which higher educational institutes are increasingly expected to conform. Governments are also trying to enlarge the policy of social inclusion though affirmative actions like reservation of seats for disadvantaged groups. Governments are engaged in creating high frequency and low frequency waves to initiate innovations in educational institutes.

In short, all these policy initiatives at the national and state level directly influence educational processes like learning, teaching, research, curriculum design, and institutional policy making and management.

Internationalization of Higher education

Higher education today is assuming international dimensions requiring sharing of

research, teaching and knowledge sharing with the international collaborators. Standards of professional practices are being established internationally. The result is that the colleges are revising currcula to incorporate international dimensions

Globalization

Globalization relates to economy and technological trends... The flow of technology, economy, knowledge, people, values and ideas are crossing borders. Institutions of higher learning are tending to upgrade their curricula to gain international acceptance of their curricula and modes of their delivery . There is a greater coordination and harmonization of regulations, procedures across countries, to facilitate transfer of credit and qualifications to ensure comparable quality in educational qualifications. They tend to create their own global brand in higher education. by developing international competences and its refinement through continuous professional development.

The most important is the shift from the current educational paradigm requiring focus on instruction to new paradigm of focus on student as an active learner and teacher as facilitator of learning. This is now a global trend.

Mobility of professionals, academicians and students and transnational education.

Open trade requires mobility of professionals across national boundaries. Such mobility is possible only when attention is paid to credit transfer; existence of educational polices allowing such transfer, mutual recognition of qualifications built around learning agreements.

Range of initiatives in transnational education to assist such mobility is:

Franchised education

- Virtual university
- Distance learning
- Branch campus operations
- Joint degrees
- Dual awards

Each of these has quality implications in education.

Inference

In order to be able to provide right type of services to the students, industry, community, and the public, the professional education system should be able to adapt its internal structures and functions. Learners , teachers, HODs , Directors and national level and state level policy makers and administrators should look out for educational practices of the successful organizations , study how they function successfully and why they succeed , then pick up those ideas and experiment with them for their systemic desirability and cultural feasibility

Today, all institutions of higher learning are working in the environment where changes are taking place rapidly. To adapt, institutions must accelerate learning. They have also to deal with complexity, as the stakeholders in education are increasing in number as well as in complexity of their needs and expectations

Accelerating learning and dealing with complexity cannot be done with help of past practices based on imitation and observations. One will have to search for the underlying principles which make the educational functions efficient , effective , and more systemic procedures are made feasible though experimentation and systemic institutionalization though management of planned change by the direct participation of faculty and management of the institution wanting to achieve excellence . Excellence cannot be achieved by any external resource systems. **It has to be institution's own internal efforts.**

In the Context of NIT scheme of the Government of India

Till now foregoing discussions were made in general terms Forthcoming discussions will now be made in the new context of that is emerging in the national higher education system. This is the new government scheme of establishing at least one National institute of technology in each state which will be upgraded to the level of IITs. Some of them are former regional engineering colleges and some are engineering colleges formerly under state control and funding, but were recommended by the states for inclusion in the NIT scheme. They have, however, weak infra structure. Author had the opportunity to deal with one such NIT recently. All references to NIT in the ensuing discussion in this article will be with reference to this type of NIT. **They are referred to as NIT(X).** Such NIT(X) represents majority of colleges and the recommendation made in this article are applicable to all of them. Any Engineering College or polytechnic that wants to engage in quality improvement activities can adopt these recommendations., even though they are made in the NIT context .

- **Need for a Helping System for quality improvement**. Improving quality of educational functions and its products needs support from educational sciences and educational professional knowledge base. NIT(X) will have be developed within its structure, a subsystem which will act as a helping system to faculty and management to achieve excellence especially in those areas of educational sciences and technology where generally engineering and technology personnel has no basic familiarity

At the national level, since 1990, The GOI is attempting to introduce quality improvement programmes. Both in polytechnics and Engineering degree education with the assistance of the Word Bank starting with Tech-Ed I, II, III programmes for the polytechnic system and since 2000 TECQUIPMENT programmes for Degree Education..

The Government of India has now passed an NIT Act in the year 2006. NIT(X) has been given autonomy and has been registered under the Society Act and is governed by a duly constituted Board of Governors (BOG). This BOG appointed EDCIL, New Delhi, as the consultant to make broad recommendations for the upgradation of the formal engineering college to NIT level. According to the document entitled 'Perspective plan for National Institute of Technology' X the Institute is envisioned as

"An Institute of excellence that prepares engineers, architects and managers who are not only thoroughly competent and futuristic but also accountable, caring and fair minded. Its mission is to offer high quality learning and research experience designed to develop skills, intellect and creativity. It also is expected to contribute to the development of knowledge and processes of use to industry and finally it is expected to be pace setting institute that other engineering institutes in the region can emulate."

This should be the general trend for all NITs in future. A stress on quality learning and research, creativity, developing usable knowledge to industry and community, and act as pace setting institution that other engineering institute can emulate.

- This national level trend will need an additional subsystem within the institute to stimulate innovative activity for giving them education training and consultancy support in educational sciences and educational related professional subjects. NIT(X) has proposed a project is for Establishment of Center for Innovation in Engineering Education within as its subsystem. For the reasons mentioned below, however, the faculty as well as the management of the Institute which, operating under traditional norms and assumptions, will not be able to bringing such professionalism in educational processes among its functionaries

II. Current Status of NIT(X)

Levels of functioning of the Engineering Education system and emergent properties

In India the higher engineering education is a highly organized system at six levels as shown in fig 1.below. Here six levels as indicated on the left side. In the middle are shown the embededness of at each level of component systems. And on the right hand side are shown the nature of the organization with its input and output features which are expected to be have emergent properties if other subsystems embedded within at each level develop roles and counter role which complement one another. to enable the higher level organization to achieve its goal. **(Checkland 1981, and Checkland and Scholes, 2000)**

However according to the General Systems theory. Emergent property means acquiring characteristics which are more than the sum of the properties of the subsystems embedded in the higher system. This thing happens only when the all these systems working together are hierarchically organized, are in communication with one another for controlling the functioning of all systems within the overall framework of the higher system. All this mean that that basic conceptual framework of Systems theory is shared by all.

Briefly,

1. Complex social organization consists of subsystems which are arranged hierarchically which means the lower systems are embedded within the higher-level system.
2. These subsystems should maintain communication with one another in order to complement each other's role and functions.
3. They should maintain feedback communication in order to carry out control functions to avoid crossing existing boundaries laid down by the higher system.

To illustrate,

At level 1. which is basically a *learning system,* the emergent property of student self directed learning in a subject will occur only when the learners macro level learning straggles for achieving subject level objectives are communicated to learner and is complemented by his own counter role of learning activities at the micro level (topic level) and provides feedback of his achievement to the learner at the strategic level. Thus communication and feedback make it possible to adopt flexibility of approach in learning to suit learning context.

At level 2, which is basically a *teaching system,* the emergent property of student centered teaching will occur only when the teacher takes into account student's active learning and designs instructional strategies to facilitate students active learning and communicates these e strategies to the learner . These strategic action must be complemented by the student's counter role of active learning and provide feedback communication to the teacher on his achievement.

At level 3, HOD 's functions can achieve emergent properties of *integrated curriculum management,* when he takes into account the teacher's role of facilitator of student's active learning a design curriculum strategies to facilitate such teaching and coordinating their efforts to lead the students to achieve curriculum objectives. He must communicate these strategies to all teachers. Teachers must complement HOD's role by their counter role of actually designing student centered teaching and communicating their achievements to the HOD through the feedback communication.

At level 4, tie principal's role will get emergent properties only when he takes into account HODs' roles of *curriculum manager* described above and make institutional level policies and strategies to facilitate their functions and communicate them to HODs. HODs in turn must

adopt a counter role by actually designing curriculum strategies decried above and provide feed back communicating on their level of achievement .to the principal.

At level 5, State level authorities role of *state level policy making and management* will achieve emergent properties when they take into account the principals' role of policy making and management described at level 4 , and design policies and management strategies to provide support to them and actually communicate to all Principals. Principals in turn must adopt a counter role of actually designing policies and management strategies as described in at level 4 and provide feedback communication to the state authorities their level of achievement and for support.

At level 6.National level authorities's *policy making and management* will have emergent property only when they take into account the roles of state authorities as described at level 5 and communicate these policies and strategies to all state authorities .State authorities in turn us adopt a counter role of actually adopting policies and management strategies described at level 5 and provide feedback communication to the national authorities on their achievements and support .

Thus the emergent properties can be attained only through hierarchy, communication and control in their systems operations. But without the theoretical framework of general and social systems framework, the educational functionaries cannot design such systems. This is the main problem of educational practice in engineering education.

(Please refer Fig. 1 on the next page)

The failure so far in attempts to reform education is the failure to understand the systemic nature of the functioning of higher education. The entire system intuitively functions within a systems framework. and is guided by certain regulations. based on experience of running the system.. But the system is not designed explicitly according to systems theory. But for this the basic conceptual framework should be **shared by all.** Following are some of the concepts of systems thinking:

While the nature of hierarchy is known implicitly in the current system its professional meaning is not yet known. Only the discipline called **social system theory of education** can equip the functionaries with the conceptual structure to be able to view of higher education system as a professional system and establish the necessary structure to formalize hierarchy, communication and control.

2. Assumption on which the traditional higher educational system is based. (Bennett, Dunn and Carre, 2000)

The educational reform started with emergence of pad logical sciences for children in pre-primary and primary education. The assumption was that the children till the age of six or eight are not mature learners and needed guidance. They were trained in pedagogical sciences in addition to the expertise in the subject content which children were expected to acquire. As educational sciences advanced the need for teacher training for lower secondary school was felt. But in upper secondary, higher secondary, and degree education the learners were considered still considered as mature learners. All that was considered necessary for competency in teaching was to be a subject matter expert. The result has been that the educational functions like learning by students, teaching by teacher, departmental management by head of the dept. and institutional management by the principal are seen as a set of skill which can be acquired on the job through apprenticeship and by observation and imitation. The educational scientist and educational professional knowledge based has now advanced enough to give guidelines to the teacher and students to manage learning and teaching systematically even in higher education.

Many reforms attempted earlier were

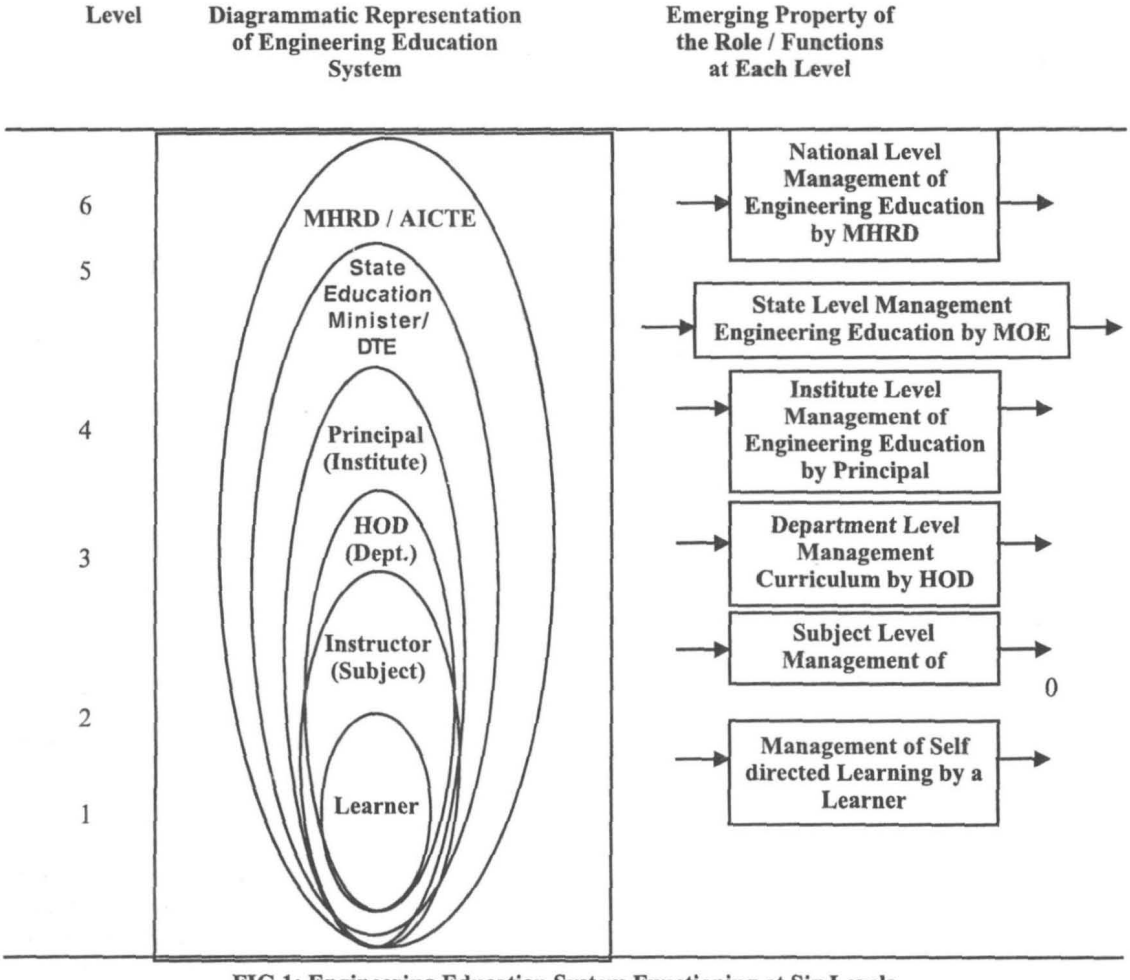

FIG 1: Engineering Education System Functioning at Six Levels

directed at improving instructional method and use of media without taking into consideration the nature of active learning by the student.

The functioning at the state level and national level educational planners and administrators also subscribe to this assumption.

The result of such assumptions has been the loss of professionalism in education.

Characteristics of professionalism in higher education.

The professional practice by definition is based on **following five characteristics**.

1. Understanding **generic features** of professional of knowledge (propositional, personal and process knowledge) to demonstrate one's professional expertise.
2. **Competence** in generic or common skills or key skills. Managing self, managing information, managing others and management of task .and learning to learn
3. **Reflective practice**, using critical thought and informed ethical judgment to make decisions in the range of contexts.
4. **Responsibility and accountability** to

students, and other stake holders.

5. Engaging in **continuous professional development** (CPD) and life long learning to develop the profession as well as professionally.

Professionals need to be self aware, self directed, having personal skills and emotional maturity to take responsible action with colleagues and clients. They should have motivation and ability to research and evaluate outcome and assimilate them into practice. All these general characteristics are equally true of educational professionals.

Emergence of educational sciences and professional knowledge based in education.

(Ormrod 1999; Norlin and Chess 1998, Checkland 1981 and 2000; Bowden and Marton , 1998; Damasio 1994, Bennett, Dunn and Carre, 2000)

Since 1980 onwards in advanced countries like European Union (ESP UK. Sweden), USA, Australia, Hong Kong, Singapore have made tremendous advances in educational sciences capable of illuminating processes in higher professional education. To illustrate, the nature of only three of the basic sciences are explained below:

• **Theories of learning** emphasize the nature of student active learning in any learning situation. This discipline today integrates the knowledge from behavior sciences, social sciences, cognitive sciences, information sciences and computer sciences. This discipline explains how a learner experiences a learning situation, assimilates and accommodates new information in his cognitive structures, stores this information, retrieves it for dealing with new situations for thorough transfer and problem solving techniques, how to control his emotions for keeping balance between the emotions and the reason before taking acting on the environment to modify it for survival.. This discipline is vital today for higher education which has to prepare younger generation for the unknown future.

• **The theory of knowledge formation** is recognizing that valid and usable knowledge is formed not only in universities, but also in professional practice and work places. Any change in the knowledge formation at one place influences the changes in knowledge formation at other places. This subject also explains how *scientific knowledge, professional knowledge* and working knowledge are produced and the shape the knowledge product takes as a result of these procedures. These are the foundation of process learning which is gaining increasing attention in curriculum design of professional courses.

• **System thinking in education** emphasizes that all higher education systems are organized systems. Their functioning at any level of such hierarchically organized system will have emergent properties only when every subsystem of a larger system have systems features like boundary, supra system, interfaces, proposed output, input, process, actual output, and feedback. Further each subsystem must be in communication with one another and exercise control so that every subsystem contributes to the overall functioning of the larger system.

System change needs leaders who are equipped with the conceptual tool of "planned change". Management for planned change itself is a discipline in its own right.

There are also other educational and professional disciplines which are not dealt with here for the sake of brevity.

• ***Lack of awareness of current educational functionaries***

The professionals like engineers and physical scientists by virtue of their background knowledge based in physics, chemistry mathematics are not favorably disposed towards learning social sciences, humanity and educational sciences which are considered as

soft sciences.

The lack of interest of these professionals has resulted in an awareness gap even of existence of this knowledge base and **this will prove to be the greatest barrier to the educational reforms in engineering education and other related professional fields.**

The strong message from the higher level functionaries like MHRD, MOE, and Board of Governors of NITs is needed to **treat educational functions as professional functions**. .

- Besides there is no provision for establishing CIEE even in the EDCIL plan. This may be a permanent feature of NIT(X); because quality improvement will be a continuous process.

6. Inference.

Absence of systemic view of Engineering Education system , traditional assumptions in higher education by the functionaries that skills required to learn , teach , curriculum , institutional planning and state and national level planning can be learned on the job, general lack of awareness about the emergence of educational and professional knowledge base for the development of professional education , will hinder progress on this CIEE project . Past experience with Educational Technology projects in IITS, IIMs and also GOI,'s World Bank assisted projects for both polytechnic education and Degree education have confirmed this fear.

It will be the task of the BOG of every NIT to first understand the nature of quality improvement of educational processes, importance of process consultancy in QIP programme and monitor progress of quality in education on a systematic basis in qualitative terms and not in quantitative terms

Special attention to faculty development programmes through initial phase to make the faculty aware of the existence of educational sciences, and providing CIEE faculty with the organized body of knowledge of educational sciences and professional subjects. Then provide them with an induction phase to introduce them to educational practice in NIT, P and help them interpret the practice in terms of educational terminologies and define educational problems .Then through in-service phase in which the CIEE faculty will join hands with the frontline faculty in NIT, P to deal with problems associated with quality of educational processes through process consultancy.

The most important thrust BOG will have to give will be to link Rand D work by Engineering and Science faculty opting for career in CIEE to the institutional career growth policies of the NIT.P Today these policies are solely geared to the engineering and science oriented R&D work . This is one major cause why Higher Education in Engineering has not made substantial progress in quality improvement in educational processes.

No NIT's academic staff and management have the competence to bring about improvement in the quality of their educational processes without getting the conceptual support from the experts of educational and social sciences .But this conceptual support should be built internally in the form of an internal structure called ' Centre for inovaton in Engineering education ' This Centre will act as an internal change agent – a helping system to the academic and managerial staff of the NIT to bring about the organizational change in a systematic and the planned way .

III. Current Status of CIEE in NITS

The GOI and MHRD do not have a clear concept of bringing about organizational change in educational institutes of higher education though the collaboration of internal and expertise in education and social and systems sciences. MHRD experimented wit IIT and certain University systems by sanctioning Curriculum development centres and Centres of Educational technologies. Some of them are still functioning, but there is no organized study of the progress

they have made in establishing methodologies for bringing about quality improvement in educational processes in higher education. Even TTTI which are now upgraded as NITTTR to serve as an external resource systems to both Degree and diploma educational institute have not developed such methodologies based on theoretical base provided by the educational and social sciences .and systems sciences .

The only information we have is that NIT, Patna is contemplating this move to establish CIEE.

IV. What should be the nature of CIEE

When CIEE will be completely established in its first phase, it will have following features:

1. Role:

The CIEE will act as **a change agent** in the role of **process helper** and will assist NIT Patna's front-line educational and managerial functionaries in all aspect of change process ranging from awareness of need of the faculty and managers through relationship building with them and helping them with methodologies needed for problem solving and applying solutions (HAVELOCK R.G., 1995)

2. Organization structure:

The proposed organizational structure is shown in Fig. 2.

The CIEE will consist of:

1. HOD, CIEE whose function is **to coordinate** the functioning of three subsections mentioned below when the CIEE is tackling educational problems at various levels. All practical problems need simultaneous attention of all three subsections.

2. Subsections will consist of:

   a) Educational sciences t subsection (for Theories of Learning, Theories of Knowledge formation, Systems thinking in Education)

   b) Instructional sciences subsection (Instructional System development, Curriculum System development)

   c) The organizational sciences subsection (organizational psychology, principles of management of routine activities, principles of management of change)

CIEE's role as **a process helper** will result in a systematic interactional process between the CIEE and NIT faculty and staff which organizes its activities with the primary focus on the practical problems faced by students, teachers, HODs and principals while dealing with their functions in a given educational programme. The further explanation of the functioning of a process helper is outside the scope of this paper .and reference can be made by the readers to the reference by R.G. Havelock .But the overall interaction is diagrammatically shown in fig 4" A linkage view of resource –user problem-solving"

This internal structure of the NIT for institutionalizing innovations will have to be supported by external resource system as shown in fig 3 (on next page) for Macro system for knowledge linkage.

CIEE and NIT will have access to basic r and applied research institutions. Institutions of professional practitioners and their user systems.

This linkage has to be facilitated by the Government policy on promoting innovations in Engineering Education. through MHRD, MOE, AICTE, UGC, and state directorates and State Boards of Technical education.

The **list of important proposed objective** to be achieved by CIEE.(**Havelock 1973)**

a. Development of a sense of what is hurting

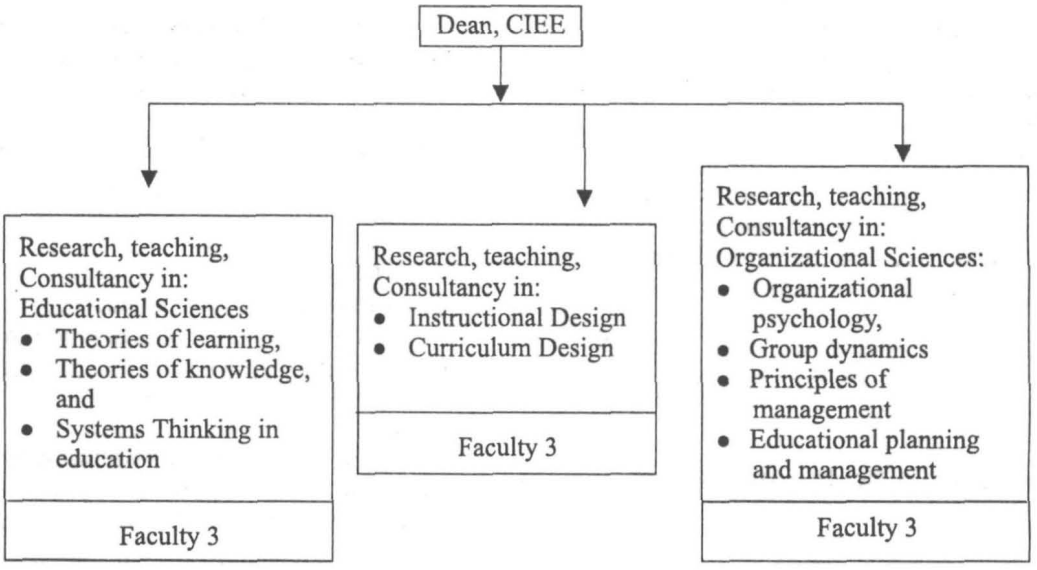

Fig. 2 Proposed organizational structure oif CIEE

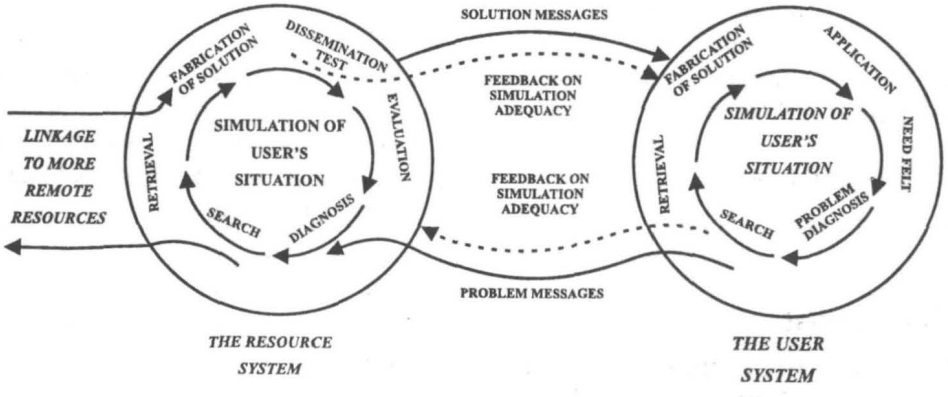

Fig. 3 : A Linkage view of Resource-User Problem Solving
Source : HAVALOCK R.G. (1973)

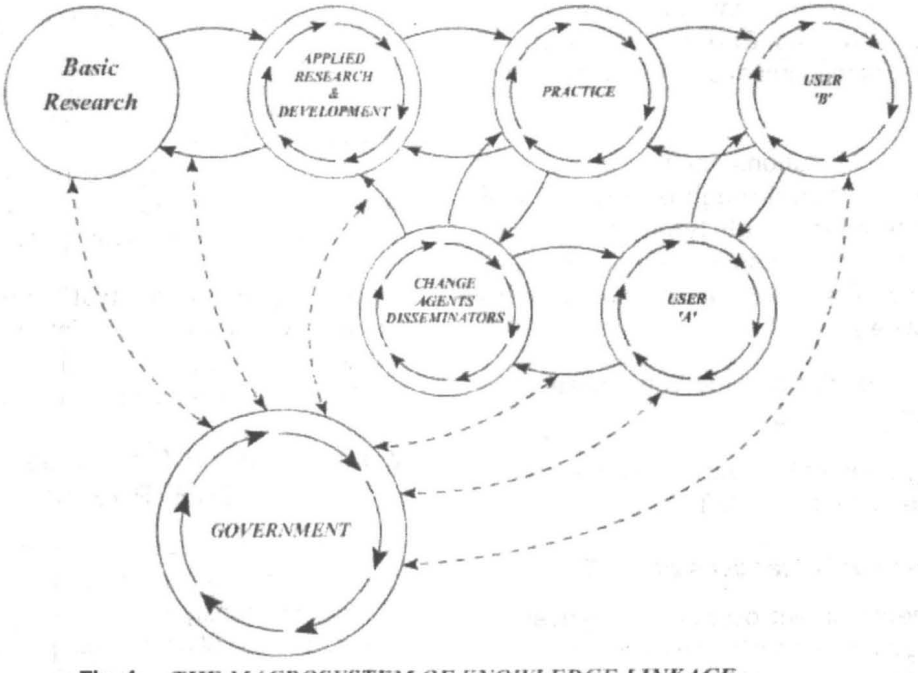

Fig. 4: *THE MACROSYSTEM OF KNOWLEDGE LINKAGE*

Source : HAVELOCK R.G. (1973)

NIT(X) at various level.

b. Development of network with NIT (X) at various levels and other External resource system.

C. Diagnosis in details of the nature of the problem and its elements of NIT (X) at its various levels.

d. Acquisition of resources needed for change efforts (Physical resources, Human resources, Information resources, Time resources, Energy Resources and Financial resources) both for the CIEE and NIT (X)

e. Choice of solutions and the possibility of its application through experimentation and testing. in all types of learning situations. (Class rooms. laboratory, simulations, actual field situation of the practice.)

f. Internalization and Institutionalization of tested solutions

g. Integration of innovation in daily activity of the Institution of NIT (X)

Developmental objectives of CIEE

The development objective is derived by answering the question: With the fully developed functionality of the CIEE and the NIT, **what generic knowledge and skills and methodological principles will NIT(X) acquire which can be used for future problem solving**

In the process of improving quality of engineering education all processes , NIT (X)will have to properly document experiences , discern patterns, and draw generalizations , and widely disseminate this to all stakeholders not only of NIT but also all those generally concerned with quality improvement of higher professional education . In the country.

Internally within a single NIT, CIEE will develop capability to act as helping system (also called resource system) and improve general problem solving capacity of the NIT (X) staff and faculty at all levels.

NIT(X) then can act as a role model for other NITs who can bench mark methodologies needed to improve quality of education in their own set up.

NIT can also provide consultancies to policy makers and managers at levels 5 and 6 i.e. state and national level. engaged in developing policy and management practices for statewide and nationwide quality improvement programmes.

It important to note that the model NIT(X) must know how to develop 'interfaces' With the networked institutions at all levels on professional lines using systems approach.

V. Management Strategies to Develop CIEE Project

Having conceptualized role functions, structure and interactional process for problem-solving, the management has to adopt strategies and sequence of objectives giving direction to the to the developmental efforts to reach the purpose of the CIEE project. Such technique consists of setting intermediate objectives and corresponding activities. Following table gives an example of how these can be written down.

Project strategy for taking the benefits of the project to direct and target beneficiaries.

Setting Intermediate Objectives & Outputs

INTERMEDIATE OBJECTIVE	OUTPUTS	REMARKS
1. CIEE project approved by the senate of NIT (X)	1.1 Consultant appointed 1.2 Project report scrutinized by Director and Chairman	
2. Project report approved by BOG	2.1 Project proposal explained to Chairman and Director by the consultantto answer probable queries from other BOG members 2.2 Agenda item prepared for the BOG's approval. BOG meeting expected to be convened only for this item alone 2.3 BOG approval obtained	
3. Budget provision by MHRD obtained	3.1 Proposal by the Director sent to GOI.for sanction and budget provision 3.2 Meeting with MHRD officials convened 3.3 MHRD's approval obtained	
4. Policy statements by Director on the project and project team appointed	4.1 Project details discussed with Deans and HODs 4.2 Project details discussed with faculty 4.3 Policy statements issued for appointment of Project team and outlining the project strategies, assigning responsibilities , financial arrangement , monitoring strategies issued 4.4 Project team called IPIU appointed (Institutional project implementation unit)	

INTERMEDIATE OBJECTIVE	OUTPUTS	REMARKS
5. Liaison developed by IPIU core team with 1 National Regulatory agencies, consultants, industrial organization, educational institute. 2 State level agencies 3 NIT level depts. and sections	5.1 List of all relevant agencies prepared by IPIU 5.2 Meeting with NIT level teams conducted to establish relationships 5.3 Information needs of parties identified and sources of information identified 5.5 Contacts established with national and state level agencies 5.6 Visits of NIT teams arranged 5.7 Information sources gathered	
6. Research and Development for acquisition of new information about establishing CIEE	6.1 Information about functions., expertise and staff structure , strategies of the proposed CIEE gathered 6.2 Organizational details worked out 6.3 Qualification of the future staff needed for manning CIEE determined 6.4 Recruitment procedures determined	
7. Information retrieved organized for preparing detailed project report of CIEE	7.1 Outline of project report prepared by the team 7.2 First draft in a given format prepared 7.3 Approval of the senate obtained	
8. Design CIEE system	8.1 IPIU prepares first draft of DPR (detailed project report) in the prescribed format 8.2 DPR discussed initially with Chairman and Director and MHRD finance and technical bureau to ascertain their requirement	

INTERMEDIATE OBJECTIVE	OUTPUTS	REMARKS
	8.3 DPR revised in light of discussions 8.4 BOG's approval obtained	
9. Develop CIEE's infra structure	9.1 DPR analyzed for isolating individual infra structure items 9.2 CIEE building designed by the architect 9.3 Building designed, estimate prepared, tenders invited and building constructed. 9.4 Equipment and furniture list prepared , specifications made , tenders invited , purchase made and installed in the buildings 9.5 Energy sources. Electrical installations designed, specification made, tenders invited, procured and installed. Vehicle specifications prepared tenders invited procured and installed 9.6 Time schedule for short term, medium term and long term is prepared	
10. Develop : Faculty and staff developed	10.1 Career growth plan outlined and approved by the Board 10.2 Current capabilities of the existing staff compared with the desirable and education and training needs identified 10.3 Education and training strategies for the CIEE faculty and staff outlined: initial, induction and in-service phase describing clearly the purpose of each phase. 10.4 Training places and training sources located 10.5 Training schedule prepared	

INTERMEDIATE OBJECTIVE	OUTPUTS	REMARKS
	10.6 Faculty and staff deputed for initial phase in outside training places.	
	10.7 Induction phase planned	
	10.8 Training on return from initial phase deputed for induction phase in CIEE	
	10.9 After the induction phase the trainees are placed in NIT team for in-service training	
	10.10 Final progress of and achievement in terms of knowledge skills and attitudes recorded	
11. Information resources developed	11.1 Information needs for project preparation , management , and education training identified	
	11.2 Information search carried out	
	11.3 Information retrieved for each phase	
	11.4 Information classified catalogued and stored in the library as well as documentation centre	
12. Implement CIEE's problem solving activities through interaction with NIT. Patna using planned change approach **(Havelock 1973)**	12.1 **Caring** : Developing some sense of what is hurting NIT(X)	
	12.2 **Relate** Establish contacts and develop relationship with the NIT system	
	12.3:**Examine** Examine in detail the nature of the problem and its detailed elements, what parts are liable to change. This constitutes diagnosis of the problem.	
	12.4 **Acquir**e : Search for resources that that might be relevant to the change effort	

INTERMEDIATE OBJECTIVE	OUTPUTS	REMARKS
	12.5 **Try** Choose a solution or a set of solutions and see whether it can be applied to practice through experimentation. 12.6 **Extend** Extend the tried solution to NIT system through internalization and institutionalization 12.7 **Renew** Try to ensure that the innovations are integrated into day to day activities of the instituition.	
13. Project evaluation	13.1 Framework for formative evaluation outlined 13.2 Each of the output mentioned above is evaluated trimonthly, semi annually and annually for detecting mistakes and errors and taking remedial measure 13.3 Framework for summative evaluation outlined after the end of every major phase conduct summative evaluation to assess the extent of achievement of project objective	

Table 1: Sequence of steps by the project management to identify intermediate objectives and outputs needed to achieve them to bring the CIEE project to fruition.

Direct beneficiaries of the project will be faculty, management, and staff of NIT. (X) through improvement of their academic functions as well as management functions to support them both in their routine as well as change management efforts

With the enhanced academic functional skills, management and administrative skills of NIT academic and management staff NIT will be able to provide following benefits to target beneficiaries:

Target beneficiaries	Benefits
1. Students enrolled in the NIT programmes	improved educational services
2. Industry	Better manpower and quality Information though quality research And consultancy
3. Community	Better consultancy services and Information to solve their local Problems
4 Public	Better information on educational Opportunities and career guidance To their wards

Most important to remember is these benefits can be delivered only if NIT develops interfaces with the target beneficiaries on the professional lines

CIEE will adopt the model proposed by Havelock in his book "Change Agents' Guide to Educational Innovations "1995 supported by contemporary finding in learning theories. The outline total implementation arrangement for the project is described above under the heading "Implementation" in section G above This is the most important intermediate objective of the project strategy, because it is here that the actual transformation is taking place through the interaction between CIEE and NIT(X) faculty .The steps are summed up through a mnemonic: CREATER, which is expended into steps 1. Care 2. Relate 3. Examine 4.Acquire 5. Try 6. Extend 7. Renew

These are the actions to be taken by the Staff of the CIEE. But there are counterroles of the faculty and management of the NIT(X) who are to act as active learners who want to learn to examine its own skilled behaviour, actively search for new information, learn new concepts and skills, and use them in new problem situations though deliberative actions, communicate the decisions to act to all stakeholders to get their support. Most important is to learn to control your own behaviour individually and in groups and learn in different learning situations. Here again the knowledge of learning , knowledge formation and systems thinking alone will help the NIT(X) faculty to learn systematically .

VI. Why Earlier Strategies of Innova tions in Engineering Education Failed

The NITTTRs, since its inception from 1969 to 1988, tried common sense methods in

improving teaching and learning without the support of principles from systems concept and learning theories. This knowledge was not available at that time. In 1990, in the capacity of Chief Project Advisor of NPIU of GOI (MHRD), the author succeeded in helping the states to prepare initial project formulation to enable the World Bank make recommendations to the Bank for sanctioning the loans .for their TECH ED projects This was possible because he used systems concept in devising the project formulation framework. But later in 1992 onwards, when it came to actual project implementation in the States, and particularly in the state of Maharashtra .my efforts to help polytechnics to improve quality of education failed, because of my inability to persuade DTEs and Chairman BTE and the principals of the polytechnics to adopt systems approach and learning theories. The result was that most subcomponents of the projects were handled independently of one another. When it came to training teachers to consider students as active learners and training them to learn independent study techniques, the teacher's lack of knowledge in learning theories prevented them from teaching students how learn actively and meaningfully for every subject and acquire knowledge cumulatively. This skill is of prime importance in UG/ PG and Doctoral programmes. The project team did not have knowledge and skill of bringing about change in an educational system in a planned way. The difficulty originates in developing countries like India mainly from the top management, the ministries and the Directorate of technical education and the e State boards of technical education. There is in fact no policy making at these locations in the system for promoting qualitative change I educational processes. The top management should be at least aware of the importance of knowledge base provided by these sciences and professional subjects in bringing quality in higher education. So long as we treat learning, teaching, curriculum design; institutional planning for educational programmes as the skills to be learned though apprenticeship without the underpinning of theoretical base, no educational project will be successful. in raising the quality of higher education.

It is also important to know is that no educational institution which wants to initiate quality improvement programme should entirely rely on the external agencies. External agencies 'strategies should be complemented by the internal effort through a structure of the type of CIEE. And also capability of the faculty and management of learning to learn

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