Engineering Council of India

6th National Convention

Industry - Specific Engineering Education for Better Employability of Engineers - Contours of Reform

Venue :
Auditorium
Indian Institute of Chemical Engineers
Dr. H.L. Roy Building, Gate No. 3
Jadhavpur University Campus
Raja S. C. Malik Road
Kolkata - 700032

Date :
September 19, 2011

Proceedings

Sponsored by :

TATA
TATA STEEL

Supported by :

Member Associations of the Engineering Council of India

GLIMPSES OF 6TH NATIONAL CONVENTION

Dr. Uddesh Kohli presenting welcome address

Opening Session in progress

Prof. Syed Samsul Alam, Chief Guest, addressing the convention

Prof. B.R. Saha presenting the vote of thanks

Dr. Sandeepan Bhatacharya, Tata Steel, presenting keynote address

Dr. (Mrs.) Suman Kumari Mishra addressing the convention

Views of the audiance

Engineering Council of India

6th National Convention on Industry - Specific Engineering Education for Better Employability of Engineers - Contours of Reform

September 19, 2011, Kolkata

PROCEEDINGS

Organised by :

ENGINEERING COUNCIL OF INDIA
3rd Floor, Jawahar Dhatu Bhavan, 39, Tuglakabad Institutional Area
M.B. Road, New Delhi - 110062
Phone : (011) 29963281, 29963282, 65640356 Fax : (011) 29963283
E-mail : eci@ecindia.org, ecindia@vsnl.net, Website : www.ecindia.org

Compiled and Edited by P.N. Shali,
Director, Engineering Council of India

CONTENTS

Programme

Time	Particulars	
0830 - 1000 hrs	Registration	
1000 - 1100 hrs	Opening Session	
	Welcome Address	Dr. Uddesh Kohli, Chairman, Engineering Council of India (ECI), Chairman Emeritus, Construction Industry Development Council (CIDC) & Chairman, Construction Industry Arbitration Council, Senior Adviser, UN Global Compact, former CMD, Power Finance Corporation Ltd.. Chairman, SCOPE, Adviser, Planning Commission, Government of India
	Theme Address	Prof D. K. Banwet, Department of Management Studies (DMS), IIT Delhi
	Address by the Chief Guest	Prof. Syed Samsul Alam, Vice-Chancellor, Aliah University, Kolkata
	Vote of Thanks	Prof. B. R. Saha, Head, Dept of Chemical Engineering, Heritage Institute of Technology, Kolkata and Honorary Secretary, Indian Institute of Chemical Engineers
1100 - 1130 hrs		Tea / Coffee
1130 - 1300 hrs	Technical Session-I	
	Theme	Reform in Engineering Education for Better Employability of Engineers - Towards Industry-Specific Engineering Education
	Session Chairman	Shri S. Ratnavel, Chief Executive Officer,Sceba Consultancy Services and Member Board of Governors, Engineering Council of India
	Co-Chairman	Prof.(Dr.) Sarajit Basu, Chairman, Chemical Engineering Division,. WBSC, IEI, Kolkata
	Keynote Speakers	Dr. P. R. Swarup, Director General Construction Industry Development Council A Case for a Degree in Construction Engineering
		Prof. Swapan Bhattacharya, Department of Computer Science & Engineering, Jadavpur University, Kolkata Challenges for Technical Higher Education in India : Perspectives, Issues and Concerns

		Prof. H. R. Vishwakarma, Senior Professor, School of Information Technology & Engineering VIT University, Vellore-63201 and the Hony. Secretary, Computer Society of India
		Discussion

1300 - 1400 hrs	Lunch

1400 -1530 hrs		Technical Session-II
	Theme	Reform in Engineering Education for Better Employability of Engineers - Towards Industry-Specific Engineering Education
	Session Chairman	Shri R.N. Parbhat, Management Consultant, former Managing Director, Indian Aluminum Company Ltd. Past President, the Indian Institute of Metals
	Keynote Speakers	Shri S. Ratnavel, Chief Executive Officer, SCEBA Consultancy Services and Member Board of Governors, Engineering Council of India Contextual Relations of Elements Involved in Technical Education In view of Industrial Needs- A Futuristic Perspective
		Dr. Uttam Roychaudhuri, Associate Professor, University of Kolkata Education, Employment and Accreditation of Engineers in Indian Hydrocarbon Industry.
		Dr. Pradipta Kumar Bose, Adviser, BFN World Service and Consultant: Environmental Planning & Sustainable Development, Former Professor Chemical Engineering, Jadavpur University, Kolkata. "Destination Germany" and Post-War Development of Chemical Industry during 1952-57
		Shri P. N. Shali, Director Engineering Council of India and former Adviser and Consultant, Planning Commission , Government of India Industry-Specific Engineering Education for Better Employability of Engineers
		Discussion

1530-1600 hrs	Tea / Coffee

1600-1700 hrs	Panel Session	
	Theme	Discussions and Formulation of Consensus Recommendations on the Contours of Reform of Engineering Education
	Session Chairman	Dr. S. K. Bhattacharyya, Steel Chair Professor, Dept. of Met & Mat. Engineering ,Bengal Engineering & Science University , Sibpur, Howrah
	Panelists	Dr. Pradipta Kumar Bose, Adviser, BFN World Service and Consultant, Environmental Planning & Sustainable Development and Former Professor Chemical Engineering, Jadavpur University, Kolkata
		Prof. (Dr.) Kalyan Mitra, Chairman, IIIE Kolkata Chapter, Indian Maritime University, Kolkata Campus (Formerly MERI)
		Dr. (Mrs.) Suman Kumari Mishra, Scientist EII, MST Division, National Metallurgical Lab, Jamshedpur
		Shri P. N. Shali, Director, Engineering Council of India & Former Adviser and Consultant (SP-NE), Planning Commission, Government of India
		Discussion and Recommendations

6th National Convention on Industry-SpecificEngineering Education for Better Employability of Engineers - Contours of Reform

Introduction

Engineering education has always occupied a place of prominence in our economic development. According to the XIth Plan Working Group of the Planning Commission on Technical Education, the key challenging issues include inter-alia: assuring quality of technical education, ensuring its relevance to global, local market and industry needs and improving employability. According to a study carried out by the McKinsey Global Institute on the emerging global labour market, though India produces a large number of engineering graduates every year, multinationals finds that just 25 per cent of them are employable. Our engineering education, therefore, is not relevant to the present needs of the Indian industry. We need industry-specific / sector-specific engineering education for making engineers employable. We need to move out of the present engineering domain-specific engineering education to multidisciplinary engineering education.

Engineering Council of India (ECI) took up this burning issue for an in-depth discussion. It organised five national conventions in the country. The first national convention was organised in August 2006 at Kolkata (W.B.) followed by the second national convention in May 2007 at Vadodara (Gujarat), third national convention in February 2008 at Hyderabad (A.P.), fourth national convention in July 2009 at Visakhapatnam (A.P.) and the fifth national convention in September, 2009 at New Delhi, which was sponsored by the Planning Commission. ECI also organized a national workshop in March 2009 at Madurai (Tamilnadu), and the sixth national conference at New Delhi in November 2009. All these programmes essentially were on the theme related to the reform of engineering education system for better employability of engineers. Concerns about the present engineering education were widely shared by the delegates from both the industry and the academia. An unanimous view emerged from these in-depth deliberations that the engineering education needs a systematic overhaul, so that India can produce multidisciplinary and multi-skills engineers. We need industry / sector-specific engineering education. Besides, we should take appropriate steps so the country is able to educate much larger numbers without diluting academic standards. This is very important because the transformation of our economy and society in the 21st century would depend, in significant part, inter alia, on the spread and the quality of technical education, particularly engineering education among our people.

A consensus also emerged from the deliberations that the present regulatory system of higher technical education, particularly engineering education is flawed and it needs an overhaul. Specifically speaking, the barriers to entry are too high; the system of authorizing entry is cumbersome; the system, as a whole, is over-regulated but under governed. The system of affiliated colleges for undergraduate education, which may have been appropriate 50 years ago, is no longer adequate or appropriate; it needs restructuring, and reformed. India is not an attractive destination for higher technical education, particularly engineering education for international students. It is time for us to make a conscious attempt to create appropriate policy framework for attracting foreign students to India for higher technical education, particularly the engineering education. This would enrich our academic milieu and enhance quality. It would also be a significant source of finance.

The supply constraint of higher technical education, particularly engineering education is an impediment today. It must ease for the better quality higher technical education. When students have relatively few choices, institutions have greater power over them. An expansion of higher technical education that provides students with choices and creates competition between institutions is going to be vital in enhancing inter-alia accountability. Such competition between institutions within India is, of course, essential. However, the significance of competition from outside India must not be underestimated. For this purpose, we need appropriate policy for the entry of foreign institutions into India and the promotion of Indian institutions abroad. Such policies must ensure that there is an incentive for good institutions and a disincentive for sub-standard institutions to come to India.

Objective

Objective of the 6th National Convention is to take forward the discussions on the reform of engineering education, which was started in August, 2006 at the first national convention held at Kolkata, for getting a consensus of the stakeholders on the final contours of reform including in the policy frame work and regulatory mechanism. Specifically, it will consider in-depth the above stated issues and try to get a consensus on the contours of reform. It will consider whether we need to move out from the present engineering domain-specific engineering education to multidisciplinary engineering education. It will also consider aspects such as, the multidisciplinary engineering curricula and its new possible branches that will meet the needs of the industry and the other sectors of our growing economy. The convention will also look at duration of the course, industry training, after the course mandatory internship with the industry, treatment to the diploma stream in the reform process, and modalities of bringing in the engineer technicians in the process of formal engineering education. Besides, it will also look at creating an effective and efficient interactive mechanism between the industry and academia for keeping time-to-time engineering education system and process dynamic so that it meets ever-changing demands of the market from time-to-time.

Recommendations

1. Engineers Bill should be brought on the statue as the Engineers Act and a statutory council of engineers set up as a consequence without further delay.

2. Engineering education should move out of its present engineering disciplines basis to industry-specific basis. But this should be done with caution and taking step-by-step approach. First, a few new such branches should be introduced, namely BE (Construction Engineering),BE (Hydrocarbon Engineering) and a combined five-years degree in Engineering & Management.

3. Meanwhile, the quality of engineering curricula, and syllabi should be made compatible with industry requirements; and it should provide a greater flexibility and choice of electives.

4. Subjects on management, humanities, social sciences and information technology should be included in the engineering curricula as compulsory subjects.

5. The earlier practice of having common subjects during the first two years of the course and engineering branch-wise education after the third year of the course should be restored.

6. Case studies on industrial problems solved should be included in the curricula for a very clear understanding of the concepts involved.

7. During-the-course industrial training in the third and fourth years should be project-based, which should also be assessed and credits obtained added to the total credits that a student may get from the written examination. While as the industrial training during the first and second years of the course may continue to be visits to industrial units only, as at present.

8. There should be a mandatory six months internship with an industrial unit after the course, which should be assessed and credits thus obtained by a student should be added to her / his total credit. The final engineering degree should be awarded after this. After [assign out the course, however, a provisional engineering degree can be given. The industry should be compensated or any expenditure that it may incur on this internship. This is a policy matter.

9. The entrance/ admission to engineering institutions should be made through an all India Common Admission test for engineers, which should also access the aptitude for engineering in a student. It is desirable that the engineering establishments in the private sector and those of the various state governments should also come under the purview of this common admission test for engineers.

10. Computer simulations should also be used for laboratory practices. It will make easy for the students to understand various concepts.

11. A greater industry-academy co-ordination- than what is happening now- is required. For this, a better academy-industry interface in bridging the skill gap in high growth industry should be setup at the earliest. This can be better done if set up in the form of a standing institutional mechanism at the national level.

12. Close interaction of academic institutions with entrepreneurs should be mandated as a social responsibility on the part of academia.

13. Spending of public money on higher education and research for non-performing universities / institutes should be reduced.

14. Performing institutions should be given more financial grants as encouragement for better quality teaching and research.

15. There should be some universities with research facilities and salaries comparable to the best in Asia.
16. Performing teachers should also be given financial rewards (e.g. cash incentives for international journal publications, patents filed, or for bringing any other laurels to the institutions, special remuneration package for course loads above average and so on).
17. The faculty jobs needs to be made more attractive for the right persons.
18. The quality of teachers is the main concern even if quantity is addressed. Poorly-trained teachers could be an even bigger problem. This needs to be addressed.
19. The CPD of the engineering faculty needs to be institutionalised.
20. There should be a mandatory working for the faculty with the industry at least for two-to-three terms of two years each during the entire service period.
21. Like-wise practising engineers and engineer consultants with demonstrated achievement in the consultancy should also be involved in teaching engineering for similar tenures. This is also a policy matter.
22. A Graduate Aptitude Test for Engineers (GATE) or the National Professiency Evaluation Test (NPET) should be designed & developed for each discipline of engineering separately. Employers should recruit those engineers who qualify GATE. or NPET. Recruitment of engineers without the GATE score should be legally discouraged.
23. The prestigious Indian Institutes of Technology (IITs) should mentor some lesser known or new engineering colleges for raising their standard.
24. Inter-institute credit transfer should be permitted
25. Skill / knowledge-centric workshops should be organized with the industry.

Executive Summary

The 21st century engineering education aims at preparing graduates to compete in a global market. They should be provided not only with sound knowledge on their fields of specialization, but also with general competencies allowing them to answer new demands from the society. These competencies are among the requirements established by the various international accreditation systems of engineering degree.

A survey of employers showed that only a handful of the large number of engineering colleges in India are recognized as providing world-class education with graduates worthy of consideration for employment. An MIT survey of human resource professionals at multinational corporations in India revealed that only one quarter of engineering graduates with a suitable degree could be employed irrespective of demand.

It is generally perceived by all the stakeholders that we have rigid and outdated engineering course curricula, we have not been able to adapt the course curricula to dynamic industry requirements, we have a poor lab infrastructure, we have limited exposure to latest tools & techniques and we have a little R&D.

The Indian (engineering) education is totally focused on a "career excellence". A student is never asked to analyze, understand, and deliver an engineering project. Very often faculty also has no engineering experience.

Professors may have an excellent academic background going themselves through graduation, post graduation and Ph.D., but this is all with a minimal exposure to industrial applications. In short, they prepare their students also for an excellent academic career expecting her / him to learn hard core engineering on the job but very often producing bankers.

In all there is about 3 months spent in training during graduation. It is taken more as a break from courses as no industry will give any serious project for such a short period. Student spends his time as an observer rather than as a responsible engineer.

There is nothing like putting a trainer on a real job under the supervision of an experienced engineer. By the time, s / he has finished 6 months to a year working on a real project, as any European student does, s / he will have something to her / his credit to show to a future employer.

There are growing cries to revamp India's education system, which focuses on learning by rote; education should create thinking minds. "Of all the big issues challenging corporates, education is the starting point. We need to get the education bit right, and then a lot of things can go right in India. This is a well recognised fact.

For reforming the engineering education, the curriculum should be based on problem-solving approach; the basic & social sciences should be integrated appropriately with the technical subjects for transition eventually towards branch-less / discipline-less curriculum (Seamless Engineering Curricula) at the under-graduate level; the state-of-the-art technology should be adopted for delivering the curricula; the faculty should be involved in industrial environment; inter-institute credit transfer should be permitted; the entrance examination for engineering course should also assess the aptitude for engineering; and skill / knowledge-centric workshops should be organized with the industry.

The situation can be substantially improved only by a concerted action between the universities and the productive industrial and business sectors, as is found in the concrete programmes in operation in the developed countries of the globe. *The coordination between academy and industry will not only improve the quality of education and research, but also fulfil the need for the adjustment of training to the prerequisites of employment at the work-place. Apart from changes in the curricula; India needs quality academicians to mentor the engineering students and researchers in right direction.*

Out of the large number of engineering institutions in the country, most are hardly involved in research. This does not auger well for the country's future. Research is symbiotic with teaching. Research in science and engineering must be encouraged; just twenty or thirty such institutions are not enough. Given India's population size, there should be at least a hundred of them.

The prestigious Indian Institutes of Technology (IITs) should mentor some lesser known or new engineering colleges to raise their standard. "Mentoring by its definition is a voluntary activity, but if we can create an atmosphere where institutions of distinction feel a sense of calling in the interest of the larger national good, it would transform our education. Further, a framework of public-private partnership is needed to establish new quality institutions.

The growth of economies and living standards of civilized societies are being increasingly determined by knowledge and innovation created and fostered by knowledge institutions. The demand for closer interaction of such institutions with entrepreneurs, communities, and industry is becoming increasingly louder. Entrepreneurship strengthens the knowledge system, converts knowledge to intellectual property, promotes ventures for commercialization of technologies, creates wealth and enhances technology competitiveness and the tech-image of the country. Furthermore, it creates new business and creative opportunities, jobs and services, and thus promotes regional as well as local development. *Close interaction of academic institutions with entrepreneurs should be mandated as a social responsibility on the part of academia.*

For the development of higher education, India has so far followed the policy of gradually increasing the number of universities, all of them with roughly the same scale of facilities. This emphasis on quantity has had an adverse impact on quality because resources have been spread too thinly. *Even the most well-funded university or research institute in India receives no more than a fraction of the funds available to comparable institutions in several Asian countries. But the financial requirements of 'world-class' universities are very large. This means that the only feasible option, as some higher education observers have suggested, is to discard the current policy of uniformly same salary scale, same rules regarding travel grants, etc., across all universities / institutes.*

Only teaching (without any productive research in the form of quality publications or usable patents) does not justify huge spending by some so-called 'elite' institutes / universities. Instead, based on some quality criteria, all institutes / universities should be graded and judged as per their performance and public monetary support should depend on that. Performers should be separated from non-performers and they should be given more incentives. Performing institutions should be given more financial grants as encouragement for better quality teaching and research.

> It is a truism to say that higher education requires larger amounts of funding. Higher education in India has been a victim of hick of finances for many years since independence. The question, therefore, arises: how can we solve the problem of financial crunch to overcome the related problem of faculty crunch in leading engineering institutes / universities? A comparison of salaries in the corporate world with those in academia explains why increasingly large numbers of bright students opt a career in the private sector instead of entering academia. The best minds are not coming to the field of teaching as this profession is not yet considered to be attractive enough in terms of salary. Consider, for example, the salaries of the teachers in Indian universities. Despite the quite large increase in salaries after the last pay commission report, university salaries in Indian remain grossly inadequate compared to remunerations available elsewhere. A bright young researcher who, after finishing a PhD abroad, has just received an assistant professorship in any US university would not perhaps wish to return to India just for the intangible joys of working 'back home'.

The teacher: student ratio in engineering education in India is not comparable with what it is in the developed countries. While the States are making constant efforts for improving the teacher: student ratio in engineering colleges falling under their jurisdiction, the central government is constantly monitoring maintaining a healthy teacher-student ratio. Therefore, maintaining an optimum teacher: student ratio should not be an unachievable goal. The quality of teachers, however, is the main concern even if quantity is addressed. Poorly-trained teachers could be an even bigger problem. This needs to be addressed.

Engineers who come out of engineering colleges are discipline-specific engineers and not multidisciplinary engineers which industry needs. They do not have sufficient knowledge to start working straight away on their jobs in an industrial unit. They need retraining which means expenditure that the industry will have to bear. We have working engineers who often get stuck in the domain-specific jobs. They do not move out to acquire multi-skills required today for meeting the changing needs of the engineering profession. Too much theory is taught; too little emphasis is given on experiments and on- the - job training. There is, therefore, no correlation in the present engineering education system between theory and practice. Our current engineering education system does not prepare engineers for the industry as engineer managers to manage mega projects which encompass many technologies.

Presently, only civil engineers, by and large, are in demand from the construction sector. A civil engineer is not a construction engineer by virtue of her / his education. Construction engineer needs a familiarity with the world of business and commerce, dealing with people and resources, environmental, health and safety aspects, legal aspects, project engineering, logistics engineering, procurement engineering, application of IT and communication technology in construction, dealing with partnerships and joint ventures learning the nitigrities of contracts and claims, apart from the changing world of technology itself. So, there is a case for a new branch of Construction Engineering.

We, therefore, need to bring up a new curricula and mode of delivery. But we should do it step by step and with caution. While reverting back to previous practice of having two years of common curricula and allotting branch after third year, we should reform the curricula itself and introduce two new branches- one on BE Construction, the second on BE (Hydrocarbon Engineering). We should also consider having a common Degree of Engineering & Management of five years duration.

We should also make it mandatory to have project-based during- the- course industrial training and six months of internship with an industrial unit thereafter. Both these trainings should be assessed and credits added to the marks obtained by a student from the written examination and internal assignments undertaken during the course. The final engineering degree should be awarded only after all these assessments have been completed. However, after clearing the written examination, a provisional degree can be given.

Opening Session

Welcome Address : Dr. Uddesh Kohli

Engineering Council of India was formed and incorporated in April, 2002 as an apex body of engineers at the national level under the Patronship of the then Deputy Chairman, Planning Commission by coming together of a large number of professional organizations / institutions of engineers to work for (a) the advancement of engineering profession in various disciplines, (b) bringing code of conduct and set standards to match the World, (c) enhancing the image of engineers in society by focusing on their quality and accountability and (d) to enable the recognition of expertise of Indian engineers and their mobility at international level in the emerging WTO / GATS environment. Since its inception, ECI has taken up several important issues concerning the engineering profession such as Engineers' Bill for the regulation of engineering profession, international mobility of Indian engineers, and the reform of engineering education for better employability of engineers. ECI also brings out a quarterly news letter-the Indian Engineer. The first and the foremost work that the ECI did was to facilitate drafting of a consensus draft of the Engineers Bill, which was submitted to the Ministry of HRD in 2007.The Bill is being processed and is at an advance stage of consideration within the Government of India before its submission to the Parliament. Once it becomes an Act, the engineers will also get the legal status as professionals like Doctors, Lawyers, Chartered Accountants, cost Accountants, Company Secretaries, etc.

The second important area on which ECI has initiated a discussion in the country is the reform of engineering education in the country, a need for which has been felt by the industry because some of the studies undertaken by different bodies, including the world renowned consultants, have concluded that only about 25 % of engineers who come out of our engineering institutions every year are considered employable by the industry. In this context, ECI initiated a series of National Conventions in different parts of the country. The first such National Convention was organized in August, 2006 at Kolkata. Thereafter, four more National Conventions were organised in different cities and it is indeed a great feeling to back in Kolkata for the 6th National Convention. While there is a general feeling that the reform of engineering education needs to be undertaken urgently, a consensus on the final contours of reform is yet to be reached. The 6th National Convention is to expected to consider this aspect. I am sure that the deliberations during the day will help us to arrive at some consensus in this regard.

I welcome Prof. Syed Samsul Alam, Vice-Chancellor, Aliah University , Kolkata, for accepting our request to be the Chief Guest at a very short notice. We are looking forward to his thought provoking address. I also welcome Prof D. K. Banwet, Department of Management Studies (DMS), IIT Delhi for agreeing to give us the theme address on the theme of the 6th National Convention. I welcome all the keynote speakers, delegates, and students

Theme Address: Prof. D. K. Banwet

We are confronted with different kinds of brain drain- engineers going abroad mainly to the US, and some other places Canada, U.K., Germany, Australia, to name a few. Yet another version of engineering graduates going for a management post graduate diploma / degree to IIMs, and others drawn into the IT / ICT sector. We in the IIT Delhi thought why not to introduce substantial contents of the management courses up to the level of B. Tech. and uniquely come up with a distinct MBA programme with a focus on Management Systems / Telecom Systems Management in the day programme & a focus on Technology Management centre so that we produce a multi-skilled analytical based techno IT savy engineer managers, which is what that is required by the Industry to day.

Dr. Uddesh Kohli, Chairman, Engineering Council of India (ECI), Chairman Emeritus, Construction Industry Development Council (CIDC) & Chairman, Construction Industry, Arbitration Council, Senior Adviser, UN Global, Compact, former CMD, Power Finance, Corporation Ltd.,Chairman, SCOPE, Adviser, Planning Commission, Government of India

Prof D. K. Banwet, Department of Management, Studies (DMS), IIT Delhi

Selling of cosmetics, toothpaste etc. is fine for the non engineering/ science background, but perhaps the engineering/ technological / analytical acumen acquired could be better utilized / applied for making techno-managerial & scientific interventions to help and facilitate inclusive growth & development. Innovative techno-managerial solutions that are affordable and accessibile that are sustainable ought to be the mindset that perhaps would be the mantra for success.

What is important is to adopt a holistic out look, and be sure first of what we need to add and what we need to discard from the curriculum for making it relevant & holistic. If we look at what it means joining two-years MBA course after engineering in time and money for a student, it would mean actually a six years course- with two more years of time and two more years of expenses after engineering. Why not integrate the two courses and make it a running course of five years by suitably making better use of summer, winter & mid term breaks. All work & no play is not what are being advocated.

We can think further and have a common degree of electrical engineering, mechanical engineering, and civil engineering with a required sprinkle of relevant topics from HSS, Liberal Arts, Law and Management subjects thrown in the curriculum. Such an engineer will be holistic; what we can say in other words is that s / he will be an engineer – manager of the type that the industry demands today. Even we can consider moving out of the current engineering domain-wise engineering education, which has lost its relevance in the present competitive economic environment, to the sector-specific engineering education, say, BE (Infrastructure), BE (Construction), BE (Transportation), BE (Energy) and so on. We can think of many more such sector-specific engineering branches. Such branches will not only meet the demand of the industry, but also it would give a wider canvas to engineers to play on, which will in turn enable them to grow in their profession and make them more relevant for solving problems both at the local and national level, without forgetting taking cognizance of the international environment. The present system of education binds them in their domains. We can also suitably integrate IT in the engineering curriculum for making it truly holistic, as is required now.

Then there is a dire need and a case for a mandatory project-based during-the-course industrial training' and a mandatory six months of paid internship with an industrial unit after the course. We need to consider these as well for making engineering education truly holistic and practical. We may initiate a discussion with the industry for implementing a paid six months internship as well as during-the-course project-based industrial training. Both these should also be assessed and the marks obtained by the students should be added to the score that the students will get from the theory papers. While after the theory papers and during-the-course project-based industrial training is assessed and the result is declared, a provisional degree can be granted; and the final degree should be awarded only after the internship is assessed and the marks obtained are added to the marks obtained from the written theory papers and the during-the course industrial training. There is a need to learn from agricultural universities that encourage in addition to regular teaching (theory), field work / extension activity & relevant research.

We need to assess the infrastructure that many of the private colleges have and if we find this not adequate and of required quality, we should ask these colleges to upgrade it within some specified time frame. Quite a lot of money is spent on decor, pomp & show, rather than good faculty rooms for individuals, lab attachments to the extent possible & facilitation of academic- industry interaction. Similarly, we can assess the faculty of these colleges and take action accordingly for improving it. After this, we cannot afford to miss an important point and this is regarding improving the quality of the engineering faculty through continuing professional development and its regular monitoring as matter of policy decision.

We need to give some practical flavour to the delivery of engineering courses by creating the “Visiting Faculties” from Industry / Research Institutions / Renowned engineer consultants / technocrats, etc. For this involvement of engineers including engineer consultants in teaching, as a matter of policy, is very necessary. Faculty needs to be encouraged to have some industry internships to get a practical field flavour. This would give an exposure to the faculty members of what the industry is like and how it works, what it wants from engineers when they come out of engineering colleges, and also to the field of engineering consultancy, faculty members should work, as a matter of policy, for at least four terms in their career for two years each with an industrial unit and a engineering consultancy firm of repute. The period, however, can be discussed and decided.

In sum, I would outline the following set of remarks for whatever they may be worth.

- Projectisation is the mantra.
- Paradigm shift is from functional specialists to sectoral generalists, to holistic, systematic, integrated approach.
- Seamless engineering with a multi disciplinary approach with multi skilling & multi tasking that needs to be taken up with all earnestness.
- Currently there exists too much of specialised deafness & dumbness, shackles need to be removed to look holistically & organically.
- Need to prepare for a all rounded personality (should start from schooling include games, co-curricular activities, society, orientation, & not just book worms or internet addicted?)
- Pure engineering is not enough: from a civil engineer to construction engineer, construction management etc.
- Indeed the need is for Engineering Management.
- From pure discipline engineering to a broad -based concept of integrated BE / Tech courses with a sprinkle of HSS, Liberal Arts, Law & Entrepreneurship & Analytical IT savy Management having relevance at the national & also international arena.

Shift from science to technology and further to IT further to MBA.

Service sector + manufacturing sector persons in USA, China à Manufacturing, Indiaàservice

- Education system need to change gears & have a new mindset
- As told earlier multi disciplined multi-skilled & multi-directional.
- Theory in isolation without application is a big lacuna.
- Sanderfched Theory + practice (BITS Pilani) needs greater encouragement.

Address by the Chief Guest : Prof. Syed Samsul Alam

The growth of engineering education in post-Independent India has been higher compared to even countries like the US, the UK, and Japan. This growth trajectory, however, has not been without some pitfalls that have been observed in recent times. On the one hand, several recent studies point out the growing problem of unemployment (and also underemployment) of engineering students in the country. On the other hand, industry is complaining of unavailability of competent students on a par with its requirement. In fact, India's problem is not unemployment but unemployability of engineers. The quality of education-curricula, and syllabi, therefore, should be compatible with industry requirement to meet the current demand. The current curricula should be reformed to provide greater flexibility and choice of electives. Laboratory courses need to be revised and case studies should be discussed. Above all, greater industry-academy co-ordination than what is happening now is required. In industry, government as well as academic domains, the dearth of quality

Prof. Syed Samsul Alam, Vice-Chancellor,Aliah, University, Kolkata education, competent teachers, and worthwhile research are generating extreme disquiet. Goldman Sachs counts the lack of quality education as one of the 10 factors holding India back from rapid economic growth. There are growing cries to revamp India's education system, which focuses on learning by rote; education should create thinking minds. " Out of all the big issues challenging corporates, education is the starting point," If we manage to get the education bit right, then a lot of things can go right in this country." said Mr Dileep Rajnekar, Chief Executive of Azim Premji Foundation. The coordination between academy and industry will not only improve the quality of education and research, but also fulfil the need for the adjustment of training to the pre-requisites of employment at the work-place.

The 21st century engineering education aims at preparing graduates to compete in a global market. They should be provided not only with sound knowledge on their fields of specialization, but also with general competencies allowing them to answer new demands from the society, as are the requirements established by the various international accreditation systems of engineering degrees. Among other things, this can be better done with adequate practical training during the course and a paid internship with an industrial unit after the course of 6-12 months period. Lack of adequate practical training in engineering education is one of the factors. Presently, employers highly value new engineers with practical training as a way to guarantee that they have competencies in leadership, team working, communication abilities, and some others.

Sh. Narayana Murthy, former Chairman and Chief Mentor of Infosys is of the view that despite being one of the largest producers of academic degrees in the world, the quality of India's engineering education is still unsatisfactory. India has hardly produced any worthwhile inventions. Almost every technology we use is from abroad. The reason is the low quality and quantity of our doctoral programmes and our emphasis on rote learning.

Prof. C.N.R. Rao, Chairman of the Scientific Advisory Council to the Prime Minister, has stated that many universities / institutes in the country "over-specialize" their students even before they are ready with the basics, and make them "unemployable." None of the country's premier institutions, including Indian Institute of Science (IISc) and Indian Institutes of Technology (IITs), "can match the best in the world. The research in the country is sadly losing quality even as the facilities to do research were increasing. We have to ponder over such assessments of so many knowledgeable observers and find out whether these are exaggerations or there is a grain of truth in such critiques.

A survey of employers showed that only a handful of the large number of engineering colleges in India are recognized as providing world-class education with graduates worthy of consideration for employment. The situation has not much improved during the last five years. An MIT survey of human resource professionals at multinational corporations in India revealed that only one quarter of engineering graduates with a suitable degree could be employed irrespective of demand. It suggests that engineering degrees from most Indian colleges do not provide signalling value in the engineering labour market. Hence, low quality (in the labour market sense) engineering schooling has come to predominate in the education market. The current situation, with an abundance of low quality engineering schooling, could stifle growth of the Indian economy.

As a remedial measure, Dr. N.R. Shetty, Chairman of the National Advisory Committee on Entrepreneurship Development Cell, Dept. of Science & Technology, Government of India, suggests change in approach to engineering education. "We should no longer be continuing with an education system that produced engineers to meet local and national demands. Gone are those days. Today we require engineers who will compete globally and possess such skills that will make them competent. Our engineers should not just meet Indian demand but also world's." Dr. Shetty also talked about 'inclusive education' where people of all segments of society had access to engineering education. However, he maintains that quality should not be compromised at all and the government must actively ensure that high quality is maintained. He also felt that the government must not withdraw from higher engineering education but involve itself more by having more IITs and IIMs.

> Apart from changes in the curricula, India needs quality academicians to mentor the engineering students and researchers in right direction. Out of the large number of engineering institutions in the country, most are hardly involved in research. This does not auger well for the country's future. Research is symbiotic with teaching. Research in science and engineering must be encouraged; just twenty or thirty such institutions are not enough. Given India's population size, there should be at least a hundred of them. One reason for this under achievement in research may be lack of required fund. According to the Kakodkar Committee, the US and China produce 8,000-9,000 PhDs in engineering and technology every year, compared to 1,000 by India. Against the present requirement of a large number of PhDs in engineering, the country has only a very limited number of them. Funding, or rather the inadequacy of it, is the genesis of another problem haunting the engineering institutes of the country.

Today most engineering colleges face paucity of skilled and experienced teaching staff because young engineers are not inclined towards teaching. Indeed, they are refusing to be drawn into teaching. Faculty crunch is affecting higher education in general and engineering education in particular, as even premier institutes are facing the problem. IITs are facing a faculty crunch with nearly one-third of the posts vacant; around 35 percent posts are vacant in central universities, 25 percent in IIMs, 33.33 percent in the National Institutes of Technology and 35.1 percent in other central education institutions. Considering the student-faculty ratio of 15:1 based on AICTE norm and the retirement of existing faculty, the estimated additional faculty requirement in the country in 2017 will be around 1, 85,000. Under normative scenario, if a student-faculty ratio of 12:1 is considered for Tire 1 institutions (IITs), 15:2 for Tire 2 institutions (NITs), and 18:1 for other institutions, the additional faculty requirement in 2017 will be around 1,08,000 or about 10,000 new engineering faculty per year (annual growth rate of about 7%). This is possible only if faculty jobs are made more attractive and the PhD initiative results in an increase in PhD output and quality.

> Indeed, India's missing teachers are a big problem. The future, however, depends on how good our engineering faculty will be and in that regard it is important to make the profession attractive. Across the world, the best minds opt for teaching profession, but this is not happening in India because teaching is not that lucrative here. We have got to make teaching in India lucrative enough to attract the best minds. The Union HRD Minister Shri Kapil Sibal has himself admitted on a number of occasions that no change in the ground realty would be possible unless teachers are offered better facilities. And that is the key point.

The fact of the matter is that the best minds are not coming to the field of teaching as this profession is not yet considered salary-wise to be attractive enough. Consider, for example, the salaries of the teachers in Indian universities. Despite the quite large increase in salaries after the last pay commission report, university salaries in Indian remain grossly inadequate compared to remunerations available elsewhere. A bright young researcher who, after finishing a PhD abroad, has just received an assistant professorship in any US university would not perhaps wish to return to India just for the intangible joys of working 'back home'.

> It is not surprising then that even leading universities and research institutes find it impossible to reverse the brain drain, leave alone brain gain. Similarly, a comparison of salaries in the corporate world with those in academia explains why increasingly large numbers of bright students opt for a career in the private sector instead of entering academia. In this software era, the remuneration of a faculty is nowhere comparable to sky-high corporate salaries. This is resisting the quality engineers to take the path of teaching and research. Some action needed to be taken by the government to encourage people to take this career. Of course, salaries are just one component of what young researchers look for when they evaluate alternative job offers.

Although the Internet, Skype, and E-mail have made the world a smaller place, it is imperative for young academics to have generous research grants so as to be able to travel abroad to attend conferences and workshops, to collaborate with foreign co-authors / researchers, to participate in joint research projects with foreign experts or associations. Experimental scientists need state-of-the art laboratories; not many Indian universities offer these facilities.

The teacher: student ratio in engineering education in India is not comparable with what it is in the developed countries. While the states are making constant efforts for improving the teacher: student ratio in engineering colleges falling under their jurisdiction, the central government is also constantly monitoring the maintenance of a healthy teacher-student ratio. Therefore, maintaining an optimum teacher: student ratio should not be an unachievable goal. The quality of teachers, however, is the main concern even if quantity is addressed. Poorly-trained teachers could be an even bigger problem. This needs to be addressed.

It is a truism to say that higher education requires larger amounts of funding not only to provide knowledge but also to give the country good architects of the society. But higher education in India has been a victim of lack of finances for many years since independence. The question, therefore, arises: How can we solve the problem of financial crunch to overcome the related problem of faculty crunch in leading engineering institutes / universities?

When modern technology and research were taking shape in India, it was in a very nascent stage as a nation. Therefore, the government could not make substantially special allocation for some "world-class" centres of excellence. Rather, for the development of higher education, India has so far followed the policy of gradually increasing the number of universities, all of them with roughly the same scale of facilities. This emphasis on quantity has had an adverse impact on quality because resources have been spread too thinly. Even the most well-funded university or research institute in India receives no more than a fraction of the funds available to comparable institutions in several Asian countries. But the financial requirements of 'world-class' universities are very large. This means that the only feasible option, as some higher education observers have suggested, is to discard the current policy of uniformly same salary scale, same rules regarding travel grants, etc, across all universities / institutes.

Spending of public money on higher education and research for non-performing universities / institutes should be reduced. Only teaching (without any productive research in the form of quality publications or usable patents) does not justify huge spending by some so-called 'elite' institutes / universities. Instead, based on some quality criteria, all institutes / universities should be graded and judged as per their performance and public monetary support should depend on that. Performers should be separated from non-performers and the former should be given more incentives. Performing institutions should be given more financial grants as encouragement for better quality teaching and research. Furthermore, there should be some universities with research facilities and salaries comparable to the best in Asia. Performing teachers should also be given financial rewards.

Concerned over the "glaring regional imbalance" in engineering education with two-thirds of the engineering institutions being located in the four southern states and Maharashtra., Mr. Sam Pitroda has suggested that the prestigious Indian Institutes of Technology (IITs) should mentor some lesser known or new engineering colleges to raise their standard. Mentoring by its definition is a voluntary activity, but if we can create an atmosphere where institutions of distinction feel a sense of calling in the interest of the larger national good, it would transform our education.

Further, a framework of public-private partnership is needed to establish new quality institutions. This call for mentoring in the fields of education and research is closely related to the continual challenge of the "third mission" of the universities / institutes, which concerns the social responsibility, community engagement, as well as socially engaged scholarship. Universities / Institutes are increasingly considered instruments of social and economic development and are expected to supply relevant skills. Although newly discovered by some universities, service to the community has a long tradition in others. It is mentioned as an explicit mandate in the charter of many universities. A university can bear its responsibility only if it maintains active relations and dialogue with the surrounding society. Service and community engagement takes many different forms, for example, community-based research and learning, assistance in regional development, continuing and community education, vocational / skill-development programmes, technology transfer, and other forms of knowledge sharing and linkages.Some of these aspects of the third mission of the universities have also been emphasized in a recent publication. Wherein a view has been expressed that growth of economies and living standards of civilized societies are being increasingly determined by knowledge and innovation created and fostered by knowledge institutions.

The demand for closer interaction of such institutions with entrepreneurs, communities, and industry is becoming increasingly louder. Entrepreneurship strengthens the knowledge system, converts knowledge to intellectual property, promotes ventures for commercialization of technologies, creates wealth, and enhances technology competitiveness and the tech-image of the country. Furthermore, it creates new business and creative opportunities, jobs and services, and thus promotes regional as well as local development. Close interaction of academic institutions with entrepreneurs should be mandated as a social responsibility on the part of academia.

Some of the origins of this third core mission lay in the desire of governments to secure a wider benefit from the public investment in higher education. Universities cannot limit their function to providing the final element of education for school leavers. They are increasingly expected to transfer knowledge more widely to the community in such a way that transfer could secure social or economic benefits, for example, in supporting community work or in transferring intellectual property to those who would most effectively be able to exploit it for the purposes of economic activity and trade. This is called 'technology transfer', but the overall mission is more usefully described as 'knowledge transfer' or, indeed, 'knowledge exchange'. The latter is at the heart of what in the United Kingdom has become known as 'third stream' activity, so called because it has been funded under a third stream of resources (with teaching and research) by the funding bodies. Thus, beyond teaching and research, the University Third Mission - services to Community / Society - has at least 3 dimensions: a non-profit social approach, an entrepreneur focus, and an innovative approximation.

Let policy makers think that it is undoubtedly right that universities and other higher education institutions should disseminate the benefits of their knowledge and expertise widely; the old idea of educating the elite has long been dropped in strategic rhetoric, but must also be transcended in practice. The Third Mission must have a proper place in the organizational structure and it needs to be accepted and championed by the faculty. For this, it must be based on excellence and integrity, and that it is recognized in career development. There may always be some diversity of mission in the universities. But each institution should have a clear strategy which is understood and accepted and which has identifiable targets and outputs. In the present circumstances, some of it may be about diversifying income streams. But the heart of this mission is the same as for any other part of the academy: to discover, develop, disseminate, and transfer knowledge for the benefit of society. Today a university focuses not only on industries and technologies but also on their socio-economic and cultural impacts..

Vote of Thanks : Prof. B. R. Saha

I would like to thank the Engineering Council of India (ECI) for organizing the 6th National convention on apt and timely theme of industry-specific engineering education for better employability- Contours of reform here at Kolkata. A short while ago, Chairman, ECI, Dr Uddesh Kohli Ji gave us the reason of these conventions.

Prof. B. R. Saha, Head, Dept of Chemical, Engineering, Heritage Institute of Technology, Kolkata and Honorary Secretary, Indian Institute of Chemical Engineers

Technical Session - I

Session Chairman's Remarks : Shri S. Ratnavel

The subject of the 6th National Convention had already been discussed at the previous five national convention held at Kolkata, Vadodra, Hyderabad, Vishakapatnam and New Delhi. A national workshop was also held on the same subject at Madurai and there is a general consensus for the reform of engineering education, for making it multidisciplinary at the graduate level. The sixth convention would consider the contours of reform and try to get a consensus on these contours.

Co-Chairman's Remarks : Prof. (Dr.) Sarajit Basu

I thank the Engineering Council of India for initiating a debate on the reform of engineering education in the country and carrying it further. While reform of engineering education was overdue for making it suitable to the current & the future needs of the industry in particular and the economy in general, we need to take it up with cautions so that we are in position to put in place engineering education that we need with the full consent of all the stake holders in the country. I am sure that as we go along with the discussions on this subject today, we will be in a position to bring up forward-looking recommendations for implementation.

Keynote Presentations :

Dr. P.R. Swarup

It will be possible to realize the growth rate of 9% of our GDP in the Xith Plan only with good quality of infrastructure and availability of required power-in units of energy and of quality. Among other things, we will have to make investment of about 300-400 billions of dollars in the next five years for making sure that we realize this kind of growth rate. It implies that we need to have lots of construction going on; also we need to set up lots of plants. We need to expand power plants, ports and services. The manufacturing sector will also grow.

Construction happens to be at the top of every development project. Construction industry has been growing at the pace of almost 15% per annum. At this growth rate, the construction industry alone needs about half a million engineers. We need multidisciplinary and multi-skilled construction engineers to do construction and not the civil engineers.

Let us, for a moment, assume that civil engineers are needed, we do not have them in numbers and of required quality that the construction industry needs. If we look into the history of past 10 or 15 years, as a matter of fact, what we find is that all the colleges that have been accredited by the All India Council for Technical Education (AICTE) do not find civil engineering as a branch. It is just not there. In the old colleges, there are limited numbers of seats.

The second problem that we have today is: where are the teachers who will teach construction engineering? Who is going to teach these people? Do we have adequate number of good experienced teachers who understand what is to be taught to these people so that when they go back to the construction industry and deliver what the industry is looking for? The third problem is how relevant is the curricula that is there in the colleges or in the universities to meet the actual needs of construction industry?

Presently, only civil engineers are, by and large, in demand from the construction sector. Is a civil engineer a construction engineer by virtue of her / his education? I think no. *Construction engineer needs a familiarity with the world of business and commerce, dealing with people and resources, environmental, health and safety aspects, legal aspects,*

Sh. S. Ratnavel, Chief Executive Officer, Sceba Consultancy Services and Member Board of Governors, Engineering Council of India
Prof. (Dr.) Sarajit Basu, Chairman, Chemical Engineering Division, WBSC, IEI Kolkata
Dr. P.R. Swarup, Director General, Construction Industry Development Council.

project engineering, logistics engineering, procurement engineering, application of IT and communication technology in construction, dealing with partnerships and joint ventures learning the nitti gritties of contracts and claims, apart from the changing world of technology itself.

A construction engineer should be far more multi - functional and better equipped to deal with complex issues of construction business. Construction engineer is much more of an engineer - manager. So, a pure civil engineer is not so equipped to be a construction engineer by virtue of education. We need engineers with some basic knowledge of civil, electrical, mechanical, metals and materials engineering, apart from knowledge of electronics and information technology, economics, statistics, law, contracts and dispute resolution, etc. So we need engineers for meeting the unique needs of mega projects of civil aviation, ports and harbours, urban renewal, transportation projects, telecom and power sector projects, oil and gas exploration projects, etc. So, there is a case for creating a new Branch of Construction Engineering.

Prof. Swapan Bhattacharya

When we look at the perspectives, we find that the seamless globalized economy is here to stay and in this scenario, sustenance of high GDP for our country is important. We have a very large young population, all pervasive deployment of technology, legacy of long heritage in education, creation of research institutes vis-à-vis teaching institutes, legacy of attaching maximum focus on under-graduate education, creation of knowledge vis-à-vis creation of wealth - conflict or synergy.

There are some issues which need consideration. These include equity, excellence, social responsibility, relevance to the industry, flexibility of education system, learning technology, managing technology and working with technology, employability, self- employability, entrepreneurship and innovation, competitive environment, influence of media and internal resource generation.

There are some concerns which need to be dealt with in any attempt that we may make for reforming our engineering education system. These are present obsession that we have with marks / grades, obsession with the status co or the past practice and lack of initiative to reform, emphasis on Input-driven criteria, little scope for innovation in the engineering education system, too much emphasis on service sector, stagnation of vision in primary and secondary education, huge disparity of quality within education system, lack of mutual respect between industrial and academic sectors and tendency to address serious issues through quick-fix approach.

I present some proposals for reforming the engineering education system. These are the following: to inculcate problem-solving approach throughout the curriculum, integration of basic science and social science with technical education, transition towards branch-less / discipline-less curriculum at under-graduate level, deployment of state-of-the-art technology, encourage and promote involvement of faculty in industrial environment, permit inter-institute credit transfer, organize skill / knowledge-centric workshops in industrial sectors.

Prof. H.R. Vishwakarma

For a majority of engineering graduates industry is one of the main job options. They either do not choose or do not get opportunity to practice engineering after graduation as such. Some of them also prefer government jobs. Going for the teaching jobs or for the research & development work are he options considered only after the first two options mentioned here are not met. Consultancy is very rarely pursued in the beginning of the career; but later after some experience, this option is also considered, but that too by only a few experienced engineers.

In India, the faculty job is not considered attractive as against the industry jobs or for that matter managerial job. The problem lies here. Engineering is pursued for employment; and those branches are selected which fetch

Professor Swapan Bhattacharya, Department of Computer Science & Engineering, Jadavpur University, Kolkata

Prof. H. R. Vishwakarma, Senior Professor, School of Information Technology & Engineering VIT University, Vellore-63201 and the Hony. Secretary, Computer Society of India

higher salaries- software engineering, for example. There is no consideration for what you like to do and what your aptitude is for? Parents decide. You do not. In this scenario, how can we expect to produce real engineers? But we do have them there; they are not from the academically qualified lot; they come up from the shop floors of factories. They come up from experience and not from engineering colleges. Obviously, we have got to look at this reality also while considering reform of our engineering education.

We have the curricula which is only one of the major quality issues. Today, we are facing a big problem in the engineering education system and this is that of its quality. Broadly, it is generally perceived by all the stakeholders that we have rigid and outdated engineering course curricula, we have not been able to adapt the course curricula to dynamic industry requirements, we have a poor lab infrastructure, we have limited exposure to latest tools & techniques and we have a little R&D.

Further, related to the quality issue of the engineering education system, we have limited exposure to industry problems, poor industry linkages, poor quality of the faculty because the best do not come to academics to teach, we show inability to enter into emerging areas and then there is the problem of economic viability of ventures elated to education due to no significant endowments / grants / donations coming to the sector as such. We do not link theoretical concepts of the engineering education to its applied framework; there is a little exposure to real-life case studies in the present engineering education system. There is a very little scope for creative learning in the present engineering education system.

Looking at the engineering education system as a whole, what we find today is that the whole system needs overhauling for producing better employable engineers. When we look at the engineering curricula framework, we find too much focus is given to discipline- specific subjects. Second, subjects on management, humanities, social sciences and information technology are not included in the curricula .Too much focus is on discipline-specific subjects; some of these have become obsolete.

From the Floor - Shri K. S. Parasuram

Exposure of mechanical engineer to Chemical engineering knowledge can be demons traded by a case study which I am presenting here. Most industries can be looked upon as chemical industries. This applies to the steel industry too since a number of chemical reactions take place within the blast furnace and it is necessary for the concerned engineer to be aware of this fact from the point of view of optimization for best results for a given set of raw materials without any financial losses in one form or the other. All industries comprise unit operations such as mixing, grinding, evaporation, distillation and unit processes involving a variety of reactions with the production of products and by-products. It will be extremely useful for a mechanical engineer to be exposed to the unit processes and operations listed above. In the absence of this knowledge s / he gets a bit distanced from the floor job and this can lead to losses.

An illustration will make it clear what I want to say. A mechanical engineer installed a double effect evaporator for concentration of soap lyre prior to the next step of distillation to produce glycerine. Evaporator yields were not found to be satisfactory and this went un-noticed for some time. I - a chemical engineer- was put in charge of investigating losses of glycerine traced to the evaporator. On a first look, I found that the mechanical engineer had installed the evaporator with the front sight glasses facing the back and vise versa .The evaporator was consequently being operated with high liquid levels with greater chances for losses under the prevailing vacuum conditions. The evaporator operator was suitably advised and undue losses were eliminated. If only the mechanical engineer was aware of the right positioning of the evaporator (chemical engineering knowledge) losses could have been avoided. With the additional knowledge of optimization using microprocessors and unit processes, specifications, basic accounting, quality and pollution control, the mechanical engineer would have been at an advantage to rise to the levels of senior management and beyond found his job more interesting and thus rewarding. In the same way, a chemical engineer with a basic knowledge of drawing, workshop practices and fundamentals of mechanical engineering practices would be in a better position to take on greater responsibilities to rise to high levels of office, other conditions remaining the same.

Technical Session - II

Session Chairman's Remarks : Shri R. N. Parbat

This is the 6th National Convention of the series organized by the Engineering Council of India at different places in the country on the apt and timely subject of "Reform of Engineering Education for Better Employability of Engineers". It is true that there has been a problem of poor employability of graduate engineers who pass out every year from various engineering colleges in the country in large numbers. This number is placed at around 8,00,000 / - engineers of all branches that come out of our engineering colleges every year .When taking a rational and in-depth look at this problem, we find that this problem is our own creation because of various reasons. One of the reasons is that we have not been assessing the demand for engineers and hence, as a matter of policy, matching this demand with the supply that we needed from time-to-time. We have not been doing it. Perhaps, we have set up many more engineering colleges than what we needed, if we would have been following the practice of first assessing the demand for engineers and then only creating more engineering colleges for meeting this demand, we would have not faced the situation, in which we find ourselves today. Mushrooming growth of engineering colleges, which we have and are witnessing even today, has lead us to having many engineering colleges with poor quality of infrastructure and faculty. This is in sum our problem, which needs to be tackled.

Then there is the issue of what we are teaching today and what we need to teach for producing engineers that the industry needs. What we have been teaching may have been right during the past era, it is not perceived to be right today, when the Indian industry is operating in a n open economy and hence is facing competition with imports fro all over the places including from China. We are in an era of technological integration and of mega projects. We need engineers with multi-disciplinary knowledge and multi skills to day for meeting the needs of the industry and emerging R&D sector. We need engineer mangers; we need design engineers. Today India is still dependent on imported designs. We do not design basic things; we may be skilled to up-scale designs, but that will not give us the leadership position in the world economy. We cannot afford this. So, we must reform our engineering education and training to meet these new challenges; and this is also needed for India seizing a significant share of the world trade in engineering services as and when trade in services is opened up, which is round the corner. With these opening remarks, I hereby open the session for keynote presentations and discussions after the presentations.

Keynote Presentations :

Shri S. Ratnavel

The practice of engineering needs to change because demand for technologies and products exceed the existing knowledge bases; and also because a visible change has occurred in the professional environment in which engineers need to operate today. Engineers need to meet these challenges. We need to re- engineer, therefore, engineering education. This is well recognized fact of our lives today.

Many opportunities will be generated for the Indian engineers' world-over with the International Engineering Agreements such as Washington Accord, Engineers Mobility Forum, Sydney Accord, Dublin Accord, etc, becoming operational, which is round the corner. For seizing these opportunities, our engineering education should be of the same standards as that of the developed countries and also the professional experience of the Indian engineers should also be of the world standards. While there is no problem with the professional experience of our engineers, our engineering degrees are not yet recognized by the developed countries, of course there is the exception in the case of degrees conferred by the IITs and some other institutions of engineering education. The exception proves the contention that generally speaking our engineering education is not of the matching standards with that of the developed countries.

Shri R. N. Parbhat, Management Consultant, former Managing Director, Indian Aluminum Company Ltd. & Past President, the Indian Institute of Metals

Professional Competency profiles record elements of competency that must be demonstrated holistically Defined for each category of registration. The EMF and ETMF define requirements for the International Registers using professional registration, time and responsible experience Agreements provide for a future competency-based route to International registers. There is a need to define assessable set of competencies for our engineers and engineering technologists. There are limitations as well in the Professional Competencies. These are that no perspective is defined, indicators of competency are not specified, and the indicators for assessment of competent performance are also not specified. GA & PC is stated generically and applies to all engineering disciplines and contexts.

The gap is widening between the engineering practice and engineering education A systemic approach is essential to achieve values in the engineering education. All changes made in the past were based on instances of successes in individual programmes. Courses developed based on isolated thoughts by few individual Institutes did not meet the required changes that needed to be made for making the engineering education what it should be for facing the current and emerging challenges. These initiatives (if we may call these as such) can be called as catalysts for the change that we need to make in the engineering education system. While considering changes that we need to make in the engineering education system, we must keep in view factors such as explosion of knowledge, growing complexity in environmental and economic policies interdependence of societal problems, worldwide variety of problems, Inconsistent demands in global economy. Integrating education and research aspects must also be considered.

Within the context of professional engineering practice, one must adopt system approach Involved in the engineering education and its contextual relations such as: application of engineering process-science, engineering, technology, energy conservation, economy, safety for public, safety for environment, optimum use of scarce resources, personal development, knowledge synthesis, data collection, collation, analysis & interpretation skills, designing skills, hypothesizing skills, software skills, hardware knowledge, teamwork skills, report writing skills, communication skills.

It is suggested that we should make the engineering curriculum at the undergraduate level seamless which should address the following: to understand the contemporary world model with the help of past and future, basic sciences, engineering sciences, engineering arts, technology forecasting, technology assessment, humanities, research ,methodology, experimental methods, system engineering concepts, impact assessments, environmental models, economy models, legal and judicial models, technological interactions, political models, importance of inter disciplinary and interactions, value system, communications, etc.

Masters programme in engineering should be based on specializations such as Architecture / Human Settlement, (texture, forms, aesthetic, creativity development), Architectural Engineering (Building Systems, Structural Design of Buildings, Plumbing, Heat Ventilations, Plumbing etc.), Infrastructural Engineering (Concrete Technology, Design of Roads, Airports, Drainage Systems, Power Generations etc), Infrastructure Maintenance (Retrofitting, Corrosion Sciences, Restoring, Rehabilitation, Structural Engineering (Buildings, Bridges, EQ engineering, Steel Structures etc),Water Engineering and Environment (Irrigation, Hydrology, Soil water Interaction etc), Geotechnics and Environment (Investigation, Soil water Contamination, Solid waste Disposal etc) ,Ocean Engineering (Offshore Structures, Tide wave energy, etc.),You Can Discover or Invent New Domains Based on need.

I suggest that we should have a BE Seamless Engineers Degree of four years. This course must be integrated and comprehensive to address Basic Sciences, Engineering Sciences, Engineering Arts, Economics, Humanities and Language and Communication, along with research methodologies. This course should cover extensive analysis of key subjects relating technology and management, planning, programming, budgeting, finance, organisation, private sector, involvement, operations & maintenance, project management, and research needs. Industries need seamless graduates to put them in the following activities: writing feasibility studies, detailed project reports, preparing impact studies, carrying out market surveys, managing human resources , dealing with government policies, preparing contract documents, tax planning, arbitrations, dispute resolution, ,etc, very immediately as Executives. With this course, we will be able to tackle complex, large-scale problems which must be overcome when dealing with the engineering and management of major engineering projects.

Dr. Uttam Roychaudhuri

We need to improve the quality of engineering education. This cannot be delayed any further. The quality of engineers should be counted first while the quality of Institutes should come next. In the present scenario, the reverse is true. In fact genuine recruiters search for the quality engineers. For this I suggest that the entrance / admission to engineering institutions should be made through an All India Common Admission test for engineers. The quality of engineers should be counted first while the quality of Institutes should come next. In the present scenario the reverse is true. In fact genuine recruiters search for the quality engineers.

AICTE curriculum should be product / industry and service oriented. Duration of study should be five years including management papers. A Graduate Aptitude Test for Engineers (GATE) or the National Professioncy Evaluation Test (NPET) should be designed & developed for each discipline of engineering separately. Employers should recruit those engineers who qualify GATE. Or NPET. Recruitment of engineers without the GATE score should be legally discouraged. Employment to the GATE qualified engineers' should be guaranteed. Present practice of campus recruitment should be discontinued. Recruiting should also be done on line using transparency in the selection, which should be based on merit only.

All the recruiting agencies and industrial organizations government / public / private should display their authenticity and mention clearly the number of vacancies with discipline. Accreditation should be awarded after acquiring at least two years of continuous professional experience. A practising license may be issued with the condition that in the case of involvement of any illegal activities / damage due to faulty design / operation or any criminal activities, the same should be forfeited. For this, Engineers Bill should be brought on the statue as the Engineers Act and a statutory council of engineers set up as a consequence without further delay.

There is a case for creating a new degree of hydrocarbon engineering. .The goal of a hydro carbon engineer is oil & gas exploration, preparing oil wells for production of crude oil, oil refining, production of petrochemicals, plastics, polymers, rubber, fibers, etc. His / her role is also to design of plant & equipment, evaluate cost, and evaluate efficiency / productivity, tracking the progress of projects, monitor quality / quantity of crude oil, of products, material & energy loss assessment, monitor wastes / effluents, workforce supervision, supervise maintenance work / shutdown / startup, fire fighting & safety operations, prepare progress reports-daily / weekly / monthly / annually, disaster mitigation, etc.

Today, a degree in chemical engineering is required for jobs in the hydrocarbon industry. But the syllabus of the chemical engineering degree course, say for example of the Jadavpur University, does not contain all of these foregoing activities. Hence, I suggest a modified syllabus for the future engineers who want to work in the hydrocarbon industry. I, therefore, suggest that we should introduce new industry / sector-specific engineering branches. I suggest that we should introduce a branch of hydrocarbon engineering. We may name it BE (Hydro Carbon). A suitable syllabus for the new degree is also suggested (see the presentation in the technical section of the proceedings)

Dr Uttam Roychaudhuri, Associate Professor, University of Kolkata

Dr. Pradipta Kumar Bose

I was fortunate, as a final year student of chemical engineering (1950 / 51) at NCE. Bengal (now Jadavpur University), to have Dr. Weingartner from West Germany as a visiting professor in chemical technology. In his opening lecture he had said that Germany built a formidable chemical Industry before the war with raw materials based on coal, limestone, air and water plus technology. They not only produced synthetic ammonia by 'Haber process' but also gasoline and diesel oil from coal by "FisherTropsh" synthesis. My dream like my other class mates was to go to Germany and learn some of those fascinating technologies. My dream came to reality when I got INDO-German scholarship in 1952 to go to Germany. Prior to that I worked for one year in Bengal Chemicals at their Panihati works after my graduation in 1951. In 1952 when I arrived in Germany it was still recovering from the impact of war which ended in 1945. Most of the towns even in 1952 were in ruins. A democratic Govt.was set up in 1947 with backing of 'MARSHALL AID'. Industry played a crucial role in W. Germany's economic recovery. A decisive factor in this process was the transition to a market economy in 1949. One of the basic principles of the social market economy was the entrepreneurial responsibility. Government economic policy was largely to create framework for development and creation of new jobs. In the FRG's(Federal Republic of Germany) view competition between firms was the best way to keep German Industry competitive. I have had an opportunity to be present during this transition period in Germany; and saw very closely the reconstruction process in W. Germany during 1952-57 and before my departure for India in 1957; I could hardly see any impact of war on the cities and towns. All this was done by engineers with multi skills and having knowledge of various engineering disciplines including their engineering technical workforce providing the valuable base-line services. Even R&D at the shop floor was order of the day managed excellently by the multidisciplinary engineers of the W.German Industry. It was all committed, dedicated practical work done by thinking engineers and engineer technicians through an excellent team work.

I observed that West Germany was the foremost country in the field of industrial research based on close collaboration between industry and research institutions. German education system at the school level laid emphasis on works education. Importance was given to research in higher education. A close co-operation between industry and academic institutions was maintained as a matter of policy. A working set up in an industrial plant included what is known in German language "Obermeister"-an experienced hand (an engineer technician in our case) who looks after day to day operation & maintenance of the plant- while the Plant Manager / General Manager (mostly Doctorate in Eng / Science) is responsible for R / D and overall management. This set up acknowledges the experience of the "Obermeister" and qualification of the young plant manager for the smooth operation of the plant. I also observed that emphasis on shop - floor industrial R / D for improvement of processes and / or development of new equipments was also laid a matter of policy of companies. There was a close co-operation between engineering organizations with the manufacturing companies for utilization of process know how for commercial utilization.

We all know that most of our engineering graduates are opting for Information Technology and / or management for their future career, Indian industry is suffering for want of capable personnel. We need to take measures to arrest this trend. We need to make engineering education such as would give a wider scope for engineers to grow in their profession. We need to make them multidisciplinary and multi-skilled at the graduate level; and we also need to make engineering career attractive for our engineers; we need to make teaching engineering also very attractive financially so that the best brains are attracted to the engineering faculty. We should consider making engineering education to move through shop-floors as is the case in Germany and many other countries in Europe.

Dr. Pradipta Kumar Bose, Adviser, BFN World Service and Consultant, Environmental Planning & Sustainable Development and Former Professor Chemical Engineering, Jadavpur University, Kolkata

Dr. Sandeepan Bhatacharya

"Engineering is the art of directing the great sources of power in nature for the use and convenience of man"- Thomas TredgoId (1828). In the past, changes in the engineering profession and engineering education have followed changes in technology and society. Disciplines were added and curricula were created to meet the critical challenges in society and to provide the workforce required to integrate new developments into our economy. Today's landscape is little different; society continually changes and engineering must adapt to remain relevant. The world is facing both rapid quantitative and qualitative changes. The former pertains to economic growth and technological innovations, while the latter to a new paradigm of an evolving society based on different values and ethos.

Drivers for change include new multidisciplinary technologies, an unprecedented rate of technological change, globalization, and off shoring. The "half life" of an engineer's knowledge - the point at which half of what the engineer knows is obsolete - may now be as little as five years. "If it's below five years, we'll get scared. That means by the time we're done with a graduate, half of what we learnt will not be relevant. In such an environment, an engineer is like a small boat in a storm-tossed sea if he or she cannot recognize global trends and lacks the ability, instinct, or desire for continuous learning.

Technical excellence is the essential attribute of engineering graduates, but those graduates should also possess team, communication, ethical reasoning, and societal and global contextual analysis skills as well as understand work strategies. Neglecting development in these arenas and learning disciplinary technical subjects to the exclusion of a selection of humanities, economics, political science, language, and / or interdisciplinary technical subjects is not in the best interest of producing engineers who will not be able to communicate with the public, to engage in a global engineering marketplace, or trained to be lifelong learners.

We must make new discoveries, innovate continually, and support the most sophisticated industries. We must also continue to bring new products and services to market faster and better than anyone else, and we must design, produce, and deliver to serve world markets. We must recognize that there are natural global flows in industry,' that, the manufacture of many goods will inevitably move from country to country according to their state of development. Manufacturing may start in India, then move to Taiwan, then to Korea, and then to USA or UK. These mega shifts will occur faster and faster and will pose enormous challenges to our nation.,

Meeting these challenges will require an accelerated commitment to engineering education. Engineering Institutes will have to do many things simultaneously: advance the frontiers of fundamental science and technology; advance interdisciplinary work and learning; develop a new, broad approach to engineering systems; focus on technologies that address the most important problems facing the world; and recognize the global nature of all things technological.

1 first heard the term "systems engineering" in a seminar about the Vanguard missile - the United States' first, ill-fated attempt to counter Sputnik by putting a grapefruit-sized satellite into space. The Vanguard rocket was assembled from excellent components, but it was designed with insufficient knowledge of how the components would interface with each other. As a result, heat, electrical fields, and so on, played havoc with them. The system needed to he engineered.

We are entering an era of rapid technology changes, which are reflected by a dramatic development of the frontiers of technology, and multidisciplinary and interdisciplinary technology trends. Together, chemical technology and mechanical engineering have facilitated the progress of process industries. The combination of mechanical engineering and electronics has enabled the development of mechatronics.

Dr Sandeepan Bhatacharya, Head Scientific Services, Tata Steel, Jamshedpur.

Future Engineering education for example 2020 and beyond will require a variety of skills not commonly taught in Engineering Colleges and universities today. The need to teach attributes like creativity, flexibility, analytical skills, creativity, ethical standards, ingenuity, leadership, dynamism, agility, resilience, and business acumen will drive a demand for an "experiential" approach to education. Some of these are "fairly foreign" in the academic environment. "It's not just how much math and circuit theory you know, it's communications, the ability to work in teams, to understand professional ethics,"

Chip-based technology, for example, has enabled many other technologies from microwave oven control (Ichip), automobile (>10 chips) to airplane control (>hundreds chips). People encountered daily microprocessors from less than three in 1985, to 10 in 1990, and more than 50 after 1995. Materials scientists are working increasingly with computer scientists and application engineers to develop biomedical materials for artificial tissues or produce reactive materials to facilitate active system control surfaces. The multidisciplinary and interdisciplinary nature of technology means a high density of knowledge integration in a single technology. This has been a great challenge for developing countries where the know-how and talents in a company are generally limited It is important to remember that students are driven by passion, curiosity, engagement, and dreams. Although we cannot know exactly what they should be taught, we can focus on the environment in which they learn and the can forces ideas, inspirations, and empowering situations to which they are exposed. Despite our best efforts to plan their education, however, to a large extent we simply wind them up, step back, and watch the amazing things they do. In the long run, making universities and engineering schools exciting, creative, adventurous, rigorous, demanding, and empowering milieus are more important than specifying curricular details. A controversial suggestion in the NAE report is that a bachelor's degree be considered a "pre-engineering" degree- depending on the course content and reflecting the career aspirations of the student, and a master's degree should become the "recognized professional degree" in engineering. A more likely alternative is to "turn the curriculum inside out." While engineering science was at the core in the 20th century, the 21st century would put engineering experience at its core, and wrap engineering science around that as it supports design.

Industry and professional societies should recognize and reward the distinction between an entry-level engineer and an engineer who masters an engineering discipline's "body of knowledge" through further formal education or self-study followed by examination. Adequate depth in a specialized area of engineering cannot be achieved in the present degree course. To promote the stature of the profession, engineering institutes should create accredited "professional" master's degree programs intended to expand and improve the skills and enhance the ability of an engineer to practice engineering.

Therefore, a critical re-examination of the current engineering education system suggests a possible reformation of the current system. It is hoped that engineering education addresses the need for technological advancement in bioengineering, biotechnology and biomedical technology, information and communication technology, and miniaturization (MEMS. nanotechnology and advanced materials). They should cover the growing complexity, multi-scale, and uncertainty, multidisciplinary and interdisciplinary characteristics of engineered systems. It should also address the ecological environment that becomes worse day - by - day, the pressure of the population explosion, as well as the disequilibria in economic development that magnifies inequality in the distribution of wealth and increase poverty, which is a source of social instability.

Departments need to more closely examine the mix of skills and experiences possessed across their cadre of faculty to determine how best to provide students with the knowledge and experiences essential to engineering practice. The engineering education establishment should strengthen the ties binding engineering education to practice not only through curricular design and provision of co-curricular activities, but through the experiences of engineering faculty in industrial research, product design, and / or production. Colleges and universities should develop new standards for faculty qualifications, appointments, and expectations.

Shri P. N. Shali

Nearly 8 lakh engineering graduates come out from colleges every year in our country. At any given time, a large number of them remain unemployed. According to FICCI, this is because of a critical shortage of skills in engineers that the Indian industry needs. According to a survey report by McKinsey global Institute, multinationals find only 25% of Indian engineers employable. According to the Knowledge Commission "Most graduates (Read Engineers) do not possess the skills needed to compete in the economy, and industries have been facing a consistent skills deficit". This is a cause of concern.

Engineers who come out of engineering colleges are discipline-specific engineers and not multidisciplinary engineers which industry needs. They do not have sufficient knowledge to start working straight away on their jobs in an industrial unit. They need retraining which means expenditure that the industry will have to bear. We have working engineers who often get stuck in the domain-specific jobs. They do not move out to acquire multi-skills required today for meeting the changing needs of the engineering profession. Mere specialization in one branch of engineering, as is the practice now, does not produce multi disciplinary and multi-skilled engineers needed by the industry today. Too much theory is taught; too little emphasis is given on experiments and on- the -job training. There is, therefore, no correlation in the present engineering education system between theory and practice. Engineering education system does not prepare engineers for the industry as such, as engineer managers to manage mega projects which encompass many technologies.

There is no subject which can make you understand today's technology in its entirety; it needs interdisciplinary skills and knowledge to understand and comprehend because it has become more interdisciplinary. We need engineers today who have skills to deal with matters such as: business and commerce, people and resources, environment, health and safety, legal aspects, project logistics and procurement engineering. So, we need to reform engineering education and change it from the present engineering branch-specific degrees to industry-specific degrees Make it more practical and multidisciplinary with additions of subjects from social sciences-economics, statistics and management.

We, therefore, need to bring up a new curricula and mode of delivery. But we should do it step by step and with caution. While reverting back to previous practice of having two years of common curricula and allotting branch after third year, we should reform the curricula itself and introduce two new branches- one on BE Construction, the second on BE (Hydrocarbon Engineering). We should also consider having a common Degree of Engineering & Management of five years duration. We should also make it mandatory to have project-based during- the-course industrial training and six months of internship with an industrial unit thereafter. Both these trainings should be assessed and credits added to the marks obtained by a student from the written examination and internal assignments undertaken during the course. The final engineering degree should be awarded only after all these assessments have been completed. However, after clearing the written examination, a provisional degree can be given. What is really important is that in today's world the manufacturing sector does not require engineers merely to construct the plants and operate them, but to see that the whole system of logistics and materials management, etc. operates in efficient manner. This will need well and appropriately qualified and quality engineers (Dr. Kirit S. Parikh, former Member, Planning Commission).

Shri P.N. Shali, Director Engineering Council of India and former Adviser and Consultant, Planning Commission, Government of India.

Panel Session

Session Chairman's Remarks: Dr. S. K. Bhattacharyya

This session is the concluding session with the theme: Formulation of Consensus Recommendations on the Contours of Reform of Engineering Education. We have heard thought provoking keynote presentations in the previous sessions, which were followed by a lovely discussion. I am happy to note that many students present in the convention also participated in these discussions. A consensus has emerged that we need to reform engineering education for making it such as would produce engineers that the industry demands today. We have here as the panelist Dr Pradipta Kumar Bose, Professor Uday Chatterjee, Prof. (Dr.) Kalyan Mitra, Dr. (Mrs) Suman Kumari Mishra and Shri P. N. Shali. These distinguished panelists will give their very brief presentations and after that we will have a discussion; after that, we will finalise the recommendations.

Panel Presentations:

Dr. Pradipta Kumar Bose

I thank Engineering Council of India for taking the initiative for the reform of engineering education. I am for the practical engineering education, which can be imparted at the shop floors. The big issue is: how to integrate the engineering education with its practical aspects. Once we are able to do it, the rest will fall in place. May be if industry is also permitted as a matter of policy to set up engineering colleges and deliver engineering education, we may be able to resolve this issue. We need to consider this. I also agree with project-based during-the-course industrial training and a six months internship with an industrial unit after the course, which should be assessed and grade that a student may get added to the total score. The final engineering degree should be awarded after that; after passing out the academic course, however, a provisional engineering degree can be awarded. The industry will have to be compensated for any expenditure that it may incur on the internship. This is the policy matter. I am not for increasing the duration of the course from the present four-years.

Prof. Uday Chatterjee*

I appreciate the initiative of the Engineering Council of India taken on this very important issue concerning engineering profession in the country. Six conventions have been held including this convention. While there is a general consensus for the reform of engineering education, the final contours of reform will have to e laid with some caution. Any change brings a resistance; we have got to deal with this resistance. I would suggest that we should not move out from the present branch-specific engineering education straightaway. We should first reform the curricula of the current branches of engineering by removing from the curricula the obsolete subjects and add subjects from the social sciences. We may also consider reverting back to the old practice of a common syllabus during the first two-years of the course; and specialization can be after the third year. But, we need to reform the present practice of industrial training, by making it project-based during the third year and the fourth ear of the course; and during the first two years, it can continue to visits-based as at present. A six months internship with an industrial unit, as has been suggested, needs to be considered. We will have to find a way for compensation g the industry for the expenditure that it may incur on this internship. This is policy matter.

Prof. (Dr.) Kalyan Mitra

After serving academic field for 15 years and the industry for another 16 years, I do feel that the there is a need for re-engineering of engineering course curricula for making it such as would produce engineers that the industry

Dr S K Bhattacharyya, Steel Chair Professor, Dept. of Met & Mat. Engineering, Bengal Engineering & Science University, Sibpur, Howrah.

Professor Uday Chatterjee, Adjunct Professor, BESU, Howrah, Managing Editor, IIM Metal News and former Professor, IIT, Kharagpur.

Prof. (Dr.) Kalyan Mitra, Chairman, IIIE Kolkata Chapter, Indian Maritime University, Kolkata Campus (Formerly MERI).

*sent after the convention.

needs today. The course curricula should be monitored regularly for keeping a balance between the theory and industry requirement. If an engineering student has worked on a real life problem, s / he should be rewarded. It is also necessary to develop the faculty development programme. This programme should also include a mandatory provision for the faculty to work in the industry for at least six months / one year. This should be repeated after say every six-to-seven year's period. The industry should be represented on the academic boards / policy making bodies.

There should be a regular feed back from the industry to the academic institutions regarding what kind of changes are needed in the engineering course curricula for meeting the new challenges that the industry is expecting to face. This will mean that we should place in position a standing and working industry-academia institutional mechanism about which we have been talking about since many years, but nothing much has happened on this score. I also agree that there should be a six months of internship with an industrial unit after the main course is over, which should also be assessed. The industrial unit may incur some expenditure on this internship, which should be compensated as a matter of policy via the tax route. There should be on standard entrance test for engineers and it should also be such as would assess the aptitude for engineering in a student seeking admission for engineering course. Then, engineering profession also needs to be regulated as the other professions are. So, the government should bring on the statute at the earliest the Engineers Act and set up the statutory council for engineers. I recommend introduction of non practicing allowance for engineers also on the lines of Doctors.

Dr. (Mrs) Suman Kumari Mishra

I think that the 6th National Convention, which is being held today, & the five national conventions prior to this that the ECI has organised on the theme: Reform of Engineering Education for Better Employability of Engineers are the steps in the right direction that the ECI has taken. Many studies have revealed that the present engineering education system is not producing engineers of the quality which the industry & engineering R&D sector need. The engineering education system continues to be in its old mould- engineering discipline-wise with more emphasis on theory and exams and less emphasis on project-based industrial training. There is no provision in the course for an internship with an industrial unit after the course.

The multidisciplinary engineering education is required, as it is the demand of today's technologies-short-term technologies, long-term technologies and businesses. The existing engineers also may need re-engineering training for coping up with the changing scenario. The new engineering education must marry sciences & engineering in the curriculum making it on one side very good in the theory and experiments and on the other side application oriented. Further, what is also required is the industrial exposure to the students, which should be an essential part of the curriculum. It is not at present so. Hence our engineering students find themselves lost when they enter the industry after they get their engineering degrees. The industrial exposure can be given during – the -course industrial training by taking up mini industrial projects, solving some industrial problems by taking up projects by the students working in groups and led by their teachers. So reforming the practice of current industrial training is very necessary. What I am saying in short is that we have got to reform the engineering education system by inter alia adding to it more industrial exposure, which will also help the students to understand very clearly the theoretical concepts taught. Such engineering education system would develop creativity and also develop innovative skills in the students. This will also lead to developing interest in the students for higher education; and eventually to taking up research projects. By this, we can get better future teachers, who are essential to produce better and better engineers, and also researchers for developing new technologies and innovation in the current technologies. We need in an engineer a balance in the bookish knowledge and practical knowledge. Hence, it is essential to bring reform in the today's engineering education system.

I think that the ECI will take this discussion to its culmination and get a new reformed engineering education system in due course which will deliver engineers that the Industry & engineering R&D sector need. I thank

Dr. (Mrs) Suman Kumari Mishra, Scientist EII, MST Division, National Metallurgical Lab ,Jamshedpur the ECI for giving me this opportunity to present my suggestions on the theme of this very important convention.

Shri P. N. Shali

In order to keep pace with the global development trends, the need of engineers in the branches like construction, ports and harbours, or say infrastructure, oil exploration, development and oil refining, production of downstream oil-based products say for example petrochemicals, polymers, plastics, etc, manufacturing, innovation, is being felt more and more along with the need of engineer managers. The emphasis of the engineering education should be on preparing a wholesome personality with engineering as core knowledge. Engineering education needs to be, therefore, looked from the "user driven "or so called "market perspective" rather than a "discipline perspective", as is the case at present. I suggest that, as a matter of reform, we should consider taking up reforming engineering education with due caution and care, step-by-step as we go along and not in one go. If we do it that way that is in one go, we many create more problems for ourselves. We should avoid this. Meanwhile, we should revert back to having two years common subjects of all major branches of engineering at the graduate level in the four year course and the branch-specific subjects can be taken up after the third year. The branch should also be allotted after third year. We should remove subjects' gone obsolete from the curricula. We should also add some subjects from the social sciences in the curricula. After this, we should ensure that the emphasis is given to practical problem solving cases in the course. During - the - course training should be compulsory and based on taking up projects in the industry. After the course is over, we should introduce a paid internship of six months with an industrial unit. The final degree should be given after this internship is successfully completed. Provisional degree can, however, be given after passing out the main course. The industry should be compensated by the government for the expenditure that it may incur on the internship via the tax routet.

The other important points that I would like to make are continuing CPD of Serving Engineers must be ensured through a regulatory mechanism of engineering profession. We need to create a standing & working Industry-academia interactive mechanism on the line of what it is in the developed countries, as mentioned by many distinguished keynote speakers of this convention and that of the conventions previous to this. The industry should play an important role in the engineering education system. Entrance examination for engineering education should also assess the aptitude for engineering. We need to have case study-based technical books. This means that the engineering concepts should be made clear through case studies of solved or unsolved industrial problems. We need to have a facilitating and not controlling regulatory mechanism for higher technical education.

It has been recognized that we need to move out of the present engineering discipline-wise engineering education, but with taking each forward step with caution. While reforming the current curricula of various disciplines of engineering education by removing the subjects that have become obsolete and adding some subjects from the social sciences and other branches of engineering, we can think of introducing a few new branches -which will be the first step towards moving out of the present discipline -wise engineering education towards industry-specific engineering education. These branches could be B.E (Manufacturing), BE (Construction Engineering), BE (Hydrocarbons) and a combined Engineering & Management degree of five years with six months of paid internship with an industrial unit as a mandatory requirement for obtaining the degree.

Many delegates including students participated in the discussion and unanimously endorsed the theme of the 6th convention. They agreed fully with the views expressed by the keynote speakers and panelists. Due to the very bad recordings of the proceedings by the professional recorder, it has not been possible to cover verbatim what they said in the proceedings, which is our normal practice and we regret it

After some discussions, recommendations were drafted, which are covered under recommendations section above.

Note : Due to technical problems with the recording of the proceedings, question-answer, writeup could not be included.

6th National Convention - Technical Paper

Engineering Education in India - Quality is the Need of the Time

— Prof. Syed Samsul Alam

The growth of engineering education in post-Independent India started with the then Prime Minister Pandit Jawaharlal Nehru's vision of the pivotal role of engineering education for the ultimate economic development of the country. This prescient perception led to the setting up of the Indian Institutes of Technology (IITs). By inaugurating IIT Kharagpur on 1811 August, 1951, at the site of a defunct prison, the Hijli detention camp at Kharagpur, Maulana Abut Kalam Azad set in motion the modern engineering education in India. IIT Bombay came next, in 1958, followed by Madras (1959), Kanpur (1959), Delhi (1961), Guwahati (1994), Roorkee (estb. 1847, joined IITs in 2001) and eight others (at Gandhinagar, Bhubaneswar, Palna, Hyderabad, Indore, Mandi, Jodhpur, and Ropar) for imparting quality engineering education in the country. The birth of the HTs epitomized modern engineering education in India. The IITs were mandated to produce the brains that would take the country into a new era of technology and industrialization. The need of the hour was to generate a high-quality pool of technical manpower, with a solid foundation in both the sciences and the humanities.

From the first Five-Year Plan onwards India's emphasis was to develop a pool of scientifically inclined manpower. The post-independence educational journey of India during the last six decades has shown impressive growth in the area of engineering education. Now India has 3617 engineering colleges (with 11.30 lakh students) including IITs, NITs, besides other good public and private institutions. [The corresponding figures in the previous years were 3500 colleges (with 10.95 lakh students) and 2297 colleges (with 8.19 lakh students) respectively]. (Hemali Chhapia, TNN, The Times of India, 20 June 2011, pll; Source: AICTE) Among the private engineering colleges, a few have been accepted as quality institutes like Birla Institute of Technology and Science (BITS) Pilani, Vellore institute of Technology (VIT), Dhirubhai Ambani institute, etc. India's growth rate of engineering education is higher compared to even countries like the US, the UK, and Japan.

However, this growth trajectory is not without some pitfalls that have been observed in recent times. On the one hand, several recent studies point out the growing problem of unemployment (and also underemployment) of engineering students in the country. On the other hand, industry is complaining of unavailability of competent students on a par with its requirement. In fact, India's problem is not unemployment but un-employabilky of engineers. (The unemployable literates of India, DNA, 17 Apr 2011) Therefore, the quality of education, curricula, and syllabi should be compatible with industry requirement to meet the current demand. The current curricula should be reformed to provide greater flexibility and choice of electives. Laboratory courses are to be revised and case studies should be discussed. Above all, greater industry-academy co-ordination than what is happening now is required. Indeed, the Union Finance Minister Shri Pranab Mukherjee, while stressing on the importance of education in promoting inclusive growth, in his key-note address at a seminar on academy-industry interface in Kolkata, also called for a better academy-industry interface in bridging the skill gap in high growth industry. (Education News, PTI, 21 Nov 2010)

In industry, government as well as academic domains, the dearth of quality education, competent teachers and worthwhile research are generating extreme disquiet. Goldman Sachs counts the lack of quality education as one of the 10 factors holding India back from rapid economic growth. There are growing cries to revamp India's education system, which focuses on learning by rote; education should create thinking minds. "Of all the big issues challenging corporates, education is the starting point," said Shri Dileep Rajnekar, Chief Executive of Azim Premji Foundation, which plans to set up a university. "If we manage to get the education bit right, then a lot of things can go right in this country." The situation can be substantially improved only by a concerted action between the universities and the productive industrial and business sectors, as is found in the concrete programmes in operation in the developed countries of the globe. This coordination between academy and industry will not only improve the quality of education and research, but also fulfil the need for the adjustment of training to the prerequisites of employment at the work-place.

Practical Training

Lack of adequate practical training is one of the factors responsible for this downward curve in the demand of engineering graduates in industry. Practical training has a leading role in engineering education, where it takes the form of industrial training, with internships and practical stages at companies in work-integrated learning activities. (It may be noted that practical training is compulsory in the case of many professionals such as nurses, doctors, school teachers, etc.) The 21st century engineering education aims at preparing graduates to compete in a global market. They should be provided not only with sound knowledge on their fields of specialization, but also with genera! competencies allowing them to answer new demands from the society. These competencies are among the requirements established by the various international accreditation systems of engineering degrees as ABET (Accreditation Board for Engineering and Technology), the Washington Accord, EUR-ACE (European Network for Accreditation of Engineering Education), the European national agencies, and NBE (National Board of Accreditation of the AICTE). At present, employers highly value new engineers with practical training as a way to guarantee that they have competencies in leadership, team working, communication abilities, and some others.

An IIT alumnus Mr. Sharad Chandra, in a recent chowk.com article tilled Indian Technical Recession, asks the following basic question about the quality of engineering education in India: "So why Indian engineering education system is not capable of producing quality engineers for the country?" Then the author goes on to answer his own question as follows:

I "One of the primary answers lies in the fact that Indian education is totally focused academic excellence. A student is never asked to analyze, understand, and deliver an engineering project. Very often faculty also has no engineering experience. Professors may have an excellent academic background going themselves through graduation, post graduation and PhD but with a minimal exposure to industrial applications. In short, they prepare their students also for an excellent academic career expecting him to learn hard core engineering on the job but very often producing bankers. In all there is about 3 months spent in training during graduation. It is taken more as a break from courses as no industry will give any serious project for such a short period. Student spends his lime as an observer rather than as a responsible engineer. There is nothing like putting a trainer on a real job under the supervision of an experienced engineer. By the time, he has finished 6 months to a year working on a real project, as any European student does, he will have something to his credit to show to a future employer."

Prof. C.N.R. Rao, Chairman of the Scientific Advisory Council to the Prime Minister, noted that many universities / institutes in the country "over-specialize" their students even before they are ready with the basics, and make them "unemployable."

The ex-chairman and chief mentor of Infosys, Mr. Narayana Murthy, too, complains of the quality of India's engineering education. "Despite being one of the largest producers of academic degrees in the world, the quality of education (in India) is still unsatisfactory," said Mr. Murthy while delivering a lecture on the 'need for world class educational institutions' at the University Institute of Chemical Technology (UICT), Matunga, during the platinum jubilee celebration function of the University. "India has hardly produced any worthwhile inventions. Almost every technology we use is from abroad. The reason is the low quality and quantity of our doctoral programmes and our emphasis on rote learning," he rued. (Indian Express, Mumbai, 02 October, 2008)

We have to ponder over such assessments of so many knowledgeable observers and find out whether these are exaggerations or there is a grain of truth in such critiques.

1 World Class or Local Relevance?

The QS (Quacquarelli Syruonds) ranking of world universities was released recently. Like all such rankings, this one too has many critics who question its methodology and hence the accuracy of its ranking. But Indian universities and educational institutions fare far too badly for this to be attributed to faulty methodology. The highest-ranked Indian institution is IIT Bombay, Mumbai, with a rank of 187 in the world. What is perhaps more disheartening is that 35 other Asian institutions have been ranked above it. Clearly, we are falling far behind even countries like South Korea, Thailand, Malaysia, and, of course, China and Japan in higher education.

Prof. C.N.R. Rao said that none of the country's premier institutions, including Indian Institute of Science (IISc) and Indian Institutes of Technology (IITs), "can match the best in the world." The scientist noted that the research in the country "is sadly losing quality" even as the facilities to do research were increasing. That is one of the reasons why India's institutions are not in a better position. (Deccan Herald, Bangalore, 1 June, 2011)

Sometime ago a survey of employers showed that only a handful of the large number of engineering colleges in India are recognized as providing world-class education with graduates worthy of consideration for employment. (Globalization of Engineering Services - The next frontier for India, NASSCOM, Aug. 2006) The situation has not much improved during the last five years. An MIT survey of human resource professionals at multinational corporations in India revealed that only one quarter of engineering graduates with a suitable degree could be employed irrespective of demand. (Farrell et al., 2005) It suggests that engineering degrees from most Indian colleges do not provide signaling value in the engineering labor market. Hence, low quality (in the labour market sense) engineering schooling has come to predominate in the education market. The current situation, with an abundance of low quality engineering schooling, is considered problematic by many in the Indian polity and it could stifle growth of the Indian economy. (Globalization of Engineering Services ~ The next frontier for India, NASSCOM, Aug. 2006)

As a remedial measure, the Chairman of the National Advisory Committee on Entrepreneurship Development Cell, Dept. of Science & Technology, Government of India, Dr. N. R. Shetty suggests change in approach to engineering education. "We should no longer be continuing with an education system that produced engineers to meet local and national demands. Gone are those days. Today we require engineers who will compete globally and possess such skills that will make them competent. Our engineers should not just meet Indian demand but also world's."

Dr. Shetty also talked about 'inclusive education' where people of all segments of society had access to engineering education: "There has to be judicious balance, and by that I mean inclusive education. People of alt segments of society must have access to engineering education and to this the number of institutions must be increased." However, he maintains that quality should not be compromised at all and the Government must actively ensure that high quality is maintained. He also felt that the Government must not withdraw from higher engineering education but involve itself more by having more IITs and IIMs.

Research

Apart from changes in the curricula, India needs quality academicians to mentor the engineering students and researchers in right direction. Of the large number of engineering institutions in the country, most are hardly involved in research. This does not auger well for the country's future. Research is symbiotic with teaching.

Research in science and engineering must be encouraged; just twenty or thirty such institutions are not enough. Given India's population size, there should be at least a hundred of them. The Prime Minister of India, Dr. Manmohan Singh, at the Infosys Science Foundation Awards function held on 6th January, 2011, said. "The strength of a nation is no longer determined by the might of its army. It comes from the quality of collective knowledge, the productivity of its working people, the creativity of its entrepreneurs, and the dedication of its professionals."

India's Institutes of excellence have not done due justice to the investment or to their names and fames. For example, in her speech on August 16, 2010, at the Golden Jubilee celebration of IIT Delhi, the President of India, Shrimati Pratibha Devisingh Patil, said:

"IIT Alumni have made their mark globally and the contributions of its faculty, including their research, are widely respected. I am informed that the Indian Institutes of Technology have a number of market patents awaiting registration and IIT Delhi filed 40 patent applications last year. I congratulate you on this. However, we must look at the global patent scenario to get a broader perspective. According to the World Intellectual Property Organization, in 2009, over 45,000 patents constituting almost a third of global patents in the year were filed by the US. Ranking fifth, China filed over 7,900 patents. India, on the other hand had only 761 applications. We have a long distance to cover. The Government of India has declared this decade as the Decade of innovation, I am confident that our scientists and researchers with their knowledge, capability and commitment will make it a success."

One reason for this underachievement in research may be lack of required fund. Union HRD Minister Mr. Kapil Sibal himself says India's annual research spend is $8 billion a year, compared to $250 billion by the US and $60 billion by China. According to the Kakodkar Committee, the US and China produce 8,000-9,000 PhDs in engineering and technology every year, compared to 1,000 by India. Against the present requirement of a large number of PhDs in engineering, the country has only a very limited number of them. (Singh, 2011)

Missing Teachers

Funding, or rather the inadequacy of it, is the genesis of another problem haunting the engineering institutes of the country. Today most engineering colleges face paucity of skilled and experienced teaching staff because young engineers are not inclined towards teaching. Indeed, they are refusing to be ' drawn into teaching. Faculty crunch is affecting higher education in general and engineering education in particular, as even premier institutes are facing the problem. IITs are facing a faculty crunch with nearly one-third of the posts vacant; around 35 percent posts are vacant in central universities, 25 percent in IIMs, 33.33 percent in the National Institutes of Technology and 35.1 percent in other central education institutions. A concerned government is looking at ways to overcome the crunch. Teacher shortage could hamper universal education goal. Considering the student-faculty ratio of 15:1 based on AICTE norm and the retirement of existing faculty, the estimated additional faculty requirement in the country in 2017 will be around 185000. Under normative scenario, if a student-faculty ratio of 12:1 is considered for Tire 1 institutions (IITs), 15.2 for Tire 2 institutions (NITs), and 18:1 for other institutions, the additional faculty requirement in 2017 will be around 108000 or about 10000 new engineering faculty per year (annual growth rate of about 7%). This is possible only if faculty jobs are made more attractive and the PhD initiative results in an increase in PhD output and quality. (Banerjee and Muley, 2009)

Indeed, India's missing teachers are a big problem. The future, however, depends on how good our engineering faculty will be and in that regard it is important to make the profession attractive. The Union HRD Minister Mr. Kapil Sibal has himself admitted on a number of occasions that no change in the ground realty would be possible unless teachers are offered better facilities. "Across the world, the best minds opt for teaching profession but this is not happening in India. So we need to give them more incentives," says Mr. Sibal. "Teaching is not that lucrative, let's admit. And that is the key point. We have to make it lucrative enough to attract the best minds," adds another government official. (Anjali Ojha, New Delhi, 4 Sep 2010, IANS)

However, the fact of the matter is that the best minds are not coming to the field of teaching as this profession is not yet considered to be attractive enough in terms of salary. Consider, for example, the salaries of the teachers in Indian universities. Despite the quite large increase in salaries after the last pay commission report, university salaries in Indian remain grossly inadequate compared to remunerations available elsewhere. A bright young researcher who, after finishing a PhD abroad, has just received an assistant professorship in any US university would not perhaps wish to return to India just for the intangible joys of working 'back home'.

It is not surprising then that even leading universities and research institutes find it impossible to reverse the brain drain, leave alone brain gain. Similarly, a comparison of salaries in the corporate world with those in academia explains why increasingly large numbers of bright students opt for a career in the private sector instead of entering academia. In this software era, the remuneration of a faculty is nowhere comparable to sky-high corporate salaries. This is resisting the quality engineers to take the path of teaching and research. Some action needed to be taken by the government to encourage people to take this career.

Of course, salaries are just one component of what young researchers look for when they evaluate alternative job offers. Although the Internet, Skype, and E-mail have made the world a smaller place, it is imperative for young academics to have generous research grants so as to be able to travel abroad to attend conferences and workshops, to collaborate with foreign co-authors/researchers, to participate in joint research projects with foreign experts or associations. Experimental scientists need state-of-the art laboratories; not many Indian universities offer these facilities.

India has one of the lowest ratios of teachers. With the states making constant effort, and the central government monitoring a healthy teacher-student ratio should not be an unachievable goal. However, the quality of teachers is the main concern even if quantity is addressed. But poorly-trained teachers could be an even bigger problem. At a recent Technology, Entertainment and Design global conference, Microsoft founder Bill Gates emphasized the importance of a good teacher. "How much variation is there between teachers, the very best and the bottom quartile? How much variation is there within a school or between schools? And the answer is that these variations are absolutely unbelievable. A top quartile teacher will increase the performance of their class based on test scores by 10% in a jingle year," he said. Although Mr. Gates was speaking of the US, the Indian scenario is not quite different. However, the government has already initiated the corrective measures, promising Rs. 2,31,000 crore to be spent on education in the next five years. The process of filling 1.2 million teaching vacancies has also begun. Obviously, it will take some time for these measures to show results. Meanwhile, we must took forward to that time when we will be able to overcome this problem of missing teachers, and when India will emerge as a producer of first-rate scientific and technological manpower. (Times of India, 5 Sep., 2010).

Quantity or Quality?

It is a truism to say that higher education requires larger amounts of funding not only to provide knowledge but also to give the country good architects of the society. But higher education in India has been a victim of hick of finances for many years since independence. The question, therefore, arises: how can we solve the problem of financial crunch lo overcome the related problem of faculty crunch in leading engineering institutes/universities?

When modern technology and research were taking shape in India, it was in a very nascent stage as a nation. Therefore, the government could not make substantially special allocation for some "world-class" centres of excellence. Rather, for the development of higher education, India has so far followed the policy of gradually increasing the number of universities, all of them with roughly the same scale of facilities. This emphasis on quantity has had an adverse impact on quality because resources have been spread too thinly. Even the most well-funded university or research institute in India receives no more than a fraction of the funds available to comparable institutions in several Asian countries.

But the financial requirements of 'world-class' universities are very large. This means that the only feasible option, as some higher education observers have suggested, is to discard the current policy of uniformly same salary scale, same rules regarding travel grants, etc, across all universities / institutes. Spending of public money on higher education and research for non-performing universities / institutes should be reduced. Only teaching (without any productive research in the form of quality publications or usable patents) does not justify huge spending by some so-called 'elite' institutes / universities. Instead, based on some quality criteria, all institutes / universities should be graded and judged as per their performance and public monetary support should depend on that. Performers should be separated from non-performers and they should be given more incentives. Performing institutions should be given more financial grants as encouragement for better quality teaching and research. (Chatterjee, 2008) Furthermore, there should be some universities with research facilities and salaries comparable to the best in Asia. Performing teachers should also be given financial rewards (e.g. cash incentives for international journal publications, patents filed, or for bringing any other laurels to the institutions, special remuneration package for course loads above average and so on). These measures are now being adopted in several Asian countries.

Indeed, we should always bear in mind what Prof. C.N.R. Rao says: "We must be really careful in utilizing our resources. I have grown the hard way and I know what not having resources could mean." (Deccan Herald, Bangalore, 1 June 2011) Therefore, we have to be very judicious in allocating available funds for the development of quality education and research.

The Third Mission

In a letter to the Prime Minister Dr. Manmohan Singh, the National Knowledge Commission chairperson Mr. Sam Pitroda suggested integration of science and engineering education. He pointed out that two-thirds of the engineering institutions were located in the four southern states and Maharashtra. Therefore, he said, a framework of public-private partnership is needed to establish new quality institutions. (Times of India, TNN, 10 May 2008) Concerned over the "glaring regional imbalance" in engineering education, Mr. Sam Pitroda suggested that the prestigious Indian Institutes of Technology (IITs) should mentor some lesser known or new engineering colleges to raise their standard. "Mentoring by its definition is a voluntary activity, but if we can create an atmosphere where institutions of distinction feel a sense of calling in the interest of the larger national good, it would transform our education," Mr. Pitroda said. (Times of India, TNN 10 May 2008)

This call for mentoring in the fields of education and research is closely related to the continual challenge of the "third mission" of the universities / institutes, which concerns the social responsibility, community engagement, as well as socially engaged scholarship. Universities / Institutes are increasingly considered instruments of social and economic development and are expected to supply relevant skills. Although newly discovered by some universities, service to the community has a long tradition in others. It is mentioned as an explicit mandate in the charter of many universities. A university can bear its responsibility only if it maintains active relations and dialogue with the surrounding society. Service and community engagement takes many different forms, for example, community-based research and learning, assistance in regional development, continuing and community education, vocational / skill-development programmes, technology transfer, and other forms of knowledge sharing and linkages.

Some of these aspects of the third mission of the universities have also been emphasized in a recent publication. (Biswas et al., 2010) They are of the view that growth of economies and living standards of civilized societies are being increasingly determined by knowledge and innovation created and fostered by knowledge institutions. The demand for closer interaction of such institutions with entrepreneurs, communities, and industry is becoming increasingly louder. They believe that entrepreneurship strengthens the knowledge system, converts knowledge to intellectual property, promotes ventures for commercialization of technologies, creates wealth and enhances technology competitiveness and the tech-image of the country. Furthermore, they point out, it creates new business and creative opportunities, jobs and services, and thus promotes regional as well as local development. Close interaction of academic institutions with entrepreneurs should be mandated as a social responsibility on the part of academia. (Biswas et al., 2010)

Some of the origins of this third core mission lay in the desire of governments to secure a wider benefit from the public investment in higher education. Universities cannot limit their function to providing the final element of education for school leavers. They are increasingly expected to transfer knowledge more widely to the community in such a way that transfer could secure social or economic benefits, for example, in supporting community work or in transferring intellectual property to those who would most effectively be able to exploit it for the purposes of economic activity and trade. This was called 'technology transfer', but the overall mission is more usefully described as 'knowledge transfer' or, indeed, 'knowledge exchange'. The latter is at the heart of what in the United Kingdom has become known as 'third stream' activity, so called because it has been funded under a third stream of resources (with teaching and research) by the funding bodies. Thus, beyond teaching and research, the University Third Mission - services to Community / Society - has at least 3 dimensions: a non-profit social approach, an entrepreneur focus, and an innovative approximation.

Man;- policy makers think it is undoubtedly right that universities and other higher education institutions should disseminate the benefits of their knowledge and expertise widely; the old idea of educating the elite has long been dropped in strategic rhetoric, but must also be transcended in practice. The Third Mission must have a proper place in the organizational structure and it needs to be accepted and championed by the faculty. For this it must be based on excellence and integrity, and that it is recognized in career development.

There may always be some diversity of mission in the universities. But each institution should have a clear strategy which is understood and accepted and which has identifiable targets and outputs. In the present circumstances, some of it may be about diversifying income streams. But the heart of this mission is the same as for any other part of the academy: to discover, develop, disseminate, and transfer knowledge for the benefit of society.

Today a university focuses not only on industries and technologies but also on their socio-economic and cultural impacts.

Conclusion

The future holds abundant possibilities and challenges; and these must be used to good advantage with more commitment. Engineering students must get the best of education and contribute towards the development of a new India. It is high time we work hard and create technologies that can shape the new world for the industry to take interest and feel proud in the outputs.

Acknowledgement

This article would not have been possible to be written without taking the help of the works of several scholars too many to be mentioned here; the author acknowledges his indebtedness to al! of them. He is also thankful to Dr. Amzad Hossain, an alumnus of IIT Kharagpur, for going through the manuscript and making valuable suggestions for improvement.

References

1. Agarwal, Pawan (2009), Indian Higher Education - Envisioning the Future, Sage publications, New Delhi.

2. Banerjee, Rangan and Muley, Vinayak P. (2009), Engineering Education In India, Macmillan Publishers India, ISBN 9780230640009.

3. Biswas, Gautam; Chopra, K.L.; Jha, C.S.; and Singh, D.V. (2010), Profile of Engineering Education in India: Status, Concerns and Recommendations, Narosa Publishing House, New Delhi, ISBN 9788184870619 (AICTE Publication, 2009).

4. Chatterjee, Jayanta (2008), How to improve India's higher education and research quality?, Nature India Forum,Tuesday,04November 200816:46UTC, http://network.nature.com/group1:/natureindia/forum/topics/3348?page=5

5. Education News (2010, September 05), Teacher shortage could hamper universal education goal, indiaedunews.net, National Network of Education.

6. Farrell, D.; Laboissiere, M.; Pascal, R.; Rosenfeld, J.; de Scgundo, C.; Sturze, S.; and Umezawa, F. (2005 June), The Emerging Global Labour Market, McKinsey Global Institute.

7. Finn, K.L. (1997), The Spaces Between: Toward a New paradigm for Cooperative Education, Journal of Cooperative Education, 32(2), p. 36-45.

8. John, J.E.A.; Doherty, D.J.; and Nichols, R.M. (1998), Challenges and Opportunities for Cooperative Education, Journal of Cooperative Education, 33(2), p. 10-16.

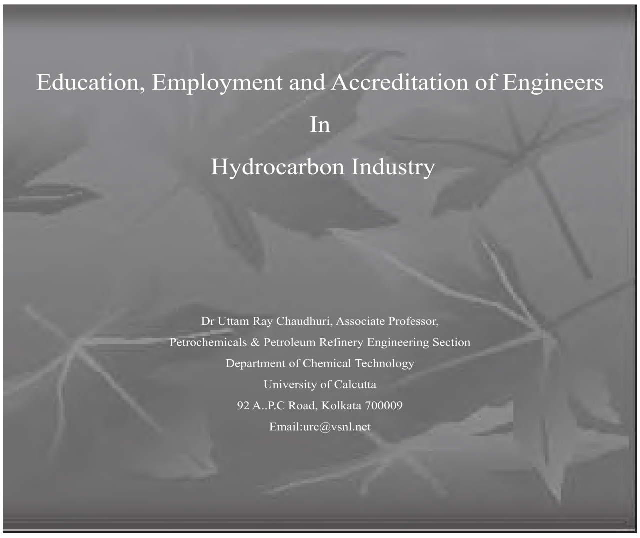
9. Magdaleno, Jesus and Dominguez, Urbano (2010), Industrial Training in Engineering Education in Europe, Joint International 1GIP-SEFI Annual Conference 2010, 19th -22nd September, Trnava, Slovakia.

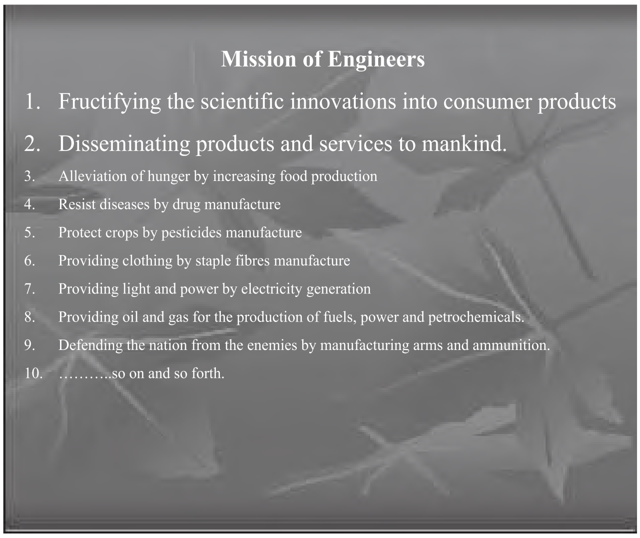
10. McMahon, Frank and Claes, Tom (2005), (Editors) Probing the Boundaries of Higher Education, Inter-Disciplinary Press, Oxford, United Kingdom.

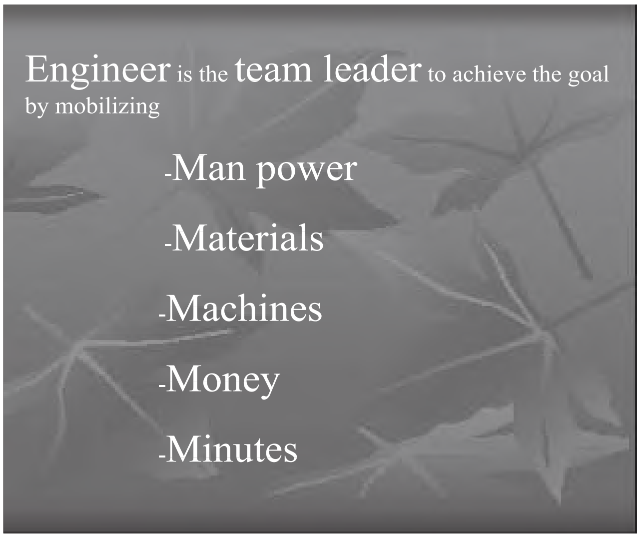
11. Singh, Shelley (2011 Jun 7), Lack of research facilities still haunts HTs ET Bureau, The Economic Times.

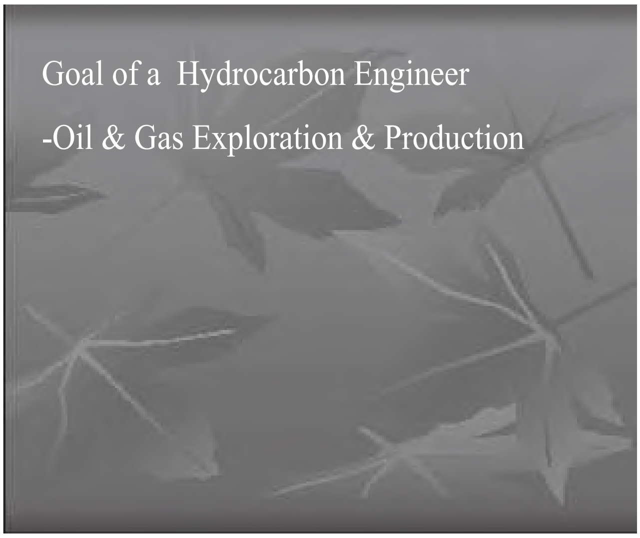
12. Natarajan, R. (2002), Emerging Trends in Engineering Education - Indian Perspectives, 16lh Australian International Educational Conference, Sept 30 - Oct 4, Hobart.

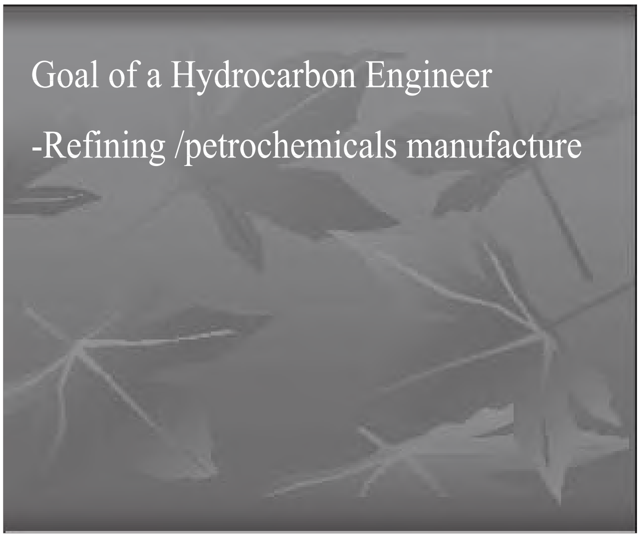
Power Point Presentations

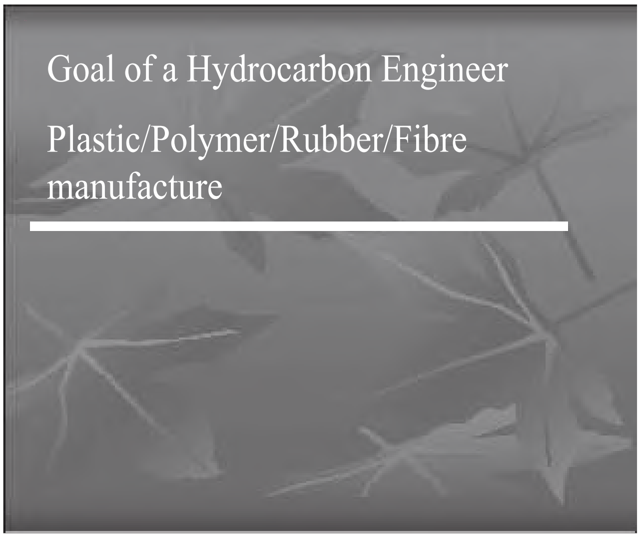












Goal of a Hydrocarbon Engineer

Automatic Plant Operation

Goal of a Hydrocarbon Engineer

-Design of Plant & Equipment

-Evaluate cost

-Evaluate efficiency /Productivity

-Tracking the progress of a Project

Goal of a Hydrocarbon Engineer

-Monitor quality/quantity of crude oil

-Monitor quality/quantity of products

-Material loss assessment

-Energy loss assessment

-Monitor wastes/effluents

Goal of a Hydrocarbon Engineer

-Manpower supervision

-supervise maintenance work/shutdown/startup

-supervise fire fighting & safety operations

Goal of a Hydrocarbon Engineer

-Progress reports-daily/weekly/monthly/annually

-Disaster mitigation planning

-Accident reporting-factories inspectors /controller of explosives /Pollution control board

-Insurance claims for losses-survey/task force leader

-Transportation rules -Railways/road/water transport formalities

Goal of a Hydrocarbon Engineer

-Excise/Product transhipments

-Customs/Crude/Product/ import

-Police/Sabotage/Burglaries/..

-Unions/IR problems

But the Syllabus in the Chemical Engineering Degree Course in Jadavpur University did not contain all of these foregoing activities when I joined IOCL refinery as a Graduate Engineer Trainee. Hence, I suggest a modified syllabus for the future Engineers in the Hydrocarbon Industry.

(Ref: Fundamentals of Petroleum and Petrochemical Engineering, CRC Press, Taylor & Francis, 2011.)

Syllabus for the Hydrocarbon Engineers

First semester

1. Mathematics
2. Engineering Mechanics.
3. Statistics and probability
4. Physics
5. Chemistry

Second Semester

6. Geological Science
7. Engineering Drawing
8. Strength of materials and structural analysis
9. Electrical machines and appliances
10. Power plant engineering

Third Semester

11 Fluid dynamics
12.Thermodynamics
13.Reaction kinetics
14.Heat transfer
15. Mass Transfer

Syllabus for the Hydrocarbon Engineers

Fourth Semester

16.Oil & Gas Exploration
17.Oil & Gas Production
18 Refining methods
19.Analysis and testing methods for Oil & Gases
20.Petrochemicals

Fifth Semester

21.Metallurgy and corrosion Engineering
22. Process Operation and automatic control
23. Plant maintenance
24. Conservation techniques (Right to energy)
25. Waste analysis and treatment

Sixth Semester

26.Computer hardware
27 Computer applications and programming
28.Computer aided design and HYSIS/CFD simulators
29.Fire fighting appliances and accidents reporting
30 Safety analysis (.Hazan and Hazop)

Syllabus for the Hydrocarbon Engineers

Seventh Semester

31. Factories Act
32.Companies Act
33.Taxation, custom and excise laws
34. Import and Export rules
35.Transportation means and rules.

Eighth Semester

31. Material and Energy audit
32. Disaster mitigation Planning and insurance
33..Enviromental impact analysis.
34.Explosive Rules and Environmental Protection Act
35.Hazardous Chemicals and gas cylinder rules.

Ninth Semester

36.Materials Purchase procedures & tendering
37.Sales of materials procedures
38.Cost estimation for equipment and operations
39 Man power evaluation, work study and time study.
40.Profitability and productivity evaluation.

Syllabus for the Hydrocarbon Engineers

Tenth Semester

41 Project evaluation techniques (PERT, CPM)
42. Human resource study, ego and personality transactional analysis.
43. Authority and delegation
44.Communication management
45.Interactive presentation of a selected Project report by the finalist.

Suggestions for improvement of Quality of Future Generation Engineers

- ***The quality of Engineers should be counted first while the quality of Institutes should come next. In the present scenario the reverse is true. In fact genuine recruiters search for the quality engineers.***
- **Entrance**:Admission in Institutes should be made through a All India Common Admission test for Engineers –AICATE.
- Syllabus should be product/industry and service oriented
- Duration of study should be five years including management papers.
- **Exit** :Degree should be offered based on the performance in the existing Graduate Aptitude Test for Engineers (GATE) designed for each discipline of Engineering separately.
- **Employment:**Employers should recruit Engineers those who qualified through GATE. Recruitment of Engineers without the GATE score should be discouraged legally. Such that the GATE qualified Engineers' employment should be guaranteed. Present practice of Campus Recruitment in the educational institutes should be discontinued. Recruiting should be done *on line* using transparency in selection based on merit only. All the recruiting agencies and industrial organizations Govt/Public/Pvt should display their authenticity and mention clearly the number of vacancies with discipline.
- **Accreditation** should be awarded after acquiring at least two years of continuous professional experience. A practising license may be issued with the condition that in the case of involvement of any illegal activities / damage due to faulty design / operation or any criminal activities, the same should be forfeited.

Challenges for Technical Higher Education in India -Perspectives, Issues and Concerns

Swapan Bhattacharya

Department of Computer Science & Engineering
Jadavpur University, Kolkata – 700 032, India

E-mail : bswapan2000@yahoo.co.in

September 19,2011

Perspectives

- Seamless Globalized Economy
- Sustenance of high GDP for our country
- Large young population
- All pervasive deployment of technology
- Legacy of long heritage in education
- Creation of Research Institute vis-à-vis Teaching Institute
- Legacy of attaching maximum focus on under-graduate education
- Creation of knowledge vis-à-vis Creation of Wealth – Conflict or Synergy ?

Issues

- Expansion
- Equity
- Excellence
- Social Responsibility
- Relevance to Industries
- Flexibility of education system
- Learning Technology, Managing Technology and Working with Technology
- Employability, Self-employability, Entrepreneurship and Innovation
- Competitive Environment
- Influence of Media
- Internal Resource Generation

Concerns

- Obsession with Marks/Grades
- Obsession with the past and lack of initiative to reform
- Emphasis on Input-driven criteria
- Little scope for innovation in education system
- Too much emphasis on service sector
- Stagnation of vision in primary and secondary education
- Huge disparity of quality within education system
- Lack of mutual respect between industrial and academic sectors
- Tendency to address serious issues through quick-fix approach

Proposal

- To inculcate problem-solving approach throughout the curriculum
- Integration of basic science and social science with technical education
- Transition towards branch-less/discipline-less curriculum at under-graduate level
- Deployment of state-of-the-art technology
- To encourage and promote involvement of faculty in industrial environment
- To permit inter-institute credit transfer
- Organization of skill/knowledge-centric workshops in industrial sectors

Conclusion

Looking forward to an era when young people all over the world will dream to come to India for technical higher education – and I believe this will happen soon !!

Preparing Next-Gen Engineers to face challenges of 21st century: *the role of professional societies*

Prof. H.R. Vishwakarma,
Hon. Secretary, Computer Society of India
President, Engg Sciences Section, ISCA
Senior Professor, VIT University, Vellore

The Engineering Education

- Just ponder over the following
  - Engineering versus other professions
  - Education versus Training
- Or attempt finding the origins of the terms
  - Engineering
  - Education

The Millennium Development Goals

1. Eradicate extreme poverty and hunger
2. Achieve universal primary education
3. Promote gender equality and empower women
4. Reduce child mortality
5. Improve maternal health
6. Combat HIV/AIDS, malaria and other diseases
7. Ensure environmental sustainability
8. Develop a global partnership for development

The 21st century and its challenges

- Scarcity of natural resources
- Disparities and divides
- Globalization, the competitors are a mouse click away
- Shrinking lead time- development and deployment almost simultaneous
- Co-evolving business and technological models

What after engineering degree?

- A vast majority of engineering graduates either do not choose or do not get opportunity to practice engineering profession
- Broad categories of employment
  - Business
  - Industry
  - Government
  - Academia
  - Research
  - Consultancy
- Industry is one of the job options
- Curricula is only one of the major quality issues

What is so special about Engineering Education?

- Development oriented – not necessarily production oriented
- Experimental oriented – not necessarily result oriented
- Human-based – not machine based
- Each activity and its outcome is unique w.r.t. use, purpose, environment
- Assessment and Packaging of experience is very complex

Multiple Stakeholders

- Direct
  - Students
  - Faculty
  - Employers
  - Parents
  - University management
- Indirect
  - Govt. and Regulatory agencies
  - Professional societies
  - Industry associations
  - Citizens forum
  - Association of Indian Universities

The Quality Issue

- Rigid and outdated course curricula
- Inability to adapt course curricula to dynamic industry requirements
- Poor lab infrastructures
- Limited exposure to latest tools & techniques
- Little R&D

The Quality Issue (Contd.)

- Limited exposure to industry problems
- Poor industry linkages
- Best do not come to academics to teach
- Inability to enter into emerging areas
- Problems of economic viability
- No significant endowments/grants/donations

The Quality Issue (Contd.)

- Pedagogy
- Examination Orientation
- Insufficient grounding in theoretical concepts
- Inability to explain applied framework
- Inadequate lab/tools & techniques infrastructure
- Little real-life case studies
- Little scope for creative learning

Levels of Assessment, Benchmarks and Accreditations

- Five levels of Maturity
  - Operational efficiency
  - Process improvement
  - Technology deployment
  - R&D competence
  - Education excellence
- Over 80% assessments and benchmarks aim at level 1

Levels of Institute-Industry Interaction

- Five levels of Maturity
  - Supplier-Buyer Relationship
  - Donor-Receiver Relationship
  - User-Consultant Relationship
  - Sponsor-Institute Relationship
  - Long-term Relationship
- Over 80% interactions are at level 1

Faculty- the most important aspect

- Five credentials
  - Qualification
  - Experience including industry
  - Research and Publication
  - Consultancy
  - Outreach- peer connectivity, industry connectivity, alumni interaction
- Unfortunately, a vast majority of hiring decisions are on – qualification alone

Curricula- as a framework

- Five Constituents of Curricula
  - Discipline specific
  - General engineering and management
  - Science
  - Humanities and Social science-
  - Information Technology
- Too much focus on discipline-specific

Infrastructure- a springboard

- Five kind of infrastructure
  - Classroom
  - Laboratories
  - Library
  - IT-enabled teaching-learning
  - Workshops, Test-beds and field-trials
- Primary focus has been basic requirement for theory classes

The Role of Professional Societies

- In thinking about the optimum use of human resources in developing countries like ours, it is natural to let our thoughts go to professional societies and to the role they play in this process.
- Typically, *professional societies such as ECI members in India and IEEE, IEE, ACM have two most important roles:*
  - *one is the setting of standards,*
  - *the other is to ensure compliance with those standards on the part of its members.*

The Role of Professional Societies

- We have two questions with respect to this.
  - *One, how do professional societies in developing economies see to it that their members measure up to international standards?*
  - The other question concerns the professional/ethical conduct of professional societies' members.

The Role of Professional Societies

- Body of knowledge
- Curricula development workshops
- Accreditation, assessment and benchmark
- Setting standards and ensuring conformance
- Conduct employability tests
- Continuing education programmes
- Professional development programmes
- Finishing school programmes

The Role of Professional Societies

1. Discovering the Potential-
2. Fostering Educational Leadership
3. Identifying Strategic and Socially relevant sectors
4. Preparing Roadmap for Research and Innovation,
5. Creating Ecosystem for Industry Institute Interaction,
6. Synergetic Evolution of Technology and Society

The Role of Professional Societies

- Facilitate interaction and collaboration among academicians, researchers and practitioners
- Engage members and participants through technical paper presentations, tutorials, workshops and exhibitions
- Show case state/territory-specific education/research competence and identify growth areas
- Promote innovation through presentation excellence awards for path-breaking projects
- Prepare 'Next-Gen Engineers' through workshops, career guidance and entrepreneurship support

The Role of Professional Societies

- Benchmarks, capability assessment, gap analysis, and recommendations to realize the specific visions
- Publication of research studies (technology penetration, innovation, diffusion and adaptation), domain specific state-of-the-art technical reports and case studies of education/ research initiatives
- Frameworks, Guidelines and Best Practices for research collaboration among government, industry and academia
- Identification of potential ideas and innovations of faculty, researchers and students for business incubation

QA in Engineering Education

- The major barriers include:
  - Over-centralization; Lack of institutional autonomy and accountability; very slow response to changes
  - Variable quality; market mismatch; inflexibility
  - Little knowledge creation– little interaction with economy, society and other academic/ research institutions
  - Difficulties in recruitment and retention of qualified teachers in critical areas
  - Diminishing and skewed public funding; system inefficiencies

Liberation and Globalisation

- QA in Indian higher education faces today new challenges,as a consequence of the existence of global markets and large influx of private players
- Most of new entrants follow "Affiliation-Transition-Transformation-Recognition-Renewal" strategy to become autonomous
- However, the poor educational performance is an imminent threat to India's global competitiveness
- A holistic assessment strategy will help answer the question "How can Engineering schools provide confidence to the stakeholders that their requirements for quality engineering education and research are continuously met?"

Assessment Mechanisms

•Defining the quality of specific curricular programmes to assure learning results and institutional excellence is often delegated to

-learned societies,

-professional/industrial associations and

-accreditation organizations

•Different Types of Mechanisms

–Accreditation: measurement, accountability

–Academic Audit: improvement, continuous

–Benchmarking: improvement, discontinuous

An Indicative Quality Index

- Vision, Mission, Goal and Objectives
- Governance, Planning and Monitoring
- Finance and Infrastructure
- Intake – Student, Faculty and Staff
- Process- Teaching-Learning, Evaluation
- Outcomes- Academic results, professional profile,employability, on-the job success, social/workplace activities

Quality Index (Cond.)

- Programme-wise Compliance with Institute's mission, Model Curricula and Knowledge Areas
- Engagement with Alumni
- Industry-Interaction
- International Linkages
- Knowledge Management System

5Ps Model and Hallmarks of Excellence

- Promise: Ad Hoc
- Performance: Skills Excellence
- Produce: Operational Excellence
- Progress: Process Excellence
- Prominence: Technology Excellence

Quality assurance becomes critical as international demands for quality, productivity, and access in higher education increase

What is Benchmarking?

- "benchmarking involves
  - first examining and understanding your own internal work procedures,
  - then searching for "best practices" in other organizations that match the identified, ones and finally,
  - adapting those practices within your organization to improve performance. It is, at bottom, a systematic way of learning from others and changing what you do."
- process for identifying gaps with an aim to improve
- not about performance measurement or rankings
  - although measures are used

What is Benchmarking? (Contd.)

- "benchmarks"
  - refer to processes and results that represent the best practices and performances for similar organizations, inside or outside of the education community.
- engage in benchmarking to
  - understand dimensions of world-class performance
  - achieve discontinuous (non-incremental) or ***breakthrough*** improvement
- comparative data
  - benchmarks are one form
  - third party data
  - performance data for competitors and comparable educational organizations
  - similar organizations in same geographical area

Approaches to Benchmarking

- problem-based or process-based
- types
  - competitive
  - functional
  - performance
  - strategic
- internal or external

Role of IT in Higher Education

- In-side out view and out-side in view of stakeholders such as
  - Student View
  - Faculty View
  - Other stakeholders View
    (e.g. Industry, Government, Society)
- Changing Nature of Higher Education in India
- What can Indian Higher Education learn from Indian IT Industry?
- What are the opportunities and challenges?

Role of IT in Higher Education – Student View

- E-enable Admissions –
  - Application Processing, Entrance Examination, Interviews, Information, Rating
  - Efficiency, Transparency, Equity
- E-enable class room teaching
  - Scheduling, course management, grading, project grouping, sharing resources,..
  - Fairness, Opportunity
- Integrate Library
  - Digital Library
  - Wide access

Role of IT in Higher Education – Student View (contd.)

- E-enable Placements
  - Scheduling, Testing, Interview processing
  - Widen Opportunity
- E-enable Alumni
  - Network alumni
  - Network opportunities

Role of IT in Higher Education – Faculty View

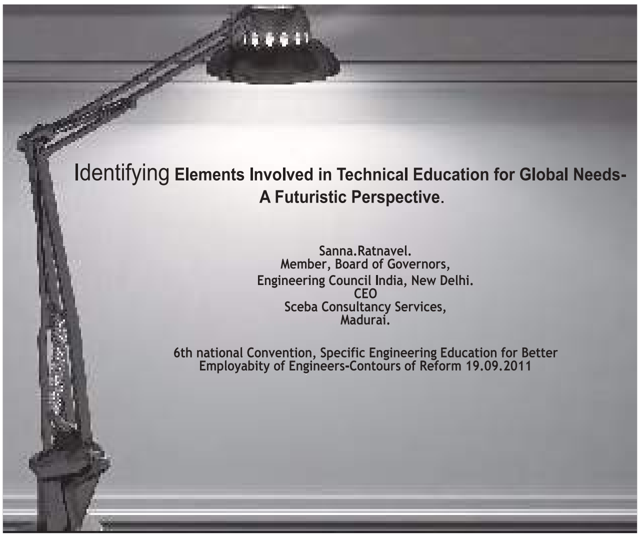
- Support Class Room Teaching
  - CMS, LMS..
  - Efficiency
- Support in Library, Journals, Database
  - Digital Library
  - Access
- Support Project Funding
  - Speedy accounting, Reporting..
  - Efficiency

Role of IT in Higher Education – Other Stakeholders View

- Parents
  - Information access, Involvement
  - Fairness
- Industry
  - Curriculum, Resources, Students
  - Speed, Efficiency, Access
- Government
  - Funds utilization, Quality norms..
  - Compliance

What can Indian Higher Education Learn from Indian IT Industry

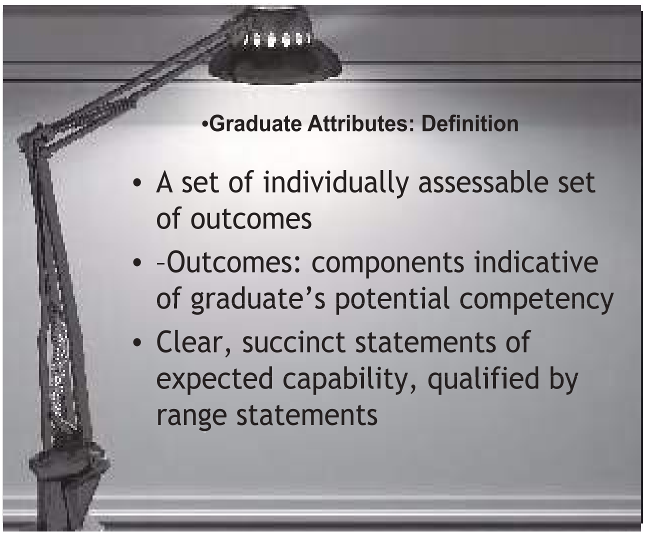
- Emphasis on processes, quality in a sustained manner
- Ability to scale
- Global mindset
- Start small, grow real fast and attempt to conquer
- IT is a Trillion Dollar opportunity – so is Higher Education
- Both Indian IT and Indian "*guru*" accepted globally

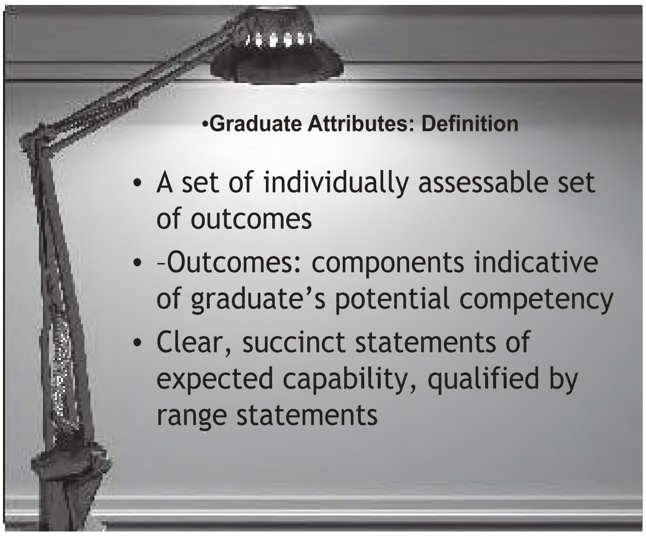

Identifying Elements Involved in Technical Education for Global Needs-
A Futuristic Perspective.
Sanna.Ratnavel.
Member, Board of Governors,
Engineering Council India, New Delhi.
CEO
Sceba Consultancy Services,
Madurai.
6th national Convention, Specific Engineering Education for Better
Employabity of Engineers-Contours of Reform 19.09.2011

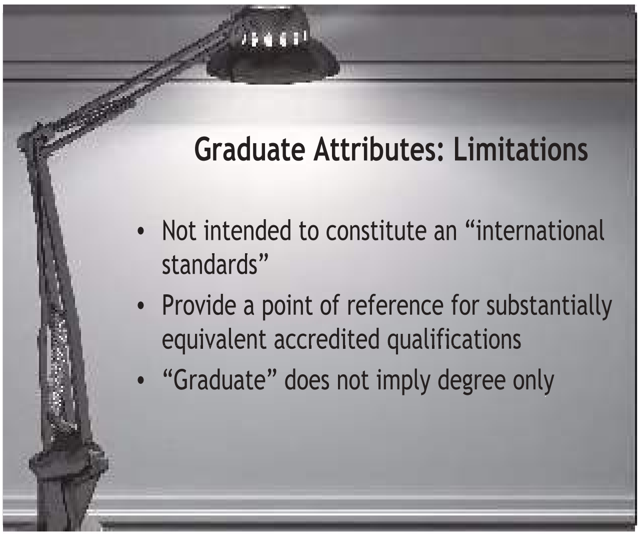

Agenda
We Need to Reengineer Engineering Education
Why?
1.The practice of engineering needs to change because of demands
for technologies and products that exceed existing knowledge bases.
2.To confront the changing professional environment
in which engineers need to operate.


Goals and Intentions
We need a system with alternatives
at affordable and sustainable
environment


OPPORTUNITIES
International Engineering Agreement
Washington Accord
Engineers Mobility Forum
Sydney Accord
Dublin accord


•Graduate Attributes: Definition
• A set of individually assessable set of outcomes
• –Outcomes: components indicative of graduate's potential competency
• Clear, succinct statements of expected capability, qualified by range statements

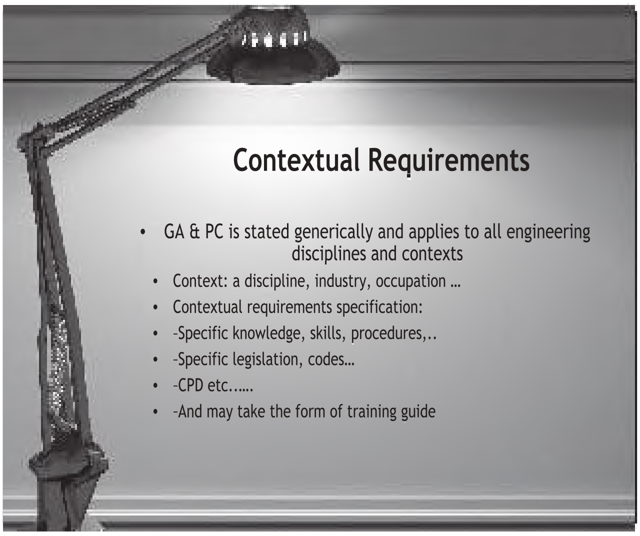

•Graduate Attributes: Definition
• A set of individually assessable set of outcomes
• –Outcomes: components indicative of graduate's potential competency
• Clear, succinct statements of expected capability, qualified by range statements

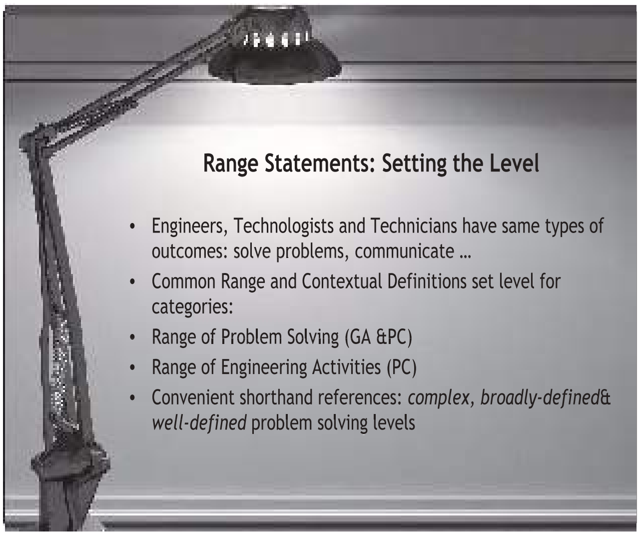

Graduate Attributes: Limitations
• Not intended to constitute an "international standards"
• Provide a point of reference for substantially equivalent accredited qualifications
• "Graduate" does not imply degree only

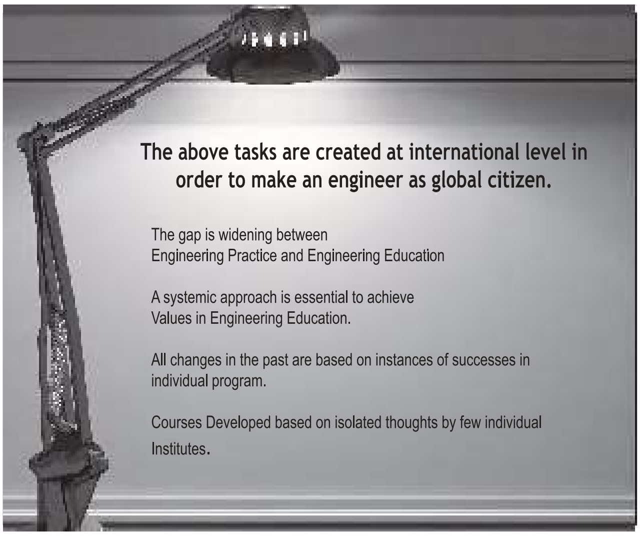

Professional Competencies: Definition
•Professional Competency profiles record elements of competency that must be demonstrated holistically
•Defined for each category of registration

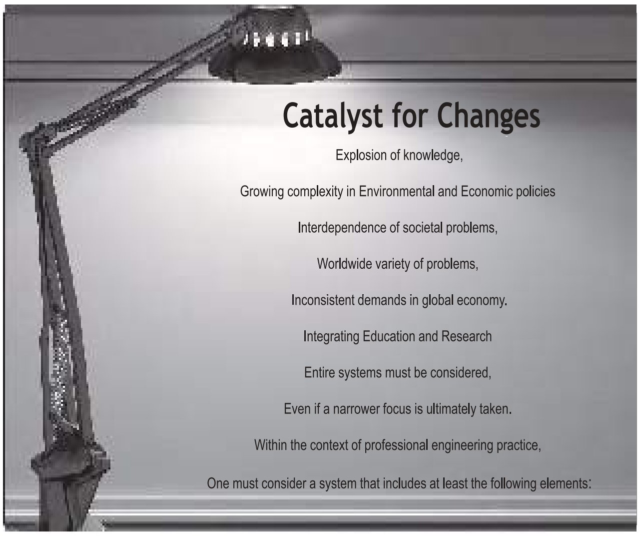

Professional Competencies: Objectives
•The EMF and ETMF define requirements for the International Registers using professional registration, time and responsible experience
•Agreements provide for a future competency-based route to International registers
•Need to define assessable set of competencies for engineer and engineering technologist

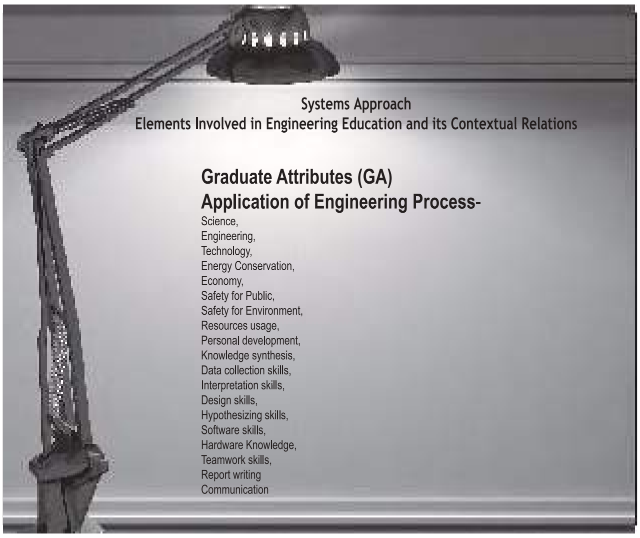

Professional Competencies: Limitations
• Not Perspective
• Do not specify indicators for assessment of competent performance

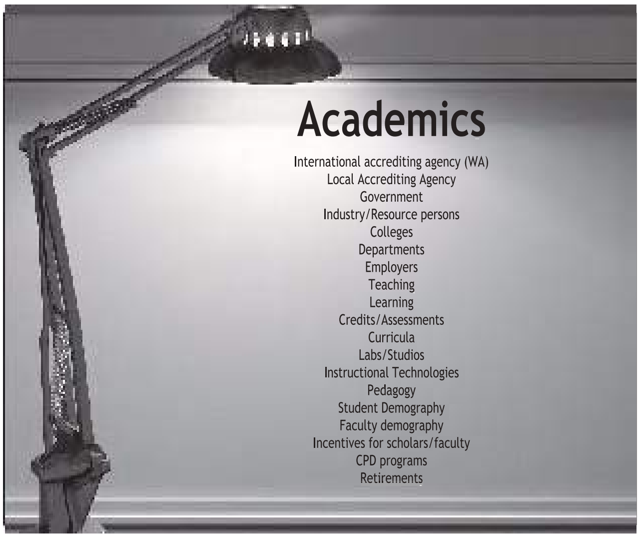

Contextual Requirements
• GA & PC is stated generically and applies to all engineering disciplines and contexts
• Context: a discipline, industry, occupation …
• Contextual requirements specification:
• -Specific knowledge, skills, procedures,..
• -Specific legislation, codes…
• -CPD etc.…..
• -And may take the form of training guide

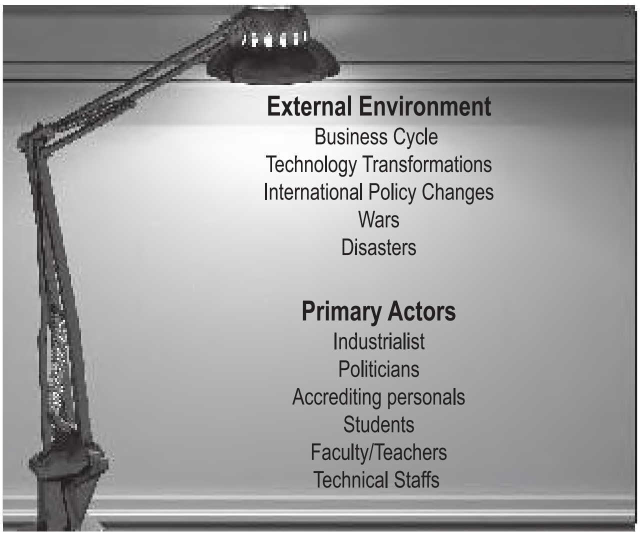

Range Statements: Setting the Level
• Engineers, Technologists and Technicians have same types of outcomes: solve problems, communicate …
• Common Range and Contextual Definitions set level for categories:
• Range of Problem Solving (GA &PC)
• Range of Engineering Activities (PC)
• Convenient shorthand references: complex, broadly-defined& well-defined problem solving levels


The above tasks are created at international level in order to make an engineer as global citizen.
The gap is widening between
Engineering Practice and Engineering Education
A systemic approach is essential to achieve
Values in Engineering Education.
All changes in the past are based on instances of successes in individual program.
Courses Developed based on isolated thoughts by few individual Institutes.

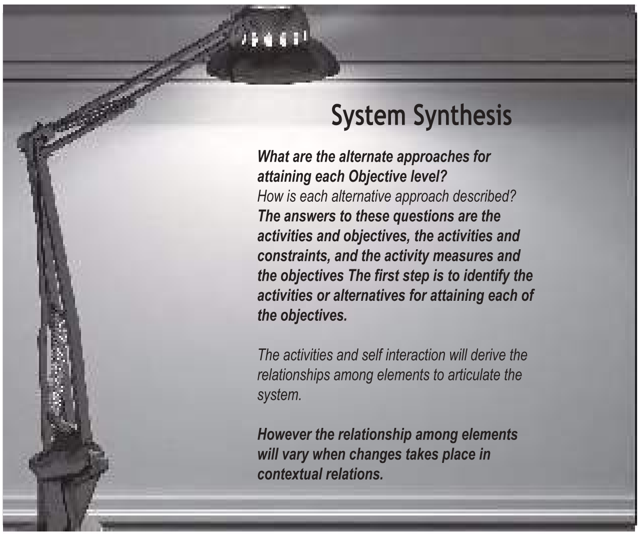

Catalyst for Changes
Explosion of knowledge,
Growing complexity in Environmental and Economic policies
Interdependence of societal problems,
Worldwide variety of problems,
Inconsistent demands in global economy.
Integrating Education and Research
Entire systems must be considered,
Even if a narrower focus is ultimately taken.
Within the context of professional engineering practice,
One must consider a system that includes at least the following elements:


Systems Approach
Elements Involved in Engineering Education and its Contextual Relations
Graduate Attributes (GA)
Application of Engineering Process-
Science,
Engineering,
Technology,
Energy Conservation,
Economy,
Safety for Public,
Safety for Environment,
Resources usage,
Personal development,
Knowledge synthesis,
Data collection skills,
Interpretation skills,
Design skills,
Hypothesizing skills,
Software skills,
Hardware Knowledge,
Teamwork skills,
Report writing
Communication

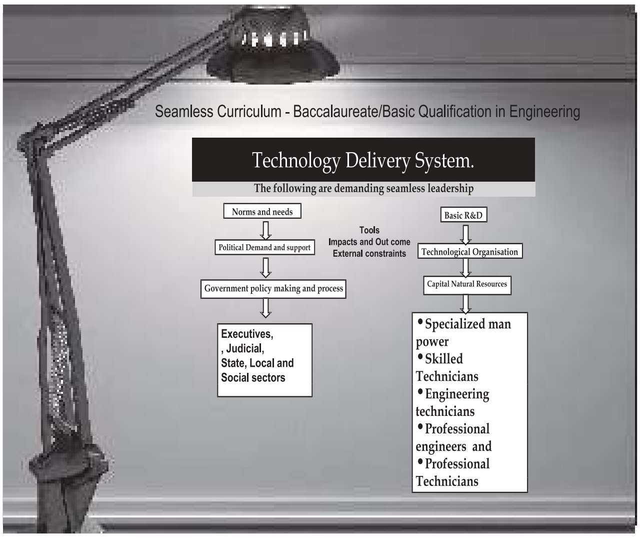

Academics
International accrediting agency (WA)
Local Accrediting Agency
Government
Industry/Resource persons
Colleges
Departments
Employers
Teaching
Learning
Credits/Assessments
Curricula
Labs/Studios
Instructional Technologies
Pedagogy
Student Demography
Faculty demography
Incentives for scholars/faculty
CPD programs
Retirements

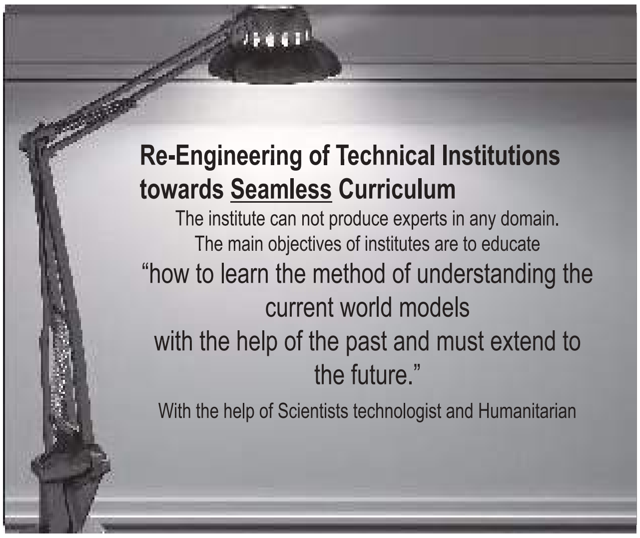

External Environment
Business Cycle
Technology Transformations
International Policy Changes
Wars
Disasters
Primary Actors
Industrialist
Politicians
Accrediting personals
Students
Faculty/Teachers
Technical Staffs

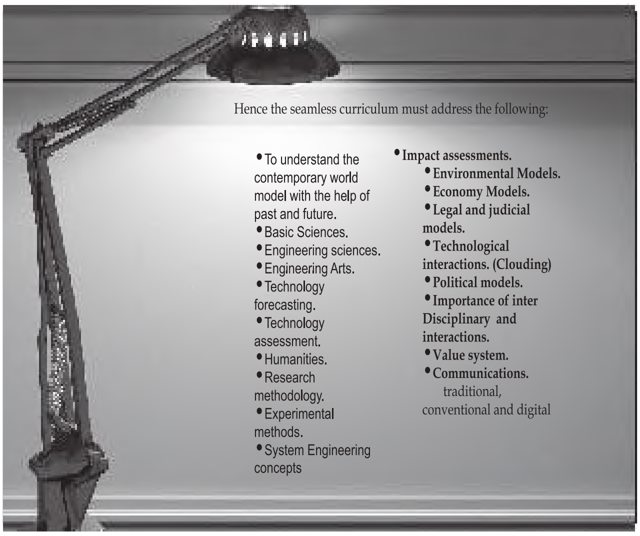

Professional Competency
Baccalaureate/Basic Qualification In Engineering
Problem Definition
Sociological
Legal
Political
Environmental
Institutional
Registration
Regulations
Accountability
Code of Ethics
CPD curriculum Opportunities
National Codes
International Codes
Professional Societies
Taxes
Awards/Incentives
Societal Sectors Involved
Consortium or Interdisciplinary Teams (Team of Professionals)
Methodologies - Tools
Interaction with Customers/Clients/ CEOs to achieve goals


System Synthesis
What are the alternate approaches for attaining each Objective level?
How is each alternative approach described?
The answers to these questions are the activities and objectives, the activities and constraints, and the activity measures and the objectives The first step is to identify the activities or alternatives for attaining each of the objectives.
The activities and self interaction will derive the relationships among elements to articulate the system.
However the relationship among elements will vary when changes takes place in contextual relations.

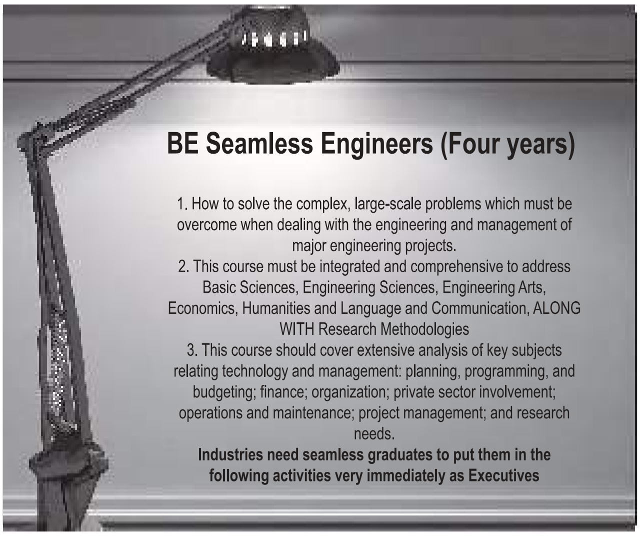

Contextual requirements may amplify how generic standards are applied in context but must not alter the standards


Seamless Curriculum - Baccalaureate/Basic Qualification in Engineering
Technology Delivery System.
The following are demanding seamless leadership
Norms and needs
Political Demand and support
Government policy making and process
Executives, , Judicial, State, Local and Social sectors
Tools
Impacts and Out come
External constraints
Basic R&D
Technological Organisation
Capital Natural Resources
•Specialized man power
•Skilled Technicians
•Engineering technicians
•Professional engineers and
•Professional Technicians


Re-Engineering of Technical Institutions towards Seamless Curriculum
The institute can not produce experts in any domain.
The main objectives of institutes are to educate
"how to learn the method of understanding the current world models
with the help of the past and must extend to the future."
With the help of Scientists technologist and Humanitarian


Hence the seamless curriculum must address the following:
•To understand the contemporary world model with the help of past and future.
•Basic Sciences.
•Engineering sciences.
•Engineering Arts.
•Technology forecasting.
•Technology assessment.
•Humanities.
•Research methodology.
•Experimental methods.
•System Engineering concepts
•Impact assessments.
•Environmental Models.
•Economy Models.
•Legal and judicial models.
•Technological interactions. (Clouding)
•Political models.
•Importance of inter Disciplinary and interactions.
•Value system.
•Communications.
traditional, conventional and digital


Masters program - Specializations
1. Architecture/Human settlement (Texture, Forms, Aesthetic, Creativity Development)
2. Architectural Engineering (Building Systems, Structural Design of Buildings, Plumbing, Heat Ventilations, Plumbing etc.)
3. Infrastructural Engineering (Concrete Technology, Design of Roads, Airports, Drainage Systems, Power Generations etc)
4. Infrastructure Maintenance (Retrofitting, Corrosion Sciences, Restoring, Rehabilitation
5. Structural Engineering (Buildings, Bridges, EQ engineering, Steel Structures etc)
6. Water Engineering and Environment (Irrigation, Hydrology, Soil water Interaction etc)
7. Geotechnics and Environment (Investigation, Soil water Contamination, Solid waste Disposal etc)
8. Ocean Engineering (Offshore Structures, Tide wave energy, etc.)
9. You Can Discover or Invent New Domains Based on NEED
With Major Projects related to Industry Specific, Societal Specific, Technological Specific or Inventions etc. (Institute Industry Interactions)


BE Seamless Engineers (Four years)
1. How to solve the complex, large-scale problems which must be overcome when dealing with the engineering and management of major engineering projects.
2. This course must be integrated and comprehensive to address Basic Sciences, Engineering Sciences, Engineering Arts, Economics, Humanities and Language and Communication, ALONG WITH Research Methodologies
3. This course should cover extensive analysis of key subjects relating technology and management: planning, programming, and budgeting; finance; organization; private sector involvement; operations and maintenance; project management; and research needs.
Industries need seamless graduates to put them in the following activities very immediately as Executives


Feasibility studies
Detailed project report
Impact studies
Market survey
Product survey
Human resources management
Dealing Government Policies
Contract Documents
Need analysis
Tax planning
Arbitrations
Dispute
Industries need seamless graduates to put them in the following activities very immediately as Executives


Masters Level: M.E/M.Tech (Two years)
M.S (One Year)
Specializations: Structures, infrastructures, architectural engineering, Geotechnical engineering etc.…


Research Program (Institute Industry Interactions)
Detail Research related to Industry Specific, Societal Specific, and Technological Specific Inventions etc.
It is nothing but clouding of Institution, Industry and Society through seamless engineering and technology curriculum
To meet uniform international standards for sustainable Engineering Education in India in view of International agreement

Engineering Council of India

6th National Convention on

Industry-Specific Engineering Education for Better Employability of Engineers

A Case for a Degree in Construction Engineering

Dr P.R.Swarup, Director General, Construction Industry Development Council

Engineering Council of India

A case for a Degree in Construction Engineering

Since 1991, the macro economic reforms have completely transformed the country and the economy is witnessing a quantum jump in its growth. The growth rate target for the economy in the XIth Plan is likely to be placed at 9 % if not more.

India has emerged as the second most attractive investment destination after China and ahead of the US and Russia. In terms of Business Confidence Index, India is ahead of the US and next to China; around 45% of the global investors are upbeat about India.

Engineering Council of India

A case for a Degree in Construction Engineering..

It will be possible to realize the growth rate of 9 % of our GDP in the Xith Plan only with good quality of infrastructure and availability of required power-in units of energy and of quality.

Among other things, we will have to make investment of about 300-400 billions of dollars in the next five years for making sure that we realise this kind of growth rate.

It implies that we need to have lots of construction going on; also we need to set up lots of plants. We need to expand power plants, ports and services. The manufacturing sector will also grow

Engineering Council of India

A case for a Degree in Construction Engineering

All this requires engineers and skilled workforce. So, the demand for quality and multi-skilled engineers, diploma holders and engineer technicians will also grow.

The power sector in India will need 200,000 engineers and over 8,00,000 technicians. In addition, technical workforce will be required for construction and fabrication industries; and India will also have to prepare itself for supplying the skilled workforce including engineers to other nations.

This demand is already growing. The nuclear power sector, based on the Department of Atomic Energy (DAE) current estimates, will require more than.50,000 engineers/ scientists and 200,000 technicians of multi-skills by 2050

Engineering Council of India

A case for a Degree in Construction Engineering

It has been assessed that 30% of the current nuclear workforce would retire within the next five years and there is hardly any nuclear-specific training being conducted by the engineering institutions. Perhaps, much of the supply is not employable and, therefore, more of the same is not going to solve the problem

Construction happens to be at the top of every development project. Construction industry has been growing at the pace of almost 15% per annum. At this growth rate, the construction industry alone needs about half a million engineers. We need multidisciplinary and multi-skilled construction engineers to do construction and not the civil engineers

Engineering Council of India

A case for a Degree in Construction Engineering

- Further, nuclear resurgence and renaissance in the US will need nuclear HR inputs from India as no reactor has been built in that country since 1979.
- They have missed 3 generations of nuclear technologists. If we do not address our HR needs for the nuclear sector, particularly the nuclear power sector by planning and training on a long term basis, the growth of the sector will be hampered by a new shortage in human resources by the year 2030.

Engineering Council of India

A case for a Degree in Construction Engineering

Let us, for a moment, assume that civil engineers are needed, we do not have them in numbers and of required quality that the construction industry needs. If we look into the history of past 10 or 15 years, as a matter of fact, what we find is that all the colleges that have been accredited by the All India Council for Technical Education (AICTE) do not find civil engineering as a branch. It is just not there. In the old colleges, there are limited numbers of seats

Engineering Council of India

A case for a Degree in Construction Engineering

The second problem that we have today is where are the teachers who will teach construction engineering? Who is going to teach these people? Do we have adequate number of good experienced teachers who understand what is to be taught to these people so that when they go back to the construction industry and deliver what the industry is looking for? The third problem is how relevant is the curricula that is there in the colleges or in the universities to meet the actual needs of construction industry?

Engineering Council of India

A case for a Degree in Construction Engineering

Presently only civil engineers are , by and large, in demand for the construction sector.

Is a civil engineer a construction engineer by virtue of his education?

I think No,

Construction engineer needs a familiarity with the world of business and commerce

Dealing with people and resources

Environmental, health and safety aspects

Legal aspects, project engineering

Engineering Council of India

A case for a Degree in Construction Engineering

Logistics engineering

Procurement engineering

Application of IT and communication technology in construction

Dealing with partnerships and joint ventures

Learning the nitti gritties of contracts and claims, apart from the changing world of technology itself

A construction engineer should be far more multi - functional and better equipped to deal with complex issues of construction business

Construction engineer is much more of an engineer – manager

Engineering Council of India

A case for a Degree in Construction Engineering

A pure civil engineer is not so equipped by virtue of education

We need engineers with some basic knowledge of civil, electrical, mechanical, metals and materials engineering, apart from knowledge of electronics and information technology, economics, statistics, law, contracts and dispute resolution, etc. So we need engineers for meeting the unique needs of mega projects of civil aviation, Ports and harbours, Urban renewal, transportation projects, Telecom and power sector projects, Oil and gas exploration projects and what you have

Engineering Council of India

A case for a Degree in Construction Engineering

And various other areas of infrastructure

Wherever investments and execution of projects on a large scale is paramount

List of Delegates

1. A. Sarkar
Sceintist Rtd.,
CMRI
Durgapur

2. A. Chakraborty
Sr. Manager (P)
Housing & Urban Development Corporation Ltd.
Kolkata

3. A.K. Ghosh
Kolkata

4. Abhijit Chakraborty
Regional Secretary
Indian Chemical Council,
Kolkata

5. Abhisek Nath
Student
Heritage Institute of Technology
Kolkata

6. Achintya Kumar Laha
WBSETCL
Kolkata

7. Alok Biswas
Consultant

8. Amit Kumar
Student
Heritage Institute of Technology
Kolkata

9. Amitabha Ghoshal
Stup Consultant Pvt.Ltd.
Kolkata

10. Anand Kumar
Student
Heritage Institute of Technology
Kolkata

11. Animesh Mondal
University of Calcutta
Kolkata

12. Aniruddha Deb
Student
Heritage Institute of Technology
Kolkata

13. Anirup Das
Student
Heritage Institute of Technology
Kolkata

14. Aniruuddha Bhaumik,
Proprietor ,
Anandam Power Electronics,
Kolkata

15. Ankan Guria

16. Ms. Ankita Prasad
Student
Heritage Institute of Technology
Kolkata

17. Mrs. Apurba Ghosal
WBSETCL
Kolkata

18. Apurba Kumar Bhattacharyya
Sr. Engineer Production
Praxair India Pvt. Ltd, Haldia.
West Bengal

19. Arghya Banerjee
Student
Heritage Institute of Technology
Kolkata

20. Arijit Das
Student, B.tech, Che., Final Year
Member of IICHE, Calcutta Institute of Tech.
Kolkata

21. Arijit Das
Student
Heritage Institute of Technology
Kolkata

22. Ms. Arka Dutta
Student
Heritage Institute of Technology
Kolkata

23. Arka Prowa Sadhu
Student
Heritage Institute of Technology
Kolkata

24. Arun Kumar Sarkar
Chief Engg. (Retd.) PWD, W.B.
The Institution Of engineers (India)
Kolkata

25. Ms. Aruni Sarkar
Student
Heritage Institute of Technology
Kolkata

26. Ms. Arunima Ghose
Student
Heritage Institute of Technology
Kolkata

27. Arup Kr. Chattopadhyay
Kolkata

28. Ashish Bahukhandi,
Chief Engineer (IT)
Personnel Department
Oil India Limited
Noida

29. Prof. Ashit Mazumdar
Managing Director
RNA Consultant Pvt. Ltd.

30. Asok Kumar Das
Convenor, Chemical Engineering Division
The Institution of Engineers (India)
Kolkata

31. Asoke Kumar Dutta
Exe. Member IIM
Kolkota Chapter

32. B. K. Basak
The Wesman Engineering Company Limited
Wesman Centre
Kolkata, West Bengal

33. B. K. Kundan
Chief Consultant
Stup Consultant Pvt.Ltd.
Kolkata

34. B. P. Jana
Indian Institute of Chemical Engineers
Kolkata

35. Prof. B. R. Saha
Head, Dept of Chemical Engineering,
Heritage Institute of Technology, Kolkata &
Honorary Secretary, Indian Institute of
Chemical Engineers

36. B. Sen Gupta
Chartered Engineer (IETE),
Kolkata

37. Dr. Basab Chaudhuri,
Former Honorary Secretary,
Indian Institute of Chemical Engineers,
Registrar University of Calcutta

38. Bimal Das
Indian Institute of Chemical Engineers
Kolkata

39. Bireswar Banerjee
Technical & Quality Consultant
Indian Institute of Chemical Engineers
Kolkata

40. Biswajit Debhnath
Student
Heritage Institute of Technology
Kolkata-700 107

41. Chander Kumar
Student
Heritage Institute of Technology
Kolkata

42. Chinmay Biswas
Group Advisor
NIRVAR GROUP
Kolkata

43. Prof. Chittaranjan Lahiri
Prof. (Retd.), Dept. of Chemical Technology
University College of Engineering & Technology
Kolkata

44. Dr. D. De Sarkar
Indian Copper Development Center
Kolkata

45. Prof. D. K. Banwet
Department of Management Studies (DMS)
IIT Delhi

46. D. Mondal
Indian Institute of Chemical Engineers
Kolkata

47. D. P. Dutta
Former DGM
Hindustan Copper

48. Debapratim Mukherjee
Student
Heritage Institute of Technology
Kolkata

49. Ms. Debasree Banerjee
Asstt. Prof., Chemical Engg.
Calcutta Institute of Technology
Kolkata

50. Debjit Ghoshal
Student
Heritage Institute of Technology
Kolkata

51. Dr. Dhananjay Saha,
Dy. Director,
Higher Tech. Education.,
Govt. of W.Bengal

52. Er. Dibyendu Majumder
Chartered Engineer(I)
Kolkata

53. Dipak Kumar Bose
Kolkata

54. Ms. Doly
Student
Heritage Institute of Technology
Kolkata

55. Dulu Das
Indian Institute of Chemical Engineers
Kolkata

56. Dwaipayan Sen
Kolkata

57. Epika Mandal
Student, B.tech, Che., Final Year (Member of IICHE)
Calcutta Institute of Technology
Kolkata

58. Ms. Epika Mondal
Student
Heritage Institute of Technology
Kolkata

59. Ms. Eshani Roy
Student
Heritage Institute of Technology
Kolkata

60. Firoza Mallik
Database Manager
WBSRDA
Kolkata

61. G.C. Dutta
Consultant
Kolkata

62. Gautam Garra
Student, Heritage Institute of Technology
Kolkata

63. Prof. H. R. Vishwakarma
Sr. Professor, School of Information Technology;
EngineeringVIT University, Vellore-63201 &
Hony. Secretary, Computer Society of India

64. Hitendralal Saha
B.E. (Chem), LMIIChE, PGDBM
Kolkata

65. Imtiaz Ahmed
Student, Heritage Institute of Technology
Kolkata

66. Prof. Indranil Manna
Director,
Central Glass and Ceramic Research Institute,
Kolkata

67. J S Saluja
M D, SCPL,
Senior Vice president
Indian Institution of Plant Engineers and
Member Board of Governors
Engineering Council of India

68. J. K. Roy
Indian Institute of Chemical Engineers
Kolkata

69. Jishan Ikbal
Student
Heritage Institute of Technology
Kolkata

70. Joydev Lahiri,
Dy Chief Engineer (E),
Personnel Department
Oil India Limited
Noida

71. K. S. Parsuram

72. Dr. Kalyan Mitra
Professor & Member Secretary, P.G. Courses
Marine Engineering & Research Institute
Indian Maritime University
Kolkata

73. Kamalesh Biswas
Kolkata

74. Kaushik Khaskel

75. Kausik Ray Chowdhary
Student
Heritage Institute of Technology
Kolkata

76. Mahjabeen Akram
Assistant Professor
Calcutta Institute of Technology
Howrah

77. Mainak Bhaumik
Student,
Heritage Institute of Technology
Kolkata

78. Ms. Monalisa Dutta
Student,
Heritage Institute of Technology
Kolkata

79. Ms. Moumita Sardar
Student
Heritage Institute of Technology
Kolkata

80. Mritunjay Kumar Shah
Student
Heritage Institute of Technology
Kolkata

81. Mrityunjay Kumar Shaw
Student
Heritage Institute of Technology
Kolkata

82. Mukunja Kumar Das
Kolkata

83. Ms. Munmun Jana
Indian Institute of Chemical Engineers
Kolkata

84. N. E. Mondal
Indian Institute of Chemical Engineers
Kolkata

85. Dr. N. Banerjee
Principal
Calcutta institute of Technology
Kolkata

86. Nayan Das
University of Calcutta
Kolkata

87. Nilanjan Ghosh
Student
Heritage Institute of Technology
Kolkata

88. Prof. P. K. Sen Gupta
Heritage Institute of Technology
Kolkata

89. P. Misra
Kolkata

90. P. N. Shali, Director,
Engineering Council of India &
Former Adviser and Consultant (SP-NE),
Planning Commission, Government of India

91. Prof. P.B. Sharma,
Vice Chancellor,
Delhi Technological University,
Delhi

92. Dr. P.R.Swarup
DG, CIDC

93. Prof. Parameswar De
Chemical Engineering Department
University of Calcutta, Kolkata

94. Parmeshwar Tiwari
Sr. Chemical Engineer
Super Oxytech Pvt. Ltd.
Kolkata

95. Ms. Piyali Ghosh
Student
Heritage Institute of Technology
Kolkata

96. Dr Pradipta Kumar Bose,
Adviser, BFN World Service and
Consultant, Environmental Planning &
Sustainable Development,
Former Professor, Chemical Engineering,
Jadavpur University, Kolkata.

97. Shri Prakash Tikare
Vice President,
Gammon India Limited
Mumbai

98. Pranab Kumar Mandal
Private Chemical Consultants
Kolkata

99. Prasanta Nandi
Student
Heritage Institute of Technology
Kolkata

100. Pratik Singh
IBNS (Press)

101. Priyadarshi Sen

102. Ms. Puja Dey
Student
Heritage Institute of Technology
Kolkata

103. Ms. Qindmila Gupta
Student, Heritage Institute of Technology
Kolkata

104. R. G. Vaidyanathan
Kolkata

105. R. J. U. Mondal
Indian Institute of Chemical Engineers
Kolkata

106. R.N. Parbhat
Management Consultant
Former M.D., Indian Aluminum Company Ltd.
Past President, the Indian Institute of Metals

107. Ms. Rajamshi Kar
Student
Heritage Institute of Technology
Kolkata

108. Rajendra Pal
JTO, BSNL
Kolkata

109. Rajib Mete
Student
Heritage Institute of Technology
Kolkata

110. Ramki Chowdhury
Student, B.Tech in Chemical Engineering
Calcutta Institute of Technology
Kolkata

111. Dr. Ranajit Chowdhuay
Ex. Senior Manager
SAIL
Kolkata

112. Riddhitamer Mondol
Student
Heritage Institute of Technology
Kolkata

113. Rittik Maji
Student
Heritage Institute of Technology
Kolkata

114. Rohit Saha
Student
Heritage Institute of Technology
Kolkata

115. Ms. Rumela Chatterjee
Student
Heritage Institute of Technology
Kolkata

116. Dr. S K Bhattacharyya
Steel Chair Professor,
Dept of Met & Mat. Engg.
Bengal Engg. & Science University
Howrah

117. S. C. Rudra
Kolkata

118. Dr. S. K. Das
Head, Chem.
Department of Chemical Engineering
University of Calcutta
Kolkata

119. S. K. Guha
Indian Institute of Chemical Engineers
Kolkata

120. S. K. Roy
Indian Institute of Chemical Engineers
Kolkata

121. S. Ponda
Dy. Director (Engg.)
West Bengal Electricity Regulatory Commission
Kolkata

122. S. R. Dhua

123. S. Ratnavel
Chief Executive Officer,
SCEBA Consultancy Services and
Member Board of Governors,
Engineering Council of India

124. Sagar Biswas
Student
Heritage Institute of Technology
Kolkata

125. Sagnik Sen
Student
Heritage Institute of Technology
Kolkata

126. Samir Kumar Ghosh
Kolkata

127. Sampad Kundu
Student
Heritage Institute of Technology
Kolkata

128. Ms. Samya subhra Das
Student
Heritage Institute of Technology
Kolkata

129. Sandeep Ghosh
Asst. Secy.
Indian Institute of Chemical Engineers
Kolkata

130. Dr. Sandip Bhattacharji

131. Sanjoy Mukerjee
Kolkata

132. Sankhajit Pal
Student
Heritage Institute of Technology
Kolkata

133. Prof.(Dr.) Sarajit Basu
Chairman, Chem. Engg. Div.,
WBSC, IEI
Kolkata

134. Ms. Sarojini Tiware
Student
Heritage Institute of Technology
Kolkata

135. Sayan Das
Student
Heritage Institute of Technology
Kolkat

136. Sayan Mukherjee
Student
Heritage Institute of Technology
Kolkat

137. Shambojit Roy
Student
Heritage Institute of Technology
Kolkata

138. Ms. Shoni Basu
Student
Heritage Institute of Technology
Kolkata

139. Ms. Shreya Mukherjee
Student
Heritage Institute of Technology
Kolkata

140. Ms. Shreya Mukherjee
Student
Heritage Institute of Technology
Kolkat

141. Ms. Shreyashi Sarkar
University of Calcutta
Kolkata

142. Dr. Sivabrata Chatterjee
Environmental Consultant
Kolkat

143. Smarajit Das
Kolkata

144. Somok sen Gupta
Student
Heritage Institute of Technology
Kolkata-700 107

145. Ms. Soumen Guha
University of Calcutta
Kolkata

146. Sourav Dey
University of Calcutta
Kolkata

147. Souvik Kumar Paul
Student
Heritage Institute of Technology
Kolkata

148. Souvik Kumar Paul
Calcutta Institute of Technology
University of Calcutta, Kolkata

149. Srikumar Ghosh
Managing Director,
Consulting, Engineering Services (I) Pvt Ltd,
New Delhi

150. Subhadip Sengupta
Student, Final Year, B.Tech in Chemical Engg .
Calcutta Institute of Technology,
Kolkata

151. Subrata Ghosh
SE (E), WBSETCL
Kolkata

152. Sudarsan Sikdar
Consultant (Chem. Engineering)
Bicorev Enviro Pvt. Ltd.
Kolkata

153. Ms. Sudeepta Sen
Student
Heritage Institute of Technology
Kolkata-700 107

154. Dr. Suman Mishra
Scientist NML
Jamshedpur

155. Ms. Susmi
Student
Heritage Institute of Technology
Kolkata

156. Suvadeep Sen Gupta
Student
Heritage Institute of Technology
Kolkata

157. Dr. Suvendu Roy Chaudhury,
Electrical Engineering

158. Suvendu Samanta
Student
Heritage Institute of Technology
Kolkata

159. Prof. Swapan Bhattacharya
Department of Computer Science & Engineering,
Jadavpur University,
Kolkata

160. Swapan Kumar Chattoupadhyay
SE (E), WBSETCL,
Kolkata

161. Syamantath Roy

162. T. K. Chakrabarty
Jt. Advisor (Engg.)
West Bengal Electricity Ergulatory Commission
Kolkata

163. T.K. Mitra
Managing Director, Tamipper & Co. and
Member, Indian Institute of Chemical Engineers
Kolkata

164. T.N. Chakraborty
GGM
Engineering Projects (India) Ltd.
New Delhi

165. Tamal Manna
Student
Heritage Institute of Technology
Kolkata

166. Tandra Sen Gupta
Senior Member(ORSI)
Kolkata

167. Ms. Tania Mitra
University of Calcutta
Kolkata

168. Shri Tarak Paul
Indian Institute of Chemical Engineers
Kolkata

169. Prof. Tarun Kumar
VECC, BARC, DAE
Kolkata

170. Ms. Trisha Sen
Student
Heritage Institute of Technology
Kolkata

171. Prof. Uday Chatterjee,
Adjunct Professor, BESU, Howrah,
Managing Editor, IIM Metal News and
former Professor, IIT, Kharagpur

172. Dr. Uddesh Kohli
Chairman, Engineering Council of India (ECI),
Chairman Emeritus, Construction Industry
Development Council (CIDC) &
Chairman, Construction Industry Arbitration
Council

173. Dr. Uttam Ray Chaudhuri
Associate Professor,
Dept. of Chemical Tech.
University of Calcutta
Kolkata

174. Victor Avisek Chatterjee
University of Calcutta
Kolkata

Engineering Council of India (ECI)

ECI was established on April 4, 2002, by coming together of a large number of Professional Organizations / Institutions of engineers, to work for the advancement of engineering profession in various disciplines, for enhancing the image of engineers in society, by focusing on quality and accountability of engineers and to enable the recognition of expertise of Indian engineers and their mobility at international level in the emerging WTO / GATS environment. It has emerged as a common voice of its member organizations.

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 the society. To this end, ECI is focusing on quality and accountability of engineers, professionalism and their mobility for delivering engineering services in other countries, with expertise of Indian engineers developed, recognized and accepted at the international level.

Tasks

- Representing Member Associations in government and non- government bodies, and interacting on common policy matters relating to engineering profession
- Working for the setting up of a Statutory Council of Engineers and later interfacing with it, providing support and inputs for developing systems and procedures for the registration of engineers, CPD, code of ethics
- Facilitating authorization of member associations to register engineers; assisting them in developing internal systems for undertaking registration, CPD, enforcing code of ethics; and providing common forum for CPD to support the member associations
- Assisting member associations in interaction with academic institutions and regulatory bodies in regard to their examinations, award of degrees etc
- Providing forum for exchange of information and experience among member associations, coordination, common thinking and views on important matters
- Helping in the analysis of existing education systems / bodies and making suggestions in order to make the education relevant for the engineering profession and employability
- Setting up a Resource Centre and Database of Engineers, which can provide necessary information required for the development of the profession
- Interacting with professional associations / bodies in other countries & international bodies
- Undertaking and supporting research for the development of the engineering profession

Engineers' Bill

ECI has facilitated formulation of a conscious draft Engineers' Bill for the consideration of the Govt. of India. Which lays down the criteria for the process of registration of Practising Engineers 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 at least four years, and
- the accounts being audited annually.

Board of Governors

Executive Committee

Dr. Uddesh Kohli *Chairman*	Chairman Emeritus Construction Industry Development Council
Shri Mahendra Raj *Vice Chairman*	President Indian Association of Structural Engineers
Shri Chander Verma *Treasurer*	President International Council of Consultants
	Chairman Construction Industry Development Council & Indian Society for Trenchless Technology
Members	
Dr. S. Chatterjee	President Consulting Engineers Association of India
Shri P. R. Swarup	Director General Construction Industry Development Council
Shri K.K. Kapila	President, Indian Building Congress
Lt. Gen. (Retd.) A.K. Puri PVSM, AVSM	Chairman, Indian Institution of Bridge Engineers (DSC)
Shri R.K. Gupta	President The Institution of Electronics and Telecommunication Engineers
Shri P. N. Shali	Director Engineering Council of India

Office Bearers of ECI

Dr. Uddesh Kohli
Chairman

Shri Mahendra Raj
Vice Chairman

Shri Chander Verma
Treasurer

Engineering Council of India

ECI has been formed by coming together of 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 Association of Structural Engineers
8. Indian Buildings Congress
9. Indian Concrete Institute
10. Indian Geotechnical Society
11. Indian Institute of Chemical Engineers
12. Indian Institution of Bridge Engineers
13. Indian Institution of Industrial Engineering
14. Indian Institution of Plant Engineers
15. Indian National Group of IABSE
16. Indian Society for Non Destructive Testing
17. Indian Society for Technical Education
18. Indian Society for Trenchless Technology
19. Indian Society of Agricultural Engineers
20. Institute of Urban Transport (India)
21. Institution of Mechanical Engineers (India)
22. International Council of Consultants
23. The Aeronautical Society of India
24. The Automobile Society of India
25. The Indian Institute of Metals
26. The Institute of Electrical and Electronics Engineers. Inc.
27. The Institute of Marine Engineers (India)
28. The Institution of Civil Engineers (India)
29. The Institution of Electronics and Telecommunication Engineers
30. The Institution of Surveyors