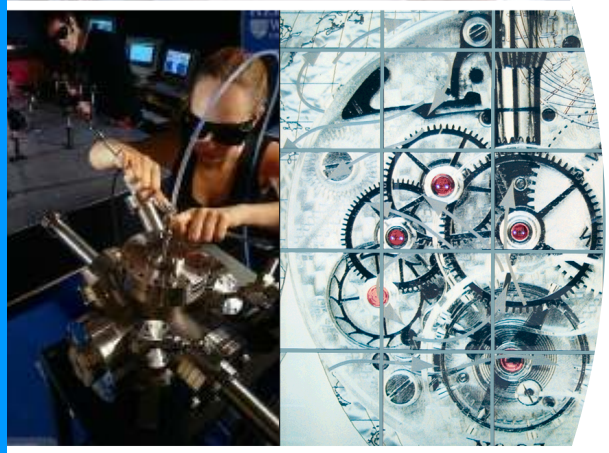
Engineering Council of India



2nd
NATIONAL CONVENTION ON
SEAMLESS ENGINEERING

May 31, 2007

MS University of Baroda, Vadodara (Gujarat)

PROCEEDINGS

Sponsored by

The Indian Petrochemicals Corporation Ltd

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The MS University, Baroda and the Indian Institute of Metals
Baroda Chapter

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Edited Proceedings

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Introduction

The evolution of engineering over the years has been tremendous. Not only has engineering helped create structures that withstand the test of time, but by the sheer dent of efforts in R&D, it has also contributed in making the world a more eco-friendly place. The industrial revolution and developments in the field of inventions coupled with technical advancements necessitated the transition of engineering from a general phase to one of highly domain specific specializations. From the staid Civil, Mechanical and Electrical, today engineering has advanced and branched into 18-20 specializations. The paradigm shift in the way projects are implemented requires application of knowledge and skills other than staid engineering. A case in point being mega projects executed for the development of physical infrastructure in a nation. An integrated approach from project conception-to-completion is required to achieve the engineering marvels in the construction of hydro-power plants, dams, roads, highways and air ports, townships, steel plants, oil refineries, petro-and heavy chemical and fertilizer plants, aluminum, lead-zinc and copper refiners. Similarly, such an approach is also required in all the segments of information industry, space and nuclear industries, etc. Project planning, appraisal, implementation, monitoring and operation require integrated skills that may not be limited to a single discipline of engineering. The feasibility of projects is determined inter-alia in the synergy between engineering and business management. Engineers also armed with a degree in business management can play a bigger role at all the stages of a project- from concept to completion.

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

In the Indian context, the realization of the need for generalization in the engineering curricula at the degree level happened around 1960s. It was during this time that the former Punjab Engineering College, Chandigarh and presently the National Institute of Technology, offered Production Engineering as a

course. Some other colleges followed suit and varied their offerings with the Industrial Engineering as an alternative. Most recently, a diploma in the Construction Engineering has been started by the Construction Industry Development Council- a leading institution dedicated to the development of construction industry in the country- in collaboration with the Indira Gandhi National Open University, New Delhi. It can be said that this step taken by the CIDC is a bold step forward in realizing the idea that is being floated, Trends across the world depict the rise in demand for Seamless Engineering. The same can happen in India as it is the cry of the day.

1st Convention

One of the objectives of the Engineering Council of India (ECI), being the apex body of Engineering Associations in India, is to help promote the profession of engineering. Therefore, in order to discuss the subject in-depth, ECI initiated the discussion on the subject with its 1st Convention, which was held at the Tata Centre Kolkata on August 16, 2006. It was well attended both by the industry and academia. While there was a general consensus for a change, it was also suggested that further in-depth discussion on the subject should continue till the general consensus is reached for the change.

2nd Convention Objective

The main objective of the 2nd Convention, which was held at Baroda on May 31, 2007, was to continue with the in-depth discussion on reforming the engineering education and training at the undergraduate level for bringing in a needed synergy in the different engineering disciplines at the under-graduate level, particularly for meeting the needs of industry. The Convention attempted at seeking the views from the industry and academia on the job requirements and doing the present conventional disciplines of engineering meet these requirements and on the suitability of the Conventional Engineering Curricula to the job requirements .

Programme

0900-1000 Hrs		Registration
1000-1100 Hrs		Opening Session
	Welcome Address	Dr. Uddesh Kohli, Chairman, ECI
	Convention Address	Prof. A. K. Singh, Director, Electrical Research & Development Association, Baroda
	Address by the Guest of Honour	Prof. B. S. Parekh, Dean, Faculty of Technology and Engineering, M. S. University of Baroda
	Inaugural Address by the Chief Guest	Prof. S. M. Joshi, Pro Vice Chancellor, M. S. University of Baroda
	Vote of Thanks	Prof K. Baba Pai, Head, Department of Metallurgy, M. S. University of Baroda and Chairman, Indian Institute of Metals - Baroda Chapter
1100-1130 Hrs		Tea / Coffee1130 – 1300 Hrs
		Technical Session -I
		The Industry View on the Present job Requirements and the Conventional Disciplines of Engineering
	Session Chairman	D. M. Mehta, M.D., P-Met Co. Ltd.
	Keynote Speaker-1	Dr. M. K. S. Sastry, Coordinator, Joint Degree Programmes, University of West Indies & University of Trinidad & Tobago, Read by Prof. P. B. Joshi, Department of Metallurgy, M. S. University of Baroda
	Keynote Speaker-2	M. A. K. Babi, Freelance Industrial Consultant
	Keynote Speaker-3	D. S. Pradhan, Immediate Past President, ISNT – Baroda Chapter, Ex. Advisor – GSFC Ltd., Gujrat
	Keynote Speaker-4	Alok Ghoshal, Sr. Manager, Technical Education, SNTI, Tata Steel
	Keynote Speaker-5	Dr. A. K. Singh, Director, Electrical Research and Development Association, Baroda
1300-1400 Hrs		Lunch
1400-1530 Hrs		Technical Session- II
		Views from the Academia on the Suitability of the Conventional Engineering Curricula to the Job Requirements
	Session Chairman	Prof. P. Prabhakaran, Head Mechanical Engineering Department, M. S. University of Baroda

	Keynote Speaker-1	Prof C. V. Ramakrishnan, INAE Distinguished Professor, IIT, Delhi.
	Keynote Speaker-2	Prof K. Baba Pai, Head, Department of Metallurgy, M. S. University of Baroda and Chairman, Indian Institute of Metals - Baroda Chapter
	Keynote Speaker-3	Antony Lobo, Senior Manager Human Resources, Tata Consultancy Services & Senior Member , Institute of Electrical & Electronics Engineers
1530-1600 Hrs		Tea / Coffee
1600-1730 Hrs		Panel Session
		Seamless Engineering
1600-1645 Hrs	Chairman	Dr. A. K. Singh, Director, Electrical Research and Development Association, Baroda
	Panelist-1	Dr Rajendra Kumar, Eminent Metallurgist & Scientist and former Additional Director, National Metallurgical Laboratory, Council of Scientific and Industrial Research , Department of Scientific and Industrial Research, Government of India.
	Panelist-2	Prof. V. L. Gadgeel (Retd.), Department of Metallurgical Engineering, M. S. University of Baroda
	Panelist-3	Deepak Pradhan, GM (Retd.), Gujarat State Fertilizers and Chemicals Ltd.
	Panelist-4	S. C. Agrawal, General Manager, PDIL, Vadodara
	Panelist-5	Lt. Col. A. K. Singh, Commanding Officer, Station Workshop, Baroda
1645-1730 Hrs		Discussions

Engineering Council of India (ECI)

Objectives

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

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

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

1. To promote the science and practice of engineering for national development, collectively along with its constituent members.
2. To encourage engineers to serve the needs of the society.
3. To promote advancement of education of engineering in the country.
4. To promote the practice of continuing education and training to upgrade the quality of engineering professionals.
5. To identify and undertake activities of common interest to the engineering profession.
6. To encourage inventions, investigations and research; and promote their applications for development of the national economy.
7. To identify and undertake activities directed to enhance prestige of engineers in the country, and to secure for them their rightful place at various levels of planning, administration etc.
8. To promote steps to attract bright persons of the younger generation to the engineering profession.
9. To assist associations / professional societies in normalizing criteria for membership so as to make these nationally equitable and internationally acceptable.
10. To establish a common "Code of Ethics" for professional and consulting engineers' adoption by associations / professional societies and to evolve the strategy for its enforcement.
11. To interact with the government at State and Central levels and help adoption of policies for betterment of the engineering profession.
12. To represent engineers and engineering professionals of all disciplines, at national and international levels.
13. To maintain a National Register of "Professional Engineers" and a National Register of "Consulting Engineers" who are engineering organisations employing professional engineers where principal occupation is the independent practice of engineering.
14. To acts as a Nodal Body, representing India, for bilateral / multi-lateral recognition of "Professional Engineers" and "Consulting Engineers" on mutual and reciprocal basis.
15. To identify and encourage the implementation of the best practices for development and assessment of engineers intending to practice for the development and assessment of engineers intending to practice as professionals in domestic as well as foreign markets.

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

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

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

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

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

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

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

Tasks

- In order to meet its objectives, ECI task include the following :
- Certify the competence of engineers for undertaking professional activities.
- Certify the competence of organisation offering engineering consultancy services.
- Integrate continuous development programme with the certification process to upgrade expertise continuously.
- Lay down norms of professional conduct and take appropriate action promoting and ensuring compliance, therewith
- Join international networks such as Engineers Mobility Forum for protecting the interests of Indian engineers in the emerging international scenario.

Engineer's Bill

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

Membership

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

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

Executive Summary

Seamless Engineering Education at the undergraduate level is, in essence, a debate launched by the Engineering Council of India wherein we talk on a multi-disciplinary type of approach for engineering education at the undergraduate level because it is being widely felt that mere specialization in one branch of engineering, as is the practice now, does not produce multi-skilled engineers needed by the industry. The role of an engineer has undergone a major change with the paradigm shift from the traditional functional organizational structure to cross-functional organizational structure.

The desirable characteristics of the 21st century engineer from the viewpoint of industry perspective are: fundamental technical domain knowledge complemented by knowledge from neighbouring technical disciplines; solid methodical knowledge; system-building and problem-solving skills; understanding of the entire value-chain; management know-how and business process skills; project management and decision-making skills; marketing and financial know-how; foreign language proficiency; knowledge about the social and ecological implications of technology; interpersonal and communication skills; leadership techniques; inter-cultural understanding and cultural empathy (identification and understanding of another's situation, feelings and motives); and, last but not the least, capacity and willingness to engage in life-long learning supported by cosmopolitan attitude and global mindset. There are many statutory regulations in force which industry has to deal with like on boilers, insurance, electrical, environmental controls, etc. An engineer has also got to deal with these regulatory issues and problems. An engineer needs to have skills to deal with various regulations and statutory bodies.

The present stoic engineering education at the undergraduate level is inadequate to produce engineers which the industry needs. There is, therefore, a need to make the engineering syllabi at the undergraduate level seamless which may include courses on management, economics, statistics, public relations, law, communications, contract engineering, computer-related courses, human resource development, project formulation, evaluation and appraisal, etc, for making it industry, specific. The other way could be to have a general engineering degree comprising basics of all the engineering disciplines plus the subjects mentioned above. There is, therefore, a strong case for the seamless engineering education.

The training by the engineering students in industry is now-a-days practically not given any significance. It has become a formality to be observed by the students; and the trainers in the industries also take it that way. This trend must be reversed. For producing industry specific and world-class engineers, we must build an efficient and effective Industry-Academics-R&D Institutions interaction mechanism on the basis of collaborative philosophy.

Engineers of all engineering disciplines today go to the companies like TCS, WIPRO, and INFOSYS and so on. These companies need only engineering students with good theoretical background and they become mere programmers there. Our task is actually to produce engineers and not the programmers. For this, tremendous changes are required right from the UGC, AICTE and to the college level.

The present administrative set-up for the higher technical education in the country is represented by the UGC and AICTE. These two bodies do not have any proper interaction; they design and administer policy and programmes according to the IIT standards. The fundamental problem here lies in the lack of autonomy which includes not only in setting the curricula but also in the administration. There is no flexibility in the present mechanism. Consequently, the engineering institutions go through a lot of

difficulties. These bodies should work together and reach the grassroots, interact with the professors from the government and other engineering colleges, call them in the meetings and try to talk to them regarding formulation of the appropriate policies for bringing about improvement and upgradation of the higher technical education, particularly engineering education in the country. The administrative set-up for the higher technical education in the country needs a through revamping and has to be made more flexible and purposeful. The government should try to integrate its own administrative set-up for managing the higher technical education. There is a need to bring in seamless or single window administrative institutional set-up for managing the higher technical education which will go a long way in improving our higher technical education in the country

Opening Session

Opening Session

Welcome Address : Dr. Uddesh Kohli

We are very grateful to this historical M. S. University, Department of Metallurgy and Chemical Engineering for supporting the convention and providing all help in organizing the convention at Baroda. While we have a large number of professional engineering associations in the country, we have been feeling the absence of a single body for a long time which could be called the voice of engineers, i.e., in other words, a voice of all professional engineering associations. While the idea of an apex body of engineers was born some 6-7 years ago, it took a concrete shape in one of the meetings taken by Shri K. C. Pant, the then Dy Chairman, Planning Commission, who is also an engineer. Consequently, the Engineering Council of India (ECI) was formed on April 04, 2002 under his patronship by coming together of 24 professional organizations / institutions of engineers including the Institution of Engineers, the largest body of engineers in the country - to work for the advancement of engineering profession in various disciplines and 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 and their employment in internationally funded projects, multinational corporations and large companies in India. It was also given the responsibility for drafting of the Engineers Bill, which it did and submitted it to the ministry of HRD. I would call it some sort of a historical occasion because the general tendency is to fall apart rather than to come together and for engineers and the engineering bodies to come together was a very important achievement.

The practice of registration of professional engineers is there in several countries. It means that engineers, who are graduate engineers and who also have well-established professional standing ranging from five to seven years which is evaluated, are registered to carry out the practice of engineering. The idea behind this is that only registered engineering professionals will be able to sign and certify designs of the engineering processes, or projects in an industry so that they are accountable for that. As a matter of fact, the idea to have licensed engineers in India got further firmed up after the incidence of earthquake in Gujarat wherein several multi-storied buildings started collapsing. Then, the matter of accountability of engineers came into picture with a view to fixing the responsibility. So, the question was that if you have the license for practicing as an engineer, it is then only that if something happens, such engineers could be charged because they only are bound by the code of ethics and conduct. Further, it is only then that they could be deregistered; thus they could be barred from practising, which happens in the other professions like medical, architecture, dentistry, lawyers and several other professions. The people of these professions have got to take the license and registration for practising a statutory council controls this. Unfortunately, engineers don't have any such body and we don' have any law and on a few occasions, the High Courts have said that engineering is not recognized as a profession. In that context, the Engineers Bill

Dr. Uddesh Kohli *is the Chairman of Engineering Council of India. He is also the Chairman Emeritus of Construction Industry Development Council and President Emeritus of Indian Society for Training & Development (ISTD). Dr. Kohli is former Chairman and Managing Director of Power Finance Corporation (PFC); Advisor, Planning Commission; Chairman of Standing Conference of Public Enterprises (SCOPE); President of the Council of Indian Employees (CIE), Chairman, Consultancy Development Centre and President of All India Management Association. Dr. Kohli is the recipient of the Eminent Engineer Award of the Institution of Engineers (I), for his significant contribution in the engineering field.*

was drafted. We had several discussions on the Draft Engineers Bill and, after these discussions, a consensus draft Bill has been formulated and it is now under consideration of the Ministry of HRD.

Once the draft Bill gets processed through the Parliament and becomes the law, every graduate engineer, not only the professional engineer, will have to register for practice and practice is defined very widely whether it is the job or it is the independent practice as a consultant. This means, just as no doctor can function after graduation alone unless he / she is registered by the Medical Council of India, similarly, once the statutory body for engineers is set up under the law, every graduate engineer will have to positively register. But then there is the other side also. Once this law comes on the statue, no engineer other than registered engineer under the law can practise. This means that even engineers coming from foreign countries will have to register in India for practising here. Today they are free to practise in India. They will not be able to do that unless they are registered in India after the Engineers Act comes on the statue. It is very similar to this that when an Indian engineer wants to work in a foreign country, he / she has to register and take a licence there.

Another important feature of the development is that the major job of registration is proposed to be given to all the professional associations like The Institution of Engineers, The Indian Institution of Chemical Engineers, The Indian Institute of metals, etc. This has been possible at the instance of ECI.

Now, this is the first gathering where we are giving the details of the proposed law. I thought it would be of interest to many of you. Well, the draft Engineers Bill is still to go through several stages. The central government will have to consider it; then the comments of the state governments will have to be solicited for which the draft Engineers Bill will be sent to them by the central government. The other central ministries / departments will also be consulted. The Cabinet will have to approve it before it is tabled in the Parliament. Perhaps, comments will also be called from the general public. This is the usual process in such cases. Further, normally in case of any law, the Parliamentary Standing Committee goes into that and once it recommends, the Parliament considers and passes it for the consent by the President. After this entire process goes through successfully, it becomes the Law. So, I think that it will take at least a year if not less, maybe even more. So, this is the job in which ECI is fully involved.

ECI is also working on the international side. We have studied the various international agreements / accords concerning both professional engineers and engineering education and the international bodies which have been formed thereto. We are looking into the question as to how Indian engineers can take advantage of these agreements / accords. There are two sets of agreements. Many of you may be knowing, many of you may not be knowing. One is the Washington Accord recognizing engineering educational qualifications given by different engineering universities / institutions / professional associations of engineers etc. in a country. It means that engineering degrees awarded by these institutions of a member-country of the Washington Accord (WA) will be recognized mutually by all the other member-countries of the WA. From India, the body, which has applied for the membership of the Washington Accord, is the AICTE. The next meeting of the member-countries of the Washington Accord is in the month of June, 2007. In fact, AICTE will be Full Member of the Washington Accord after two years of getting the provisional membership. In the June meeting, it will try for a provisional membership of the Accord. Once the AICTE becomes the full member of Washington Accord, then only our engineering degrees will be considered equivalent to the other member-countries of the Accord. We will have to meet certain parameters, certain criteria for standardization and accreditation of our engineering degrees. National Board of Accreditation, a part of AICTE, will also be a party in this particular field.

Engineers Mobility Forum (EMF) is a world grouping of countries mutually recognizing professional engineering experience of its member-countries. Thus, it deals with post- engineering qualifications. The professional experience of engineers of its member-countries is assessed based on the System and Procedures developed by them including for continuing professional development (CPD) and ethics which are equivalent to and recognized as such by the EMF. Such engineers are called professional engineers. There is a separate registration process for this. Once the statutory body for engineers is set up, it will take up that registration also. Presently, India is a provisional member of EMF. It has still to go up to the full membership stage of EMF. These are some of the activities on the international side that the ECI is engaged in.

ECI have organized four national conferences and three workshops wherein we have discussed the subject on professionalisation of engineers, their continuing professional development (CPD), registration of professional engineers and ethics and morality. ECI developed the systems and procedures for registering professional engineers, for their CPD and ethics and morality in India which are equivalent to those of the EMF. CPD will ensure that the engineers after their graduation will be able to keep themselves updated not only with the latest developments in their field of specializations but will also pick up additional skills from the other relevant disciplines and fields of study, particularly in those areas which are relevant to the job. Incidentally, the draft Engineers Bill, about which I have mentioned earlier, also provides for the continuing professional development of engineers. After five years of registration under the systems and procedures, engineers are required to re-register themselves and this will be based inter alia on their continuing professional development that they have undertaken for the previous five years. So, ECI has been working on those standards and criteria which are required including on the code of ethics which should be there.

Another area, which ECI has taken up for an in-depth discussion in the country, is the seamless engineering education at the undergraduate level. In essence, it is a debate launched by the Council where we talk of a multi-disciplinary type of approach for engineering education at the undergraduate level because it is being widely felt that mere specialization in one branch of engineering, as is the practice now, is not enough. Every engineer has to do multi-disciplinary tasks. So, in order to do these tasks, an engineer needs to have multi-disciplinary skills apart from the basic engineering degree in an engineering discipline. While a specialization is required, the industry requires multi-skilled engineers having knowledge of the other branches of engineering as well apart from his/her branch of specialization. Additionally, an engineer should also have some more skills such as that of management, economics, statistics, and law. Well, I am not an academic expert. We have academic experts and experts from the industry present in this convention here. So, I am looking forward to educative discussions in this convention which will take the debate/discussions on this subject of national importance further. After this convention on the subject of seamless engineering, ECI will organize more such conventions. We want to bring about a change in the engineering education system and to change anything requires a lot of efforts. We also have a plan to involve the AICTE in the discussions at the appropriate stage.

Prof. A. K. Singh

I will start with complimenting the Engineering Council of India for having organized such a relevant and thought-provoking convention at Vadodara, the Cultural Capital of Gujarat. I strongly believe in and also try to practise the concept of seamless functioning. Although the topic is Seamless Engineering, I will like to go one step backward from the concept of seamless engineering, i.e., to the division between Science and

***Prof. A. K. Singh**, Director, Electrical Research & Development Association, Baroda*

Engineering and would like to start with the beautiful quotation by Bill Wulf and I quote: "There is only one nature. The division into science and engineering is a human imposition, not a natural one. Indeed, the division is a human failure. It reflects our limited capacity to comprehend the whole." Unquote

We should first take a look at the difference between engineering and technology. How has the word 'engineering' been substituted by 'technology' in academia? It has been seen that the nomenclature "Engineering College" has been substituted by "Institute of Technology". 'BENCO' is today 'IT' (Institute of Technology). "Thomson College of Engineering" is today IIT, Roorkee. SVREC, closer home at Surat, is today SVNIT. Most of the colleges, which started on the pattern of self-financed institutions, chose the word Technology and were christened as Institutes of Technology. What I feel is that the word 'Technology' is considered to be more glamorous but my generation has grown up with the word 'Engineering' and feels nostalgic about it. India today is marching forward to have its tryst with destiny and emerge as an economic superpower. The Industry today needs practical visionaries. The scenario that we see today in the wake of the Information and Communication Technology (ICT) revolution is that the first preference of the IT companies is the engineering graduates. The software companies today go to the engineering colleges and pick up the engineering undergraduates at the pre-final year level itself. They say that they need candidates of very strong background, core competence and domain knowledge and are going to train and mould them to meet their requirements. A very common term used in industries today is "Cross-functional team". I have myself experienced that when we worked in a cross-functional team where persons from different disciplines like engineering, technology (production engineering), supply management, manufacturing etc. all came together and formed a team, we delivered what was expected of us. For our generation, the most deadly combination has been "IIT+IIM". And we have seen many young boys and girls aspiring to get into IITs through JEE and, after that, their next destination is IIM through CAT. We all have seen this happening.

Let us take a look at the word 'engineer'. It has got two roots. The first root is 'creative one' and that is what the word engineer is. The other root of engineer is 'to bring about' or 'to make manifest'. Now the creative one, the first root of the word 'engineer', relates to engineering as a function, which means that engineering is simply a design-oriented activity and engineering design happens to be the most important ingredient in the education and training of an engineer. The other root meaning "to bring about" or "to make manifest", relates to making things happen which is nothing but management. After all, an engineer is required to deliver some deliverables, in a specified period of time, on a fixed budget and most often with limited resources. That is the challenge before an engineer. If an engineer fails to deliver his knowledge of engineering, he/she is considered to be no good. A very good example that comes to my mind is the difference between 'Efficiency' and 'Effectiveness'. To quote Peter Drucker, "Efficiency is doing things right and Effectiveness is doing the right things." Efficiency is action-oriented whereas Effectiveness is result-oriented. We need both. Only one of these doesn't help us. So, technology enables us to do things right and management facilitates to focus on the right things. That is why the combination of an Engineer and an MBA becomes most desirable and most wanted and most sought-after career.

The role of an engineer has undergone a major change with the paradigm shift from the traditional functional organizational structure to cross-functional organizational structures. I have some points regarding the perception of the industry, what the industry desires from engineers. I am reminded of a very good quote from an eminent personality, Joseph Bordogna, from US National Science Foundation and I quote: "21st Century engineers will need to be astute-makers, trusted innovators and agents of change, master integrators, enterprise enablers, technology stewards and knowledge handlers". Unquote

The desirable characteristics of the 21st century engineers from the viewpoint of industry perspective are: fundamental technical domain knowledge complemented by knowledge from neighbouring technical disciplines; solid methodical knowledge; system-building and problem-solving skills; understanding of the entire value-chain; management know-how and business process skills; project management and decision-making skills; marketing and financial know-how; foreign language proficiency; knowledge about the social and ecological implications of technology; interpersonal and communication skills; leadership techniques; inter-cultural understanding and cultural empathy (identification and understanding of another's situation, feelings and motives); and last but not the least, capacity and willingness to engage in life-long learning supported by cosmopolitan attitude and global mindset. The present stoic engineering education at the undergraduate level is inadequate to produce engineers the industry needs. There is, therefore, a strong case for the seamless engineering education. Dr. Uddesh Kohli has, in his address, talked about that fact that the learning process does never end and it continues till there is life. An important aspect, which I strongly believe in, happens to be having the sense of social and ecological responsibility. After all, whatever we engineers do should, in some way, help in improving the lives of the common men and women living on this planet. Then only it is worthwhile.

Further, sharpening your written and oral and communication skills is the most important skill that engineers need to have. Everything, that we write or say, is a product and we have to be conscious of its quality. Learn to listen. Most of us love our own voices. So, we fail to listen to others. It is very important to learn to listen. Advertise yourself effectively. Learn interpersonal politics. Be aware of how the media works and about public relations and the mantra for this are Effective Networking with People. Be persistent, aggressive and passionate about your career but also learn to adjust, adapt and compromise. Not succeeding in getting the desired promotion, posting or assignment does not mean end of the world. Learn the fundamentals of accounting, marketing and sales. Industry today needs practical visionaries. I can share with you that, in the 32 years of my professional career, the phase wherein I learnt the basics of finance and accounting, was a very important phase. We have to have a proper appreciation of terms such as Bottom-line, Return-on-Capital-Employed (ROCE), etc. No business can survive unless it makes profit. We should not be shy of making a mention of the word 'Profit'. Also understand the implication of tax laws and regulations. A very important characteristic is to study history. It repeats itself most of the times. We cannot change history but we can be wiser by studying it and prepare ourselves for anticipating and managing the change. Studying international cultures and languages is another important area for engineers to speak to the world in words other than English. It gives you immense advantage when you speak to them in their own language. Continuing professional development means keeping you updated. Be aware of the new and evolving technology. Using time effectively is perhaps the most difficult task to master, but engineers need to master it. The personality trait, that the 21st century engineers should have, is being cool without being cold, patient without being weak and strong without being proud. The present engineering education, therefore, needs to be revamped and converted into seamlessness.

Prof. B. S. Parekh

Engineers of all engineering disciplines today go to the companies like TCS, WIPRO, and INFOSYS and so on. These companies need only engineering students with good theoretical background and they become mere programmers there. Our task is actually to produce engineers and not the programmers. For this, tremendous changes are required right from the UGC, AICTE and to the college level. What are the changes required? UGC is the highest body. They don't have any proper interaction with the AICTE. AICTE says that we are a separate body and UGC says we are a separate body. At our engineering college,

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which is under the M. S. University of Baroda, the Faculty of Technology says that we are neither under UGC nor AICTE. But, in case any committee or committees from the UGC or AICTE visit us, we have to attend to them and submit reports, if asked to do so. Why they cannot come out with a common guideline at the national level? So, the govt. should first decide whether we should report to the UGC or to the AICTE and they should come out with a common guideline in this regard.

There are two types of institutes in India. One is producing thousands of very good engineers and managers, like IITs and IIMs. The other type includes government and private engineering colleges producing many more engineers compared with the IITs. Why the other institutions of engineering and management are not doing like-wise? We have to think about this ground reality. Why these other colleges are not represented on the committees of AICTE or UGC? Only persons from the IITs and some other renowned colleges are being taken into these committees. They don't know under what type of environment the teachers of a government engineering college are working. They are always thinking of the IIT-level colleges and design all the things according to the IIT standards. That is not going to serve the purpose. You have to reach the grassroots. They should reach the grassroots and interact with the professors from the government engineering colleges and call them in the meetings and try to talk to them regarding formulation of the appropriate policies for bringing about improvement and upgradation of the higher technical education, particularly engineering education in the country. The entire administrative set-up for the higher technical education needs an urgent overhaul.

AICTE and UGC have formed the rules for giving the promotions and for giving the increments. But, there is no rule for the commitment of the teachers. Every teacher, irrespective of he / she works or doesn't work, is given the same reward. I talked to one of the professors in a foreign university; he stated that every teacher's performance is reviewed every year on the basis of how much consultancy they have provided to the industry, what kind of projects they have got in the faculty from industry, how many people are working as Research Assistants or Teaching Assistants. If a research project comes up, it becomes the property of one teacher in our country. The Head of the Department does not know about the details of it. The research project comes to the faculty for its development, not as a resource for one particular person. It is the property of the department as a whole and not of a particular person. The AICTE has to change the rules so that a project comes to the department and not to a particular person who is the coordinator of the project. The money for the project comes from the industry. Laboratory load is always taken up by the Research Assistants and Teaching Assistants in the foreign universities. Review of the teachers should be done in coordination with the Alumni Associations. Every year, the UGC and the AICTE should indicate, as a matter of guideline, the teaching load to be taken up by professors and after that indicate also the research workload for them. There are actually no guidelines or rules and regulations at the UGC or AICTE level about these things. The guidelines or rules and regulations should clearly say that unless the teachers provide so much of consultancy to the industry, they won't be given any increment or promotion. A frequent visit to industrial units by the teachers is a must to enable them to have an effective interaction with the industry. This way, the teachers can have a better idea about the industrial problems and, based upon this, they can suggest appropriate solutions to these problems, say, for example, to improve designs.

For your information, in IITs or IIMs there is no reservation. But, in any state government engineering college, there is 50% reservation for the students and there is reservation for the teaching posts as well. Now, in a class of electronics and communication engineering, there are, say, 60 students. It has been seen that 30 students get marks in the range of 90-92% and 30 students get marks in the range of 50-60%. We have to teach all of them collectively. It is a challenge. It is not like an IIT where all the students play an equal part. I know that after publication of the class X results, every parent is worried about their wards'

tuition about the 12th class. I am giving you an instance. I know that the parents went to a Tuition Class where it was written that students securing only 90% marks in class X are admitted in class XI. I don't know whether the students are clever or the teachers are clever. If only such brilliant students are admitted, the concerned teachers actually don't have to do anything, they have only to guide the students. Similar things happen in the case of IITs also. The role of the teachers in IITs is only to guide the students as they are basically very intelligent. But, our roles become very difficult. If we become strict, the students at the lower level are the sufferers. There is a problem because students securing 90% marks as well as 60% marks are sitting together and we have to take care of all the students of the class. The UGC and the AICTE should take these factors into consideration. They should think that there should be separate class depending on the quality of the students. The teachers can also then teach very well. To teach in a government engineering college is a challenging job.

Secondly, continuous review of the syllabus is required and that should also be according to the needs of the industry. I used to go to many colleges as a member of the National Board of Accreditation in Southern India. I have found there that English is a compulsory language in each and every engineering college. It is missing in Gujarat. We don't have any additional subject such as English and that is why when many students are coming out from the class XII Gujarati-media schools, they suffer in their first year of engineering course. Because, firstly they come from Gujarati-media schools and secondly they come from class XII which is a 15-months' course because they start their classes before the vacation. They actually come to the semester-system from the yearly-system, which are of a short duration. Students, who are intelligent, can cope up with the situation. But other students, who want 90% marks, suffer. The students from the Gujarati-medium schools suddenly land into the English medium and they suffer.

The next is the Project Management. How to work in a team, what to be done in collaboration, all this should be taught as a part of the syllabus to all the engineering students. The industry requires this today. After the engineering is over, the student does not know whether he/she will go for M. Tech., M.B.A. or employment. Around 90% of the brilliant students automatically go for inter-disciplinary studies and get admission in IIMs. After that engineers work as managers; they have to work in the fields of manufacturing, marketing or finance. He/she has to work in every field in order to become a master. If I have to start these courses in engineering, I have to do it at the grassroot level. Such things should be included as a part of syllabus in the engineering course. Frequent changes in the syllabus along with the technological advancements should be made.

Interaction of the engineering colleges with the industries should be continuous and regular. The UGC or the AICTE should think in terms of making such interaction compulsory. They should make some conditions for such interaction while giving grants to the engineering Colleges. Then and then only the colleges would go for such interactions. The industrial training to the engineering students during the summer vacations should be made compulsory. In BITS, Pilani, this is a part of the scheme. In 80% of the engineering colleges affiliated to the Gujarat University, examinations are conducted after the summer vacations. So, how to organize the summer training is a question in such cases. Students thus miss this summer training which is an important part of the career development. The UGC and the AICTE should also ensure that there should be summer training in the engineering Colleges. Students should be encouraged to go for summer training by giving some incentives by the college. It should also be seen that the industry comes forward for sponsoring the particular type of training to the students during their summer training. Today, it is also happening that the maximum numbers of students of the third year are absorbed by the industry at a salary of Rs. 3.5-4.0 lakhs per annum. Who will come to the teaching profession where the salary is so low and that too a person wanting a teaching job should be M. Tech. when

a B.E. level student is getting a much better salary, why he/she would opt for a teaching job and that too after getting M.Tech degrees? We say that this is the reward. But this is not actually the reward. Reward is a constant thing. The industry has the power to appoint anybody at any time, we do not have this power. In a government engineering college, we do not have the power to appoint even lecturer on the temporary basis, forget on a permanent basis. I am sure that some of the points that I pointed out will be taken care of.

Prof. S. M. Joshi

Dr. Kohli gave the institutional idea about the Engineering Council of India, its organization, Engineers Bill - a part of it - and the idea of seamless engineering which is the requirement of the day. We heard Dr. A. K. Singh about the industrial perspective of seamless engineering and how we can integrate the different parts of technology and engineering into a seamless whole. We heard the speech of Prof. B. S. Parekh from the viewpoint of educationist and administrator. He mentioned about the difficulties that the engineering institutions go through, particularly with the present administrative institutional set-up represented by the UGC and the AICTE. If we are talking about seamless engineering, we should talk about seamless or single window administrative institutional set-up from the viewpoint of government. Such a mechanism will go a long way in improving our higher technical education in the country. We need to think about this before we consider the subject of seamless engineering education. In other words, it means that when we are talking about seamless engineering, the government should also try to integrate its own agencies into a seamless whole.

When we go millions of years back to the point in time when the earth was formed, we find that the nature did not ask us whether we should study chemical engineering, mechanical engineering or electrical engineering; the nature works in an integrated manner; it did not ask us to use a particular branch of engineering or a particular science stream like physics or chemistry or anything else; it does the whole work integrally; it develops the biological product. We should understand the process of nature. It first multiplies the disciplines; later on, it integrates these disciplines into a seamless whole. The nature starts with a comprehensive idea and then multiplies its own efforts in the various branches. Similarly, human civilization has also proceeded like that. It first got stabilized as a human entity and then multiplied itself into various activities and disciplines of knowledge. Through this process, several disciplines of knowledge got developed during the period of human civilization. After multiplying knowledge into different disciplines, we have started thinking about integrating them together. This is what the nature has been doing. Therefore, our thinking now to integrate the different disciplines of engineering knowledge into a seamless whole is as per the process of the nature. It could not be different because we are a part of the nature; human being is not outside nature. Nature also starts with a very big comprehensive idea first, it then breaks it out into various disciplines and then integrates these disciplines into one whole.

Knowledge is not the monopoly of human beings. We are being aware of the knowledge. Knowledge was already there provided by the nature when the earth was formed. It was embedded in the system itself. We are now trying to liberate this knowledge by taking it out. But, we do not have the power to create. We learn things, imitate nature, imitate rational thinking and then try to do something, to create something which is our human civilization. So, what is the idea of nature now? By giving the idea of this type of integration, the idea of seamless engineering, integration of knowledge and integration of various disciplines of knowledge, we are trying to learn how to decipher the integral knowledge which is there in the nature and that is our future effort. Unless we get the integration of all knowledge, I do not think we will have the power to create. We have the power to create from the materials provided to us by the nature.

Prof. S. M. Joshi *is the Pro Vice Chancellor, M. S. University of Baroda.*

But, we cannot create the original. If we want to have the power to create originality, we must learn this integration of knowledge and reach out to that knowledge which nature has displayed in her creations. She has created the material universe. She has created a biological universe. She has created a human civilization. We are part of that civilization. In our lives, we are talking about seamless engineering which is integration of knowledge of different professional practices. But, as an individual, we know that we require integration of so much knowledge. Perhaps, we mean combining together of different knowledge streams; it is then that we can conduct our lives in the present scenario. So, all this kind of integration of knowledge is necessary. But, the integration of knowledge is not possible at the human level, at the mind level because mind by itself is a discursive kind of entity. Mind always breaks apart; it converts anything into so many parts; learns them and then puts them together; it cannot create a whole and that is the limitation of mind. That means the nature is pointing us to something where we can go above the mind.

Think, this idea of seamless engineering; this idea of systems engineering; this idea of integration of knowledge; all these are pointing us towards a future where we will have put the human civilization behind us and will have gone a step further on the evolutionary path of nature which is enabling us to learn. I hope the deliberations of this seamless knowledge, seamless engineering being part of it, will motivate us to think in terms of much beyond.

Prof. K. Baba Pai

The seamless engineering is nothing but engineering without any boundary, i.e., boundary-less engineering. There is no compartment; there are no hurdles; the joining of all the branches together as a single engineering branch. This is the convention proposed by the Engineering Council of India and this is the second convention which is being held after the first convention was held at Kolkata last year. You are already aware, the motive of this seamless engineering convention is to get over our creation rather than to become an individual engineer without any power to create over the period. As mentioned by Prof. B. S. Parekh that we are presently producing merely mechanics, we need to produce engineers which the Industry wants and not mere mechanics. The present engineering education is inadequate to meet the demand of the industry. We need to add subjects to the present curricula such as, personnel development, project management, law, economics, statistics, economics, communications, finance, project formulation and appraisal, marketing, etc,. The seamless engineering idea from this viewpoint makes a strong sense and needs to be considered. The administrative set-up for the higher technical education in the country needs a through revamping and it should be made more purposeful. It is proposed to be discussed quite widely at different locations in the country. After the Baroda convention, it is planned to have the Chennai convention and then it may be Chandigarh or Delhi. The proposals of all the regions of India will be put up to the Government of India, as mentioned by Dr. Kohli.

It is my privilege and pleasure to propose a vote of thanks. I am indebted to and thank Hon'ble Pro Vice Chancellor, Prof. S. M. Joshi for having agreed to spare some time from his busy schedule and be with us today. He has given us a very thought provoking and spiritual presentation with that of the engineering background a short while ago. He stressed on the need for engineers to integrate knowledge for getting the power of creation.

I thank Dr. A.K. Singh, Director, Electrical Research & Development Association, Baroda for giving the industrial perspective of the convention and presenting his views on the multi-qualities which are required for the 21st century engineers. This is really a thought which has to be given to the future

***Prof. K. Baba Pai**, Head of the Department of Metallurgy, M. S. University of Baroda, Vadodara*

generation. All the qualities have to be put into framework along with the engineering courses so that engineers coming out in the near future will be good enough to face the profession.

I thank Prof. B .S. Parekh, Dean, Faculty of Technology and Engineering, for giving his thought-provoking address in which he has identified what needs to be included in the syllabus / curriculum at the undergraduate level of engineering education required for the 21st century engineers. He suggested inclusion of the courses such as project management and personality development in the curriculum of the undergraduate engineering education. He further stressed on the need for the integration of government bodies for the smooth running of engineering education.

I am grateful and thank Dr. Uddesh Kohli, Chairman, Engineering Council of India, for being with us today and giving us the opportunity to organize this national convention at Baroda, sharing his thought with us, highlighting the future programmes of the Council and the role that the Council has played in the formulation of the Engineers Bill.

We have two technical sessions; the first session is on industry view and the second session is on academic view on Seamless Engineering. I thank Shri D. M. Mehta, Managing Director, P-Met Company, Prof. P. Prabhakaran, Head, Mechanical Engineering Department, M.S.University, Baroda and Dr. A. K. Singh, Director, Electrical Research & Development Association, Baroda for agreeing to Chair these technical Sessions.

The convention could not have been held without the support from the industry and the technical institutions. I am grateful and thank all the supporters of this convention, particularly, Faculty of Technology and Engineering, M.S. University of Baroda, the Indian Institute of Metals, Baroda Chapter, Management of all the major supporting companies like Indian Rare Earth Limited, Indian Petrochemicals Corporation Limited, etc., the M.S. University of Baroda (Chemical Engineering Deptt.) for providing the venue for the convention, all the departments for providing the required technical help in organizing this convention.

I am grateful and thank Lt. Col. A. K. Singh, Secretary, the Station Officers Mess for providing the Guest House for the accommodation of our delegates. Last but not the least, I am thank you all for sparing your valuable time by coming over to Baroda and having made the convention a grand success. I thank you all ladies and gentlemen.

Technical Session - I

Technical Session - I

Shri D. M. Mehta

We had a lot of discussion in the opening session about seamless engineering. As engineers, our society is seamless. The idea mooted by the Engineering Council of India, I think, is apt and timely. Understandably, the subject has been discussed at Kolkata and the conclusion arrived at was encouraging. I am sure, it will be discussed again here today with an open mind. I can see that we have a very little time for presentations. I would, therefore, request the distinguished speakers that they keep this in mind while delivering their papers.

Prof. P. B. Joshi

I am here to present the Paper on Professional Recognition of Engineers in India: A Challenge by Dr. M. K. S. Sastry, Coordinator, Joint Degree Programmes, University of West Indies & University of Trinidad & Tobago, who could not make it to the convention due to some unavoidable reasons.

Basically, the presentation is regarding the disparity in institutions which are offering degree in engineering within the country. The author states that presently there are many academic institutions offering engineering education and there are no common standards for the engineering programme. We do not have the common curricula for the different disciplines which are offered by the different institutions. The extremes are already prevailing, like on the one extreme, the IITs are there and on the other extreme, the self-financed engineering colleges, or affiliated colleges, are there. The curricula differs, the assessment pattern differs, the mode of education or mode of disseminating or transferring the know-how of education to students differs from college to college and, despite that, you have to think about the professionalisation of the products coming out of these institutions. AICTE (All India Council of Technical Education)/NBA (National Board of Accreditation) is the accrediting body which determines the standards/quality of programmes (but not the professional skills of individuals). The quality/professional standards of individuals is a complicated exercise with growing numbers of private engineering colleges in recent past and the presence of few foreign universities in the mechanism of engineering education in India.

There is a difference between the tasks being carried out by the AICTE and the NBA. The difference is that the AICTE or NBA is actually recognising the institutions. It is the accreditation or the recognition of institutions, evaluation of the standards, quality of teaching and so on and so forth. Whereas the professional recognition is altogether a different story and altogether a different aspect, it is the individual who is to be evaluated; who is to be assessed; who is to be certified for competence for performing a certain engineering job. This has to be looked into. The roles played, therefore, by agencies such as the Indian Medical Council or Indian Pharmaceutical Council need to be looked into when laws and bye-laws for the recognition of professional engineers are framed because, as was mentioned by Dr. Kohli, Chairman, Engineering Council of India (ECI) that every doctor, whether he/she is on a job or he/she is an independent practitioner, has to register himself/herself with the Indian Medical Council. As against this, as of now, despite more than fifty years of independence, we do not have any such body or law or rule in position for the engineers. This is one of the very important aspects which ECI must take up on the topmost priority. So, the first aspect is the recognition of an institution as a body to assess and certify the students

D. M. Mehta, *Managing Director, P-Met Co. Ltd.*

who are coming out of the various engineering Institutions like the affiliated colleges, the universities or the deemed universities or from the institutions of similar nature.

The different levels of academic institutions which are offering the degrees in engineering are rated as IITs / IISc, NITs (National Institutes of Technology), state universities, autonomous universities, private engineering colleges and so on. On the one hand, we have institutions like IITs and IISc which offer not only undergraduate, postgraduate and PhD level qualifications but also they focus on the research and development activity. The scope and the level at which these institutions work are of global order. They get funds even from many overseas agencies, foreign industries, foreign universities and institutions and they have a very wide scope of contributing to the field of engineering and technology. On the other hand, we have the NITs, which are the second-rank institutions compared to IITs and IISc. They are doing, more or less, the same job but with a little lesser emphasis on the research and development. Then we have the state universities, which, to a certain extent, try to reach the standards that have already been achieved by IITs or NITs; but, they face certain constraints, as Prof. Parekh has mentioned. With all these constraints, it is not possible for these universities to exactly come up to the standards of the IITs IISc and NITs.

Then we have several autonomous universities which are self-financed or partly self-financed or partial financed by the government the central or state governments. The emphasis given on research and development and other industry-related activities is, of course, less in case of such institutions because of the various problems related to the infrastructure, their funding position and so on.

And then we have the private engineering colleges, so-called self-funded institutions which are, by and large, ending up as the institutions offering graduate-level education. So, these different universities, different organizations, different-level institutions ultimately deal with a common product, i.e., a graduate in engineering; they all come out with engineering graduates. Again, there is a lot of disparity as far as their intake is concerned; the intake in terms of the quality of the students; the academic competence of the students and so on. The disparity in terms of their mode of admission; their criteria for admission; for instance, as far as IITs and IISc and NITs are concerned, you have joint admission test. At state level in Gujarat, you have 12th level results as well as good CAT results, in Maharashtra you have MHT. Besides this, there is a parallel admission pattern, selection pattern that is known as AIEEE examination, in Karnataka you have CET, and many other similar practices prevail in different states of the country. Ultimately, the result is that you have intake with vast difference in their capabilities and still you are having the same final target of producing a graduate in engineering. Obviously, this disparity is going to have and is having an equal effect on the quality of the product in terms of their competence, professional skills, academic achievements, etc. All of them are definitely the candidates for recognition as the engineering professionals. The theme of the talk that Dr. Sastry has framed is professional recognition; and when you are talking about professional recognition, we have to give a thought to the fact that the input for this purpose is not the same. It is different in all respects.

The undergraduate programmes, which are offered by the organizations like IITs, IISc, NITs, state universities, autonomous universities and private engineering colleges, are some of the very classical traditional programmes and start with civil, mechanical engineering and their allied disciplines such as metallurgical engineering, chemical engineering or electronics, computer science / engineering, IT and many others. Generally, the engineering disciplines introduced at any institution are based on the several factors including the most common one of popularity factor. The popularity is one of the most important factors. For instance, we are planning to introduce one postgraduate programme at M.S. University of Baroda, Faculty of Technology and Engineering, on nanotechnology. This programme is coming up from

June, 2007. It is very difficult, first of all, to get candidates for such a course because there is minimum awareness about this course. Likewise, the other institutions also face the same difficulty in starting new disciplines at the undergraduate level. Consequently, all offer only popular programmes, which are normally of civil, mechanical and electrical engineering, metallurgy and so on. Ultimately, the students undergo a rigorous educational training for four years and get B.Tech. Degree or a B.E. Degree whether they are from university-affiliated colleges or from IITs, NITs, etc. in these disciplines.

Ultimately again, as Dr Sastry has pointed out, the question remains as to how to recognize the professional skills of the individuals. They are not only the graduates of different institutions, they are graduates in different disciplines and the professional recognition criteria need not be the same for all the disciplines of engineering. So, when we are talking of seamless engineering, such factors are also going to be inevitable while recognizing them as professionals. Besides, there is one more dimension that is coming up these days in a big way and that is the introduction of foreign universities in the country. As of now, a few foreign universities have already approached AICTE for liaison or tie-up with the Indian universities. Similarly, a reputed college of UK has also approached our government for having their ways in India. They will be offering engineering and other education in India with the degrees of their respective countries. Obviously, our students are going to be attracted in such a lucrative plan. And once again, you have to compare those graduates with a graduate who is coming out from a place like Warsa, Changa or Bharuch in Gujarat. These are exemplary cases. I have no intention of commenting on anybody. But then this fact remains that we do not have to overlook this aspect that we have a very vast variety of products coming out.

As far as global perspective is concerned, there are two very popular terminologies known as Chartered Engineer and Incorporated Engineer. The Chartered Engineer is the term used where one has to be professionally competent in education, training and professional practices. Typically, the candidate must be a Master in Engineering and above. The term is used in UK. The term is basically for a person, a graduate or a postgraduate in engineering who has more aptitude for design, planning and all sorts of such things rather than the person who is on the execution side of an important task. A person, who is on the execution side, is called as the Incorporated Engineer. Incorporated Engineers are those professionals who need not have a formal degree. Incorporated engineer is a professional with qualification in engineering (not a degree) offered through professional associations that act as subsidiary instruments of the Engineering Council (UK). The Engineering Council (UK) is the regulatory authority for professional registration of engineers in the United Kingdom. In the United Kingdom, an incorporated engineer (IEng) is a professional engineer (Registered at final stage in the professional engineers section of the Engineering Council register) as defined within the scope of European Directive 89/48/EEC and by the UK Statutory Instrument (SI)1991 No 824, "The European Communities (Recognition of Professional Qualifications) Regulations 1991"(also Statutory Instrument (SI)2005 N.18). Incorporated engineers currently require an accredited bachelor degree in engineering or technology or a higher national certificate or diploma or a foundation degree in engineering or technology, plus appropriate further learning to degree level. Incorporated Engineers are characterised by their ability to act as exponents of today's technology through creativity and innovation. To this end, they maintain and manage applications of current and developing technologies, and may undertake engineering design, development, manufacture, construction and operation. Incorporated Engineers are mostly engaged in technical and commercial management and possess effective interpersonal skills.

Chartered Engineers are characterised by their ability to develop appropriate solutions to engineering problems, using new or existing technologies, through innovation, creativity and change. They might

develop and apply new technologies, promote advanced designs and design methods, introduce new and more efficient production techniques, marketing and construction concepts, pioneer new engineering services and management methods. Chartered Engineers are mostly engaged in technical and commercial leadership and possess effective interpersonal skills. Based on similar lines, India can also plan for some sort of nomenclature and that could be useful to us for qualifying and recognizing our professionals.

So, the parameters for professional recognition are, in short, level of qualifications and academic performance, programme composition, the kind of course the candidate has undergone (whether an individual has graduated from recognized / accredited programme), work experience in relevant domain and demonstration of professional skills for the person in his / her work, in his / her own activity. Whether a person has graduated in one area and is expert in some other area of engineering because of work experience. we have to be very careful when we are using the term seamless engineering. It is now not necessary that a mechanical engineer will work in very hardcore mechanical engineering and, in that context, this is also a very important aspect that one may be a graduate in any discipline but is holding expertise in some other area, still you are eligible for getting recognized as a professional in that area.

There are certain guidelines which Dr. Sastry has proposed for various programmes, on what basis they are designed, how they are framed and what is the total procedure which one has to undergo. Dr. Sastry gives the total timeframe before which a particular course is put to the students by any organisation, in an institution or in a college. So, the questions at our disposal are: why do they need different institutions like IITs, NITs, etc.? How these institutions are actually different from one another? How different are there outputs (graduates)? What are the expected standards for an engineer? These questions need to be answered before we recognize the professionals coming out of the institutions.

Dr. M. A. K. Babi

Fortunately for me, I was amongst the first 31 students in the department of metallurgical engineering who passed the B.E. examination and in the first batch way back in 1971. More than 30% of my batch-mates have settled in the USA. It would be encroaching upon precious discussion-time, if I recall here the enormous difficulties we faced as pioneering students in this well-established department, which did not have even a teacher when we started. Prof. J. N. Patel, a practising foundry-man but a mechanical engineer, was asked to lead us and another foundry-man, Prof. M.R. Shah, a metallurgist but with no teaching experience was asked to help him. The first real teacher we had was Prof. V.N. Gadgil of Nagpur with a doctorate degree in Metallurgical Engineering., and he remained at the helm till we passed our finals, and he retired some ten or fifteen years ago. There were no books for us in the library, no labs or special instruments which those labs need. We used to travel to other universities or other departments in our own university for practical sessions.

I would feel guilty of talking through my hat, if I don't qualify myself here, i.e., to explain why my views on engineering education are needed at all. During the 1980s, some ten years after graduation, I had taken a brief vacation in my engineering career to come to my alma mater and teach. I had never been a very bright student, and I could see that by a quirk of fate I had learnt a lot about practical aspects of TIG or Argon-Arc welding, plasma arc cutting and micro-plasma welding too. This was useful for a new Master of Technology course the department had instituted lately. In addition, I was given some materials science lecturers for the textile engineering and textile chemistry departments, and later, for the chemical engineering department too. I had started involuntarily on the course of seamless engineering. Since I

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would have no more than two lecturers per day, I found myself holed up in our library and that changed the course of my future.

Through sheer serendipity, I stumbled across 12 volumes of Vacuum Metallurgy Techniques, an authoritative collection of latest information, covering theory and practice in a field, I had vaguely heard of considerable portions referred to plasma processing, and having had spent a decade in plasma arc cutting and welding, two major pillars in a gamut of processes based on thermal plasma, I found those chapters more meaningful and of immediate interest. In those two years, I increased my knowledge a great deal, and it was but natural that references to high technology areas like vacuum plasma melting, alloying, re-melting, refining, etc. would slip out during my materials science lectures.

I fondly recall as many as 50 students used to attend voluntary lectures I used to give on vacuum technology and plasma processing, in this department, and more than half of those students used to be from chemical engineering branch. I feel very proud when some stranger approaches me at some out-of-the-way airport and thanks me for having lit a spark in his bosom, the spark of hi-tech science / engineering., through my lectures on plasma processing and vacuum technology.

In reality, I have no way of authenticating exactly how many of those hundreds of students I taught, turned to plasma processing, or vacuum technology or leading-edge research which saddens me somehow. The only discernible feeling that remains with me is that there exists in the heart of every engineering student, this wish to work on hi-tech leading-edge applied science and get a few patents on their names, if not the Nobel prize. If you analyze the percentage of Gujarati engineers in the USA, who have been earning royalties out of their US patents based on sometimes very simple common sense ideas that improved transferred arc plasma cladding or thermal plasma spraying, over 80% of them would be from Bombay (Mumbai) and Baroda (Vadodara). This is a heart-warming fact, indeed. It also highlights the fact that engineers from here are more pragmatic and reach for higher earnings for the rest of their lives, rather than seek awards and citations.

Often a long distance traveler like me, sits down to take stock of the cracks and nails in his own shoes, the single implement most useful for walking around and finds that there are always many of such obstacles and obstructions. I have often been invited by the College of Engineering, Pune - a 150 years' old engineering college - as an external examiner to tackle the Surface Modification Technologies (SMT), which is my field of specialization since late 1980s, and I am usually disappointed at the lack of fundamental knowledge of today's students. They all seem to be treating these oral examinations as a necessary evil, and usually treat SMT just as another subject.

It is nearly impossible to lecture these ambition-filled young men and women who will go abroad to carve out bright niches for themselves, on the importance of new technologies. When I look back, I remember that after ten years of working on TIG / Argon-Arc welding and its highly metallurgical nature, plasma arc welding, pulsed arc welding and even transferred arc plasma cladding, I was aghast to come back to teaching and see only one paragraph in a text book on fundamentals of metallurgy mentioning TIG welding alone. Plasma processes were ignored. I tried hard to raise my voice in various meetings, against this evasive nature of technical syllabi but my Head of the Department, overtly exhausted by fighting bureaucracy all along, would say more committees and more meetings will result in no progress worth mentioning. I never tried again, after this discouragement, and I do not know what the syllabus is like right now. The gap of 20 to 40 years in the engineering syllabus being taught and that being used by Indian industry is common. That really causes me terrible heart-burn.

The question here is of those boys and girls who paid scant attention to the fundamentals of ordinary processes like electro-deposition of chromium described in two pages, regarding how do they master advanced processes like thermal plasma spray technique and write thesis for their Masters or Doctoral degrees abroad. How do those, who didn't feel like applying themselves honestly here, manage to do precisely that, and much more when in the US or UK or Germany or Japan? I would embolden myself to ask this question, slightly rephrased as: what is so different about the IIT's compared to the hundreds of other engineering institutions that the same students perform differently when in an IIT? Having worked in partnership with IIT-Powai, Mumbai on their CDC career development courses, I have spent time observing how the students behave there in comparison with the students at the institutions perceived to be slightly low-brow types. Music is a passion with me, and due to international acclaim, I have a jazz music reviewer, on board with www.jazzreview.com and other portals. Once I was invited to be a judge at the famous Mood Indigo, a home brewed Rock Festival at IIT Powai, where teachers disappear and the students load the roads and open spaces with an enviable sense of freedom. Thus I have watched those IIT'ian - boys and girls - work hard not only at studies in classrooms, labs and libraries but also work hard at having fun. This helps, I have noticed, the human being always to add several dimensions to their personalities, and being focused only on studies does not allow for an overall growth. The other passion of mine, that I have fed luxuriously, is fiction writing, and I have often seen the books that the IIT'ians carry with them, are seductively impressible ones like The Life of Pi y Yann Martel or, " Five Point Someone - What not to do at IIT and One Night @ the Call Center *by* Chetan Bhagat himself an ex-IIT'ian, and other 'off-the-main-course' sort of writers. Perhaps, the same may apply to the cinema, and non-curriculum reading by way of magazines. What this implies is that the ambiance, the culture that has been set up at such places is responsible to make an IIT'ian feel he or she is cat's whiskers, and it is my strong belief that without an ego, no engineer nor executive can go very far. The ego needs to be controlled during teamwork but if you keep hiding it behind useless veins, severe distortions in the crystalline matrix of your personality will certainly bottleneck your best from emerging. It also implies that an overall development of personality helps you melt seamlessly into the western, technology-based society when you leave our shores. This is what we message we should try to send to the students of the other side of the engineering education spectrum about which Dr Sastry has mentioned.

It is a sad realization that hordes of NRIs leaving our shores, never come back to help us in revamping our syllabi, or upgrading our age-old cultural singularity for I do not see clones of Mood Indigo happening in far-flung places, nor one of the Dagar brothers setting up an ashram in an engineering college elsewhere and sadly the same applies to the reluctance on the part of the smaller institutes to send their boys and girls to a host of lesser known companies engaged in PVD physical vapour deposition techniques: a range of very high technology SMTs that have multiplied ten or twelve times in last one decade alone. Plasma nitriding and plasma spraying have been well established, but job-shops performing these hi-tech operations are more likely to get students from IITs or more adventurous engineering colleges down south than others.

As an industrial consultant carrying out hi-tech in-house workshops and refresher courses for the executives who haven't got the foggiest notion of leading edge surface modification technologies, I strongly recommend that eminent bodies like ECI with the help of other like-minded bodies set up a committee to upgrade engineering education. I would love to be a part of that, and bring along some others too. There is a whole vital link missing today between the engineering institutions and their alumni there is no public relations effort worth the name to rope in their more successful ex-students. If that were to be a reality, as is happening with COEP in Pune, millions of dollars in aid and grants would flow from the

alumni into the depleted purses of these hoary institutions. When it comes to educational progress via infrastructure improvement, once again the ill-famed ego takes a backseat, in my opinion.

D. S. Pradhan

I would present my thoughts, which are based on my forty (40) years of experience in industry, on the subject being discussed in this convention. Seamless engineering education essentially means bringing synergy between different engineering disciplines particularly for meeting the needs of the industry. From this viewpoint, seamless engineering education is a very apt and timely subject. When with the Gujarat State Fertilizer Corporation (GSFC), in 1984-85, I took a lead and attempted for four consecutive years the residential training programme for professors from all over India on the subject: the need of industry. Unfortunately, nothing materialized from this exercise. It is, therefore, felt that the initiative taken by the Engineering Council of India for organizing the 1st convention on the subject of seamless engineering education in August, 2006 at Kolkata was the first step in the right direction. It deliberated exhaustively on the subject and concluded that there was the need to make the engineering syllabi seamless at the undergraduate level which may include the suitable courses on management, economics, public relations, law, communications, contract engineering, computer-related courses, human resource development and management, etc, for making it industryspecific.

In an industry, we deal with five m's: men, machine, money, material and movement, i.e., time. As I am coming from the fertilizer and petrochemical industry with all my related experience, I am presenting my thoughts on these five aspects, which were very useful to me during my stay in the organisation. While the in-depth knowledge of the disciplines, say, civil engineering, metallurgy, electrical and mechanical engineering, etc, is very useful for us during our work, mere the knowledge in our disciplines is not enough, say for example, when we talk of the first m, i.e., men, is the industrial liaison. The first day I joined till I retired, I had occasions to deal with the people because society is made of people, we have to have effective communication with the people to get the results during which negotiating long-term packages with them, because we need to know how to tackle problems and issues origin of which is not the knowledge of the discipline to which we belong but it is in other domains and it is the knowledge and skills of these domains which will enable us to tackle these problems and issues. For example, a small industrial relation problem takes a very big shape. There can be other similar problems which need other skills in an engineer for tackling them squarely than mere knowledge of the stoic engineering discipline. Secondly, the human resource development and the human resource management are the other two important areas in an industry where a very limited human workforce is available. You have to identify the workforce of the best quality to be deployed on a right spot and in the right direction. You need to find out constantly the areas for their further training for enhancing their skills and ability to get fruitful results for the company.

There are many statutory regulations in force which industry has to deal with like on boilers, insurance, electrical, environmental controls, etc; an engineer has got to deal with these regulatory issues and problems. He / she has to deal with the people statutorily responsible for these regulatory subjects. These are very crucial areas of work an engineer has to do when he / she enters the industry. Subjects, which will impart knowledge and skills to engineers for dealing with these subjects, are not, by and large, covered in the present engineering curricula. So, such subjects also need to be taught to the engineers. Besides, the knowledge in other disciplines is absolutely essential because when you are dealing with any of the statutory bodies or you are dealing with matters within the company, it is absolutely essential to have a cross-functional skill including of the other engineering disciplines apart from your discipline.

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I am a mechanical engineer by qualification and maintenance engineer, general manager (operations) and the new projects adviser by my experience. One can see from this that an engineer, when in work, does not remain confined say to mechanical engineering, he / she may have to deal with other areas of work as well like, provide engineering services, deal with project design and construction matters, etc. So, these need multi - skills in an engineer. This is how generally in GSFC or any industry, engineers are expected to know dealing with multi -functional activities. It is only then that the engineers become asset to a company-industry. Presently, engineers have also to deal with matters related to the corporate social responsibility. In this functional area, engineers have to deal with the villagers and understand their problems apart from ensuring that the environment is not damaged.

One more area is the contract engineering. We have to follow the norms of the contract engineering in an industry. This is normally not covered in the present syllabus of the engineering education. We can see that many disciplines such as, electrical, mechanical, civil, instrumentation, etc. will have to work together. As Dr Singh has said in the morning that your business is not for charity and it is for making reasonable legitimate money. For this, engineers will have to have multi-skills and mere knowledge of the stoic engineering discipline will not do. This is why industry does not find most of the present engineering graduates employable. Engineers should be skilled enough to develop and understand the system of complete computerization of the company with five modules: operation module, marketing module, finance module, HR module and materials module. Ready-made things will not do; it will mean spending more as against spending much less by optimum combination of all the people from the various departments, which will ensure proper interaction between the various departments. Engineers should know how to read and interpret daily balance sheet, daily profitability statements, daily variable cost statements, operating cost statements, margins, etc. So, basic knowledge and skill of finance is also must for engineers to have. This subject, by and large, is not covered in the present syllabi of the engineering education. Engineers will have to deal with procurements, with contracts, with the foreign companies. So, they need to have skills like bank guarantee, foreign currency rate variation, communications, net working, etc. These are also, by and large, not taught presently to them in the engineering colleges. When we talk of materials, there are three types: raw materials, intermediate products and final products and we are concerned with selling (or marketing) of products. Seamless engineering knowledge will only help engineers in getting the job done.

So, what I feel is that exposure of the five Ms should be given to the students by way of covering it in the syllabus. Indians are better placed in the average IQ, analytical and logical thinking compared to the other developed nations. For example, you ask any American to pay Rs. 36 from a hundred rupees' note. He will take out a calculator to find out how much rupees he should get back for which we do not require a calculator. This is what we have learnt and this is our culture. We should make a point to further extend our quality for the betterment of the people.

In my opinion, changes in the education system should be introduced at the grassroot level, i.e., right from the school-days. Basically, the knowledge imparted in the institution is not only for the better way of living of an individual but should also help the society as a whole to improve the standard and quality of life. How to use full brain and mind power can better be taught at the school level by introducing the Vedic mathematics, yoga and such subjects. I have seen at the corporate level that executive-level seminars are organized for stress-relieving. This should be a part of the education system at the school-level and should be extended to the graduate-level by modifying it, if considered necessary.

What lacunae we find in the present education system is probably the semester system. Students do not remember what they studied in the first semester by the time they graduate. Students are not to get so

many theoretical details of the engineering subjects into their memories by cramming. Are all such things going to be implemented in the industry? Naturally no. It never means one should neglect one's studies. With so much advancement in the information and communication technology and which is available at our disposal, the present syllabus should be modified to suit the industry's needs. Knowing and doing the things should be properly matched. Knowing the things is one thing and doing these things is completely another thing. I strongly feel that there must be a very close and warm interaction between the industry and academia. Today, 3rd and 4th year engineering students go to industry for the training. But, none of their teachers bother to see whether the students are really getting the required training which is a part of their curriculum. There is no use of such training. I personally feel that a compulsory industrial training for certain duration should be a must for all the students to get the certification as engineer like the medical science.

The sixth M represents the change of mindset. It is very important and is the real crux of the problem. I have seen the society, the university, the industry, politicians, UGC and various administrative bodies, etc. They have to change their mindsets. The speed of the change in the traditional mindset is very slow. What we are getting is the half-cooked thing and such half-cooked things are damaging the whole thing. So, there is a change but the change is very slow. We must go for a very fast change. I, therefore, dream, and there is nothing wrong in dreaming. It is said that dream, dream and dream. Unless you dream, you cannot achieve anything. But, then be fast and act. If you do not face facts and act on that, you cannot make a change. We need to produce quality engineers for meeting our needs as well as of the global market. For this, we should move fast towards the seamless engineering education at the undergraduate level.

Alok Ghosal

I will first give some statistics about the present engineering education system in India. When we look at the ratio of population to engineers, it is seen that India is catching up with China. When we look at the Indian scenario, we find that India currently has 113 universities and 2088 engineering colleges. Engineering colleges in the country have been growing at 20 percent a year, while business schools have grown at 60 percent. When we look at the number of engineers we produce, we find that the five Indian states Tamil Nadu, Andhra Pradesh, Maharashtra, Karnataka and Kerala account for 69 percent of India's engineering colleges, while the states of Uttar Pradesh, Bihar, Gujarat, Rajasthan and Orissa account for only 14 percent. Rests of the country's engineering colleges go to other states.

When we look at the engineers being produced in various parts of the country, we find that compared to the national average of 350 students per million people in technical degree programme, the east, north, south, west and southwest zones, respectively, are having 131, 102, 1047, 486 and 689 students per million people in the technical degree programme. Look at the disparity. This is what happened due to the long and delayed planning on the part of the AICTE. According to a Mckinsey Global Institute of Study on the emerging global labour market, only 25 percent, out of the four lakhs of engineers we produce in India, are employable in the multi-national companies (MNCs). It is primarily due to the poor quality of engineering education, the lack of trained faculty, dismal state-spending on research and development, poor infrastructure, overlapping of curricula and everything to everyone. Let us consider the overlapping of curricula. Here, we have degrees like Bachelor of Computer Applications (BCA), Master of Computer Applications (MCA), Bachelor of Engineering or Technology (B.E./B.Tech.) in computer science, B.E./B.Tech. in information technology, Bachelor of Science in computer science, Master of Science in computer science and an integrated M.Sc. in computer science / software engineering.

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According to the National Institute of Educational Planning and Administration, the share of government expenditure on technical education is presently around 4 percent. Please look at the statistics of China. There, the amount spent on research and development, especially in engineering fields, is a good 10 percent. Obviously, the quality of around six lakhs of engineers being produced in China is definitely far better. A year ago, the U R Rao Committee studied the problems afflicting engineering and higher education in India and stated to improve research and development. India needs well over 10,000 Ph.Ds. and twice as many M.Tech Degree holders as currently being produced. Currently, India produces barely 400 engineering Ph.Ds. a year, mostly from the IITs and the Indian Institute of Science, Bangalore, as opposed to 4,000 produced in the basic sciences. The Indian scenario is that out of the total engineering graduates (464743 nos.) during 2004-05, 31% were computer engineers, which was 144070. Combined intake of software companies was more and this resulted into the exodus from general stream. Is it not a national waste? Because the government is spending money to produce engineers and they spend four years in engineering colleges and the mechanical, civil, structural engineers move to software engineering and they move to software companies. This is a national waste. So, what to do about that? Why does the student of one stream join another stream? The reasons for this are variety such as, career options, challenging work, intellectual development, benefit to society, financial security, prestige, working in a professional environment, working in a technological and scientific environment and creative thinking.

The points to ponder over are: (i) majority of the students do not know why they are studying in a particular stream. They are in that stream because their parents / neighbours want. They go to class for the heck of it, (ii) if the examinations are standardized incorporating academic research papers and genuine projects, majority of the Indian students (75%) will not make the grade, (iii) the current examination pattern is ridiculous, students cram three or four question papers and they are the distinction-holders, (iv) students are not hardworking and are always on the lookout for shortcuts. Students are seldom found doing home-works on their own. At the lab. point, I will differ with the opinion of Dr. Babi. He has said that students are very busy. I feel that they are not busy. They do not even sit in the library. They keep on wandering. In seven hours of sessions in the engineering colleges, they hardly spend 3-4 hours in the colleges and classes. They are free for the most of the sessions. They are just moving around.

The engineering and technology education is generally imparted at three different levels, namely, diploma-level courses, undergraduate courses and postgraduate courses and we are talking of undergraduate courses. This is depicted in the collaborative model of engineering education. Many of the speakers have been of the view that there has to be a collaborative education system with the industry. In the model of the Three-tier Collaborative Project in Engineering and Technology Education (TCPET) that has been shown, there has to be interaction between the industry and the undergraduate programmes. Unless we collaborate with the academic media, quality of engineering will not improve; wrong distribution of engineering colleges all over India will lead to this problem. Because there are a lot of industries in the eastern zone but only 131 students per million people go to engineering colleges. So, the load comes to the south. Of course there are more industries, but there is a heavy load in the south. And that is the reason there is no collaboration, no interaction, no interface between the engineering students and the industry.

What is the prescription? Introduce a quality auditing system. Bodies like AICTE, UGC & ECI should ensure this. The next point is: establish a datum for measuring the quality and excellence. The accreditation inputs should be the quality of teaching, level of research, faculty expertise (many of the engineers join the teaching faculty and still keep on looking for jobs outside and as soon as they get it, they leave the teaching job the moment they are groomed up for being good faculty), evaluation methods of teachers (I would say

that the teachers must be evaluated regularly and I am sorry to say this in the presence of eminent teachers present here (having knowledge only does not make a good teacher), standard of infrastructure and resources available at the institution. In the case of the last factor of resources available at the institution, the role of AICTE comes into play. Increase the share of money going to the research with proper planning at the government level and increase the of money spent on the faculty to lure the best talent are the two important areas which need to be given a serious attention that job demands for improving things. In the morning session, some speaker stated that the students go to the industries for more money. Even a fresh engineering graduate joining a BPO gets more money than if he joins the teaching faculty. The salary of the faculty should, therefore, be increased with a view to luring the best talent.

The next step in the prescription is: Increase interaction between institution and companies. Introduce new subjects on soft skill in the curricula such as manpower handling (this is a very sensitive issue and should be tackled very delicately), positive thinking (students of the engg. college have to have this to enable them to become free of all the feelings of negativity by the time they pass out from the college), managerial quality in profession (Mr D.S. Pradhan has already laid stress on this aspect), safety & health (very vital point and should be discussed in the colleges), finance for non-finance, power of observation and creativity (should be taught to engineers)), leadership (each engineer is going to be a leader and this point should, therefore, be taught in the class), proficiency in English language & communication and presentation skill (it has been talked that students come from villages and remote areas and they have very poor English background. So, this must be attached a lot of importance). The students should be stretched to the fullest possible by showing no mercy at all. In IITs, students are bound to study in the night hours. They cannot go to the pictures or cannot move around in odd hours. No mercy is shown to them. You have come to attend a 4-years' course and you have to spend the four years' time on studies.

Last, but not the least, strengthen seven statutory regional committees across the country for assisting the AICTE in planning and development of technical education, monitoring and periodic evaluation of the approved institutions in the region. Since the technical education determines the development and socio-economic condition of a nation, there is a greater need for high quality technical education to produce technically skilled manpower in India.

Dr. A. K. Singh

Prof. S. M. Joshi has highlighted the basic thought in his talk much more than I have done because he said that nature is one. Basically, Prof. Joshi told about the inability of human beings to create something. Of course, the mankind, the human being cannot create, but mankind can engineer things. For example, the fusion of materials science with other disciplines such as chemistry, physics, electronics, metallurgy, biology and computer science, etc., has offered to us the possibility for an inversion in the logic of production leading to significant improvements and developments in materials analysis, design, processing and testing. It is now possible to intervene at the molecular and atomic level of matter and rearrange the microstructure of materials with a view to obtaining the desired properties and performance. The linkages between research, design, production, marketing and consumption have certainly been strengthened in order to permit the development of 'tailored' materials for specific applications. The notion is that the structure of a material determines its properties and those properties may, therefore, be controlled by controlling structure, which originated in metallurgy. However, it was not restricted to metals and alloys. The same principle has been applied to ceramics, polymer and mineral materials, whether natural or artificial. Recognising this fact, it was but natural for the various specialists working with these materials to come together to pool their knowledge and it was in this way that materials science was born and most of the prestigious institutions today call it by this nomenclature. The

Materials Science is thus pure seamless engineering. The difference between efficiency and effectiveness is that efficiency is doing things right and effectiveness is doing the right things. Engineering and technology enables us to do things right while the management facilitates to focus on right things. Engineer needs both these skills and he / she, therefore, needs to be seamless to deal with the present and the emerging world.

Changing Roles of an Engineer

The roles of an engineer have been going on changing over the years. In 1970s, everybody used to talk of specialists in engineering. There has been a paradigm shift from the traditional functional organizational structure to cross-functional organizational structure. Organisations are becoming flatter and flatter. Organizations still need motivated people who feel stretched and challenged in their roles. The old world had the need to manage resources like stone, wood, iron, etc. The new world has the need to manage complexity which is the very stuff of today's world. The world is changing much faster in respect of technological developments, financial constraints, expanding markets (in the wake of globalisation), restructuring & mergers, new philosophies and govt. legislations. Characteristics of the changing era are short boom-to-bust cycles, knowledge management & intellectual capital (concept of intellectual property rights is being enforced) and age of professionalism. According to Joseph Bordogna of U.S. National Science Foundation, 21st century engineers will need to be astute makers, trusted innovators, agents of change, master integrators, enterprise enablers, technology stewards, and knowledge handlers. Competence profile of tomorrow's engineers are hard skills (fundamental technical knowledge complemented by knowledge from the neighboring technical disciplines, solid methodical knowledge, system thinking & problem-solving skills, understanding of the entire value-chain, management know-how & business process skills, project management & decision-making skills, marketing & financial know-how, foreign language proficiency, knowledge about the social & ecological implications of technology) and soft / process skills (interpersonal & communication skills, leadership techniques, intercultural understanding & cultural empathy, capacity & willingness to engage in the life-long learning supported by cosmopolitan attitude & 'global mindset', sense of social & ecological responsibility).

Desirable Characteristics of XXI Century Engineers- Perceptions of Academic Community

According to the perceptions of the academic community, desirable characteristics of the 21st century engineers are a strong foundation in basic sciences, mathematics & engineering fundamentals, a capability to apply these fundamentals to a variety of problems, knowledge & experience in experimental methods, knowledge & skills in the fundamentals of engineering practice, strong communication skills - writing, reading, speaking & listening, a sense of social, ethical, political & human responsibility, a historical & social perspective of the impact of technology, a unifying & interdisciplinary view, a culture for life-long learning, a creative & intellectual spirit, a capacity for critical judgment & an enthusiasm for learning, advanced knowledge of selected professional-level technologies, a sense of corporate & business basics, leadership capability, proficiency in team work as well as in individual contributions, and a strong customer focus.

Desirable Characteristics of XXI Century Engineers- Perceptions of industry Community

According to the perceptions of the industry community, desirable characteristics of the 21st century engineers are: 1) sharp written & oral communication skills (everything we write or say is a 'product), 2) Effective personality (advertise yourself effectively, learn interpersonal politics, how the media works & public relations, the mantra: 'net working with people), 3) Persistent, aggressive & passionate about career (but learn to compromise), 4) fundamentals skills of accounting, marketing & sales (industry needs practical visionaries), 5) Skills of tax laws & regulations, 6) Knowledge of history (it repeats itself - most of

the time), 7) English and the other important world languages' skill (study international cultures & languages), 8) Knowledge of new & evolving technologies (keep yourself updated), 9) Time management skill (use time effectively perhaps the most difficult task to master), 10) cool without being cold (patient without being weak and strong without being proud), 11) Balancing skills of personal & career priorities (know when to go home) and 12) Pride in ones profession (be proud of your profession).

Industry-Academic- R&D Institutions Interaction

Generally, people talk about Industry-Academic Interaction. Dr. Babi has talked about the interaction with laboratories also. A lot of research work is being done in laboratories. In IIT, Bombay, there is an industry-institute-integration. There must be integration between the industry and the R&D Institutions as well. I would rather say industry-academics-R&D institutions collaboration. This is a must. The training by the engineering students in industry is now-a-days practically not given any significance. It has become a formality to be observed by the students and the trainers in the industries also take it that way. This trend must be reversed. For producing industry-specific and world-class engineers, we must build an efficient and effective Industry-Academics-R&D Institutions Interaction mechanism on the basis of collaborative philosophy.

Portfolio of the 21st Century Engineer

Portfolio of the 21st century engineer should be Core Competence (always have a domain-knowledge), Excellent Communication Skills, Excellent People's Skills (dealing with people, conflict management, management of problems of people with whom you are working, it is said that managing one's boss is the most difficult task), Basic Managerial Skills, Positive Mental Attitude and Strong Fundamental Core Values (kindness, mutual respect for others). Supplementary value-addition takes place to the engineering graduates during the period of their training in industries after they join there and the values added are creativity & innovativeness, dedication & sincerity, strong communication skills, business management overview and commercial & financial aspects.

There are two distinct periods of an Engineer's Life: 1. Training and 2. Professional Practice (Life after Qualifying). Please always remember that efficiency is doing things right effectiveness is doing the right things. Effectiveness is the foundation of success. Efficiency is a minimum condition for survival after success has been achieved. The biggest challenge faced by any organization is to focus on doing the few right strategic things and focus on doing those few things right. It is to be borne in mind that the 21st century engineers have experienced a technologically saturated childhood; have grown up with technology; use it to communicate, collaborate and shop on-line even for knowledge; need multiple stimuli; are not surprised by technology, simply integrate it into their lives and want & expect to collaborate with their teachers / bosses and do not take orders from them.

D. M. Mehta

Dr. Singh mentioned about the poor quality of engineering education in India giving statistical figures, problems being faced in practice and suggested suitable remedies. I agree with him. Further, he has talked about materials science, the tasks of an engineer and about so many relevant aspects. He has defined tomorrow's engineer. He has talked about the industry-institute integration and the qualities of the 21st century engineer. He has conveyed one very important message: engineers must be very proud of their profession.

Technical Session - II

Technical Session - II

Prof. C.V. Ramakrishnan

A lot of talk has been made regarding how the engineers of 2020 should be. What are the challenges facing the 21st century engineers and what is the environment under which they have to work? Outstanding technological innovations are taking place at an astonishingly fast pace. Apart from Information Technology, which has been much talked about, new technologies, namely, Bio-Technology and Nano-Technology are going to have much influence. The other visions of engineering, which are going to have influence in the 21st century, are relationship between macroscopic, microscopic structures at molecular, atomic and subatomic level and explosion / revolution of knowledge in many scientific fields may occur resulting in reconceptualization. Biological Engineering is something which will look at the biology of engineering materials thereby enhancing the quality of life. It is a totally new branch of engineering having immense potential apart from Bio-Technology and Nano-Technology. There are a whole range of issues. Bio-Technology is influenced by our understanding of Biological engineering.

One of the great dangers to engineering is the ongoing "Physicization" of the field. In USA, most engineering programs are hiring large number of Physicists (perhaps an indication that too many physicists are being produced) and the focus of many programs is rapidly shifting from the development of technology to the study of first principles. A result of this shift is a growing disconnection between undergraduate engineering students and the faculty that should be training them. The future of engineering depends on the development of technology from nanotechnology to biotechnology. One can already see that nanotechnology is being sidetracked into "nanoscience" and losing track of the precept that new technology should be developed at the nanoscale.

Our goal is to ensure effective engineering education. It should be pursued within the context of a comprehensive examination of all relevant aspects of the interrelated system of engineering education, engineering practice and the global economic system. Engineering education must be realigned to promote attainment of the characteristics desired in practising engineers; and this must be done in the context of an increased emphasis on the research-base, underlying conduct of engineering practice and engineering education. This will require that action be taken by key stakeholders, particularly engineering faculty and the engineering professional societies.

Engineering education for 2020 and beyond will require a variety of skills which are not commonly taught in universities today. According to Leah Jamieson, Dean of Engineering at Purdue University and President, IEEE, 2007, the need to teach attributes like creativity, flexibility, leadership and business acumen will drive a demand for an "exponential" approach to education.

What are the issues before the engineering profession in 2020? The challenges that the 21st century engineers are expected to face are physical infrastructure, information and communication infrastructure, the environment - degradation, global warming, energy, ecological sustainability, green engineering, technology for aging population and pace of change. Biological engineering is totally a new branch of engineering with immense potential. The three key attributes of the engineer of 2020 are: design and problem-solving skills, interdisciplinary competence and contextual competence.

Within a very short time of 20-30 years, so many things have happened, including development in the field of computer technology; and within another 30 or 40 years, things will become quite common and

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engineering education should be prepared for handling these things. The pace, at which the new technologies are coming, is phenomenally rapid. These advancements are going to have a great impact on the life and healthcare systems. The future engineers should not neglect the impact of these advancements on the aspects of life and healthcare. It is being said that the future engineer is going to be a global engineer. If the computer is being manufactured in China, its hard-disk is coming from Singapore and other parts are coming from the different locations of the globe. Engineers will have to cope up with this development. This is going to be the order of the day for them. Multi-language and effective communication skills will have be learned and used by the 21st century engineers.

By 2020, 56% of population will be in Asia, 16% in Africa and only 25% in western hemisphere and Europe. By 2020, 37% of US population will be non-white; and by 2050, it will be more than 50%. Urban settlements in developing nations, who are not affluent, will face major problems which need to be addressed. There will also be the energy and ecology crisis to be tackled. By 2020, a sizable population will be elderly and apart from handling the healthcare, the economic stress will be enormous. Senior engineers may have to work out of economic necessity. They will need training to meet the situation squarely.

Internet and advanced telecom have resulted in work being outsourced to India and China and manufacturing to China; and design and manufacturing are carried out by the global teams. The developing nations will have to have the right kind of skilled engineers for producing goods and services for the whole world. Seamless Engineering education will only enable them to have such a workforce for meeting this emerging challenge. Besides, the developed western countries are realizing that the future business lies in Asia only. This realization has also dawned on the developing countries in Asia, particularly China and India. Already, we are finding healthcare to be extremely unaffordable. In future, it is going to be much more complicated. Obviously, governments and societies should be prepared for that. So, you will find engineers of 70 years working, out of sheer necessity because, otherwise, they cannot take care of themselves. This is, therefore, going to be the future scenario.

The Engineer of 2020 urges the engineering profession to recognize what engineers can build for the future not just through technical jobs but through a wide range of leadership roles in industry, government, and academia. Engineering schools should attract the best and brightest students and be open to new teaching and training approaches. With the appropriate education and training, the engineer of the future will be called upon to become a leader not only in business but also in nonprofit and government sectors. The next several decades will offer more opportunities for engineers, with exciting possibilities expected from nanotechnology, information technology and bioengineering. Other engineering applications, such as transgenic food, technologies that affect personal privacy and nuclear technologies, raise complex social and ethical challenges. Future engineers must be prepared to help the public consider and resolve these dilemmas along with challenges that will arise from new global competition, requiring thoughtful and concerted action if engineering is to retain its vibrancy and strength.

We have not been able to tackle the normal disaster conditions. Disaster litigation is a very major area. We are finding ourselves unable to cope up with simple earthquake conditions. These are the issues the future engineer has to address. Obviously, environmental engineering and related topics and energy engineering have to be accorded much greater priority. The kinds of crises, which can result from such conditions due to improper management, are very serious. So, training of our engineers to handle such events and making them sensitive to these matters is a must. Apart from that, flexibility, sensibility, dedication will have to be the root properties of engineers. Engineering education will have to be monitored, keeping all these things in view. Various models of engineering education will have to be thought about.

I agree with the observation made by Prof. B. S. Parekh regarding the present All India Council for Technical Education (AICTE) controlled administrative mechanism of the technical education in India. I have been associated with the AICTE and I am, therefore, fully aware of the problems faced by the technical institutions. The fundamental problem here lies in the lack of autonomy which includes not only in setting the curricula but also in the administration. The whole thing should be much more flexible and much easier and that is the key. A lot has been talked about the IITs. One fact is that IITs are doing well because of getting good students at the intake level itself and after that they are groomed into world-class engineers in an flexible and autonomous system. What must be remembered is that the best engineers, who are staying in the country from IITs, are our M. Techs. or PhDs. They are the people who launch our rockets, have created our atomic power plants, etc. We take a lot of benefits by riding over our pre-intelligent undergraduate students but by creating an environment where we are able to attract the best talent. This is not the case unfortunately with the other engineering colleges. This must be reversed through bringing in appropriate reforms in the administrative mechanism of the engineering education in the country. This is another important point after seamless engineering education which needs also to be kept in view while suggesting the change.

Prof. B. S. Parekh mentioned about the low salary of teachers of the other engineering colleges. The teachers of an IIT are not getting more than whatever a university professor gets. There are 600 people in every IIT who are PhDs from Purdue, Carnel and other places and are getting the pay at par with the teachers of the other engineering colleges. Let us persuade the state governments to give more grants to enable us to attract good students.

Environment prevailing in the normal engineering colleges should be upgraded to that prevailing in the IITs. According to the National Academy of Engineering, it should be made known to the public what the engineers are doing. In view of the fact that an engineer is directly launched into the profession which is not so in the other professions like medical, etc. the U.S. system of engineering education is under consideration for changes. I will request you all to look at the website of the National Academic of Engineering (NAE) of United States and study it.

In sum: Attributes of Engineers in 2020 should include strong analytical skills, practical ingenuity, creativity, good communication skills, leadership qualities, business management skills, high ethical standards, personality dynamism, agility, resilience and flexibility. Engineers should be competent to address world's complex and changing challenges; should be well grounded in mathematics, applied science, humanities, social sciences and economics. They should be able to make interdisciplinary efforts into other non-engineering disciplines; should serve as positive influencers of the public policy and governance. They should develop technologies for economical sustainable development; should accept global trends and arrive at a balance in the standard of living for developing and developed countries alike; should recognize rapid pace of change in the world and the lack of predictability and should be responsive to disparate learning styles.

Prof. P. Prabhakaran

The theme of Prof. Ramakrishnan's presentation was "Challenges for Engineers in 2020 and beyond". He mentioned about the emerging technologies like, nanotechnology, biotechnology and I may add, mechanotronics - mechanical and electronics taken together. That is nearer to the central theme of seamless engineering. Prof. Ramakrishnan stated about the need for fusion of various compartmentalized sciences and technologies. He also made a very valid and relevant point for the teachers, autonomy for the

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universities, engineering institutions including academic, financial, managerial and administrative. These four autonomies are the need of the hour. This is precisely what the World Bank has recommended and the government should look into this with the urgency that it demands.

Prof. K. Baba Pai

Generally education is considered as a prime supporter and resource of the industry. Our engineers are one of the biggest resources for the industry and so, automatically, the outcome of the industry would depend on the resources. Good-quality-products can be achieved from only certain levels of standards and quality and it can come only through seamless engineering. As was mentioned in the opening session, we need the boundary- less engineering education because the new challenge cannot be met and the creativity cannot be achieved only by the preset stoic engineering education.

Mr Kiran Karnik, President, National Association of Software and Services Companies, has said in an exclusive interview, "Indians are merely going for software programming; it is like a car mechanic repairing cars, which is a tremendous ability. But while we can repair cars, we cannot design them. We are merely roadside mechanics". According to him, software is nothing but retiring. You just insert the data and get the output. In this job, creativity is not there. It is a zero-product base. What we require is the product, the product-based engineer who can deliver goods. I remember the statement of Albert Einstein, "Engineers create that which has never been created". Our country has produced great personalities like Sir Vishwesharaiah, Sir J. C. Bose, Dr. Homi Bhabha, Dr Abdul Kalam the present India's President. They are all engineers / scientists. During their times, there were no IITs or IIMs. They are all products of small institutions or engineering colleges located in different corners of India and they have created.

Engineering is, therefore, seen as a creative field that makes a positive impact on people's day-to-day lives by allowing for the designing, building and construction of things. Are our engineers able to do this? Are our engineers of this standard now? Can only civil, mechanical, electrical or computer engineers build certain things? It has to be done in groups, i.e., collectively, it has to be done by interactions.

We have to come out of the boundary of a particular discipline of engineering. As far as education system is concerned, it is o.k. that you are a mechanical engineer; you are an electrical engineer, and so on. But, in practice, only intermixing of expertise of different disciplines of engineering can result into a product. Different types of engineers combined together can only make the final product. We can think of this intermixing in the beginning only, i.e., at the time of basic engineering education. The industry wants design engineers, system engineers, process engineers, engineer managers and R & D engineers. The present engineering education does not meet the needs of the industry. There is a heavy demand for engineers, both from software and hard core industries. If you see the recent announcements from some of the companies, you find that the Infosys demands 80,000 engineers, L&T demands 8,000 engineers and yet another reputed company demands 12,000 engineers in the next few years. Though, we have large number of colleges / institutions and the number of engineering colleges in some parts of our country is more than the requirement. The question arises whether these engineers are capable of getting jobs. The answer is simply no. Only 50 to 60% of graduated engineers are getting selected by the above reputed companies and rest of the graduates remain either unemployed or hunt for low-level employments though they are having good percentage of marks and are coming from the same institutions. It seems something is missing in the present engineering education system and there is the need for some brain-storming. It becomes apparent that there is a need to upgrade the level of engineering and technical education.

Engineering is defined as the application of scientific and mathematical principles to practical ends such as the design, manufacture and operation of efficient and economical structures, machines, processes and

systems. These practical ends cannot be designed and built up by one type of engineer. It requires a core engineer, i.e., an engineer with vast expertise, i.e., the engineer without any boundary or seamless engineer. If you combine telecommunication and instrumentation with electronics, the outcome is a much more solid engineer. So, it can be seen that how useful an electronics engineer becomes if its boundaries are slightly enlarged. It is logical to think about the greatly enhanced usefulness of an engineer if we are able to produce a seamless (or boundary-less) engineer.

Now, what is going to be our approach for this? It should be like this that the academic curriculum should be modified with the purpose of creating engineering excellence and confidence in problem-solving and preparing students for industry and a fast globalizing world. Designing and building products, structures, systems and processes should be the dream of every engineer. The objective should be to create a sense of pride within the students for engineering career for it brings prosperity, particularly in the present economic scenario through more global exposure. The curricula should include developing better understanding of the project management, collaboration and teamwork skills required by the industry, exposure to real-world industry and engineering products, strengthening fundamental engineering skills for better problem-solving and global branding of Indian engineers as a well-trained, experienced and productive workforce. The curriculum development should be such as to ensure no global branding for the students of IITs and IIMs only. The question arises as to whether this brand can be achieved by the other engineering colleges also. The target for the reform of the engineering education should, therefore, be to produce engineers from these colleges who are found competitive globally as the engineers are from IITs. We should make these engineering colleges also brand Indian engineering colleges.

It has been seen that many industrial units select some students who still have two years to go in the college. They keep on guiding and inducing them as per their requirements. They also canvass for the change in curricula suiting their requirement. Can we not have a solid curriculum which matches the requirements of most of the industrial units? The type of activities which should be undertaken as a part of the curricula are industrial training and seminars thereon, competitions / project sponsorships from the industry, research assignments from R & D institutions and industry, industrial site / factory visits, exposure to journals & distribution of trade magazines, white papers / articles, exposure to standards & codes, exposure to western culture (this is in, fact, the main requirement of a global engineer), arrangement of job offers & placement for competition winners and branding of participating schools initially by various industries. The total weightage should be around 200 hours per year, i.e., 100 hours per semester per student for a total of 600 hours over three years, excluding the first year. If we modify our syllabus as suggested above, I think we shall be able to produce good engineers. Our engineers need to be better trained to design and improve problem-solving skills.

Recently, we at M. S. University of Baroda have initiated the HeadStart Programme for civil, mechanical and electrical engineering courses. The programme is supported by Neil Soft, Pune. The proposal of 600 hours, distributed over the 2^{nd}, 3^{rd} and 4^{th} years is under consideration of the respective faculty board of our university. This programme was launched not only at M. S. University but a few other engineering colleges also.

Anthony Lobo

Engineers are the people who solve problems and focus on making things work more efficiently and effectively. Engineers apply the theories and principles of science and mathematics to research and

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develop economical solutions to technical problems. Their work is the link between perceived social needs and commercial applications.

Engineers design products, machinery to build those products, plants in which those products are made, and the systems that ensure the quality of the products and the efficiency of the workforce and manufacturing process. Engineers design, plan, and supervise the construction of buildings, highways, and transit systems. They develop and implement improved ways to extract, process, and use raw materials, such as petroleum and natural gas. They develop new materials for improved product quality by utilizing the technological advances. They harness the power of sun, earth, atoms, and electricity for meeting the nation's power needs, and create millions of products using power. They analyze the impact of the products they develop or the systems they design on the environment and on people using them. Engineers also manage people, conflicts, finances, markets and many more things when on their jobs either on projects or when supervising production. So, you talk about engineers managing people, managing conflicts, finances, sales, draw strategies, business perspective and so on. Their work is the link between perceived social needs and commercial applications. Engineers also need to work ethically under a code of conduct. Engineering knowledge is applied to improving many things, including the quality of healthcare, the safety of food products, and the operation of financial systems. More than twenty-five major specialties are recognized in the field of engineering and engineering technology. In most countries, degrees in the different fields of engineering and engineering technology are accredited to ensure that the programs provide students with a top-notch engineering education. How can, therefore, an engineer with mere stoic degree in an engineering specialization do all this? He has to be of multi-skills and hence of seamless engineering discipline. The subject chosen by the Engineering Council of India for these national conventions is, therefore, apt and timely and I fully support it.

Prof. Prabhakaran

The theme of the presentations was importance of engineering education to various targeted engineering institutions specifically for producing the 21st century engineers. In curriculum development, what level of amalgamation should be permitted among various engineering disciplines is the question that one should pose and how it can be targeted for specific duties at undergraduate level. One should not forget the idea of core subjects while thinking about the elective subjects. The line of thinking can be directed to proper combination of elective subjects. This may probably be relevant to seamless engineering. These are the points Prof. Baba Pai has raised.

Panel Session

Panel Session

Dr. A. K. Singh

I do have the privilege of having very distinguished panelists in Dr. Rajendra Kumar, Lt. Col. A. K. Singh, Sh S. C. Agarwal, General Manager, PDIL, Sh. Deepak Pradhan, Prof. Gadgeel. We had two very interesting technical sessions. In the first technical session, the focus was on the industry view and in the second session, the focus was view from the academia. We had very wonderful thought-provoking presentations in both the sessions. To set the ball rolling for the panel discussion, I would start with an observation regarding employability of our engineering graduates. It was pointed out that 25% of our engineers only are having good employment. The question that I would like to ask is, "Will this seamless engineering facilitate employability of our engineers and will the engineers of India become a brand world-wide, i.e., global brand?" I remember, in the late 1990s, when the Indian industry was passing through a recession, I was really ashamed to know that the gold-medalist of a university was employed for only Rs. 1,500 / - per month by an industry. I am sure, he must have been spending much more while living in the hostel in the engineering college. Fortunately, those days are over. But, the question still remains, "Why the employability of our engineers is so low?" The other important point is what Prof. Baba Pai has said about the fresh engineering graduates who would start getting an annual package of Rs. Seven lakhs from the year of 2009. I would now request the distinguished Panelists to start the discussions with this dream in view.

Dr Rajendra Kumar

I had been at IIT, Kharagpur, BHU and have been associated with the other engineering colleges also. It is wrong to classify the Indian engineering degrees into two groups: so-called branded IITs and non-branded engineering institutions. My experience is and I should be proud to say that the shape, in which the Indian industry is today, is because of the efforts of the large number of engineers who have graduated from colleges other than BHU and IITs. Earlier, many of the engineering graduates from these branded institutions have gone abroad and contributed to the engineering profession there. The second point, that I would like to make, is regarding the employability of engineers. There are two types of organizations. The first type is the large organizations who recruit engineering graduates from IITs and / or RECs / NITs and impart exhaustive training to them for two years. They don't distinguish whether it is IIT or it is NIT. They take them at par as raw materials. It takes them two years for making them suitable for use. In colleges, these engineering graduates learn many specifics. The second type of the organizations are those who do not have a training programme for the newly-recruited engineering graduates. That is why the problem comes. That is why when you talk of globalization, it pertains to such group of companies only. I feel that the ECI or the IE(India) should hold an examination for such graduates just as they have section A or section B. They should have another section for such graduates who would become competent to be called global engineers in the context that they would be knowing about law, finance and all such things that an engineer is expected to know.

I would like to come to the important question and this is: how far we should modify the engineering curricula at the undergraduate level? As you may recall that earlier we had a combined degree in electrical and mechanical engineering. Later on, these became two disciplines. In BHU, we had combined degree in mining, metallurgy and geology. It was separated into geology and mining as well as metallurgy. Then,

Dr Rajendra Kumar, *Eminent Metallurgist & Scientist and former Additional Director, National Metallurgical Laboratory, CSIR*

these were separated into mining, metallurgy and fuel technology. Fuel technology gradually changed over to chemical engineering and so on. The number of engineering disciplines went on multiplying over the years. What I felt by interacting with the engineers and the chemical industry over some of the past years is that it is the non-metallurgical engineers that use metals or materials; without metals or materials there is no engineering whatever branch of engineering you may like to consider. It is an engineer who deals with metallurgy or metallurgical materials. 90% or 95% of the materials today are those bulk engineering materials the courses of which are covered in the metallurgy degree course here or in any other college. But the users of the metals and materials like, the mechanical engineers, electrical engineers, civil engineers, chemical engineers, aeronautical engineers, electronics engineers and so on, know precious little about the metals and materials, about their properties or their limitations. It is this aspect that has to be covered if you are to amalgamate various disciplines of engineering in some manner.

One can think in terms of a combined degree in metals and mechanical engineering, electrical and mechanical engineering or a combined degree of the disciplines that I have mentioned earlier. When I say metals, I only talk of metals in the sense of physical and mechanical aspects of metallic behaviour, not the production aspects, as those aspects are closer to chemical engineering, but in the degree of mechanical engineering, maybe in the final year as I think and the Dean of the Faculty of Technology, M.S. University of Baroda, has suggested, we may put a specialization, a special paper on this, for mechanical engineers for understanding metallurgy. Prof Baba Pai also mentioned about welding operations, surface reducing operations, corrosion aspects. You have to cover these aspects in a composite degree which you may like to call mechanical or metallurgical engineering, you can find out a terminology. But there is need for such a combined degree.

Two or three participants talked about the wonderful iron-carbon diagram. When I taught, I think I finished that portion in a matter of half an hour or something like that. When I was a student, my own teacher taught me over weeks the iron-carbon diagram and I felt that you have steels because they depart from the iron-carbon diagram not because they conform to the iron-carbon diagram and that is the beauty of steels. It is only because the steels depart from the iron-carbon diagram that you develop such variety of properties. Therefore, teach metallurgy in such a manner which is useful and when I say metallurgy, I cover also the aspects of welding technology. So, the mechanical engineering or production engineering today.

In the US, a much greater degree of freedom is given to the students for opting for the studies of selective subjects. They have programmes whereby students can take extra paper in metallurgical engineering when mechanical engineering input comes in; or students can take extra paper in mechanical engineering when metallurgical engineering input comes in and they both get M.S. degrees. I think this is one way to look at it. I also like to make a point about bioengineering. I feel that the solution for environmental pollution and global warming, caused maybe by the bio-engineering industry, metallurgical industry, power industry, automotive industry, etc, will have to come through bio-control methods. I strongly feel that we should make knowledge of the microbiology, biochemistry compulsory for all the engineering disciplines.

You are talking today of conserving energy in the name of global warming; we are talking of CFL bulbs or other systems. What does the CFL bulb contain? It contains mercury. Are we making our users of these bulbs aware of it? In advertisements, we always say that please take CFL bulbs because it helps energy conservation. We never say that please dispose it off properly. Because, if you do not dispose it off properly, it would cause environmental pollution. Already, we have in Bengal illnesses arising out of

arsenic pollution. Similarly, we shall be having problems arising out of mercury pollution tomorrow. This will not be easy to solve. So, when we talk of seamless engineering, such subjects should also be taught therein. When the industry introduces a CFL bulb, it should also talk about its retrieval system - as how to retrieve it. If you want to put a price on it, you will get Rs. 10/- back so that you can know about the harmful materials that go into it and save the society from the damage in future. Taking this discussion further, I would agree with the suggestion made in some of the presentations in the technical sessions that engineers should have additional knowledge of the subjects such as, law, economics, finance, management, etc,. What I think should now be considered, after what I have said earlier, is that we should make the engineering education comprehensive and hence industry-specific. This, in other words, will mean seamless engineering. I, therefore, fully agree with the proposal that is being discussed today.

Prof. (Dr.) Gadgeel

I want to know from Sh Alok Ghosal how many metallurgical engineers were recruited by TATA STEEL as trainees. Sh Ghosal said that in 2006, 32 metallurgical engineers were recruited out of which 7 were from IITs. India cannot grow from the branded engineers (from IITs) only. The industries have to take the general, i.e., non-branded category of engineers also. I never belittle the quality of engineers that are from the unbranded colleges. Our branded colleges (IITs) cannot produce sufficient engineers for the growth of the nation. The demand of engineers can be met by the non-IIT engineers.

Alok Ghosal

There are students in the non-branded colleges also who could not enter into the so-called branded colleges. But they are at the same level as engineers from the branded colleges.

Prof. (Dr.) V. L. Gadgeel

Actually when we talk of the national group, we have to have both of these engineers. I am talking about more than 50% of the engineers who do not get right employment after passing out from the colleges. I know one of my colleague's son who has just passed out from an engineering college in Nagpur and has been employed @ Rs. 5,000/- per month. This is really the problem. We need to solve it for the good of our economy. May it be of quality related or it may be related to the very basic education that the present system is providing. Maybe that the seamless engineering education will solve it. We need to analyse the problem and then find its solution. We may have to bring up the quality of education provided by the engineering colleges at large including NITs to the standards of the IITs. This needs to be considered with the speed that it demands.

Dr. A. K. Singh

I think that we come back to the main issue of training and this is essentially a teaching-learning process taking place either in the class-room or the laboratory or in the campus itself or in some exhibitions or in some seminars. This teaching-learning process, seamless engineering, how does it really facilitate improvement in value addition? When the young boys and girls join engineering colleges or institutes of technology, they are taught during those four years the value-addition which shapes them for their professional career. The faculty plays an import role in this teaching-learning process. The quality of this faculty is also very important factor in this process.

Prof. Ramakrishnan has been writing about it in the ISTD and other journals. I have read some of his thought-provoking articles. I think this process has to be improved. It is also the continuing professional development (CPD) after employment of engineers which cannot be ignored and the member-

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professional-engineers-associations of the Engineering Council of India can play an important role in the CPD, which they should.

In this country, a problem is that the aptitude of the student is generally really not considered. Kota is a place which has become well-known in India for its coaching institutions. Day before yesterday, I happened to meet a family and came to know that the mother of the son had stayed at Kota for two consecutive years with the only objective that the son should qualify at the engineering entrance examination. What is the aptitude of her son, what does he like to do or what does he want, nobody cared. It means, in other words, that what parents could not achieve in their own lives, they want to relive in the lives of their sons / daughters for this. These are societal issues. How do we tackle them? And then, I remember one of my colleagues, who had been in IIT with me and is today DGP of Rajasthan. I asked him, "what about your engineering education? How does it help in discharging the law & order situation?" He gave a very interesting answer. He said, "The training, which I got during my engineering education at the IIT, helps me a lot during investigations of the cases that I handle". This is because the skills of analysis for a problem, that I acquired at the IIT, it could be a law & order problem, it could be any problem, the problem of leakage of a competitive examination paper, etc, come handy during investigations. So, what it means is that it is not a loss when an engineering graduate goes to IPS, IAS or the other civil services.

I remember a case when I was with BHEL, Haridwar; and this was that, when it was established, majority of electrical engineers were recruited during the intake of first batch of engineers compared to mechanical engineers. They were all sent to the USSR for two years of training. I know, two gentlemen (both of them were electrical engineers and my bosses, one gentleman was from the Thapar Engg. College, Patiala and the other from Roorkee). When the results took the number count, they found that there were more of electrical engineers and less of mechanical engineers. Electrical engineers were put in the category of mechanical engineers. These fellows thought they had been totally ruined because they were basically electrical engineers and had reached the USSR for training and these Russians are going to train them as mechanical engineers. They were worried thinking what would happen to them. They were highly stressed. Surprisingly, the training, the Russians gave to them, was so nice that I still remember, for my M. Tech. Project, while talking to them, they told me to remain very careful while dealing with the particular type of technicalities. This is an example of seamless engineering which I have seen. Later, both of them rose to be the head of the core mechanical engineering areas. In terms of knowledge, they became the authority. So, what type of training is given is important. It is not difficult for engineers to move from one discipline to another during their employment, provided they get the best and appropriate training. Similarly, if engineers are trained at the undergraduate level to be seamless, they will serve industry better, especially if they are also trained to be economists, managers, satiations, etc, at that level. I would, therefore, agree fully with the theme of the convention.

S.C. Agrawal

We have experienced the same thing in our company also. Generally, we give two years' training to fresh graduates and rotate them as well while on job. I would share with you a case. During the job rotation process, mechanical engineers were transferred to the instrumentation department. They retired as the head of the instrumentation department. I met a civil engineer of the Indian Oil Corporation (IOC) who was transferred to the instrumentation department and he rose to be a reputed instrument engineer. We have seen that, in the colleges also, students study so many things in the first to third semesters that they forget the preliminary fundamentals while facing an interview. I think that the theme of the convention makes sense and needs to be given a serious consideration for making available engineers to industry of qualifications and skills that it really need. I fully agree with it.

S. C. Agarwal *is the General Manager, PDIL*

Col.A.K. Singh

I give a very classic example. I am a metallurgist and Dr. Pai was my teacher about 26-27 years ago. I am heading a branch of electronics and mechanical engineers. The name has been changed from Electrical & Mechanical Engineers (EME) to Electronics & Mechanical Engineers (EtroME). We are already seamless engineers and doing seamless engineering. We have varieties of equipment, from a pin to a helicopter. We do give the engineering support. We have the latest generation of vehicles like tanks and computers also. I am having about more than 600 computers. So, what do you like to call me, a computer engineer? I have varieties of medical equipment including sophisticated ones. We have the mechanics over there. So, what do you call me, a bio-medical engineer? So, it is only the attitude which matters. We can attain the attitude. It is not difficult. Engineers are very logical in their approach. Basically, I am doing administrative job here. It is a routine. I am a seamless engineer.

I will give a little story of another thing. Somebody has mentioned about the genius of various colleges. I was posted in Punjab. I was to interview the teachers. A math's teacher was there. She was an M. Sc. I asked her very simple mathematics. I asked, “Madam, can you tell me what is meant by 0/0?" She replied that 0 & 0 would cancel out to give 1 finally. Ultimately, we had to select her. She was, otherwise, a good candidate but may be that due to some reasons she said like that. The other story that I would like to tell is that the Chairman of the Governing Board of a school went to the school. He noticed during the round of the school that a teacher was teaching English and she was telling that the way to pronounce girl is garal. The Chairman went to the principal's office and asked him to call the teacher for an explanation. The teacher came in and the chairman asked her as to why she was teaching a wrong way of pronouncing the word girl. Her instant reply to this question was that no better way of teaching can be expected out of such a meagre salary to a teacher. With handsome salary, we would definitely be getting good teachers. This is the case also with the engineering faculty in India. With the competitive and comparable remuneration, best engineering faculty can be attracted and the results will be better. This was also an important point that was made earlier.

I heard the speech of Prof. Ramakrishnan and I wish to be attending the entire convention but, due to some pressing official engagements , I have to go back.

It is the calibre and competence which brands engineers. Even 30% or 40% from the top order of any good engineering college like NITs (Engineers from NITs are not less than any IITs) can match IIT engineers in this brand competition. We all are engineers in our EME. We do multi-phase jobs. You can say that we are seamless engineers or otherwise. Now, for the last 23-24 years, I have been doing mostly the administrative jobs. I have hardly done any technical job. Now, gamma-radiation instrument has been installed. I have not done much of metallurgy there, only some foundry. A pattern was to be made. Nobody knew about my being a metallurgist. Somebody was giving a wrong heat-treatment (tempering). Probably he must have read an ordinary book of metallurgy (book of Lakhtin or so) and he became a metallurgist overnight. That is an irony. I was taught machines design in three semesters. I think I do not remember anything of this. If I am asked to draw an isometric view, I am afraid that I would be able to do that. We have been doing that. In my personal opinion, we must amalgamate that. Should we call it seamless or single window? What I mean to say is single-window system. Anyway, I will not take much of the time. It is a good idea that we should have seamless engineering. It should not be discriminatory. It must be recognized. I agree fully with the theme of the convention.

Lt. Col. A. K. Singh *is from the EME School, Baroda*

Prof. V. L. Gadgeel

We have four years in graduation course. We must accommodate seamless engineering in this time frame. Attempts must be made to develop an analytical outlook in students. Proper analysis of the engineering situation is must. CPD / on-the-job-training is a must.

D. S. Pradhan

Whether a student studies in IIT or in a normal engineering college, it is only during doing jobs that he / she gets multifaceted exposure and acquires multi-skills. The question is, if 90 out of 100 IIT students are good and 50 students out of the other-engineering college are good, why this difference? Everybody agrees that there is no substitute for hard work and Sh Ghosal has rightly said so. This is what Dr. Gadgeel also says. If a student, after coming out from the college, is made to work hard, it benefits the industry and ultimately the society also. It is a win-win situation for everybody. Any change for the better should be welcome by all but to bring about any such change is normally met with many difficulties in the beginning. But if we train students as seamless engineers at the undergraduate level itself and after that when they go to the jobs, their exposure will be more reinforcing and strong when compared to making engineers seamless during their work. From this viewpoint also, I think, that there is a strong merit for the theme of the convention and we should take it up for implementation, as early as possible.

From the Floor:

Alok Ghosal

As the situation stands today, there are two groups of engineers, the first one is General Engineers and the second one is Branded Engineers. Branded engineers come from branded institutes like IITs, BHU, BITS Pilani and so on. In the MNCs (software companies), the branded engineers are paid more salary than the general engineers. Now, fortunately or unfortunately, number of general engineers has to be reduced and their position has to be improved by branding the standard and quality of the engineering education system, i.e., its quality should be improved. As I spoke during my presentation, the quality of engineering education is poor in India. It should be looked into. The functions of AICTE need to be looked into in depth and improved for bettering the whole process and mechanism of the engineering education in India.

A Delegate

Being a corrosion specialist, I think, that corrosion specialists can become only the right and useful man if he becomes a seamless engineer. As you know, corrosion is the phenomenon which takes place by a reaction between the environment and the material. Unless somebody knows all aspects of engineering like temperature, pressure, biological aspects, etc., unless he understands the problems involved in a seamless way, he cannot solve the problems of corrosion. So I think that corrosion engineering is, in true sense, seamless engineering. One has to know each and every aspect of the engineering side and then and only then he can solve the problems of corrosion. Corrosion takes place only at seams. I thought it prudent to share my experience at this platform. I, therefore, fully agree with the theme of the convention.

A Delegate

Presently, does the Engineering Council of India have any concrete proposal as to how to go about the seamless engineering?

Dr. Uddesh Kohli

We have floated the idea for debate and discussion throughout the country. We are not the experts in this field. After the exhaustive brainstorming only, the concrete idea of seamless engineering would precipitate.

A Delegate

India alone cannot start with seamless engineering and go further with it while the rest of the world, including the western countries, is not going with it. All these issues have to be, therefore, taken into consideration.

Prof. C.V. Ramakrishnan

Some foreign universities are following 4 and 5 years' integrated course programme in engineering and the products of such courses are leaders of industries, politicians, etc. These are special models and need to be replicated in India in some selected institutions. If this system succeeds, other universities can follow suit initially on an experimental basis. But for this, autonomy to the institutions is very important. It is extremely important that these degrees are recognized by AICTE. While, AICTE is very flexible for the new ideas, the problem can come at the state governments' level. The state governments must bear with the universities concerned doing such types of experiments. In IITs, we are getting very good students compared to the normal engineering colleges at the UG and the PG levels. They work very hard with the facilities available in the IITs and come out with the international level of research work. Students of the other engineering colleges are definitely brilliant and work hard also. This is the reason why IIT students contribute more to the country.

Dr A. K. Singh

In 4 or 5 years of time, everything cannot be taught in the classroom and efforts for self-development are a must. Eklavya did not receive any training from Dronacharya. But Dronacharya saw in him a potential threat to Arjun and asked for his thumb as the Guru Dhakshana. Everything, therefore, need not be covered in the classroom. History and general knowledge are not to be covered by a teacher in the classroom. This thing is totally against the spirit of seamless engineering. We learn the ethics in a society just like a family. These things come under self-development. We should ask ourselves only if we should be taught about such things in the class. I just tell you that what we learn as education in the school of life is much important rather than what we learn in our schools/colleges. This should be the spirit in the seamless engineering also. What ECI is doing is really a welcome move and every speaker has unanimously welcomed this move in the direction of making our education system really seamless. The emphasis is not being given on the engineering side only, importance is also being given to finance for non-finance, accounts, history, language, literature (literature is the food for soul), project engineering, etc. We all the panelists and you all the distinguished delegates in the audience support this move of seamless engineering of the Engineering Council of India and we are ready to contribute in whatever way we can to make this mission a success.

Technical Papers

Convention Address
The Industry View on the Present Job Requirements and the Conventional Disciplines of Engineering

by
Prof. A. K. Singh

It is indeed an honour and privilege to be invited here to the Inaugural Session of the 2nd National Convention on "Seamless Engineering" and I will start with complimenting the Engineering Council of India for having organized such relevant and thought-provoking convention at Vadodara, the Cultural Capital of Gujarat. I strongly believe in and also try to practice the concept of seamless functioning. Although the topic is Seamless Engineering, I will like to go one step back from the concept of seamless engineering to the division between Science and Engineering and would like to start with the beautiful quotation by Bill Wulf and I quote:

"There is only one Nature. The division into Science and Engineering is a human imposition, not a natural one. Indeed, the division is a human failure. It reflects our limited capacity to comprehend the whole." Unquote

We should first take a look at the difference between engineering and technology. How has the word 'engineering' been substituted by 'technology' in academia? It has been seen that the nomenclature "Engineering College" has been substituted by "Institute of Technology". 'BENCO' is today 'IT' (Institute of Technology). "Thomson College of Engineering" is today IIT, Roorkee. SVREC, closer home at Surat, is today SVNIT. Most of the colleges, which started on the pattern of self-financed institutions, chose the word Technology and were christened as Institutes of Technology. What I feel is that the word 'Technology' is considered to be more glamorous but my generation has grown up with the word 'Engineering' and feels nostalgic about it.

Ladies and Gentlemen! India today is marching forward to have its send tryst with destiny and emerge as an economic superpower. The Industry today needs practical visionaries. The scenario that we see today in the wake of the ICT (Information and Communication Technology) revolution is that the first preference of the IT companies, are the engineering graduates. The software companies today go to the engineering colleges and pick up the engineering undergraduates at the pre-final year level itself. They say that they need candidates of very strong background and core competence, domain knowledge and are going to train and mould them to meet their requirements. A very common term used in industries today is "Cross-functional team". I have myself experienced that when we worked in a cross-functional team where persons from different disciplines like engineering, technology (production engineering), supply management, manufacturing etc. all came together and formed a team, we delivered what was expected from us.

For our generation, the most deadly combination has been "IIT+IIM". And we have seen many young boys and girls aspiring to get into IITs through JEE and after that the next destination is IIM through CAT. We all have seen this happening.

Now let us just take a look at the word 'engineer'. It has got two roots. The first root is 'creative one' and that is what the word engineer is. The other root of engineer is 'to bring about' or 'to make manifest'. Now the creative one, the first root of the word 'engineer', relates to engineering as a function, which means that engineering is simply a design-oriented activity and engineering design happens to be the most important

ingredient in the education and training of an engineer. The other root meaning “to bring about” or “to make manifest”, relates to making things happen which is nothing but management. After all, an engineer is required to deliver some deliverables in a specified period of time, on a fixed budget and most often with limited resources. That is the challenge before an engineer.

If an engineer fails to deliver, his knowledge of engineering is considered to be no good. A very good example that comes to my mind is the difference between 'Efficiency' and 'Effectiveness'. To quote Peter Drucker, “Efficiency is doing things right and Effectiveness is doing the right things.” Efficiency is action-oriented whereas Effectiveness is result-oriented. We need both. Only one of these doesn't help us. So, technology enables us to do things right and management facilitates to focus on right things. That is why the combination of an Engineer and an MBA becomes most desirable and most wanted and most sought-after career.

The role of an engineer has undergone a major change with the paradigm shift from the traditional functional organizational structure to cross-functional organizational structures. I have some points regarding the perception of the industry, what the industry desires from engineers. I am reminded of a very good quote from an eminent personality, Joseph Bordogna, from US National Science Foundation and I quote:

"21st Century engineers will need to be astute-makers, trusted innovators, agents of change, master integrators, enterprise enablers, technology stewards and knowledge handlers". Unquote

So, the desired Competence Profile of a 21st Century Engineer encompasses:

- Fundamental Technical Domain Knowledge complemented by Knowledge from Neighbouring Technical Disciplines;
- Solid Methodical Knowledge; System-building and Problem-Solving Skills; Understanding of the Entire Value-chain;
- Management Know-how and Business Process Skills;
- Project Management and Decision-making Skills;
- Marketing and Financial Know-how;
- Foreign Language Proficiency;
- Knowledge about the Social and Ecological Implications of Technology;
- Interpersonal and Communication Skills;
- Leadership Techniques;
- Inter-cultural Understanding and Cultural Empathy (identification and understanding of another's situation, feelings and motives); and last but not the least
- Capacity and Willingness to Engage in Life-long Learning supported by Cosmopolitan Attitude and Global Mindset. Dr. Uddesh Kohli has in his address talked about that fact that the learning process does never end and it continues till there is life.

An important aspect that I strongly believe in happens to be Having the Sense of Social and Ecological Responsibility. After all, whatever we engineers do, should in some way help in improving the lives of the common men and women living on this planet. Then only it is worthwhile.

The desirable characteristics of the 21st century engineer from the viewpoint of industry perspective are:

- Sharpening your Written and Oral and Communication Skills. Everything that we write or say is a product and we have to be conscious of its quality.
- Learning to listen. Most of us love our own voices. So, we fail to listen to others. It is very important to learn to listen.
- Advertising yourself effectively. Learn interpersonal politics. Be aware of how the media works and about public relations and the mantra for this is Effective Networking with People.
- Being persistent, aggressive and passionate about your career but also learning to adjust, adapt and compromise. Not succeeding in getting the desired promotion, posting or assignment does not mean end of the world.
- Learning the fundamentals of accounting, marketing and sales. Industry today needs practical visionaries. I can share with you that in the 32 years of my professional career, the phase where I learnt the basics of finance and accounting was a very important phase. We have to have a proper appreciation of terms such as Bottom-line, Return On Capital Employed (ROCE) etc. No business can survive unless it makes profit. We should not be shy of making a mention of the world 'Profit'. Also understand the implication of tax laws and regulations.
- A very important characteristic is to study history. It repeats itself most of the times. We cannot change history but we can be wiser by studying it and prepare ourselves for anticipating and managing change.
- Studying international cultures and languages. Speaking to the world in words other than English. It gives you immense advantage when you speak to them in their own language.
- Keeping yourself updated. Be aware of the new and evolving technology.
- Using time effectively perhaps the most difficult task to master. I am quite sure that in thisconvention also, we will always have the pressure of the time and managing time is supposed to be the most difficult task.
- Being cool without being cold, patient without being weak and strong without being proud. Balance personal and career priorities and know when to go home.
- And last but not the least, Being proud of your profession.

Ladies and Gentlemen! I would conclude with a quotation by Alfred North Whitehead and I quote

“Our minds are finite, and yet even in these circumstances of finitude we are surrounded by possibilities that are infinite, and the purpose of life is to grasp as much as we can out of that infinitude.” Unquote

Professionalism & Ethics - Value Addition for the Engineer

by
Anthony Lobo

Synopsis

Engineers are people who solve problems and focus on making things work more efficiently and effectively. Engineers apply the theories and principles of science and mathematics to research and develop economical solutions to technical problems. Their work is the link between perceived social needs and commercial applications. Engineers design products, machinery to build those products, plants in which those products are made, and the systems that ensure the quality of the products and the efficiency of the workforce and manufacturing process. Engineers design, plan, and supervise the construction of buildings, highways, and transit systems. They develop and implement improved ways to extract, process, and use raw materials, such as petroleum and natural gas. They develop new materials that both improve the performance of products and take advantage of advances in technology. They harness the power of the sun, the earth, atoms, and electricity for use in supplying the nation's power needs, and create millions of products using power. They analyze the impact of the products they develop or the systems they design on the environment and on people using them. Engineering knowledge is applied to improving many things, including the quality of healthcare, the safety of food products, and the operation of financial systems. More than twenty-five major specialties are recognized in the fields of engineering and engineering technology. In most countries, degrees in the different fields of engineering and engineering technology are accredited to ensure that the programs provide students with a top-notch engineering education. Engineers are people who solve problems and focus on making things work more efficiently and effectively. Engineers apply the theories and principles of science and mathematics to research and develop economical solutions to technical problems. Their work is the link between perceived social needs and commercial applications. Engineers design, plan and supervise. They develop and implement. They analyze the impact of the products on the environment and people using them. They develop the systems they design. Engineers also manage people, conflicts, finances, markets and many more things when on their jobs either on projects or when supervising production. So, you talk about engineers managing people, managing conflicts, finances, sales, draw strategies, business perspective and so on. Engineers also need to work ethically under a code of conduct. How can, therefore, an engineer with mere stoic degree in an engineering specialization do all this? He has to be of multi-skills and hence of seamless engineering discipline. The subject chosen by the Engineering Council of India for these national conventions is, therefore, apt and timely and I fully support it.

The aspirational requirements when we want to move from being, shall I say, mechanics to engineers, want to move beyond just merely people with the knowledge, we want to get into practice, and then looking at some of the soft skills, some of the managerial skills, some of the inputs which come along with management education, which have a great deal of help for forming the concept of the profession. I had the benefit of going to Malaysia in 2004. Then, there was a group of Malaysian engineers which was getting ready for the Washington Accord approval and we (there were six from America and myself) were training them on these very topics, on professionalism, ethics and other things so that they could be well-versed. You know that Malaysia is already qualified to be on the short list of the Washington Accord; and it is nice to know that India is also contemplating to be a member of the Accord.

The website www.Try Engineering.org is a wonderful site and I would like you to note. May be some of you already might have been to this site. It is a lovely site. Try Engineering.org is a resource for students (ages 8-18), their parents, their teachers and their school counselors. This is a portal about engineering and engineering careers, and it is hoped that it will help young people understand better what engineering means; and how an engineering career can be made part of their future. Students will find here descriptions of the lifestyles and experiences of engineers, and on the different disciplines within engineering. The site provides hands-on experiments and activities, referrals to summer programs and internship opportunities, and search tools for schools that offer engineering programs. Useful tips on course selection, applying to university programs and financial aid are included. Students can also use this portal to send questions to engineering students in universities and to practicing engineers. Parents and educators will find here, in addition, teaching resources, information about school accreditation, and description of plans, organizations and programs that can be of help in planning and preparing students to develop a future career in engineering. This portal is brought to you by engineers and educators, and is a collaboration of engineering associations, industry, and teacher / counselor organizations. We all know that engineering is an exciting and rewarding profession, and the site invites you to share in our enthusiasm about this rich and influential discipline.

Engineers are people who solve problems and focus on making things work more efficiently and effectively. Engineers apply the theories and principles of science and mathematics to research and develop economical solutions to technical problems. Their work is the link between perceived social needs and commercial applications. Engineers design products, machinery to build those products, plants in which those products are made, and the systems that ensure the quality of the products and the efficiency of the workforce and manufacturing process. Engineers design, plan, and supervise the construction of buildings, highways, and transit systems. They develop and implement improved ways to extract, process, and use raw materials, such as petroleum and natural gas. They develop new materials that both improve the performance of products and take advantage of advances in technology. They harness the power of the sun, the earth, atoms, and electricity for use in supplying the nation's power needs, and create millions of products using power. They analyze the impact of the products they develop or the systems they design on the environment and on people using them. Engineering knowledge is applied to improving many things, including the quality of healthcare, the safety of food products, and the operation of financial systems.

Students who are interested in pursuing a degree in engineering can prepare for the application process as early as middle school. By selecting a variety of science, mathematics, and engineering-related course work and participating in programs and projects that expose students to engineering concepts, students will have advanced exposure to university level work. While in middle and high school, students interested in engineering should consider taking accelerated courses in several of the following subjects.

- Algebra II
- Biology
- Calculus
- Chemistry
- Computer Science
- Language Arts

- Precalculus
- Physics
- Second Language
- trigonometry

More than twenty-five major specialties are recognized in the fields of engineering and engineering technology. In most countries, degrees in the different fields of engineering and engineering technology are accredited to ensure that the programs provide students with a top notch engineering education. Select a degree field from the list below to find out more about the different engineering and engineering technology career paths.

Engineering Majors

- Aerospace
- Architectural
- Bioengineering
- Chemical
- Civil
- Computer
- Computer Science
- Electrical
- Environmental
- Industrial
- Manufacturing
- Materials
- Mechanical
- Nuclear
- More...

Engineering Technology Majors

- Architectural
- Bioengineering
- Chemical
- Civil
- Computer
- Electrical
- Environmental
- Industrial
- Manufacturing
- Mechanical
- More...

National and International projects and competitions will help introduce pre-university students to engineering principles which integrate teamwork into the experience. They are also a great way to interact with other students who have an early interest in engineering. Try Engineering offers a variety of lesson plans that align with education standards to allow teachers and students to apply engineering principles in the classroom.

In the U.S. people are not getting attracted to mathematics and engineering. They are going out of the way to get people interested in these subjects. This particular site has been sponsored by IBM and some other organizations just to foster an educative atmosphere. You won't believe, among the resources, are also listed Indian engineering colleges where people can qualify as engineers if you go into the site. Now what is that I find from this site.

The first thing they talk about is what basically consists of engineering profession. What do we understand when we look at an engineer or mere technicians or a mere quack. What differentiates a doctor from a quack? Engineers are people who solve problems and focus on making things work more efficiently and effectively. Engineers apply the theories and principles of science and mathematics to research and develop economical solutions to technical problems. Their work is the link between perceived social needs and commercial applications. Engineers design, plan and supervise. They develop and implement. They analyze the impact of the products. They develop or the systems they design, on the environment and on people using them. Engineering knowledge is applied to improving many things, including the quality of healthcare, the safety of food products, and the operation of financial systems.

However, given that, we find that, in actual practice, life is not that simple. Whether we can straightway work in a laboratory, we can develop, design and have a lot of interactions. You talk about people management, you talk about conflict management, you have the reality of Satyendra Dubey and all others who stood up as engineers for the principle and found that they have to have an answer for the situation under the challenges of life. Challenges which are facing us are the conflict of interests. We found in TCS (I am from TCS by the way) that people, who are in Hyderabad office and are working for the government agency, now that is nothing that but the conflict of interest. Now what is there in the conflict of interest? I can work in a BPO during the night. No, it is not like that. If you do not take care of conflict of interest, you will not know where the interest lies, you will not know who is my real employer and what do I have to do as an engineer. It is all the more important that you have to have very clear mapping of the things involved. Life is like this only. Similar points, such as Conflict of Interest, Gifts & Bribes, Compulsion & Expediency, DILEMMAS, Duties & Rights… third party, Risk and Reputation, Product Liability and Responsibility & Accountability, etc. the points to be always borne in mind. Engineers bring the link between the needs and the commercial application.

A gift becomes a bribe when there is an element of influence and return, influencing some decisions, some change. Any kind of gift can become a bribe -even a gift of Rs. 5/-. Where as, some companies allow that you spend as much as Rs. 5,000/- to take a client for dinner. It is the natural way of entertaining a client because the client knows that this the practical way of dealing with the business. So, an engineer has to face several other things like this, experiencing it. An engineer has to hasten the project. I have a deadline. What I can do as a short-cut. What is allowed and what is not allowed. So, real life is not as simple. What can help us to face these problems of life? Added to it, we have a global village. The Global village throws up newer and more formidable challenges. So with the opening up of the economy, we have to face problems from some other places. Why work in Saudi Arabia? What is the culture over there? How do I manage in places like South America and Mexico? National borders are no longer constraint for trade and travel. You have more challenges to face as an engineer because of the expanding more vistas of work. Workforce migration brings up need to recognize qualifications outside country of origin.

There is need for Certification and Equivalence of Educational & Technical Qualifications.

We have to work with different types of cultures and have the need to know whether our qualification will be accepted abroad. Some of the countries want us to prove our worth. I think Dr. Kohli has mentioned that if we go to America to work with our present qualifications, we have to pass there another examination. One way of placing this is to look inside ourselves and put certain questions to ourselves, look as an engineer: am I a single engineer who belongs to a certain grouping. Do I have the necessary competence, etc.? They have got the competence and have got the sense of responsibility. They have an awareness that they are working in a public domain. That is the typical profession. In fact, I have mentioned of taking the

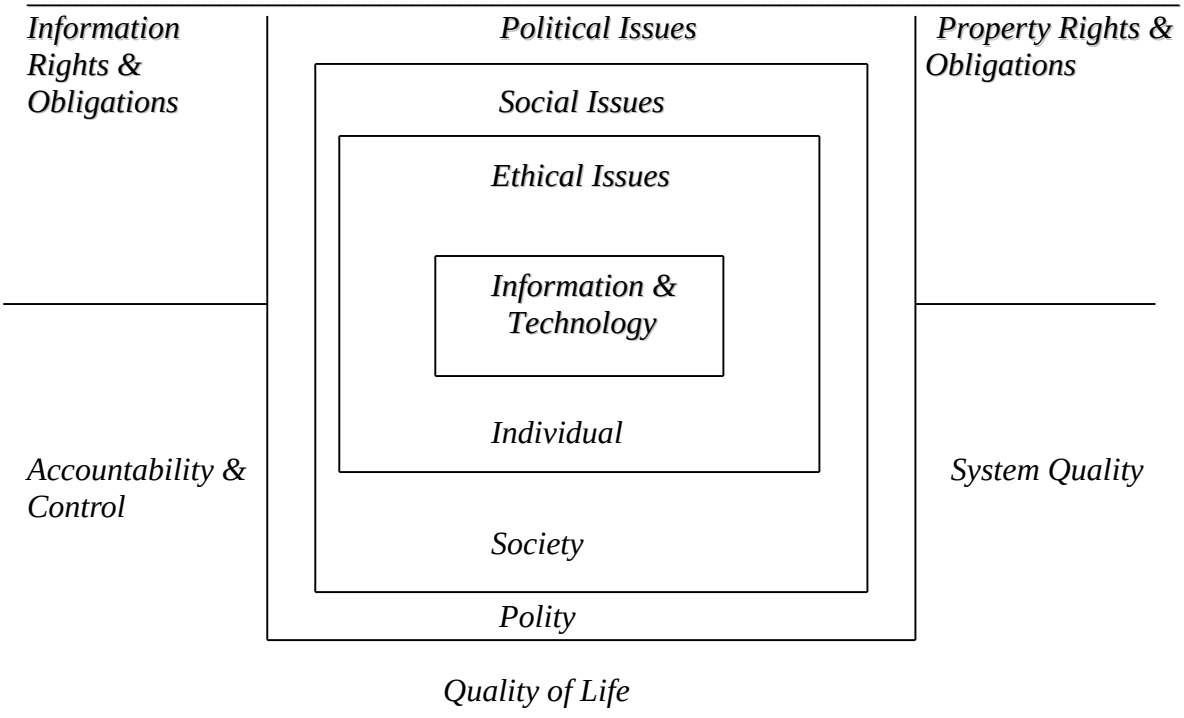
responsibility. In case of Gujarat earthquake, what happened? Persons concerned say that I have done it long back. Even a software engineer does so. We try to absolve ourselves of everything but we have got to admit the responsibility. We must admit the responsibility in some way. "Professionalism" typically signifies a tempering of technical competence with an acknowledgement of responsibility and an awareness of society and the public as key stakeholders.

We, engineers, must have a code as it is the hallmark of a profession. Tendency of sticking to a code means you want to be the member of a profession and appreciate and accept these particular lines of code: A Professional Code serves to define acceptable behavior, to promote high standards of practice, to provide a benchmark for self evaluation, as a framework for professional behaviour and responsibility, as a vehicle for occupational identity and as a mark of occupational maturity

The moment we talk of code and all that, we must talk about ethics. It talks about right or wrong. If According to K. Laudon, "Principles of Right and Wrong used by Individuals as Free Moral (moral means you are aware that there is some choice in it) Agents to guide behaviour". If choice of right or wrong is up to the person concerned, it is the question of ethics. Business Ethics is the study of how personal moral norms apply to the activities and goals of commercial enterprise. Business Ethics generally dwells on what is right or wrong in the workplace and doing what's right -- this is in regard to effects of products / services and in relationships with stakeholders.

There appears to be some confusion between ethics and law. Law reflects society's MINIMUM norms and standards of business conduct. There is a great deal of OVERLAP between what's legal & what's ethical. Law-abiding behavior is generally believed to also be ethical. There are many particular situations not covered strictly by law that fall under the umbrella of "ethical dilemmas." Laudon has made a good analysis of social, political and ethical issues and it has been shown in the following sketch.

Ethical, Social & Political Issues (Laudon)



How to distinguish between these various issues? Let us talk a little bit about IT. In the morning session, everybody was speaking against IT. If you look into the matter of dilemma, you have political issues, social issues and ethical issues. Individual, society and polity, the whole society. You can have various aspects which affect the lives of people, say, quality of life, property rights and accountability.

Just as engineer you are as clear as possible about efficiency and effectiveness, you must be as clear as possible about responsibility and accountability. RESPONSIBILITY is accepting costs, duties, obligations for decisions and ACCOUNTABILITY is assessing responsibilities for decisions & actions. LIABILITY is that you must pay for legal damages and DUE PROCESS is that you must ensure that laws are applied properly. So, next is how to put ethical analysis to work. Typical approaches are arguing from example, analogy and counter-example; Identifying stakeholders in concrete situations; Identifying ethical issues in concrete situations; Applying ethical codes to concrete situations; and Identifying and evaluating possible courses of action.

Say, somebody has said that the AICTE asks for so many lakhs of rupees. You must analyse such situations by examples. In the example considered, who is going to be affected: students, university, the institution, and in what way. This is another way of analyzing. Identify the issues of the complex situation.

In Indian philosophy we have our own guidance from the Bhagawad Geeta which is excellent. You can study that. You will come to know how to have the ideas of being responsible. There are four types of ways of looking at the problem. Ethical behaviour is guided by these four theories:

I Duty : create a good society by having people do the right things

2 Pursuit of happiness : choose an act resulting in the greatest good for the greatest number

3 Pursuit of virtue: Creating a good society by having each agent be a good person

4 Pursuit of justice: Enjoy, so far as possible, an equal opportunity to develop knowledge, skills and talents, and to reach potentialities

The following is a beautiful practical way of addressing ethical tensions for professionals:

- Consider broadly who is affected by their work;
- Examine if they and their colleagues are treating other human beings with due respect;
- Consider how the public, if reasonably well informed, would view their decisions;
- Analyze how the least empowered will be affected by their decisions;
- Consider whether their acts would be judged worthy of the ideal professional….

(Ref ACM/IEEE CS SECEPP)

The above approach is so good that you can simply forget what I have talked till now and remember it. By keeping these principles in mind, you can solve 99 out of 100 problems. Ethical decisions require

- Competence to recognize ethical issues and to think through the consequences of alternative resolutions.
- Self-confidence to seek out different points of view and then to decide what is right at a given time and place, in a particular set of relationships and circumstances.
- Tough-mindedness : the willingness to make decisions when all that needs to be known cannot be known and when the questions that press for answers have no established and incontrovertible solutions.

This is about the Software Code of Ethics & Professional Practice. The 8(eight) principles of the Software Engineering Code of Ethics are Public Interest, Best Interests of Client & Employer, Product to meet

highest professional standards, Integrity & independence in professional judgment, Ethical approach in software development & maintenance, Advance the integrity and reputation of the profession (this aspect of advancing the profession is very important), Fair to and supportive of colleagues and Self: Lifelong learning & ethical practice. We have various types of codes like voluntary code in which if I feel that Engg. Council of India is doing a good job, I should abide by it and, similarly, we have The Institution of Engineers' Code or The IEEE Code. In Tatas, we have Tata Code of Ethics. In a Business Code, either hit out or get out as the door is not very far. Finally, having said everything else, a professional should b e informed about the Code both in broad guidelines and in interpretation, abide by the guidelines of the Code, set an example for subordinates and junior engineers, encourage constructive debate and awareness of issues, seek out issues and stakeholders involved, realize that a dilemma arises when both options seem equally good, be ready for a "drill down" process to find answers to the dilemma, seek out expert help and advice in case of need, have the courage to abide by the final choice and accept consequences and be prepared to accept new evidence if any, and formulate a response. The main thing is that the code of ethics must be practiced.

The following 6(six) points represent the hallmark of a professional:

- Integrity: Open, honest
- Independence - from secondary interests
- Impartiality: free of bias
- Responsibility: Personal Commitment
- Competence: Knowledge
- Discretion: Care

I have taken the above-cited materials from the followings:

1) "Showstopper or Showcase Ethics & the IT Professional" published in CSI Communications, June 2005 (Anthony Lobo)
2) Presentation at IEEE Sections Congress 2005, Tampa FL, USA, Ethics Track. "Making the IEEE Code of Ethics Relevant to the Sections", 14-17 Oct., 2005
3) "Essentials of Management Information Systems" 5/e, Laudon & Laudon, Pearson, 2002, NY
4) VIEW & DOWNLOAD THE IEEE-CS/ACM SOFTWARE ENGG CODE (pdf format) at : http://csciwww.etsu.edu/gotterbarn/secepp/page.asp?Name=Code
5) Also largely based on insights from the process of Management of Business Ethics in Tata Consultancy Services

Issues of ethics are complex A professional should:

- Be informed about the Code both in broad guidelines and in interpretation
- Abide by the guidelines of the Code
- Set an example for subordinates and junior engineers
- Encourage constructive debate and awareness of issues
- Seek out issues and stakeholders involved
- Realize that a dilemma arises when both options seem equally good
- Be ready for a “drill down” process to find answers to the dilemma
- Seek out expert help and advice in case of need
- Have the courage to abide by the final choice and accept consequences
- Be prepared to accept new evidence if any, and formulate a response

A Study of US Model for Engineering Education and its Relevance to India

by
Prof. C. V. Ramakrishnan
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I will mainly concentrate on the issues involved in Engineers and Engineering Education for 2020. Well, a lot has been said regarding how the engineers of 2020 should be. What are the challenges facing the 21st century engineers and what is the environment under which they have to work. Outstanding technological innovations are taking place at an astonishing pace. Apart from Information Technology - which has been much talked about, new technologies, namely, Bio-Technology and Nano-Technology are going to have much influence. The other divisions of science, which are going to have enormous influence in the 21st century, are the relationships between macroscopic, microscopic materials and structures at molecular, atomic and subatomic level. Biological Engineering is something which will look at the biology of engineering materials thereby enhancing the quality of life. It is a totally new branch of engineering having immense potential apart from Bio-Technology and Nano-Technology. Bio-Technology is influenced by our understanding of Biological engineering.

One of the great dangers to engineering is the ongoing "Physiczation" of the field. In USA, most engineering programs are hiring large number of Physicists and the focus of many programs is rapidly shifting from the development of technology to the study of first principles. A result of this shift is a growing disconnection between undergraduate engineering students and the faculty that should be training them. The future of engineering depends on the development of technology from nanotechnology to biotechnology. Our goal is to ensure effective engineering education. It should be pursued within the context of a comprehensive examination of all relevant aspects of the interrelated system of engineering education, engineering practice and the global economic system. Engineering education must be realigned to promote attainment of the characteristics desired in practicing engineers; and this must be done in the context of an increased emphasis on the research-base, underlying conduct of engineering practice and engineering education. This will require that action be taken by key stakeholders, particularly engineering faculty and the engineering professional societies.

Engineering education for 2020 and beyond will require a variety of skills which are not commonly taught in universities today. According to Leah Jamieson, Dean of Engineering at Purdue University and 2007 the need to teach attributes like creativity, flexibility, leadership and business acumen will drive a demand for an "exponential" approach to education. What are the issues before the engineering profession in 2020? The challenges that the 21st century engineers are expected to face are physical infrastructure, information and communication infrastructure, the environment - degradation, global warming, energy, ecological sustainability, green engineering, technology for aging population and pace of change. Biological engineering is totally a new branch of engineering with immense potential. The three key attributes of the engineer of 2020 are: design and problem solving skills, interdisciplinary competence and contextual competence.

Within a very short time of 20-30 years, so many things have happened, including development in the field of computer technology; and within another 30 or 40 years, things will become quite common and engineering education should be prepared for handling these things. The pace at which the new technologies are coming is phenomenally rapid. These advancements are going to have a great impact on

the life and healthcare systems. The future engineers should not neglect the impact of these advancements on the aspects of life and healthcare.

It is well known that the engineer of today is a global engineer. If the computer is manufactured in China, its hard-disk is comes from Singapore and other parts are coming from the different locations of the globe like Taiwan and Australia. Engineers will have to cope up with this development. Multi- language and effective communication skills will have be learned and used by the 21st century engineers. By 2020, 56% of population will be in Asia, 16% in Africa and only 25% in western hemisphere and Europe. By 2020, 37% of US population will be non-white; and by 2050,it will be more than 50%. Urban settlements in developing nations, who are not affluent, will face major problems which need to be addressed. There will be also the energy and ecology crisis to be tackled. By 2020, a sizable population will be elderly and apart from handling the healthcare, the economic stress will be enormous. Senior engineers may have to work out of economic necessity. They will need training to meet the situation squarely.

Internet and advanced telecom have resulted in work being outsourced to India and China, manufacturing to China and design and manufacturing are carried out by the global teams. The developing nations will have to have the right kind of skilled engineers for producing goods and services for the whole world. Seamless Engineering education only will enable them to have such a workforce for meeting this emerging challenge. Besides,the developed western countries are realizing that the future business lies in Asia only. This realization has also dawned on the developing countries in Asia, particularly China and India. Already, we are finding healthcare to be extremely unaffordable. In future, it is going to be much more complicated. Obviously, governments and societies should be prepared for that. So, you will find engineers of 70 years working, out of sheer necessity because, otherwise, they cannot take care of themselves.This is, therefore, going to be the future scenario. The Engineer of 2020 urges the engineering profession to recognize what engineers can build for the future not just through technical jobs but through a wide range of leadership roles in industry, government, and academia. Engineering schools should attract the best and brightest students and be open to new teaching and training approaches. With the appropriate education and training, the engineer of the future will be called upon to become a leader not only in business but also in nonprofit and government sectors. The next several decades will offer more opportunities for engineers, with exciting possibilities expected from nanotechnology, information technology and bioengineering. Other engineering applications, such as transgenic food, technologies that affect personal privacy and nuclear technologies, raise complex social and ethical challenges. Future engineers must be prepared to help the public consider and resolve these dilemmas along with challenges that will arise from new global competition, requiring thoughtful and concerted action if engineering is to retain its vibrancy and strength.

We have not been able to tackle the normal disaster and extreme event prediction and management. Disaster mitigation is a very major area. We find ourselves unable to cope up with simple earthquake, tsunami and cyclone conditions. These are the issues the future engineer has to address. Obviously, environmental engineering and related topics and energy engineering have to be accorded much greater priority. The kinds of crises, which can result from such conditions due to improper management, are very serious. So, training of our engineers to handle such natural events and also other manmade crises and making them sensitive to these matters is a must. Apart from that, flexibility, sensibility, dedication will have be the root properties of engineers. Engineering education will have to be monitored, keeping all these things in view. Various models of engineering education will have to be thought about.

I agree with the observation made regarding the present All India Council for Technical Education (AICTE) controlled administrative mechanism of the technical education in India. I have been indirectly

associated with the AICTE and therefore, am fully aware of the problems faced by the technical institutions. The fundamental problem here lies in the lack of autonomy which includes not only in setting the curricula but also in the administration. The whole thing should be much more flexible and much easier and that is the key. A lot has been talked about the IITs. One fact is that IITs are doing well because of getting good students at the intake level itself and after that they are groomed into world class engineers in an flexible and autonomous system. What must be remembered is that the best engineers, who are staying in the country from IITs, are our M. Techs and PhDs. They are the people who launch our rockets, have created our atomic power plants, etc. We take a lot of benefit by riding over our intelligent undergraduate students but by creating an environment where we are able to attract the best talent. This is not the case unfortunately with the other engineering colleges. This must be reversed through bringing in appropriate reforms in the administrative mechanism of the engineering education in the country. This is another important point after seamless engineering education which needs also to be kept in view while suggesting the change

There was a mention about the low salary of teachers of the engineering colleges. The teachers of an IIT are not getting more than whatever a university professor gets. There are 600 people in every IIT who are PhDs from US Ivy league institutions and other renowned places getting the pay at par with the teachers of the other engineering colleges. Let us persuade the state governments to give more grants to enable us to attract good students. The environment prevailing in the normal engineering colleges should be upgraded to that prevailing in the IITs. According to the National Academy of Engineering, it should be made known to the public what the engineers are doing.

In view of the fact that an engineer is directly launched into the profession which is not so in the other professions like medicine etc. the U.S. system of engineering education is under consideration for changes.I will request you all to look at the website of the National Academic of Engineering (NAE) of United States and study it.

In sum: Engineers for 2020 should be competent to address world's complex and changing challenges, should be well grounded in mathematics, applied science, humanities, social sciences and economics. They should be able to make interdisciplinary efforts into other non-engineering discipline; should serve as positive influencers of the public policy and governance. They should develop technologies for economical sustainable development; should accept global trends and arrive at a balance in the standard of living for developing and developed countries alike; should recognize rapid pace of change in the world and the lack of predictability and should be responsive to disparate learning styles.

Attributes of Engineers in 2020

Attributes of Engineers in 2020 include strong analytical skills, practical ingenuity, creativity, good communication skills, leadership qualities, business management skills, high ethical standards, personality, dynamism, agility, resilience and flexibility.

Engineering Education System for 2020

1. The B.E Degree should be "pre engineering" degree
2. The system should recognize a 'professional masters degree an

   accredited Master Engineer - AME.
3. Explicit novel models for B.E degree.
4. The four year engineering curriculum should be taught from the earliest stages

5. Endorse research in engineering education
6. New standards for faculty qualification etc.,
7. Lifelong learning program- executive programs
8. Study case studies of Engineering Success and Failures
9. B.E Schools to work with local community colleges
10. Encourage / Reward those who aspire for M.S / Ph.D
11. National effort to improve engineering awareness in schools. Public education regarding engineering
12. Introduce Interdisciplinary learning at UG level

References

1. National Academy of Engineering The Engineer of 2020, The National Academic Press, Washington D.C, 2005
2. National Academy of Engineering Educating the Engineer of 2020, The National Academic Press, Washington D.C, 2005

INAE Report " Salient Issues in Higher Technical Education", 2005

List of Delegates

2nd National Convention on Seamless Engineering

May 31, 2007

S. N.	Name
1.	A. B. Lele
2.	Dr.A. K. Singh
3.	Lt. Col. A. K. Singh
4.	A. P. Bhagvanani
5.	A. P. Mehta
6.	Prof. A. R. Chudasama
7.	Dr. A. S. Patel
8.	Abhishek Shrivastava
9.	Alok Ghoshal
10.	Anthony Lobo
11.	Arun B. Shah
12.	Dr. Ashok K. Mittal
13.	Dr. C. Chandramohan
14.	Prof. C. V. Ramakrishnan
15.	D. G. Roheda
16.	D. H. Trivedi
17.	Prof. D. K. Basa
18.	Dr. D. L. Shah
19.	D. M. Mehta
20.	D. S. Jain
21.	D. S. Pradhan
22.	Deepak Pradhan
23.	Deepak Singhal
24.	Dilip Gorana
25.	Dilip S. Kanetkar
26.	Esha P. Sudhir
27.	G. C. Sahsrabudhe
28.	G. Chauhan
29.	Dr. G. H. Thanki
30.	G. S. Grewal
31.	H. C. Chauhan
32.	H. J. Thakar
33.	H. S. Choksi
34.	H. T. Dalal
35.	J. B. Sonar
36.	J. M. Davis
37.	Prof. K. Baba Pai
38.	K. M. Tamboli
39.	Kalpna Singh
40.	L. J. Rohekar
41.	L. Pugazanty
42.	M. A. K. Babi
43.	M. D. Mistry
44.	M. N. Patel
45.	M. P. Singh
46.	Dr. Manoj Soni
47.	Mayank Cholksi
48.	Mohsin Ansari
49.	N. Bhatt Kashyap
50.	N. C. Sham
51.	Neeraj Baji
52.	Dr. P. A. Krishnamoorthy
53.	Prof. P. B. Joshi
54.	P. D. Patel
55.	P. G. Mewada
56.	P. K. Ghosh

S. N.	Name
57.	P. N. Shali
58.	Prof. P. Prabhakaran
59.	Pooja Kamath
60.	Prof. Prabhakar
61.	R. D. Engineer
62.	R. R. Bhati
63.	Dr. R. Sengupta
64.	Dr. R. Vaghmare
65.	Prof. Raja Kumar
66.	Rajen Patwa
67.	Dr. Rajendra Kumar
68.	Rajendra Sompura
69.	Ronak J. Shah
70.	Roochay Shukla
71.	Rupali Jain
72.	S. C. Agrawal
73.	S. C. Bohra
74.	Prof. S. C. Khurana
75.	Dr. S. K. Dutta
76.	S. Laxminarayan

S. N.	Name
77.	S. P. Dabke
78.	Dr. S. R. Rawal
79.	S. Ratnavel
80.	S. Sangeet
81.	S. Siva Subramarnian
82.	Dr. Sandeep Bhattacharya
83.	Dr. Shailendra Tamotia
84.	Shravan Kumar
85.	Sumant R. Shah
86.	Sunil D. Kahar
87.	Tushar Agarwal
88.	U. K. Dwivedi
89.	Dr. Uddesh Kohli
90.	V. Eswaran
91.	V. J. Badhera
92.	Prof. V. L. Gadgeel
93.	Dr. V. Srinet
94.	Vaidehi B. Sheth
95.	Vasavada
96.	Vishesh J. Badhekha
97.	Yogesh Vohra

Board of Governors

Chairman

Dr. Uddesh Kohli	Chairman Construction Industry Development Council

Vice -Chairman

Dr. P. S. Rana	Patron Institute of Urban Transport (India)

Treasurer

Chander Verma	President, International Council of Consultants & Chairman, Indian Society for Trenchless Technology

Members

Dr. S. K. Jain	All India Council for Technical Education (AICTE)
S. Ratnavel	Chairman, Task Force, Engineers Bill Committee & Professional Development Committee, Association of Consulting Civil Engineers (I)
Dr. A. R. Upadhya	Council of Scientific & Industrial Research (CSIR)
P. R. Swarup	Director General Construction Industry Development Council
Shrikumar Ghosh	President Consulting Engineers Association of India
Rajeev Kher	Joint Secretary Department of Commerce, Ministry of Commerce and Industry
Prof. D.V. Singh	Vice President Indian National Academy of Engineers
Dr. Jose Kurion	Vice President Indian Concrete Institute (N)
A. Chakraborti	President Indian Buildings Congress
D. P. Misra	Past President Indian Institute of Chemical Engineers

Maj. Gen. S. Mukherjee	President, Indian Geotechnical Society & VC, Laxmibai National Institute of Physical Education
Prof V. N. Rajasekharan Pillai	Vice Chancellor Indira Gandhi National Open University (IGNOU)
Lt. Gen. (Retd.) A. K. Puri PVSM, AVSM	Chairman Indian Institution of Bridge Engineers (DSC)
J. S. Saluja	Member Indian Institution of Plant Engineers
K. Viswanathan	Immediate Past President Indian Society for Non Destructive Testing
Niranjan Swarup	Executive Director Indian Society for Trenchless Technology
A. K. Sinha	Ministry of Urban Development, Govt. of India
Dr. Placid Rodriguez	Past President The Indian Institute of Metals
N. T. Nair	Chairman-India Council The Institute of Electrical and Electronics Engineers Inc.
S. Narayana	President The Institution of Electronics and Telecommunication Engineers
Ashok K. Sehgal	Member The Institute of Marine Engineers (India)

Executive Committee

Dr. Uddesh Kohli *Chairman, ECI*	Chairman, Construction Industry Development Council
Dr. P. S. Rana *Vice Chairman, ECI*	Patron, Institution of Urban Transport (India)
Mr. Chander Verma *Treasurer, ECI*	President, International Council of Consultants Chairman, Indian Society for Trenchless Technology

Members

Mr. Srikumar Ghosh	President, Consulting Engineers Association of India
Mr. P. R. Swarup	Director General, Construction Industry Development Council
Mr. P. N. Shali	Director, Engineering Council of India

Glimpses of the Convention

2nd National Convention on Seamless Engineering
held on May 31, 2007
at MS University of Baroda, Vadodara (Gujarat)

Opening Session

Prof. S.M. Joshi, delivering Inaugural Address

Dr. Uddesh Kohli, delivering Welcome Address

Registration of Delegates in progress

View of Delegates

Members of Engineering Council of India (ECI)

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

1. Association of Consulting Civil Engineers (India)
2. Broadcast Engineering Society (India)
3. Computer Society of India
4. Construction Industry Development Council
5. Consultancy Development Centre
6. Consulting Engineers Association of India
7. Indian Association of Structural Engineers
8. Indian Building 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 Trenchless Technology
18. Institute of Urban Transport (I)
19. International Council of Consultants
20. The Aeronautical Society of India
21. The Indian Institute of Metals
22. The Institute of Electrical & Electronics Engineers, Inc., India Council
23. The Institute of Marine Engineers (India)
24. The Institution of Electronics & Telecommunication Engineers
25. The Institution of Surveyors

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