Engineering Council of India







1st National Convention on

SEAMLESS ENGINEERING

August 16, 2006
Tata Centre, Kolkata

PROCEEDINGS

Supported by :

Tata Steel & Indian Institute of Metals

A convention commemorating the Diamond Jubilee of the Indian Institute of Metals

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Engineering Council of India

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INTRODUCTION

The evolution of engineering over the years has been tremendous. Not only has engineering helped create structures that withstand the test of time, but by the sheer dent of efforts in R&D, it has also contributed in making the world a more eco-friendly place. The industrial revolution and developments in the field of inventions coupled with technical advancements necessitated the transition of engineering from a general phase to one of highly domain specific specializations. From the staid Civil, Mechanical and electrical, today engineering has advanced and branched into 18-20 specializations.

The paradigm shift in the way projects are implemented requires application of knowledge and skills other then staid engineering. A case in point being mega projects executed for the development of physical infrastructure in a nation. An integrated approach from project conception to completion is required to achieve the engineering marvels in the construction of hydro power plants, dams, roads, highways and air ports, townships, steel plants, oil refineries, petro- and heavy chemical and fertilizer plants, aluminum, lead-zinc and copper refiners. Similarly, such an approach is also required in all the segments of information industry, space, nuclear industries, etc.

Project planning, appraisal, implementation, monitoring and operation require integrated skills that may not be limited to a single discipline of engineering. The feasibility of projects is determined inter alia in the synergy between engineering and business management. Engineers also armed with a degree in business management can play a bigger role at all the stages of a project- from concept to completion.

It is an attitude and approach of people for embracing multi disciplines including of engineering and business management sprinkled with essential components of the other professional disciplines such as law, information technology, etc, which will make project leaders in the present economic and business environment (because experience confirms the hypothesis). It is an attitude and approach for multi tasking for which people have to be multi skilled which is what is required for people to be able to take up leadership role in the present complex world of competition. And, therefore, engineers must change their attitude and bring in flexibility in the whole approach for their career building as engineers and imbibe spirit of other disciplines in addition to their own engineering discipline. It could more effectively be done through bringing in a major change in the very approach to the present practice of engineering education and training in the country. This is an issue which needs to be given a serious consideration.

In the Indian context, the realization of the need for generalization in the engineering curricula at the degree level happened around 1960s. It was during this time that the former Punjab Engineering College, Chandigarh and presently the National Institute of Technology offered Production Engineering as a course. Some other colleges followed suit and varied their offerings with the Industrial Engineering as an alternative. Most recently, a diploma in the Construction Engineering has been started by the Construction Industry Development Council- a leading institution dedicated to the development of construction industry in the country- in collaboration with the Indhira Gandhi National Open University, New Delhi. It can be said that this step taken by the CIDC is a bold step forward in realizing the idea that is being floated

Trends across the world depict the rise in demand for Seamless Engineering. The same can happen in India, as it is the cry of the day. A greater impetus to the cause of Seamless Engineering can be provided if the leaders of Indian Industry, Professional Associations / Societies / Institutions coupled with academic establishments like IITs, NITs, etc, join hands to do some brain storming and an in-depth discussion on the subject.

One of the objectives of ECI, being the apex body of Engineering Associations in India, is to help promote the profession of engineering. This includes their professional development for which the Systems and Procedures have been developed by the ECI, which are equivalent to that of the EMF. It is also felt that there is a need to start an in-depth discussion on the Seamless Engineering in India for meeting the required synergic demands of the profession in the new WTO environment particularly for taking part in the global market of engineering services. It is for this purpose a day's Convention is being organized on August 16, 2006 at the Tata Centre, Kolkata.

OBJECTIVE

The main objective of the convention is to start a discussion in the country on reforming the engineering education and training for bringing in a needed synergy in the different engineering disciplines at the graduate level and for awarding a basic general engineering degree. The discipline-wise engineering degrees could be pursued at the post graduate level should some students want to go for the R&D steam as a career. At the basic level some subjects on the industrial law and managerial economics and international trade could be added to the syllabus. After passing out, the students will like to go in the different streams of profession such as construction, infrastructure, mining and steel, aluminum and the other non ferrous metals, production, manufacturing in general, oil exploration and production, etc,.

PROGRAMME

August 16, 2006, Tata Centre, Kolkata

0900-1000 Hrs	Registration	
1000-1045 Hrs	OPENING SESSION	
	Welcome Address	Dr. Uddesh Kohli, Chairman ECI
	Address by	Dr P. Rodriguez, Visiting Professor, IIT, Chennai, former Director, IGCAR and Past President, IIM
	Convention Address	Mr. P. R. Swarup, Director General, CIDC
	Inaugural Address by The Chief Guest	Mr. Raji Philip, Vice Chairman, SCOPE & CMD, Hindustan Paper Corporation Ltd.
	Vote of Thanks	Mr. J. C. Marwah, Secretary General, IIM
1045-1100 Hrs	Tea / Coffee	
1100 1200 Hrs	TECHNICAL SESSION-1	
	Synerrgy Between Different Engineering Disciplines for Seamless Engineering	
	Session Chairman	Dr. P. Rodriguez, Visiting Professor, IIT, Chennai, Former Director, IGCAR and Past President, IIM
	Key Note Speaker-1	Dr. A. R. Upadhya,, Director, National, Aerospace,Laboratories, Bangalore
	Key Note Speaker-2	Mr. Alok Ghosal, Sr Manager Technical Education, SNTI, Tata Steel
	Key Note Speaker-3	Mr. S. Ratnavel, Chairman-Engineers Bill Committee & Professional development Committee, CCEA
	Key Note Speaker-4	Dr. Sandip Bhattacharyya, Tata Steel
1200-1300 Hrs	Technical Session-11	
	International Experience on Seamless Engineering	
	Session Chairman	Dr. T. K. Dev
	Key Note speaker-1	Prof C. V. Ramakrishna, Perfessor Emeritus, IIT, Delhi
	Key Note speaker-2	Mr. John Tripllet, Senior Consultan, DMRC
	Key Note speaker-3	Prof. B Dattaguru, Dept Of Aerospace Engineering, IISc, Bangalore
1300 1400 Hrs	Lunch	
1400-1530 Hrs	Panel Session	
	Seamless Engineering	
1400-1410 Hrs	*Chairman*	Dr. Manmohan R. Kalgal
1410-1440 Hrs	Panelist-1	Dr A. K. Das, Chief of Flat Products Technology, Tata Steel
	Panelist-2	Mr. Prabir K. Datta, Consultant, Chartered Mechanical Engineer
	Panelist-3	Dr. Sudip K. Das, Honorary Secretary, IIChE, Kolkata
1440-15-10 Hrs	Views from the House	Four Speakers from the House
1510-1530 Hrs	Discussions	
15301600 Hrs	Tea / Coffee	

ENGINEERING COUNCIL OF INDIA (ECI)

OBJECTIVES

The main objectives of ECI are to work for the advancement of engineering profession in various disciplines and for enhancing the image of engineers in society. To this end, ECI will be focusing on quality and accountability of engineers.

In the emerging WTO / GATS environment, mobility is becoming an important issue. Mobility of Indian engineers for delivering engineering services in other countries will be hindered unless expertise of Indian engineers is recognized and accepted at the international level. Conforming to internationally laid down norms is essential also for protecting employment of engineers in internationally funded projects, multinational corporations and large companies in India.

According to its Memorandum of Association, the objectives of ECI are as follows :

1. To promote the science and practice of engineering for national development, collectively along with constituent members.
2. To encourage engineers to serve the needs of the society.
3. To promote advancement of education of engineering in the country.
4. To promote the practice of continuing education and training to upgrade the quality of engineering professionals.
5. To identify and undertake activities of common interest to the engineering profession.
6. To encourage inventions, investigations and research; and promote their applications for development of the national economy.
7. To identify and undertake activities directed to enhance prestige of engineers in the country, and to secure for them their rightful place at various levels of planning, administration etc.
8. To promote steps to attract bright persons of the younger generation to the engineering profession.
9. To assist Associations / Professional Societies in normalizing criteria for membership so as to make these nationally equitable and internationally acceptable.
10. To establish a common "Code of Ethics" for professional and consulting engineers adoption by Association / Professional Societies and to evolve the strategy for its enforcement.
11. To interact with the government at State and Central levels and help adoption of policies for betterment of the engineering profession.
12. To represent engineers and engineering professionals of all disciplines, at National and International levels.

13. To maintain a National Register of "Professional Engineers" and a National Register of "Consulting Engineers" who are engineering organisations employing professional engineers where principal occupation is the independent practice of engineering.

14. To acts as a Nodal Body, representing India, for bilateral / Multi-lateral recognition of "Professional Engineers" and "Consulting Engineers" on mutual and reciprocal basis.

15. To identify and encourage the implementation of best practices for the development and assessment of engineers intending to practices for the development and assessment of engineers intending to practice as professionals in domestic as well as foreign markets.

16. To standardize criteria to be adopted for according status of "Professional Engineer" and "Consulting Engineer" and to accord licence / accreditation to practice engineering in India.

17. To identify major engineering disciplines in which substantial cross-border mobility is expected and to cater to those disciplines in which substantial cross-border mobility is expected and to cater to those disciplines in ECI's policies, practices and their registers / sub-registers.

18. To identify barriers to professional engineers' mobility and to develop and promote strategies, to advice and, if required, assist Central and State Government Departments, in managing those barriers in an effective and non-discriminatory manner.

19. To develop mutually acceptable standards and criteria for facilitating cross-border mobility of experienced Professional Engineers and Consulting Engineers among WTO signatories.

20. To establish such committees, as may be necessary, for reciprocal joint activities with similar professional bodies in other countries who are signatories of WTO and other related agreements.

21. To network and cooperate with other such international bodies / for a who are engaged in similar activities.

22. To perform any or all other acts, deeds and things, which may become necessary to be performed at any stage to achieve the main objectives of improving the image of the engineering profession and of the professional engineer and to serve the needs of the society.

TASKS

In order to meet its objectives, ECI task include the following :

- Certify the competence of engineers for undertaking professional activities.
- Certify the competence of organisation offering engineering consultancy services.
- Integrate continuous development programme with the certification process to upgrade expertise continuously.
- Lay down norms of professional conduct and take appropriate action promoting and ensuring compliance.

- Join international networks such as Engineers Mobility Forum for protecting the interests of Indian engineers in the emerging international scenario.

ENGINEER'S BILL

ECI has prepared a draft Engineer's Bill for the consideration of the Government of India, which lays down the criteria for the process of registration of Professional Engineers and Consulting Engineering organisations and provide necessary statutory framework for the same. The draft is being processed by the Ministry of Human Resource Development.

MEMBERSHIP

Membership of the ECI is open to societies / organisations of engineers who meet the following requirements :

- having been established statutorily or registered in accordance with law.
- having atleast 100 corporate members.
- having existed for atleast four years.
- the accounts being audited annually.

PROCEEDINGS
1st NATIONAL CONVENTION ON
SEAMLESS ENGINEERING

The 1st Convention on Seamless Engineering was organized by the Engineering Council of India with the support of the Tata Steel and IIM on August 16, 2006 at Kolkata. Around 100 engineers from the Industry and Academia attended the Convention. It was inaugurated by the Chief Guest, Shri Raji Philip, CMD, Hindustan Paper Corporation and was presided over by Dr. Placid Rodriguez - an eminent Nuclear Scientist and Metallurgist and Guest of Honour.

The convention was covered in three sessions apart from the opening session. The last session was a panel session in which three panelists spoke and Dr. Manamohan R. Kalgal, Secretary General, Association of Consulting Civil Engineers (India) chaired the Session and concluded the discussions.

Shri J.C.Marwah, Secretary General, the Indian Institute of Metals presented his views on the theme of the Convention and the vote of thanks

The Convention was also organized to commemorate the Diamond Jubilee of the Indian Institute of Metals - a Member Institute of the Engineering Council of India.

Broad Conclusions of the 1st Convention

Engineering has emerged as a multi -task profession. Mere training in compartments of different disciplines will not meet the present requirement of the industry. The problem in the engineering education in India is that things have not changed during the last three decades. Some of the concepts that are being taught, topics and subjects that are in the curricula are quite outdated. There is too much of pure sciences and mathematics with no clear idea of their relevance to applications. While too much theory is taught, too little emphasis is given on experiments and on- the - job training. There is no solid interdisciplinary base. There is too much of the compartmentalization. Students have no idea as to what they are studying and what they are going to do. An engineer after passing out enters industry and then only he / she is trained there for meeting his / her job requirements. There is, therefore, no correlation in the present engineering education system between theory and practice. Technology today has become more interdisciplinary. There is no subject which can make you understand technology in its entirety; it needs interdisciplinary skills and knowledge to understand and comprehend

The basic challenges of the engineering education are the ever-changing world of engineering which demands a new way to educate future engineers. So, the engineering curricula should encompass effective use of computer tools, a greater variety of organizational work contents, management concepts, basic concepts of economics, statistics, basic concepts of other disciplines, etc,. As a matter of fact, since the last decade the engineering profession as such has become more interdisciplinary. Therefore, seamless transition in the engineering education has become important. This cannot be ignored and keeping status-quo in the engineering education cannot be afforded in the given circumstances. Hence, this convention is very apt and timely.

Engineer should also have sufficient knowledge of other disciplines such as, finance, law, dispute redressal, computer applications, public relations, team dynamics, HRD, management skills, etc. The latest example of seamless engineering can be found in the emergence of a new multidisciplinary nano science and technology. An effective interaction between academia and industry is also required for producing practising engineers. Therefore, the debate that has been initiated by the ECI with organizing the convention is apt and timely.

According to the August, 2006 issue of Business India, USA produces more engineers despite having less number of universities and around a little more than half of its population when compared with India. Primarily, it is because USA produces more general engineers; and India does not.

A definite trend in the world of knowledge creation and its dissemination can be seen quite clearly today which is essentially a trend towards convergence and indivisibility. Whatever we may do with regard to re engineering, the engineering curricula for which a lot of ideas have been thrown up like, campus-corporation collaboration, institute-industry interaction, we want reflective practitioners. Academicians should make a temporary transition to the world of work from the world of teaching. Any change that we may want in the conventional practices cannot be done through legislation. It can be better and quicker done through credible consensus building process. This is what this convention on the Seamless Engineering, organized by the Engineering Council of India is trying to realize.

The Indian industry today is generally of the view that engineers who come out of colleges are not suitable for them. The Industry does not provide information to the academia about what they expect from passing out engineers. There is no interactive mechanism in place between the two. This is the problem. Industry-academia interaction mechanism abroad is well established to the extent that professors become with their position in the academy (an academic institution) automatically the top most industrial consultants. There is a need, therefore, (for us) to put in place such a mechanism for synchronizing what we need to teach students so that they can meet the needs of industry. It is only then that it would be possible for both the stakeholders to come to common understanding as what engineering curriculum needs to be taught. Perhaps, if we are able to create this synergy between the industry and academia that the need for the seamless engineering will get more prominence.

In order to meet the present requirement of industry, anybody who wants to finish engineering with general engineering should be able to do so and enter industry as an engineer; and anybody, who wants to branch out into various special streams of specialization, he / she should be able to do it during the subsequent two years i.e. during 4^{th} and 5^{th} year of the course. We should, therefore, have general engineering course and produce general engineers who could do any kind of job. Specializations can also be done at the undergraduate level itself with two years more course in continuity to the three years of general course. Alternately, it could be a general course of three years and two years of specialization thereafter- either in continuity or with a break of two years which can be spent in an industrial unit. Another alternative could be four years of general engineering course at the undergraduate level and two years course in particular specialization at the postgraduate level. In this alternative also there could be a break of two - to -three years for taking up employment in an industrial unit. We can select the required alternatives. We should further discuss this, in-depth.

Creating seamless thinking primarily is the responsibility of the professional bodies. They should discharge this responsibility. Engineering Council of India has taken the first step by organizing this thought provoking, apt and timely national convention and now we should move further on this subject for getting a consensus on it in the country.

Strategy for action is that the professional guilds, institutions and the Engineering Council of India should join hands and evolve a workable curriculum. Industry must spell what to teach; the professional guilds should validate it and adopt continuous professional development. Seams in the engineering education should be removed at the undergraduate level. Finally, as a sequel of the discussions, a task force may be set up by the Engineering Council of India which would look into these aspects and suggest remedial measures.

The proceedings have been edited for the sake of convenience of reporting.

OPENING SESSION

OPENING SESSION

Welcome address	-	Dr. Uddesh Kohli
Opening Address	-	Dr. Placid Rodriguez
Keynote Address	-	P.R.Swarup
Inaugural Address	-	Raji Philip
Vote of Thanks	-	J.C.Marwah

Dr. Uddesh Kohli

While welcoming the Chief Guest Raji Philip, key note speakers and the delegates to the convention, Dr Rodriguez, Visiting Professor, IIT, Chennai, former Director, Indira Gandhi Atomic Research Centre, Kalpakam, Tamil Nadu and the Past President, Indian Institute of Metals (IIM), who presided over the Session, , stated that the Engineering Council of India (ECI) has organized the convention with the support of the Tata Steel and the Indian Institute of Metals (IIM). IIM is celebrating this year its Diamond Jubilee and the convention also commemorates the event. He briefly explained the development which led to the setting up of ECI as an apex body of engineers in India and its purpose, the need for a statutory body for engineers and the Engineers Act and registration of professional engineers in India, particularly for giving them international recognition for the purpose of the trade in engineering services under the regime of WTO, which was around the corner. He further added that the need was being felt that the multidisciplinary engineering profession in the emerging scenario -in which the engineering was fast getting into multitasking profession - was not perceived to be conducive of meeting the new challenges and seizing the opportunities that were being generated due to the globalization. Therefore, the convention had been planned for soliciting the wider views on the subject of making engineering profession seamless. While it would take quite some time to arrive at a consensus on the subject, ECI would continue with this discussion and would organized similar conventions in the other parts of the country and finally it would be held at Delhi when a policy paper would be prepared for the change - over and submitted to the government for its implementation. AICTE would also be involved in the exercise.

Dr. Placid Rodriguez

Historically, engineering did not exist as a discipline till 18th century. It came after that. While the concept of seamless engineering has been explained by Dr. Kohli, this is a subject on which there can be a debate and more than one viewpoint. This convention would do that. Engineering has emerged as a multi -task profession. Mere training in compartments of different disciplines will not meet the present

Dr. Uddesh Kohli is the Chairman of Engineering Council of India, Consultancy Development Centre and Construction Industry Development Council

Dr. Placid Rodriguez, Visiting Professor, IIT, Chennai, Former Director, IGCAR and Past President, IIM

requirement of the industry. Engineer should also have sufficient knowledge of other disciplines such as, finance, law, dispute redressal, computer applications, public relations, team dynamics, HRD, management skills, etc. The latest example of seamless engineering can be found in the emergence of a new multidisciplinary nano science and technology. An effective interaction between academia and industry is also required for producing practicing engineers. Therefore, the debate that has been initiated by the ECI with organizing the convention is apt and timely.

P.R.Swarup

While presenting his theme paper, he stated that first of all he would like to thank the Indian Institute of Metals and the Tata Steel for joining Engineering Council of India in organizing this national convention. This is relevant today. A number of issues are there which I thought I will present before you which have already been visualized in the construction industry for its streamlining. Construction industry is the second largest sector of the economy after agriculture. It does lot about engineering. A streamlined functioning of construction industry brings in many engineering disciplines together and that is the reason that I have taken as an example what exactly is happening in the construction industry, which would be covered later.

The factors which contributed to the genesis of engineering in general and branches in particular have been covered by Dr. Rodriguez in his thought - provoking address. There are two terms - Engineering and Technology. They appear synonymous. But there is a little bit of difference. Engineering is the application of scientific knowledge concerned with matter and energy to practical problems of design, operations and maintenance of devices in everyday life. Technology is practical use of scientific knowledge in industry and everyday life. These are almost synonymous. Engineer is a person who designs, makes and works with machinery and brings something about by skills. Engineering and technology appear singular but the issue is that of not having a singular faculty, not having any kind of regulatory agency though about 100 years have passed.

Science started evolving after practices. It was reverse working. Everybody wanted to know what logic behind action was. Thus, science answered questions of those who had these questions. Factors which contributed to the genesis of engineering were formations of social groups and the need for organized habitats. Consequently, many branches of engineering came about due to this like, metallurgy, mechanical engineering, electrical engineering, water resources, water supply, etc.

Problem today is that we have so many branches of engineering that one stream of specialist does not know what is happening in the other streams of knowledge or sciences. The kind of exigencies that we have today, they need us to revisit and home back to a situation where we would be able to combine and synergize and then we would find that we need a kind of seamless engineering practices brought about, professionals trained because it is not a singular branch of engineering which would answer all the questions.

It brings out the point about technology and technologists. Who are the technologists? Probably it was an intermediate step towards engineering, more fashionable to use. That is why the terms

P. R. Swarup is the Director General, Construction Industry Development Council

technology and technologists came about. Basically, it is all about engineering. While it is all about engineering, technology and technologist was probably used for it because it was more fashionable. Both are homologous. With the various branches of engineering and the boundaries that have thus been created; there are different kinds of phases; they no longer perform the same functions. What we need is to blend them together and rediscover seamless engineering.

What is seamless engineering? How do we define it? It is a solution to the needs arising out of practical requirements without defining the limits of applications in the context of specializations and workable assembly of streams of knowledge, which can be put to practical applications.

Engineer came up by default from administration because administrators started construction. The schools of engineering came up consequently with first at Gundy, Tamil Nadu and then at Shivpur in West Bengal and Roorkee. The curricula thus developed primarily included studies on tax collection, revenue collection and some engineering subjects. Irrigation also came up. The administrators were given a choice to teach in these engineering colleges for a term and come back to the job.

The intention was that these schools will teach administrators who have technical knowledge. Surveyors and the science of survey came up and surveyors were also basically administrators - revenue collectors and there was a bit of engineering. Irrigation was solely developed in Roorkee. Administrators were given a kind of choice that they would come back to the school and teach and then go back for keeping their position in tact in the public works department. The tradition is still continuing in IIT, Roorkee.

Let us take a look at the construction industry which is today the second largest economic activity and the biggest spender with the annual expenditure around Rs. 3,00,000 crore, employing around 31 million people. It is the second largest employment - providing sector in the economy. Looking at its employment pattern, we find that out of a total employment at 14.6 million in 1995 - 96, around 73 percent were unskilled needing training. It was 31 million in 2005-06; out of which around 83 percent were unskilled needing training in several construction trades. Distribution pattern between unskilled, supervisory and engineer segments also changed with widening shortage in supervisory and engineering cadres.

It is not that we are not creating trained persons; it is because the training that we give is no more relevant. Therefore, they are passing into the bracket of unskilled persons because in the today's context, the conventional civil engineering trades and education, which is being imparted in the colleges and institutions, is no more valid. The earth is not now dug by humans as it was done in the past; a lot of it is now being dug by machines. A project manager at the construction site today needs to be more of a mechanical and automobile engineer than a civil engineer because he / she has to handle a plenty of machines. A project manager at the construction site needs to be a better manager. So, he / she needs to acquire several other skills. These may be related to metallurgy, chemical engineering, electrical engineering or mechanical and automobile engineering. But unfortunately this is the kind of situation that exists. We continue to be in the same mind - set, with the same curricula, same kind of teaching that electrical engineers and mechanical engineers are electrical and mechanical engineers, civil engineers are civil engineers and they are all very different. This is why construction industry is

facing the situation today. We have qualified people, but they are not qualified! We have trained people who are not trained. This is the dichotomy that we have today. We have got to do something to remove it. It is where the professional guilds and the organizations such as the engineering council of India have to do a few things.

Coming to the kind of deficits and looking at the demand, the nation is undergoing a tremendous change as far as the construction of physical infrastructure is concerned. If we look at the requirements and the kind of assignments that we have in hand, as a nation to day, possibly the gaps are much wider and in the next few years, we are getting into a very difficult situation. The same situation, I believe, exists in almost all branches of engineering to day. There is, therefore, an urgent need to cut and tailor things according to the present day requirements.

What does industry need? Industry needs experts in mixed faculties, with better understanding of legal, financial and regulatory systems by the professionals, better understanding of human situation. We have these fine institutions- IITs and of course many other good institutions. Earlier engineering course was of five years' duration when humanities and social sciences, which included macro and micro economics, behavior patterns, language, social practices and other subjects, were taught substantially with 110 credit points in the total of 550 credit points of the complete course. During the fourth and final year of the professional course, a copious inclusion of humanities and social sciences was also included then in the curricula; now it is not the case when the engineering course duration has been reduced from five to four years; in this, the biggest causality has been in the humanity and the social sciences curricula. It has been a biggest blow to the IIT education. This unfortunate development is proving detrimental for the composite skill building of engineers.

It is felt that some kind of internship on the pattern of medical education, some kind of an extended duration of training and teaching is required. We must inculcate this. We should not have gone backwards, as we did!

A strategy for action is that the professional guilds, institutions and the Engineering Council of India should join hands and evolve a workable curriculum. Industry must spell what to teach; the professional guilds should validate it and adopt continuous professional development. Seams in the engineering education should be removed at the undergraduate level. Finally, as a sequel of the discussions, a task force may be set up by the Engineering Council of India which would look into these aspects and suggest remedial measures.

Raji Philip

While delivering his inaugural address, Philip stated that he was glad to know that the Engineering Council was in the process of taking a firm shape as an apex body of engineers in India, which is very much required particularly in the context of WTO environment that had come up and was going to stay.

Raji Philip is the Chairman and Managing Director, Hindustan Paper Corporation Ltd

For a practising manager like me, knowledge is in-divisive. In management, we have been grappling with the problem of managerial functions and managerial processes. Many of you would have heard about the business process reengineering. It means that we first unbundled the managerial tasks, we go to different functions and sub functions, departments and sections. Then we reassemble the tasks which at the basal level we call coordination and at the sufficiently enlightened level, we call it information processing and synchronization. I would like to add one more term, therefore, to the subject of seamless engineering, which is being discussed at this national convention today.

It should be synchronous; it should be concurrent; it should be simultaneous. A definite trend in the world of knowledge creation and its dissemination can be seen quite clearly today which is essentially a trend towards convergence and indivisibility.

We see in the paper industry a tell tale of convergence. Every newspaper wants today to be a media conglomerate. They are no longer confining themselves to the print media. They also broadcast own FM radio and move into cyber space. So, there is a definite movement towards convergence. A similar parallel can be seen happening in the medical sciences today. This can also be seen in the concepts that are coming up now like the holistic healthcare and holistic medicine. There are many super specialties where patients are treated on the basis of reports that it is a situation when the Doctors, Physicians treat reports rather than the throbbing, pulsating humans - the patients.

A similar parallel is occurring even in the classical discipline of economics. There has been a dichotomy between development and growth. Economists like Dr. Yandrees and Prof. Amrtya Sen have brought it out in sharp focus. While the growth can be cancerous, development cannot be lopsided.

Likewise, in the engineering disciplines, a similar dichotomy is visible. Paper industry does not find today engineers of pulp and paper technology anywhere. None is joining the pulp and paper technology course in the IIT, Roorkee. Engineers are either joining software firms or the consultancy firms. If these are not available, they go for higher education in management.

Whatever we may do with regard to re - engineering of the engineering curricula for which a lot of ideas have been thrown up like, campus-corporation collaboration, institute-industry interaction, we want reflective practitioners. Academicians should make a temporary transition to the world of work from the world of teaching.

Any change that we may want in the conventional practices cannot be done through legislation. It can be better and quicker done through credible consensus building process. This is what I think that this convention on the Seamless Engineering, organized by the Engineering Council of India, is trying to realize.

As Swarup, DG, CIDC has suggested that for the CPD, Engineering Council of India should have a role to play in the renewal of the engineering curricula. Let people go back; let them be trained, tested and certified.

I would like to thank the Engineering Council of India for organizing this forward looking, apt and timely national convention.

J. C. Marwah

While presenting vote of thanks, he stated that the Engineering Council of India (ECI) has been created by 24 professional engineering bodies and the Indian Institute of Metals (IIM) is one of the founder members of the council. It would have to be contended with IIM and many of its other member bodies who are much older to it. ECI, as an apex body, would have to take care of the age of its member associations / societies while dealing with the matters of common interest.

Dr. Placid Rodriguez, Past President of IIM and former Director, IGARC has talked about the vanishing boundaries of the various engineering disciplines. P. R. Swarup has dealt at length with the construction industry, which is the rising sun industry. Unfortunately, India is lagging behind in this important sector and many a time it has to import expertise for taking up construction projects in the country. While presenting his views, he stated that there is the need for seamless engineering, which he explained with appropriate and illustrative stories from the Panchtantra.

Citing his own example, he stated that a person's career is guided and shaped by circumstances. He moved from Aeronautical to Mechanical and finally to Metallurgy consequent to some circumstances which emerged. There are many similar examples in industry. Raji Philip has mentioned about human resource shortfall in the paper and pulp technology. This is a common factor in almost all branches of engineering- Civil, Mechanical, Electrical, Metallurgy, etc. Institutions like IITs, NITs and others are going to play a vital role in dealing with emerging phenomenon. With the first convention on seamless engineering, which is being held today, we are creating a history. It may take a few years to take shape to formulate itself into a policy framework, it is a landmark step that the Engineering Council of India has taken and IIM has supported. I can say that IIM, which is 60 years old today, has encouraged such pioneering efforts.

J. C. Marwah is the Secretary General, Indian Institute of Metals

TECHNICAL SESSION - I

(Synergy between Different Engineering Disciplines
for Seamless Engineering)

TECHNICAL SESSION - I

(Synergy between Different Engineering Disciplines for Seamless Engineering)

Chairman	-	Dr P. Rodriguez
Key Note Speaker-1	-	Dr. A. R. Upadhya
Key Note speaker-11	-	Alok Ghosal
Key Note speaker: III	-	S. Ratnavel
Key Note Speaker-IV	-	Dr. Sandip Bhattacharya

Dr. P. Rodriguez

Dr. Upadhya is eminently qualified to be the lead speaker at this session. Before he took up his present position as that of the Director, Aerospace Laboratory of the DRDO, he was with the Aeronautical Development Agency-ADA. This is the agency which developed and implemented the project of Light combat aircraft LCA. In this project there is a lot of seamless engineering involved. So, the subject of the convention makes more sense to him. Views that he will share with us will set the tone for discussion on this important subject.

Dr. A. R. Upadhya

I share the view expressed by Swarup, that in our times at the IIT, we had to study engineering for 5 years and the course was of annual scheme and not in semesters. There were many general subjects that we had to study. This included humanities subjects like history, economics, constitution of India, surveying, industrial engineering, industrial psychology, industrial management, etc. It laid a solid foundation towards developing an overall appreciation and understanding of the socio-economic needs which, I believe, is very important in an engineer. Professionally, I have been involved with aerospace engineering, which is a multi- and inter- disciplinary area involving many engineering fields. The areas include materials, structural design, aerodynamics, propulsion, flight mechanics and controls, ground and flight testing and evaluation and the like. One can see that in this area of engineering specialization, a lot of seamlessness is involved. Therefore, seamless concept makes sense in such areas of specialization which demand across- the- field skills and abilities. You need people with highly specialized skills and expertise. At the same time, there is a lot of seamlessness required because if you want to make an efficient flying machine as an engineering system, all the groups involved need to work with each other with perfect understanding and a continuous flow of information between them.

Dr. A. R. Upadhya is the Director of the National Aerospace, Laboratories, Bangalore

Young children are inherently very curious and active, with strong impulses to investigate, to share with others what they have found out, to create and construct things. In other words, a child is a natural engineer. Unfortunately, in India, our education system tries to suppress these impulses by overburdening children with extraordinary amount of academic work from a very tender age. In fact, children are not allowed to play. From the age of 3, they start in the nursery school and then to KG, primary school and so on. They have to carry a heavy load of books on their shoulders and at the end of the day, come home and do a lot of home work. Also, at home or in school, they are not allowed to touch things and explore for fear of spoiling them. Thus, children do not get enough time to play and develop their creative impulses. Unless you allow children to ask and question, to do things with their hands, give vent to their creative impulses and imagination without any fear or complexes, they are not able to develop in them skills to find out for themselves as to what it means to create things. And that skill is fundamental to a good engineer.

Looking at the current status of engineering education in India, we find that there are a large number of disciplines and so many colleges dealing with these disciplines. We started with the traditional branches- mechanical, civil, electrical, chemical, metallurgy and so on. Subsequently courses like electronics and communication, instrumentation, computer science and engineering, information technology and software engineering, bio medical engineering, environmental engineering, etc, were added to these disciplines depending on the need in the society. So more and more specialised courses came into being, making an engineer a specialist even before he passed out of the college. This has resulted in engineers who know very little outside their branch of specialization.

As has been stated in the convention brochure of Engineering Council of India, you may have noticed that an attempt has already been made at introducing the concept of seamlessness in engineering education with the introduction of courses like production engineering, industrial engineering, mechatronics and design engineering etc. in the engineering disciplines. What has come and what is going to come in the future is basically directed by the users and industry demands. Some seamlessness is already brought in, say, in production and industrial engineering because the production engineering curricula also covers manufacturing, design as well as production management principles; mechatronics curricula covers also mechanical engineering as well as control engineering, designs etc,. It has however generally started becoming highly compartmentalized in terms of specialization. It is seen that nowadays many new engineering colleges are coming up with some of the disciplines which fall somewhat on the seamless side of the engineering education (perhaps inadvertently!). For example, this is the trend in Bangalore; it may be the practice elsewhere in the country also.

It is ironic that IT- related engineering courses are started in colleges where there are no hard-core engineering laboratories or workshops while the IT industry itself employs engineers from all the disciplines. Perhaps, it is because of the fact that an engineer (properly trained one!) is basically trained to plan and manage things very well. Hence, the IT industry finds them useful.

The problem in the engineering education in India is that things have not changed during the last three decades. Some of the concepts that are being taught, topics and subjects that are in the curricula, are quite outdated. There is too much of pure sciences and mathematics with no clear idea of their

relevance to applications. While too much theory is taught, too little emphasis is given to experiments and on-the-job training. There is no solid interdisciplinary base. There is too much of the compartmentalization. Students have no idea as to what they are studying and what they are going to do. An engineer after passing out enters industry and then only he / she is trained there for meeting his / her job requirements. There is, therefore, no correlation in the present engineering education system between engineering courses taught and their relevance to the job requirement in the industry.

In the present four years curricula of engineering, one is not sure whether it is keeping pace with the developments in technologies. Many times these developments are interdisciplinary in essence, concept and applications. In the present semester system, students are interested to study only that much which will enable them to pass with enough marks. It is the grade / marks that are actually pursued seriously by them. Students do not look at the full course content because that is not considered necessary to get a first class or distinction in the course.

What is, therefore, needed in the circumstances is making subjects up- to- date and more relevant to the present day requirements or job profile. Science and mathematics curricula need to be made application oriented and, therefore, more relevant. More interdisciplinary subjects need to be added to the engineering curricula. The courses should be such that they would give confidence to experiment, invent and innovate. What is required by an engineer at the basic learning stage is that he / she should be able to design a system, build it and test it. It is only then that he / she would know as to what it means to design and develop and implement a project or operate and maintain a system.

Technology today has become more interdisciplinary. There is no subject which can make you understand technology in its entirety; it needs interdisciplinary skills and knowledge to understand and comprehend it. Take for example controls and software; it has become a part of every engineering discipline because software and control concepts are used everywhere today. We are developing almost all future aerospace technologies based on these concepts. We need highly and widely skilled scientists and engineers to work on the futuristic technologies. So, perhaps some seamlessness is already built in here.

Engineers today are packaged as problem solvers rather than innovators addressing grand challenges. Primary school is not too early to start building the foundation for an engineering education. You need to develop in a child appreciation for what is engineering. It is what it means to create, develop, build and test it on its own. Young people need to understand the contributions that engineers can make to improve the quality of life which is controlled now a day by technology to a large extent. Engineers on the other hand must respond to the sudden changes in the real world. They should be able to absorb and respond to these changes quite fast. Integrating engineering with liberal arts is necessary so that the technical literacy is also considered a basic component of the basic literacy of the child when it comes to engineering. What we also need is to develop excellent communication skills, a role in and responsibility to the society, role in creating responsible and informed public policy.

We generally compare when we talk about seamless engineering with medical education. When a Doctor can be a general practitioner, why not an Engineer? Yes, there are similarities. But there is also a major difference there. A General Medical Practitioner diagnoses the problem and tries to find a solution to it. Every one of us needs a Doctor, but every one of us does not need an engineer. If the

problem is beyond the capacity of the General Medical Practitioner, he / she will suggest a higher level or a specialist examination. An engineer also needs to diagnose a problem and also find a solution to it. Say, like a maintenance engineer finding a problem and also suggesting a solution. Sometimes even he / she also needs to consult a specialist to solve the problem, if it comes from a bad design of a machine, a component or an assembly. What is more important however, is that he / she has to create a new product, a new technology, a new idea unlike a doctor.

The basic challenges of the engineering education are the ever changing world of engineering which demands a new way to educate future engineers. So, the engineering curricula should encompass effective use of computer tools, a greater variety of organizational work contents, management concepts, basic concepts of economics, statistics, basic concepts of other disciplines etc,. As a matter of fact since the last decade, the engineering profession as such has become more interdisciplinary. Therefore, seamless transition in the engineering education has become important. This cannot be ignored and keeping status-quo in the engineering education cannot be afforded in the given circumstances. Hence, this convention is very apt and timely.

Suggestions that can be made are that the basic concepts of the social sciences and management, more of applied science and mathematics and basic knowledge of the other branches of engineering for making basic engineering education truly interdisciplinary need to be brought into the curricula of the engineering education at the undergraduate level; specialization not in the traditional mode of civil, mechanical, metallurgical and so on, but in a subject specific mode, say, design, processes, etc, could be brought in at the postgraduate level. Bringing in interdisciplinary mode in the curricula can be done in the first three years of the course. In other words what is being suggested is that seamlessness needs to be brought - in in the first three years of the engineering course. The other way could be creating rather specific branches like, say, general engineering (with a mixture of mechanical, electrical, civil, control, software, etc for catering to the needs of the general engineering industry). The curricula for engineering needs to be set according to the present day and emerging needs of the industry. It has to be worked out by the industry itself for what it wants. We should not look at engineers as just service providers, but also as innovators and creators.

There could be a four - year course at the undergraduate level followed by a year or two years' internship in an industrial unit and a two years' postgraduate course thereafter depending on what the student wants to do - become an engineer, manager, a design specialist, a process specialist, a hardware specialist, a nuclear engineer, an aerospace engineer or technologist, a power engineer, a steel specialist, a thermodynamics specialist and so on. We could also, as suggested above, consider a basic three years course at the undergraduate level followed by two years of working and then returning to the college for another year's course and then go for post graduate courses, if one wanted to do so. This subject needs to be further discussed in depth before a consensus is arrived at for a change through an appropriate policy framework.

A beginning has been made with this convention. It needs to be taken further to its logical conclusion.

Alok Ghosal

When we go to the engineering colleges, we are not oriented in the right direction. Even in my case, when I went to the engineering college, my orientation was not proper. I spent five years in the college and I was, therefore, not that lucky as those students who did engineering in four years time as against my five years time. In those five years, I also became an engineer like them. What I want to say is that there is a difference between a product and a process. Engineering is a process and engineer is a product of this process. In my case I think a product was produced taking more time when compared with the students who did engineering in four years time. I would not say that my process was better, because it took five years time to complete as against four years in case of them. Almost all engineering colleges do give much importance to the product; less importance is given to the process. It means that what we learn in engineering colleges becomes more important rather than how we learn. In my opinion, this is the unfortunate case in present engineering colleges.

We are becoming good engineers but not good engineering professionals. We go on like this. We have not learnt how to observe, how to innovate, how to create, because, we are not taught all these. Emphasis in engineering colleges is on a set course curricula and the time in which it is to be finished. It is routine and dull, so to say. As engineers, experience says that normally engineers of one particular discipline land in jobs of a different discipline. Engineer does different things than what he has been taught in an engineering college. This is why engineers forget all that they have learnt in engineering colleges by the time they get to 40 years of their age.

I am a mechanical engineer by qualification; I am working in a steel manufacturing company and teaching technical education in the company. In other words what it means is that what I was trained to do, I am not doing. Similar is the story of most of our engineers. I have met a metallurgical engineer working in a thermal power plant. You may have a similar experience to share, I am sure. I became a good engineer i.e. the product, but the process was perhaps wrong. I am not applying what I have learnt in a right field. Over the years, so much knowledge in engineering and technology has increased. We are still compressing it in four years. Are we on the right course?

I think, in the present engineering institutions, we spent four years where we should spend 6 years for keeping pace with what the present canvas of knowledge contains which is ever increasing in size .When engineers join a two - years MBA course, a general experience is that they have to toil hard for it. What I mean to say is that so much is being taught in an MBA course in two years, why cannot we compress it and include it also in the four years or five years of the engineering course. It is essential because engineers, when in an industry, mostly land into doing management job and, therefore, engineer considers it a requirement to study also the MBA course. Without this, engineers end up as bad professionals as well as bad managers; and that is why we have problems around us. It is also the reason, I think, why the IT sector makes mockery of engineering institutions.

You must have heard that the Indian School of Mines in Dhanbad, mining is taught which is a special course, a special stream altogether. IT companies pick up mining engineers for their field.

Alok Ghosal is the Senior Manager, Technical Education, SNTI, Tata Steel

Recently they have picked up around 60 mining engineers from the school. Is it not a mockery? Next time probably we will hear that IT companies are picking up MBBS students because they seem to need hands with little brains. General Ford, when he wanted to use men to increase his production, said that I require only two hands for this purpose. Like-wise, IT sector is looking for hands with a little brain.

According to the August, 2006 issue of Business India, USA produces more engineers despite having less number of universities and around a little more than half of its population when compared with India. Primarily, it is because USA produces more general engineers; and India does not.

I would, therefore, suggest that in order to meet the present requirement of industry, anybody who wants to finish engineering with general engineering should be able to do so and enter industry as an engineer; and anybody, who wants to branch out into various special streams of specialization, he / she should be able to do it during the subsequent two years i.e. during 4^{th} and 5^{th} year of the course. We should, therefore, have general engineering course and produce general engineers who could do any kind of job. Specializations can be done at the undergraduate level itself with two years more course in continuity to the three years of general course. Alternately, it could be a general course of three years and two years of specialization thereafter - either in continuity or with a break of two years which can be spent in an industrial unit. Another alternative could be a four - year general engineering course at the undergraduate level and two years course in particular specialization at the postgraduate level. In this alternative also there could be a break of two - to- three years for taking up employment in an industrial unit. We can select the required alternatives. We should further discuss this, in-depth. In other words adopting seamless engineering at the undergraduate level has the merit in the given circumstances. It needs, therefore, an in-depth consideration.

S. Ratnavel

As a practicing engineer consultant, I will like to make a statement that there is no difference between theory and practical. If anybody says that he does not know how to interpret theory, he will do practical. It means that whatever we are learning in the colleges, it is all useful in the field. Whenever we have to implement any policy for meeting the societal needs, we have to consider two things; one is its intended impact and the second is its unintended impact on the society. Technology is a doubled edged knife. You take any professional, a Doctor, an engineer, or any other, unless you know how to convert your mental model into reality model or practical model, you cannot effectively communicate with the policy makers, clients and with your subordinates and you cannot achieve any productivity.

You need methodology and not merely information-methodology for communication and for implementation. For this, what is required is that we must be familiar with the basic sciences. No invention takes place without a need for it. For example, it needs to be addressed properly because these are generally dynamic and complex. Technologist as well as politicians need address the needs properly for bringing in the appropriate response through an appropriate policy and technology for meeting these needs again appropriately. There has to be a synergy between the two. For addressing the needs properly, we again need methodology.

S. Ratnavel, is the Chairman of the Engineers Bill and the Professional Development Committees of the Association of Consulting Civil Engineers (India)

In the name of development, we are doing constructive destruction; take any project for that matter; a dam, a road, any other infrastructure project. Most of the projects from an automobile to nuclear power plant are destructive. If the technologists and policy makers had a vision 25 years back, the problem of environment that surfaced seriously in Delhi due to auto - pollution, as it would not have come up because the technologists and policy makers would have thought of bringing in CNG in place of petrol or diesel then. They did not do this probably because of lack of knowledge or initiative or both. The crises, which arose because of the problem of auto -pollution, would not have arisen; as it did arise due to not taking preventive action for a change from petrol and diesel fuel to CNG fuel.

In Faridabad, reportedly, around 1000 industrial units have been closed due to environmental considerations. Therefore, vision is more important. Presently, more then 90 % of engineering graduates reportedly are unemployed. This means that their engineering degree does not meet the needs of the industry. The industry needs multi skilled engineers. This is primarily due to emerging interconnectivity and synergy among various engineering disciplines at the industry level. It is not that they are not capable; it is because they do not meet requirements of the present jobs in the industry. One such example that can be cited is the construction industry. Graduate engineers who come out of colleges are of conventional specializations-Mechanical, Electrical, Civil, Electronics, etc, while as the construction industry needs multi skilled engineers who have in them skills to deal with mechanical, electrical, electronics, computer, automobile, etc, related engineering tasks; which are combined in a job in the construction industry. In other words it means that a construction engineer should be a multi - skilled engineer and not an engineer having merely skills of traditional engineering disciplines. Presently, engineers are not taught to handle multidisciplinary technologies as these are in the construction industry.

Engineer is ready to work for Rs 1000 a month pay. Why? He / she wants to work for this pay because he / she wants to learn as to what is happening in the industry. For this, he / she considers the money offered handsome for this learning. Engineering colleges do not provide this learning. A saying supports the argument which says that it is on the shop floor that an engineer becomes a skilled engineer and in the discipline in which he / she is working there, which may encompass, as it does actually, many traditional disciplines of engineering as well as the other disciplines such as, management, economics, statistics, etc. Is it not a seamless engineer that he / she becomes on the shop floor?

Construction industry is willing to pay Rs 15,000/- a month, but it does not get a civil engineer; while as engineers join for Rs. 1000 elsewhere. An engineer joins instead construction industry at a low pay just to understand what is really there and after four years of working in the industry, he / she starts calling himself / herself construction specialist or in other words construction engineer, which is in demand with a very attractive pay package So, in other words an engineer enters the industry in the first place at a low pay to become a construction engineer, which is in demand, not a civil engineer. This is what is not happening through the present engineering curricula in engineering colleges, as it should have happened.

There is difference between knowing and learning. Learning cannot be done in the present educational system that we have. It can be done through gaining experience when working in the field. If you learn something and in the field do some thing else, your learning will be seriously affected. It is the mismatch of knowing and learning in the present engineering profession. We can remove this mismatch through seamless engineering.

Coming to defining broadly the contours of the seamless engineering curricula, it is opined that the subjects such as technical forecasting, management, technical assessment, environment assessment, legal, arbitration, settlement of disputes, mediation for this, system dynamics, and system engineering methodology are needed to be taught and can be applied in any discipline of engineering. The other subjects that can be added include human dynamics, human settlement, rural dynamics, etc. We should also teach inter- relations between the various disciplines at the graduate level of the engineering course. It is then only that an engineer will become skilled, wholesomely. This is what we need today.

Dr. Sandip Bhattacharyya

The seamless engineering comes as a process of graduate engineering. All practising engineers have to be basically seamless engineers. Why it is so? It is because that it will be difficult for an engineer of one discipline to work in an industrial unit on a product which involves knowledge and learning of many other disciplines. My own experience tells me that it is a practical reality. An American Thinking says that a man is wise with the wisdom of his time only; and he is ignorant with his ignorance only. This is the basic philosophy. This is true of people like me and you because we are ordinary people. A handful of people appear amidst us once in a while. We prove exceptions to this rule. At one level these exceptional people are products of their time. But at another level they transcend their times, their perceptions, their insights and their concerns are truly universal in time and space; they are neither constrained by the circumstances of their birth nor are they limited by the ignorance of their time.

Basically, modern science and technology work in simplicity. There should be no artificial boundaries. Not so for mind. A borderless mind and borderless thinking will only lead to borderless world. It would be better for human progress if we use borderless professional skills in solving our problems in developing our future ease. It is enshrined in the philosophy of seamlessness and hence seamless engineering makes ample sense. For the borderless thinking and borderless mind, we need a fundamental change.

It is not that we are now talking of seamless engineering. It was there in the past as well. Think of aviation, we find that it is the synergy of different disciplines of engineering and coupled with science which makes the final product- an aircraft. Developing an Atom Bomb was not a task of a single engineering discipline; it was a task of many engineering disciplines working together which seamlessly produced the Bomb.

Presently, bio technology and nano technology (ies) are the fast emerging fields. It needs a multidisciplinary research for developing these emerging technologies. Similarly, industrial engineering is not only engineering, it is much more then that- materials, equipments, controls, information technology, metallurgy, mechanical engineering, chemical engineering, plastics, fibers, furnaces, fuels and so on rolled into one whole-which is industrial engineering. It also encompasses social sciences, management sciences, etc. Is it not seamless engineering?

Bio-medical engineering (BME) is a combination of physical, biological, mathematical and engineering principles of many disciplines -all coalesced into one whole.- for the study of bio medical

Dr. Sandip Bhattacharyya is Head Metallography, R&D and Scientific Services, Tata Steel Limited

systems. Besides, patent laws, intellectual property and ethics are also involved in this subject. Is it not a seamless engineering? Take for that matter another example; this is of medical imaging. It requires collaboration among computer science, bio engineering, applied mathematics and the school of medicine. It involves diagnostics and treatment technology using medical scanning data such as CT, MRI, Ultrasound-Rays and PET, SFECT. These subjects do have engineering principles which transit many disciplines.

There is seamless-synergy geographical also being witnessed these days. Exchange of ideas is a universal phenomenon among scientists and engineers today. The vanishing boundaries between engineering and sciences are fascinating, indeed. A new breed of engineering scientists is emerging. Such engineering scientists would be real compatibleness when it comes to forging new partnerships. Partnerships between disciplines are beginning to not only give rise to new vistas to knowledge but also to new insights. There are many instances where one is trying to gain understanding of a common problem considering the issue of human mind itself. For example, computer science emulates its capacity to visual perception. These days one meets engineers who work on speech perception; biologists who investigate the mental representation of the spatial relations; and physicists who want to understand consciousness. Physiologists continue to study perception, memory, and action. There are numerous similar examples which indicate a serious and fast integration of knowledge and thus vanishing boundaries of disciplines and its conversion into seamlessness. A successful engineer in the present context should not only have a strong technical capability, but also the knowledge of the functioning of interdependent elements of an engineering system.

In conclusion: it is stated that the development of a multi disciplinary engineering curricula appears apt and timely and needs to be pursued.

From the Floor

Dr. T. K. Dev

The border less thinking is very essential these days for tackling various issues concerning technology and industry. These days a new phenomenon has surfaced, it is a sort of role changing from the traditional things, as we know them. This is that physicists do engineering and engineers do what the physicists have been traditionally doing. Engineers need to learn at the undergraduate level some fundamental subjects such as, physics, mathematics, engineering management, science management, etc, for enhancing their skills. Knowledge is integrating fast all over. Engineers need to keep pace with this change. Therefore, we need to enable them to do so. For this, teaching through simulation technologies would give quicker and clear concepts to engineers in multidiscipline. This is what would enable engineers to acquire a large and wider knowledge. The use of animation technology would also be very useful as a tool to make engineer's multi - skilled. We should not increase number of years at the undergraduate level; we can do it in the present span of engineering course by using simulation and animation technologies. The other way would be training engineering students for specific work in industry and set up courses and colleges accordingly; even the industry can itself do it.

Dr. T. K. Dev is from the Variable Energy Cyclotron Centre Calcutta, which is a constituent unit of the Department of Atomic Energy and Chairman, IET, Kolkata Centre

TECHNICAL SESSION - II

(International Experience on Seamless Engineering)

TECHNICAL SESSION - II

(International Experience on Seamless Engineering)

Session Chairman	-	Dr T.K.Dev
Key Note speaker - I	-	Prof. C.V.Ramakrishna
Key Note speaker - II	-	John Tripllet
Key Note speaker - III	-	Prof. B Dattaguru

Prof. C.V. Ramakrishnan

The importance of the engineering education is very well known because it is engineers who create wealth and hence the well being of people. The paradigm change with globalization has brought in split location manufacturing and outsourcing of services. Some component is manufactured in India and some other elsewhere and assembling is centralized at some other place. In such a situation quality of engineers is extremely important. Consequently, the quality of engineering will determine the talent pool which should meet the requirements of the paradigm shift. So, every country is trying to produce the best engineers for improving its overall global position. This is what is now required in order to stay in the business in the field of engineering.

What are the different engineering systems that are present? Anglo-American system is where we have a bachelor's degree followed by the masters' degree and then PhD. The German system is a diploma in engineering which is of four-and-half to five years' duration followed by a PhD. The French system is slightly different from the German system. The Russian system is of four years of bachelor's degree and so on.

South Korea is a fast emerging economy with a population of around 15 million and 4 % of the population is in the universities .Out of the population in the universities, 80 % study engineering. This gives the kind of importance that is being given to engineering in South Korea. This being so because they think that the prosperity is due to engineers.

It is not that we alone are having confusion about the engineering education. The whole of Europe has been having quite a bit of discussion in this regard. A variety of engineering qualifications are there. So, to remove this confusion, Europe has adopted Bologna Declaration. Consequently, they have decided to have a bachelor's level of education followed by a master's level education.

What is that which has changed during the recent times? The work is done today by teams across different places. Education is no more static; it is continuing; job-skills are always changing. Career advancement involves adopting multiple strategies. Work performance is now linked to personnel growth.

Prof C.V.Ramakrishna is the Professor Emeritus, IIT, Delhi

What is happening in IITs in India? While the curriculum in IITs is flexible, it is based on a rigid format. Review of the curriculum is, however, carried out periodically. In IIT, Delhi, credit requirement is 180; out of this, the concerned department has 50% of the credit; and the other 50% consists of categories such as, the basic sciences, engineering arts and sciences, humanities and social sciences and management including entrepreneurship, engineering discipline core and electives and outside electives. Essentially, only 50% is engineering discipline curriculum. The current proposal of AICTE which is getting through, 185 credits are proposed and the break up is more or less very similar to that of the IIT system with a little bit of changes here and there to accommodate university- specific innovative variations.

What are we really suggesting when we talk about seamless education? Are we going to propose that it will be adopted in all the 1400 engineering colleges? Probably not. What are we looking into to start with? We are looking forward to introducing seamless engineering curriculum in a few engineering colleges for testing it for a few years and then replicate it in more engineering colleges. Let us look at some international models which are there. We have got to think out of the box. We have to think that the programme would have to be highly interdisciplinary; it has to have a high industry-related inputs; it has to be international in nature - both students and faculty; it has to be such as would lead to industry seeking students rather than students seeking industry.

Ecole Polytechnique in France produces and similar Institutions produce the industrial leaders of the country. In other words, most industry leaders come from these institutions. Students prefer to go to these colleges and prepare for two years for entering in these colleges. In case they fail to do so, they opt for the other colleges.

Cambridge University has an engineering college. The University offers a BA (Hons) degree in engineering which is of three years' duration; but it is not considered as the complete engineering education programme. It is to be followed by the 4^{th} year engineering programme. The University offers B.A. (Hons) in engineering and Masters in engineering degrees. The structure of the programme is that in the first year common engineering subjects are covered, which is, by and large, also repeated in the second year. In the third year, discipline-wise courses are covered along with some general courses; and the same thing is repeated in the fourth year. In the first year, all the students study sufficient amount of subjects of all the disciplines of engineering including information technology, computers, materials, etc. They undergo 16 laboratory experiments. They even study some foreign language courses during this period. In the second year, courses taken up in the first year continue. In the third year, they choose some specific courses in a particular discipline. Essentially, branching starts in the third year. The most important component is an elaborate team project.

Oxford University also offers an engineering degree. Essentially, Oxford University and Cambridge University courses for the first two years are similar. In the Oxford University, from the 3^{rd} year there are two streams - one is engineering, the second is engineering and computer sciences and the third is engineering, economics and management. The specialization is done in the 4^{th} year.

In France, Ecole Polytechnique programme starts after two years of the university preparation for admission-that is after higher secondary education- students go to the university for preparation to enter the Grand Ecoles when they learn thoroughly mathematics, physics and chemistry. After this

university preparation which is called "pre petoire", they write a competitive examination for entering the polytechnique. It is one of the toughest examinations and only around 60 students are selected on an average in a year from whole of France. Some international students are also selected. The examination is also the common entry test for other Grande-Ecoles, which are also prestigious, apart from Ecole Polytechnique. They come through track two examinations.

After the two years of university "prepetoire", it is a four years master's level programme. It is a highly multidisciplinary scientific education leading to high level of expertise. The programme also includes internship and work place experience. After a student enters the Ecole Polytechnique, during the first two years of the four years' course, common courses are done and thereafter the graduate courses are offered. Thorough emphasis is given on the basic sciences and engineering sciences and subsequently into various specializations. In this, personality development is considered very important. A military training for the French students is also compulsory. The programme is highly specialized.

There are different ways of professional experience before graduation; these are by attachment with a national laboratory for doing the project there; or by attachment with an industrial unit and doing the project there, or, visit another country and do the project there.

John Tripllet

The standard model thirty years ago in the US the engineering education at the undergraduate level was four years followed by two years of masters degree. Probably, it was four years of PhD thereafter if you decided to go all the way through the system. Through all the branches, in all the educational disciplines, first two years at the undergraduate level, survey courses were given. It did not matter if you were doing engineering, arts or business courses. After survey courses, you were free to choose a specific measure for the next two years when you completed the BS. If you wanted to go for your masters, for another two years, you choose continuing with the same specialization. Engineering colleges found that they could not get all the necessary course work completed in four years course schedule for engineering. Further, if the university required further course work to call some body educated, it would have to be done. Thirty years back, the calculus course was done in three-quarters time in the art education courses and just in one quarter time in engineering education course. Thirty years back, squeezing exercise of courses for engineering education programme had already started. The trend continues even today also. Engineers were required to do more in the same time frame. It was a very vicious squeezing exercise, indeed.

The problem India is facing to day, we are facing the same problem in the US. We have engineering students getting more and more education in shorter and shorter space. We have at some places engineering programmes of four years duration and at the other places also of five years duration. You have survey courses of two-three years duration across the board, art courses and other general courses and two years of specific engineering courses. At the masters level you specialize in some specific area and the PhD is a specialized area altogether.

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Prof. B. Dattaguru

The Problems faced by the industry in recruiting and using undergraduate and graduate engineers for its work have been covered excellently in the outstanding previous presentations in the convention. There are certain lacunae in the engineering education. The industry looks for leaders who could have real seamless thinking, borderless thinking because most of the mega projects are interdisciplinary, inter fields which in other words mean that these projects cut across both the engineering disciplines and educational fields. Interdisciplinary means-civil engineering, mechanical engineering, chemical engineering, computer engineering, metallurgy, aeronautical engineering and so on; and inter field means schools of medicine, engineering humanity, economics, information technology, law and so on.

What are we talking about is just not only to have seamless education but to have seamless teams in industry. It means in other words that the industry needs people who can look across the domains; across the boundaries and across the schools.

Will it help to have a seamless education? Prof Ramakrisnan, IIT Delhi who made an outstanding presentation before me said that "don't go and dump it across in all 1400 engineering colleges; but develop it at some colleges and pick up some people who will go for seamless way of thinking; and with some experience expand it further to more engineering colleges". I would not agree more with him. It is how we will be able to develop some leaders for the industry. Whole world cannot be leaders. Otherwise, there is every possibility of the whole system collapsing. We should see how it works. It is not going to be easy. We need teachers who will teach seamlessly. We will have to develop these teachers as well. Unless you have good teachers, you cannot get the benefit of having a borderless education system.

What are the issues with the current education? These are that there is too much and too many specializations; it is not conducive to developing industrial leaders who can handle multi disciplinary mega projects; it does not provide enough knowledge about globalization; about international issues; about intellectual property rights (IPR); about legal matters; about contracts and how to draw them up; about how to resolve disputes; about arbitration; about management functions which are needed for engineers to handle mega projects; about effective communication and managing communication and so on. There are many more like issues. It is not a complete education system that we have at present and what we should have for making engineers' multi skilled for managing the mega projects - from concept to completion and operation.

What are we talking about for tackling these issues? We are talking about producing engineers without specializations i.e. seamless engineers have the leadership capability, are very effective and efficient in communication skills, are well aware of the issues of globalization, have a reasonable knowledge of management functions, law and developing contract documentation, managing them, skills to handle disputes, skills of inter personal relations, skills to handle arbitration, a reasonable knowledge of economics, markets, a bit of skills of statistics and so. In short, engineers should have

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these skills for managing interdisciplinary mega projects and competition. The postgraduate education may combine specializations for those who choose research and teaching career. This is like swinging the pendulum from one extreme to another extreme. This needs further in-depth consideration, which we should give to it before we decide finally about the change in our engineering education system in spite of the merit of the seamless engineering.

What should be the duration of the courses? We can examine in depth having four (4) years of general engineering curricula followed by two years of specialization- provided one wants to go for it. We can consider of having a year's of internship in an industrial unit after general engineering curricula before granting the degree. For those who want to go further for two years of specialization course, no internship may be required. As an initial step, we may develop a few colleges of the seamless engineering curricula; and let us see how it works; and then go for its expansion. We should also keep in view that we have a large population, some of them are born brilliant while some are not so born. We, therefore, need to consider about a methodology to choose from among such a population who should opt for specializations and who should go for the seamless curricula. We should also look closely at the list of various specializations and we should try to prune it down for making it to meet the needs of the time.

We should impart a wider engineering background in subjects other than those of the field of specializations at the undergraduate engineering level; while as the specializations can also be retained for those who want to go for it. But we should, at the same time, consider cutting down institutions of specialization far below the current level. We should consider mergers in specializations for better synergies in the cutting down exercise of the institutions of specializations. The entire engineering education system needs to be looked into closely for working out the desired change in this.

We should have schools of the type of the School of Engineering and Technology, University of Purdue which impart education across the fields. In this school students go through many general courses also apart from engineering. This is why the school produces leaders. The School has one department which is very close to our seamless engineering concept that we are discussing. We need to have such multi departmental schools for training industrial leaders.

In conclusion, I quite agree that we have remained fixed in the matter of engineering education. We have not maintained the kind of dynamism for changing it so that it could meet the needs of the time and produce true industrial leaders that we need very badly now. We need the change. We should erase our mindset. We should go for it. I, therefore, agree with the subject being discussed at this first convention, which, I would say, is apt and timely. We should develop engineering schools with multiple fields and where multiple disciplines including other than engineering are taught under one roof; and where facility is provided to students to study with credits across the specializations and of inter fields; a sort of a hybrid approach is what we need to adopt for realizing the primary objective; and, at same time, we should retain the postgraduate education with its research flavour.

PANEL DISCUSSION AND RECOMMENDATIONS

PANEL DISCUSSION AND RECOMMENDATIONS

Session Chairman	-	Dr Manamohan R. Kalgal
Panelist-I	-	Dr A. K. Das
Panelist-II	-	Prabir K. Datta
Panelist-III	-	Dr. Sudip K Das

Dr. A. K. Das

While starting a discussion and debate on a topical and professional subject like the seamless engineering, one question comes to mind: what is the purpose of education. The purpose of education should be to prepare an individual to be useful to society, to earn his / her livelihood, to lead a fulfilling life. Assuming that there is some agreement on the subject of this convention, any attempt to draw up a plan of education whether it is seamless engineering or whatever it may be, it must satisfy these purposes of education. Developments which are taking place all-around us in this 21st century are so fast that it is very difficult to match your steps with these. Education, particularly in science and technology and engineering is not the exception to this development. Perhaps, one way of approaching the subject that we are discussing today at this convention- seamless engineering- will be to lay stress on the basic sciences, basic mathematics by taking them under the broad subject of applied sciences because if there is any common link between the one subject and the other, it has to be found in the basic sciences and mathematics.

There is no contradiction between a theory and practice thereof. It is the theory which is a common thread between the various engineering disciplines or lines of engineering. Often it is said that in colleges, we should give more hands on - experience and less of theory. I differ with this view. When students are young, they can learn fast and quite well. If at that time of their life they are not taught the basic scientific principles or hypothesis or theories behind a phenomenon; they are never going to learn these in their later life.

Engineering students, however, need to be oriented towards industrial work atmosphere. This can be done by plant visits, short projects and the like. We should not neglect teaching basic sciences and theories in engineering colleges. The subject being discussed today at this convention raises a question: should we have specialists or only generalists will do? This being so because if you lay down a curricula which is totally seamless which, in other words, means that every thing is given equal importance and engineers come out with engineering hands and mind, we are bound to loose certain things. With only seamless engineering, disciplines will not develop because sharp focus on the specializations of engineering only can lead to realizing our objectives. There is also a school of thought that the specializations or a specialized education is needed only for research. I do not agree with this

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school f thought. In some areas specialists are also needed even at the operation or production stages. We cannot afford doing away totally with specialists. Obviously, it is premature to draw conclusions on the subject that we are discussing today; though it being a subject of great importance, indeed.

What should we do at this stage? We should first figure out our vision: what is that the country needs, what will satisfy the aspirations of the young people. Based on this, we should draw our vision statement. Once we are through with it, we can chalk out how to go about realizing the vision. We may need to set up a committee or committees for working out details as to how to go for the change. After this, we can try the change at a few colleges and after its review, we can work out our further course of action. If we are satisfied that the change is giving us the desired results, it can be implemented widely. The whole exercise is going to take time. There is no short cut available; and it should not be pursued as such. Ad hoc attempt to change the engineering curricula into the seamless format may do a great harm than good.

Prabir K. Datta

Engineers have already become seamless as on date. Everybody today is consuming software which is developed by engineers of almost all disciplines. They prefer to work for this sector despite their training being in some other disciplines of engineering. Till last year chemical engineers were not taken by the software industry; they are now also being taken by this industry. Engineers prefer to go for this sector in hordes because it is paying them three to-four times more than the sectors of their specializations pay. So, economics has become the main criterion for engineers to select their branches while getting into the engineering colleges and after that also. The result is that serious shortages are developing in the availability of engineers of many core disciplines such as civil, mechanical, electrical, metallurgy and so on. Even mining has not been spared. Mining, being a most specialized profession, has also fallen to the glamour of the software industry.

Engineering is already entering seamlessly into the software sector. We may change the curricula of engineering and go for seamless engineering education; will it help in changing this trend? This is the question for which we should first find the answer. For consulting engineers, it is very important to be a jack of all trades. The client will want him / her to be so i.e. in other words, the client perceive that a consultant will know all about arbitration, law of evidence, about matters pertaining to sale tax and other indirect taxes, power of attorney-how it is created and used, etc. It is seamlessness in a consultant which will make him / her tick in the market. Do we teach all these things at the undergraduate level? No, we do not; exceptions here and there will not prove it so. From this view point and as has been stated by the various previous learned speakers at this first convention on seamless engineering , we need to give the subject of seamless engineering in-depth consideration and work out the way for its implementation since it has the merit as such.

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Prabir K. Datta is a Consulting Engineer & a Chartered Mechanical Engineer.

associated with the two national institutes namely- Indian Institute of Port Management, Kolkata and the National Institute of Port Management, Chennai, as Visiting Faculty in Port related Engineering & other matters.

Dr. Sudip K Das

The seamless engineering is an interdisciplinary concept. Dr. Mashelkar, former Director NCL, Pune and present DG of the CSIR presented this concept of the seamless engineering in chemical engineering at the time of his Danckwerts Memorial Lecture delivered in the year 1994. Dr. K. V. Ragavan, the then Director of the Institute of Chemical Technology, Hyderabad started this concept. Chemical engineering basically started from the market demand soon after the discovery of oil and its refining processes. Thereafter the development of other industries like petrochemicals and polymer industries etc. and it was the starting point of the development of chemical engineering.

Basically, the chemical engineering emanated from the mechanical engineering. Both the chemical engineering and mechanical engineering are the blend of the applied basic sciences including chemistry and physics, mathematics and to a large extent of the other discipline of engineering including materials, metallurgy, electrical engineering, electronics, computer engineering, biology and botany, civil engineering, etc,. Artificial intelligence, CFD and carbon trading especially in the Indian context are some of the other subjects which find application in the other branches of engineering but these are not included in the undergraduate chemical engineering curricula. These subjects need to be included in the chemical engineering curricula. Environment issues have also now found its place in the chemical engineering curricula as it has in the other disciplines of engineering though it started in the civil engineering curricula.

Thus, it would be concluded that the chemical engineering has already moved into a seamless domain. The subject of survey has also transacted from its traditional domain of civil engineering into the other branches of engineering. The boundaries of the chemical engineering are moving into the boundaries of the other disciplines of engineering. It is, therefore, apt and timely that we discuss the subject of seamless engineering in-depth and come out with a policy paper and an action plan for ushering the change in the engineering education in the country.

From the Floor

Prof. S. K. Biswas

When students come out of engineering colleges after passing out, they do not know what they have got to do in life. They get branches when they enter engineering colleges based on the competitive tests and based on the merit at which they are placed after these tests in the admission list. This is irrespective of whether they have the aptitude for the branch for which they have been selected or not. Most of the time, demand of a specialization is what determines what the students will prefer to go to. Earlier it used to be the civil engineering followed by the mechanical engineering and then electrical

engineering and so on. This changed later to mechanical engineering, electrical engineering, civil engineering and so on. Presently, Computer engineering and electronics is preferred and it is software industry which hooks the students lock stock and barrel. Liking of the students is not what is given importance. We do not, therefore, produce engineers committed to their specialization. This is the basic problem.

After passing out from engineering colleges, some students go for R&D, some for higher studies in management sciences, some opt for the civil services, some for marketing and sales, some specialize further in finance and most of the students go to industry. In short they go in many diversified areas. There is as such no link with what they studied at the undergraduate level in an engineering college.

Engineering today has diversified and, therefore, restricting knowledge at the undergraduate level to disciplines will not meet the needs of industry. Even the electrical engineering discipline, which I belong to, has become so diversified that it is not possible for me to keep track of what my other colleagues are doing. With having knowledge in one engineering discipline only would not be sufficient for an engineer even to work in an industrial unit since new ideas and new technologies come up regularly and at a fast pace. However, even if we give a general exposure to students is not going to be feasible. We have to restrict their knowledge base to some areas. We can, however, consider as what more to add to the present list of their knowledge base which will meet the current needs.

This can be done in every engineering discipline. Since the current engineering curricula do contain many common subjects which are interdisciplinary in essence, we may consider extending the list of the common subjects. Some sort of seamless engineering curricula can make the difference, no doubt, but it needs to be considered further, in depth, and it will be only then possible to develop a feasible course of action for a change.

We should remember that experiments as such cannot be encouraged. Academic institutions teach why and industry how. These two need to be synthesized in the action course that we may develop. This anomaly, if we think, can be removed with the seamless engineering curricula, we should not wait but go for it with a carefully assessed and well laid out action plan which will ensure linking why with how. It is also opined, however, that if students want to pursue R&D and teaching as their field of work, they should go for specializations even at the undergraduate level. We cannot compare engineering consultancy with the medical consultancy. These are different fields altogether and as such are not comparable.

Prof. K. K. Malik

Basically we are looking at convergence of all disciplines of engineering at this first convention on the seamless engineering into one curriculum of engineering education at the undergraduate level which will meet the emerging needs of industry, particularly in handling integrated multi technology mega projects. Engineering education at the undergraduate level cannot be called a specialty. It can

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come with education at the postgraduate level. At the undergraduate level we train students in specializations to some extent only. It is difficult for a student to cover every thing. What we need is a base model as has already been mentioned by some speakers. In this base model there can be general curricula covering all the engineering disciplines and also humanity, English, social sciences such as economics, statistics and some management subjects. In other words, it would mean that in between school and postgraduate education, we may have general engineering education at the undergraduate level and specialization at the postgraduate level. With this model of education, we might be able to have engineers who are suitable to industry as well as to R&D and academic sectors. We need to give it a serious consideration.

S. N. Das Gupta

Marine engineers and navigators work in the high seas and inland water. I have found - as an electrical engineer - a very good scope of a multidimensional technology in the marine engineering field. Marine engineering is a specialized branch of engineering. Engineering Council of India should recognize it as such.

S. Ratnavel

We must look into the problem of not getting the civil engineers to work in the infrastructure sector which has a high turn - over when compared with software sector. While in the USA, civil, mechanical, electrical engineers are given the status of a professional, it is not given to the software professional. Why? We should try to go into these problems and find out how the seamless engineering can solve them.

Prof. C. V. Ramakrishnan

Migration of engineers to software has been discussed at a great length in the National Academy of Engineering with the leaders of the software industry. It is a transitional problem. Software is also the area in which we are getting the international business. It is a discipline in which we seem to excel because of our nature, work ethics and intellectual environment. I do not agree with the contention made by some speakers that the software jobs are of a lower level when compared with engineers. It was only a perception in the early days when we were considered good in fixing the Y2K problem. There is a lot of higher level software work which is being done in Microsoft by Indians including those who are running software companies in the US, some of whom have migrated and established businesses in India. Very high quality software research work is being done in Microsoft, IBM, and Intel by the Indian engineers; Silicon Valley is full of them working in Internet and mobile applications. They are all high skilled professionals.

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Many westerners are today talking that if you want to learn software go to India. That is why probably they are migrating to India. Probably we are all aware about the large number of foreign professionals in Bangalore and NCR. The number of engineers, which will be required if India wants to become a knowledge society say like Finland, will be ten or twelve times as much. We are nowhere near that. Obviously, requirement of software engineers is going to increase further, if we want to become rapidly a knowledge society, which we are not as such.

We thought that we would become a manufacturing superpower, we have not. Obviously, therefore, our skilled and semi-skilled employees have not been able to find jobs. IIT graduates were fighting for a job of Rs 3500 per month until ten or twelve years back. Now they reject anything below ten times as much as a starting salary. The situation has changed now. A person working in the software sector also cannot sustain his momentum for long. Obviously, the life span of a software engineer is going to be short unless he / she changes the lifestyle. It will happen when he / she will not be able to earn at the rate at which he / she is earning now. These facts will have to be kept in mind.

Coming to the subject of seamless engineering, as I have said in my presentation, we may consider a model in which an integrated bachelors and masters programme is tried at a few places in which around 60-70 % of the courses could be of general nature including courses drawn from the other disciplines and 30 % of the core engineering discipline. There could be other somewhat similar models. We can take it to the other colleges after it is well sought after.

Prof. B.Dattaguru

We should set up the task force as has been suggested by Mr. Swarup or a committee which will go into the subject in-depth and from all the angles for evolving the national consensus and suggest the course of action.

Dr. A. K. Das

We are discussing whether the curriculum of seamless engineering will serve the country and society at large. This question should not be coupled with the migration to software. It is happening because of so many internal and external factors.

A comparison of the engineering profession with the medical profession or for that matter with the other professions can help in finding out how these other professions bring out the professional confidence in these disciplines. The comparison between the medical and engineering profession is valid in this regard.

In whichever direction the world moves, specialization will be needed. The question is what should be the proportion of generalists and specialists and how fast a generalist can be converted to into a specialist if needed. At some stage or the other, we have got to answer this question. It may bring some stability in the technical (engineering) education.

One Speaker mentioned that he, being a civil engineer and working in a steel plant on designing the foundation of blast furnaces, wanted to study about blast furnaces and metallurgy but he could not do it because he could not find a way out for it. In a steel plant for the career growth adding metallurgical qualification by a civil engineer or any engineer not of metallurgical specialization would be a desirable thing to do. It will be the same story in many other segments of the industry. From this viewpoint, the subject of seamless engineering has a merit and needs consideration.

P. N. Shali

It is the job you land in at the first instance that determines what you will be doing in the industry. Industry needs a wider and deeper technical skill which the present engineering education at the undergraduate level is not providing. Second, if one wants to go up the career ladder in the present competitive environment, one needs to have multi skills which is the only sure way to go up the ladder. Mere specialization in one discipline will not do. Continuing professional development helps in a great measure in acquiring skills which are needed at the each stage of ones career. From this point of view, seamless engineering at the undergraduate level of the engineering training has the merit and needs consideration.

Alok Ghosal

I would like to clarify the software issue. People feel that the software is a highly paid job, which is wrong. Software companies pick up students from engineering colleges not as chemical engineers, mining engineers, mechanical engineers, etc., they want workers with engineering qualifications. Tata Steel picks up boys and girls with an average salary of Rs 4.50 Lakh per annum as against Rs 2.5 Lakh average salary per annum paid by the software companies. It is not only the money which attracts engineers to software; it is the cozy and comfortable work environment of the software sector as against the rough and tough work environment of industry which attracts them there. Later on general experience tells us that they get frustrated there.

Dr. M. R. Kalgal

We have so many branches of engineering today that we cannot count them with all our fingers and toes. We have now the bio medical engineering also. One reason for this development is the phenomenal knowledge base that has come up. As against this, students have a limited capacity to absorb. We cannot teach them every thing. Earlier the knowledge base was small and now it is large. For example earlier one could have two engineering degrees like electrical and mechanical by going through first four years course for electrical engineering and the one year course for the mechanical engineering. Between the two, there were many common subjects that were taught. Perhaps it was the

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seamless engineering at a small scale. With the coming up of super specialty era, seams in the knowledge base came up. Now, we want to go back to the seamless thinking. It is true that the concept of seamless thinking has become now a buzz word.

It is also true that many would not agree for it. Perceptions, viewpoints vary from person to person. There has not yet been a consensus on this subject. The subject would have to be approached from the various viewpoints such as, those of students industry, academia, etc. It would not be easy to say that let us change the engineering curricula to seamless engineering! We know it that it would be difficult to do it. More so, it would be difficult in the context of India because of its large number colleges and a strong regulatory system in force apart from various interests involved in the engineering education. At the same time, it is opined that the subject of seamless engineering has merit and, therefore, needs in-depth consideration for arriving at a consensus on it, at least of a large body of working engineers, academia and professional engineering bodies. It is then only that a course of action as to how to go about it can be worked out. Presently there is no involvement of the academia with the industry as it is abroad. Indian industry does not treat academia as a part of theirs.

The Indian industry today is generally of the view that engineers who come out of colleges are not suitable for them. The Industry does not provide information to the academia about what they expect from passing out engineers. There is no interactive mechanism in place between the two. This is the problem. Industry-academia interaction mechanism abroad is well established to the extent that professors become with their position in the academy automatically the top most industrial consultants. There is a need, therefore, for us to put in place such a mechanism for synchronizing what we need to teach students so that they can meet the needs of industry. It is only then that it would be possible for both the stakeholders to come to common understanding as what engineering curriculum needs to be taught. Perhaps, if we are able to create this synergy between the industry and academia that the need for the seamless engineering will get more prominence. We should change. Fortunately, of late, thinking has come up in India in the concerned quarters including the State establishment that we should also create such a mechanism. It is, therefore, likely that such a mechanism would come up in India also.

Creating seamless thinking primarily is the responsibility of the professional bodies. They should discharge this responsibility. Engineering Council of India has perhaps taken the first step by organizing this thought provoking, apt and timely national convention and now we should move further on this subject for getting a consensus on it in the country.

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Glimpses of Convention

1st National Convention on "Seamless Engineering" held on 16 August, 2006 at Tata Centre, Kolkata

Members of Engineering Council of India (ECI)

ECI has been formed by coming together a large number of professional associations / institutes of engineers. The present members are:

1. Association of Consulting Civil Engineers (India)
2. Broadcast Engineering Society (India)
3. Computer Society of India
4. Construction Industry Development Council
5. Consultancy Development Centre
6. Consulting Engineers Association of India
7. Indian Building Congress
8. Indian Concrete Institute
9. Indian Geotechnical Society
10. Indian Institute of Chemical Engineers
11. Indian Institution of Bridge Engineers
12. Indian Institution of Industrial Engineering
13. Indian Institution of Plant Engineers
14. Indian National Group of IABSE
15. Indian Society for Non-Destructive Testing
16. Indian Society for Trenchless Technology
17. Institute of Urban Transport (I)
18. International Council of Consultants
19. The Aeronautical Society of India
20. The Indian Institute of Metals
21. The Institute of Electrical & Electronics Engineers, Inc., India Council
22. The Institute of Marine Engineers (India)
23. The Institute of Electronics & Telecommunication Engineers
24. The Institution of Surveyors