Engineering Council of India

5th National Conference

on

Role of Engineers and Technologists in the Fast Growing Indian Economy

November 5 2007

PROCEEDINGS

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Dr. P.S. Rana
Vice Chairman

Mr. Chander Verma
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Engineering Council of India

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Edited Proceedings

5th National Conference on Role of Engineers and Technologists in the Fast Growing Indian Economy

Introduction

The approach to the 11th Plan document states "there is considerable evidence that the industrial sector has gained in strength in many ways over the past fifteen years as a consequence of liberalizing industrial controls and the gradual integration with the world economy". The surge in industrial production in 2005-06 and 2006-07 provides further evidence in support of this assessment. The 11th Plan is contemplating to aim at raising the rate of growth of the industrial sector to 10% and manufacturing growth to 12% per annum. The most critical short-term barriers to growth of the manufacturing sector are absence of world-class infrastructure (power in particular), shortage of skilled workforce (engineers), etc. The 11th Plan is likely to place special emphasis on infrastructure and skill formation."

The demand for engineers in the 11th Plan will grow on two counts: one because of a higher industrial and manufacturing growth and the second due to opening up of the services sector which includes engineering services. In order to meet this challenge, we inter alia need to have engineers of professional experience of international standards (largely those set by the Engineers Mobility Forum (EMF) - a world grouping recognizing member countries engineers' professional standards). Engineering Council of India (ECI) has developed the Systems and Procedures for professional engineers, for their continuing development and ethics and morality which are equivalent to that of the EMF. Though India produces around a little more then 4 lakh engineers every year, many do not meet the quality standards. According to a survey report of McKinsey, multinationals find around 25 % of Indian engineers only employable. This is attributed to the present mismatch in the skills that industry needs and the institutions of training and development provide. According to the Round Table confabulation organized by the FICCI on Industry-Academia convergence to match skills (of engineers) with business needs, an efficient and effective working industry-academia interactive mechanism would also have to be created for keeping our training and development of engineers on the required track ensuring thereby no mismatch in the skills that industry needs and what the institutions of training and development provide in a fast growing economy.

From the R&D side also, demand for postgraduate engineers and PhDs is going to be much higher as against the present level. This contention is supported by the U.R. Rao Committee which has projected that India needs well over 10,000 PhDs and twice as many M.Tech Degree holders for meeting its huge R&D needs. As against this, the country produces barely 400 engineering PhDs a year! In order to match the rising demand for these skills, a big push will need to be given to the output of both PhDs and M.Tech degree holders.

According to the approach paper to the 11th Plan, construction sector has been growing at over 10% per year over the last five years and the infrastructure development has been identified as a major thrust area. The demand for engineers of many disciplines from this sector will also be higher when compared to what it has been hitherto. As a matter of fact, we need construction engineers as such for this important sector which we may have to produce through appropriate seamless engineering education at the undergraduate level.

The growing information and communication and tourism sectors will also throw a higher demand for engineers. From the supply side of engineers, we will have to assess the position and take appropriate action for meeting the demand of engineers of international standards. Besides, newly passed out engineers would need considerable time to become seasoned professionals as there are no structural initiatives available to help them absorb industry skills. It will be worthwhile to consider the possibility of consultants helping in reducing the supply deficit. They can as well help the newly passed out engineers to acquire industry - specific skills through personnel training and guidance.

OBJECTIVE

The objective of the 5th National Conference was to take a closer look on the role of engineers and technologists in the fast growing Indian economy. Many issues have been raised, as outlined above. These issues need in - depth consideration for ensuring availability of world -class engineers so that it does not become a serious constraint in realizing the higher growth of the economy in the 11th Plan and beyond. The Conference took a look at the demand and availability of engineers and technologists, R&D professionals, role of consulting engineers and technologist, role of the engineering professional associations in the CPD of engineers in the growing economy and suggested measures for bridging the gap. Finally, the conference also looked at the certification issue of engineers.

PROGRAMME

OPENING SESSION

Welcome Address	:	Dr. Uddesh Kohli, Chairman, Engineering Council of India
Theme Address	:	Dr Ajeet N. Mathur, Director, Institute of Applied Manpower Research
Address by the Guest of Honour	:	Prof. V.N. Rajasekharan Pillai, Vice Chancellor, IGNOU
Inaugural Address by the Chief Guest	:	Dr. Kirti S. Parikh, Member, Planning Commission
Vote of Thanks	:	Shri Chander Verma, , Chairman Construction Industry Development Council, President International Council of Consultants, President, Projects Export Promotion Council and Treasurer, Engineering Council of India

TECHNICAL SESSION – I

Demand Projections & Availability Scenario of Engineers and Technologists

Chairman	:	Shri S.Ghosh, President CEAI
Keynote Speaker	:	Dr Placid Rodriguez, the Raja Ramanna Fellow and AICTE-INAE Distinguished Visiting Professor, Department of Metallurgical and Materials Engg., Indian Institute of Technology, Madras, Past President of the Indian Institute of Metals and a Distinguished Nuclear scientist
Keynote Speaker	:	Shri P. R. Swarup, Director General, Construction Industry Development Council
Keynote Speaker	:	Prof. C. V. Ramakrisnan, Prof. Emeritus, IIT, Delhi
Keynote Speaker	:	Dr. Manoj Kulshreshtha, Prof. IGNOU
Keynote Speaker	:	Dr. Ranjan Moodithaya, Head, KTMD, National Aerospace Laboratory, Bangalore

TECHNICAL SESSION – II ;

Options Available for Meeting the Gap

Chairman	:	Shri N.T. Nair, Chief Editor, Executive Knowledge Lines Monthly and Chairman, IEEE India Council
Keynote Speaker	:	L Pugazhenthy, Vice President and Chairman, Non Ferrous Division, the Indian Institute of Metals and Executive Director, Indian Lead Zinc Development Association (ILZDA)
Keynote Speaker	:	Shri Alok Ghosal, Projects (VE), Central Project Engineering Division, Tata Steel

TECHNICAL SESSION – III

Quality Considerations and Role of Professional Associations in CPD

Chairman		:	Shri D P Misra
	Keynote Speaker	:	Shri K Viswanathan, Immediate Past President, Indian
		:	Society of Non Destructive Testing
	Keynote Speaker	:	Shri Ranjit Sinha, Development Specialist at Kransu Qb
	Keynote Speaker	:	Prof. Seshadri Bose, Department of Mechanical Engineering, ABES Engineering College, Ghaziabad.
	Keynote Speaker	:	Shri R K Abrol, Chartered Engineer

CONCLUDING SESSION

Keynote Speaker	:	Dr P.S.Rana, Vice Chairman, Engineering Council of India, Patron, Institute of Urban Transport and former CMD, HUDCO

ENGINEERING
COUNCIL OF INDIA

Engineering Council of India (ECI)

Objectives

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

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

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

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

16. To standardize criteria to be adopted for according status of "Professional Engineer" and "Consulting Engineer" and to accord licence/accreditation to practice engineering in India.
17. To identify major engineering disciplines in which substantial cross-border mobility is expected and to cater to those disciplines in which substantial cross-border mobility is expected and to cater to those disciplines in ECI's policies, practices and their registers/sub-registers.
18. To identify barriers to professional engineers' mobility and to develop and promote strategies, to advice and, if required, assist Central and State Government Departments, in managing those barriers in an effective and non-discriminatory manner.
19. To develop mutually acceptable standards and criteria for facilitating cross-border mobility of experienced Professional Engineers and Consulting Engineers among WTO signatories.
20. To establish such committees, as may be necessary, for reciprocal joint activities with similar professional bodies in other countries who are signatories of WTO and other related agreements.
21. To network and cooperate with other such international bodies/for a who are engaged in similar activities.
22. To perform any or all other acts, deeds and things, which may become necessary to be performed at any stage to achieve the main objectives of improving the image of the engineering profession and of the professional engineer and to serve the needs of the society.

TASKS

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

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

Engineer's Bill

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

Membership

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

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

EXECUTIVE SUMMARY

EXECUTIVE SUMMERY

Dr. Ajeet N. Mathur - There is worldwide shortage of engineers and technologists at the moment and there are considerable cross-border opportunities for Indian engineering professionals and technologists abroad. But, these don't directly translate into opportunities for the Indian talent because there are many intervening variables. Most importantly, in the WTO environment, the largest portion of revenue arises in Mode 3 of the trade in services which creates dependant services in other countries besides creating a footprint abroad which facilitates both technology access and market penetration. In Mode-3, a significant human relocation is involved for which while it is certainly desirable that labour markets be free as much as the product markets, the portability and reciprocity in the structure of social security and immigration are formidable barriers and likely to remain so in foreseeable future. Modes 3 & 4 remain matters for bilateral negotiations with other countries. India has arrangements with Sri Lanka and ASEAN to some extent but is missing out a lot of opportunities in China, Brazil, Canada, Africa, Kazakhstan and Central Europe, to mention a few. The other issue here is the mutual recognition of professional qualifications and experience between India and abroad which can open many new avenues. The progress on this is slow.

There has been a considerable drop in all the engineering branches and technical specializations in India due to demand in the IT industry. While it is generally perceived that there is supply deficit of engineers in India, the National Technical Manpower Information System (NTMIS) database has recorded year after year that about half of the engineering graduates especially diploma-holders remain jobless even two years after graduating and the waiting time has increased for all the branches of engineering. The worst affected is civil engineering and the least affected is mechanical engineering. It is, therefore, intriguing. The wages of the skilled workers and engineering diploma-holders have not been significantly above minimum wages in most cases. Coming to the supply side constraints, the greatest supply side constraint is teacher and the relevance of curricula. Degree-granting institutions in our country, by design, post graduates in engineering and technology need PhD teachers. By this logic, there is a shortage of more than 77,000 teachers in engineering and technology.

Prof. Rajsekharan Pillai - As mentioned in the theme address, mutual recognition of qualifications and a national qualification framework linking engineering profession with other professions is very essential. The country is set to prepare a national qualification framework, at least, in the technical-related area. Only when there is a mutual recognition of qualifications and a national qualification framework, there may be professional mobility across disciplines, mobility within the country; and a transnational mobility is possible only when the national qualification framework is in conformity with the international qualification framework. We have to have a national qualification framework combining the higher levels of engineering education with normal levels of vocational education and related areas. So, it is our duty to bring the level of competence of engineers and standards to that of a developed country. The Ministry of Human Resource Development has brought out a new scheme: National Programme for Technology-Enhanced Learning (NPTEL) - a joint activity of seven IITs and Indian Institute of Science. IGNOU has been identified as the nodal agency to develop and deliver this programme. We have developed the programme and digitised it. We have to identify and then quantify the existing workforce with some prior learned skills and train them up to the level of knowledge and skills which the workforce of countries such as South Korea or any other developed country has and thus bring them up to the level of competency of the workforce of these countries. This will definitely enhance their capability, mobility and their acceptance all over the world.

Dr. Kirit S Parikh -We have targeted to have 9% plus growth of our economy in the 11th Plan. It will be possible only with good quality of infrastructure and availability of required power. Among other things, we will have to make investment of about 300-400 billions of dollars in the next five years for making sure that we realise this kind of growth rate. It implies that we need to have lots of construction going on; also we need to set up lots of plants. We need to expand power plants, ports and services. The manufacturing sector will also grow. All this requires engineers and skilled workforce. And this will have to be done not by just the public sector, but also a large part of the jobs will have to be created by the private sector. So, the demand for engineers will come up more from the private sector than the public sector.

The manufacturing sector does not require engineers merely to construct the plants and operate it, but also to see that the whole system of logistics and materials management, etc, operates in an effective and efficient manner. So, seamless engineering education is required for this. This is only one aspect. The other aspect is the availability of new technologies and more technologists. We do find that there is a large brain-drain of engineers taking place to other professions in the country. While brain-drain to the west may have ceased, there is a brain-drain of skills going to Finance. Engineers, who do not want to go for higher degrees like M. Tech. and PhDs, become finance managers. I think this is a huge drain of training that is taking place. We need to worry about it. The quality of life of engineers has to be improved so that people are attracted to this profession.

We have also to recognize that in this rapidly changing world knowledge has emerged as one of the most important factors of production. The 11th Plan, therefore, emphasizes and recognizes that we need to put a lot more money into education. We have proposed to spend four times as much money in education than we have spent in the 10th Plan. Getting vocational training is equally important. We have talked about innovative ideas in terms of vocational training to bring in private sector and private institutions to work in this area. We believe that many of our Industrial Training Institutes (ITIs) need involvement of industry so that the training they give is relevant. Private firms should also get into the vocational training business. Such public-private partnership in the area of vocational training will have a very important role to play in training our workforce for meeting the new challenges of the 11th Plan.

Prof. Mathur pointed out that we are not having shortage of engineers but are having shortage of properly trained engineers. Now nearly 4.5 lakh engineering graduates and technical persons come out every year in our country. But, according to some estimates, only one-fourth of them are employable. Whose fault is this and how can we improve upon this? We know that controls do not necessarily work. For example, all these 4.5 lakh technically trained people are coming out of AICTE-certified institutions. So, that kind of certification of institutions does not simply work. If AICTE has done its job correctly, then all these 4.5 lakh persons should be employable. The question then arises what should we do? First, I think what we need to do is to provide incentives to the institutions for improving their quality. Secondly, the professional engineering societies in India should have a role in setting the standards and in the accreditation mechanism of the engineering education in India. Thirdly, these societies should also certify engineers by testing them as per their standards.

Dr. Placid Rodriguez - India will become a major economic power in the world by the year 2050 if not earlier. It was predicted in year 2003 in the Goldman Sachs Global Economics Report No: 99. In fact, the

report predicted a growth rate of 6.5% in India, but the growth since the year 2003 has already surpassed growth prediction of the said Report. There is unanimity among all the growth forecasts and economic analyses made in recent years that by Year 2050, India will be within the top four economies of the world. The total Power Sector in India will need 200,000 Power Engineers and over 800,000 Technicians. In addition, technical manpower will be required for Construction and Fabrication Industries, and India will also have to prepare to supply to other nations. The Nuclear Power Sector, based on DAE current estimates, will require more than.50, 000 Engineers/ Scientists and 200,000 Technicians by 2052. To quote example, nuclear resurgence and renaissance in USA will need HR inputs from India as no reactor has been built in USA since 1979. They have missed 3 generations of nuclear technologists. If the HR needs are not addressed by planning, and training on a long term basis, by 2030, the growth will be hampered by a new shortage in Human Resources. It is assessed that 30% of the current nuclear workforce would retire within the next five years and there is hardly any nuclear-specific training being conducted by the engineering institutions. Perhaps, much of the supply is not employable and, therefore, more of the same is not going to solve the problem.

P. R. Swarup - Construction happens to be at the top of every development project. Construction industry has been growing at the pace of almost 15% per annum. At this growth rate, the construction industry alone needs about half a million engineers. We need multi-skilled construction engineers to do construction and not the civil engineers. Let us, for a moment, assume that civil engineers are needed, we do not have them in numbers that the construction industry needs. If we look into the history of past 10 or 15 years, as a matter of fact what we find is that all the colleges that have been accredited by the All India Council for Technical Education (AICTE) do not find civil engineering as a branch. It is just not there. In the old colleges, there are limited numbers of seats. This is a serious matter. The second problem that we have today is where are the teachers who will teach construction engineering? Who is going to teach these people? Do we have adequate number of good experienced teachers who understand what is to be taught to these people so that when they go back to the construction industry and deliver what the industry is looking for? The third thing is how relevant is the curricula that are there in the colleges or in the universities to meet the actual needs of a construction industry?

Prof. C. V. Ramakrisnan - The Indian economy is growing fast at 9-10% GDP. It has higher growth in services and manufacturing sectors. There is a requirement of a very large higher technical education workforce. The need can be met by rapid expansion of higher technical education segment by private sector. There is uneven match/distribution between supply and demand among different disciplines in the human resources generation. Some levelling is taking place during recent years. Currently the engineering student intake is over 5, 00,000 per year including 2620 for IITs and 6200 of NITs and it is still growing. But there is an uneven match between supply and demand. A rough estimate of 2% workforce for R&D will mean 10,000 people with PhDs per year. The teaching profession alone will require 10,000 PhDs per year to sustain good quality teaching. Even assuming that educational expansion through distance education may mean reduction by 50%, the requirement is enormous. The present experience is that nearly 50% of PhDs are absorbed in the industry in non R&D occupations. Conservatively, we need to produce around 20,000 to 30,000 PhDs. The growing economy may need even more engineers considering that a sizeable fraction will be needed to meet the international demand. Thus, further expansion in terms of quantity will be necessary. Quality may be questionable. The weakest link in the higher educational sector appears to be post-graduate and doctoral-level training.

Dr. Manoj Kulshreshtha- The presentation highlights a joint initiative being contemplated by the IGNOU and Engineering Council of India (ECI) for repositioning of the Associate Membership Certificates in appropriate engineering disciplines granted by the Member Associations of ECI with that of an IGNOU degree by jointly working with these associations and with the support of ECI. It is for the benefit of large number of students who pursue engineering education informally via the Associate Membership (AM) route of the Member Associations of ECI. AM Certificates are not recognized as degrees by the industry in the matter of employment nor by the institutes of higher learning for the post-graduate courses. In the context of opening up of the trade in engineering services, it has become necessary that the AM holders should not be left out from this trade basket. These certificates are not recognized by the AICTE/DEC or any other equivalent body as such. It is generally seen that due to lack of structured training, the pass percentage of these examinations is very low. Finally, in the context of India becoming a full Member of the Washington Accord, in future, it will be possible only for the engineers holding an university degree to bid for jobs internationally and for mega projects in India.

Dr. Ranjan Moodithay- Connectivity is vital for economic development of country. Aerospace is rapid means of communication and transportation. The boom in aerospace sector has been phenomenal due to growth of interior regions and low cost carriers. Indian aviation growth rate is fastest in the world. All the aircrafts are imported. There is wide scope for civil aeronautics development in India. India has a total of 449 airstrips of which only 61 are used. There was 41% growth in domestic passengers in the year 2006. Emphasis is on regional operators' low cost carriers. India's focus is to provide connectivity to every corner of country. It is estimated that India will need 5000 aircraft in future involving $ 120 billion investment by 2020. Asia-pacific is the most important civil and pra-public growth market. By 2025, India will become world's largest civil aviation market. India will be requiring 20,000 to 25,000 engineers in the Aerospace Sector by the year 2025. The careers in aerospace sector cover varied fields. These include Systems engineers, Field service engineers and Analytical and Design engineers, Manufacturing and software engineers, Quality assurance engineers, Aircraft maintenance supervisors, Technical Specialists, Flight Research Engineers and Research Scientists. We will have to increase the supply of Aeronautical Engineers.

S.Ghosh - When we talk about the teaching, we talk about the PhD. It is not necessary to have only PhD teachers. Teaching requires both, academic knowledge as well as the ground experience of engineering practice. There can be about 70% non-PhD post-graduates. You can find excellent teachers from the industry. I think the belief that only PhDs can teach is misplaced. It needs to be discarded. We need to encourage experienced engineers from the field to teach college-level students.

L. Pugazhenthy - Since 1991, the macro economic reforms have completely transformed the country and the economy is witnessing a quantum jump growth. Since then, India is maintaining impressive GDP growth rates. The growth rate target for the economy in the XIth Plan is 9 %. India has emerged as the second most attractive investment destination after China and ahead of the US and Russia. In terms of Business Confidence Index, India is ahead of the US and next to China; around 45% of the global investors are upbeat about India. We need world - class infrastructure and employable qualified workforce, especially the technical workforce for meeting the new challenges and meeting our growth target squarely. Three lakh engineers come out of the technical institutions every year but only 20 % get the employment opportunity, it means 80% take sundry jobs or become unemployed. Continuous drift

of engineers' to InfoTech sector is leading to severe shortages in many engineering disciplines like that of metallurgy, mining, etc. Because of low priority, many seats remain unfilled, for instance, in civil engineering discipline. The demand for engineers in almost all engineering disciplines will grow many folds during the coming twenty years. We will have to gear up and match this demand. While doing so, we also should ensure that we produce engineers not only in quantity, but most importantly of the quality that the industry is looking for. A drastic overhaul of the higher technical education system including that of its accreditation mechanism is thus required for improving the quality of our engineering education. As a matter of policy, we should permit foreign institutions for higher education including technical education to invest in India so that we turn out the best skilled workforce not only for the Indian industry but also for the global industry.

Alok Ghosal - There will be a shortfall of metallurgical engineers for meeting the demand which will arise from the massive steel expansion plan ahead, not only in numbers, but also in quality. The only way to forestall this possibility is a complete overhaul of the present education system to "synchronize with global technological developments," applying Dr Eliyahu Goldratt's Theory of Constraints. Despite the industry's efforts to raise recruitment standards, there is a widespread perception that school standards are not meeting the needs of industry. The quality and relevance of education provision at all levels is of deep concern, because of the severe shortage of pupils studying mathematics, physics and chemistry, the key subjects for future metallurgists and materials scientists. Not only are employers looking for good levels of literacy and numeracy, they also need an education system that is capable of producing school and university leavers equipped with workplace skills such as communication, IT and problem solving.

N.T. Nair - Shortage of quality engineers and the difficulties faced by non-IT sector to fill the gaps is a well known phenomenon. In fact, what the industry is looking forward for those (engineers who are employable) who can be employed straight- away rather than trying to train them for the assigned task ahead. There is a gap between the need of the industry and the skill developed in academic institutions. To quote an example, what industry needs is readymade shirts, whereas they are getting cut pieces and they have to put these fresh engineer graduates to finishing schools. Technologies in the engineering field are changing very fast. The need of hour, therefore, for the working engineers is to update skills and continuing professional development. The salary of engineers also needs to be addressed.

K Viswanathan -There is mismatch of scientific manpower to the emerging technological challenges. According to the World Bank, while India has one of the world's largest stocks of scientists, engineers and technicians, this has not enabled India to face the emerging technological challenges because of the mismatch / inadequacy of education and training.

Ranjit Sinha- For building infrastructure in the XIth Plan, there is a need of competent engineers with diverse interface and multidisciplinary exposure having exposure to world-class engineering practices, tools and software. Further, for meeting the shortage of such engineers, the proposed solution calls for establishment of common facilities for clusters of engineering consultancy services termed Knowledge Manufacturing Units to replace conventional consortium approach having linkages with institutions, collaborations, etc. Engineers available in India are domain-specific, having vertical knowledge and lacking interfaces / linkages having multidisciplinary exposure of traffic, transportation, structures, etc,. Technologists available in India with application software exposure are mostly limited in top 30 towns and generally quality orientation is lacking.

Prof. Seshadri Bose- Rapid growth of technical education in the country during the last 10-15 years, both in terms of number of institutions and intake capacity, was perhaps necessary. But in the process, it is felt that some compromise was made with the quality of education, It is, therefore, necessary to consolidate and ensure quality education so as to provide world-class technical workforce and to usher in technology -driven economic development in the country.

D.P.Misra -The quality of the graduate engineers has been a point of concern, as expressed in all the sessions of this Conference. There is more of quantity than quality. Faculty shortage is producing unsuitable engineers. The private institutions do not want to pay suitably to faculty. The basic issue is that there has been a gap between the Industry and the Institutions imparting education. It is the need of the hour to legally define as to who is an engineer and lay down its globally compatible competency standards as has been done by the Washington Accord and Engineer Mobility Forum.

Dr. P. S. Rana -Engineers in India are large in numbers, but not of the right quality, right skills and right attitude. Our Institutions are producing quantity and not quality. We need quality technical workforce not quantity, as such. We are not putting in enough efforts for creative and innovative development. There is worldwide shortage of engineers and technologists at the moment and there are considerable cross-border opportunities for Indian engineering professionals and technologists. They can seize these opportunities only when Indian engineering degrees and experience are recognised world-wide. For this, India will have to be a full Member of the Washington Accord and the Engineers Mobility Forum. We need to address these issues.

OPENING SESSION

1.1 Dr. Uddesh Kohli

Engineering Council of India (ECI) was formed on April 4, 2002 by coming together of a large number of professional associations including institutions of engineers. ECI has come a long way since then. The Council started with the objective of working 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, for evolving a system of registration of professional engineers and consulting engineers, continuing professional development, developing code of ethics, drafting engineer bill and to enable the recognition of expertise of Indian engineers and their mobility at international level in the emerging WTO/GATS environment. The Council also made efforts for India joining international bodies such as Engineers Mobility Forum, Washington Accord, etc. India became a Provisional Member of the Washington Accord in 2007 for which the application was moved by the NBA-AICTE. Earlier, India had become the Provisional Member of the International Mobility Forum in 2003 for which the application was made jointly by the Institution of Engineers (India) and the ECI. The draft of the Engineers Bill was prepared and it was submitted to the Ministry of HRD in September, 2004. But then, there were problems in achieving consensus amongst the engineers in the country. A Committee was set up by the Ministry to achieve that consensus. We have arrived at a consensus draft of the Engineers Bill which has again been submitted to the Ministry around May this year. We understand from the ministry that it has gone to the Law Ministry for comments. Hopefully, the Draft Bill will be introduced in the next session of Parliament.

The other areas of activity of the ECI include setting up of a Resource Centre for the engineering profession, providing all the data about what is happening in India and in other countries and some progress has been made in that direction. We have started the Newsletter of ECI. We have been holding the National Conference every year successfully. Another area, on which we are working, is bringing about some change in the thinking about the educational system. We had two National Conventions on the topic Seamless Engineering, where we talked of a multidisciplinary approach where we focus on specialization in not just one area but on several specializations which are required today in the present complex world. We have been working on all these aspects and, I hope with the support of our member associations, the Council will continue working as a Confederation of the engineering associations, even after a Statutory Body is formed when the Act is passed, and will be the spokesperson for all of them

1.2 Dr. Ajeet N. Mathur

In 2006, Indian institutions added about 4, 30,000 engineering and technical professionals. The engineering profession has much to be proud of and I congratulate the Engineering Council of India (ECI) and its constituents (twenty-five engineering associations) for taking responsibility in standard-setting that you have taken upon your shoulders. Through the theme of this 5th National Conference,

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

'the Role of Engineers and Technologists in the Fast Growing Indian Economy', ECI has courageously caught the proverbial bull by the horns. However, I believe, you have also landed on the horns of a dilemma. The concept of role, in my understanding, comes alive only when the roles are systematically linked with tasks. So, I have to ask, does this conference's theme focus on those roles and tasks, which are the tasks of the ECI or does the conference theme aims to focus on new opportunities, new roles and new tasks arising in India and abroad from a new volley of changes across border flows that create opportunities for the current lot of engineers and technologists. Clearly, there is some overlap between these two aims but there can also be considerable conflict in the resource allocation of time and energy between these. As you prepare to deliberate and debate on the relevant issues important for your profession, let me briefly mention a few important issues.

First issue, there is worldwide shortage of engineers and technologists at the moment and there are considerable cross-border opportunities for Indian engineering professionals and technologists abroad. But, these don't directly translate into opportunities for Indian talent because there are many intervening variables.

Services constitute a very large segment of national economy compared to manufacturing, 54% in India, 50% in China and the tradable scope of services is expanding. There is a widespread belief that there are four modes of service delivery of cross-border supply. Mode1: consumption abroad. Mode 2: foreign commercial presence. Mode 3: movement of natural persons and Mode 4: perceives bigger role. Such reliance on mode 4 is misplaced. While it is certainly desirable that labour markets be free as much as the product markets, the portability and reciprocity in the structure of social security and immigration are formidable barriers and likely to remain so in foreseeable future. While all four modes of service delivery have been advantageous for specific types of engineering services and product service linkages, India's success has so far mainly been in Mode no. 1 based on IT and related services. Technology-based engineering work abroad continues to be led by North American and European firms worldwide. Despite their growing presence through subsidiaries, contractors and sub-contractors in India, industrial services such as design, evaluation, etc., can be achieved in Mode 2. But the largest portion of revenue arises in Mode 3 which creates dependant services in other countries besides creating a footprint abroad which facilitates both technology access and market penetration.

Mutual recognition of professional qualifications between India and abroad can open many new avenues and I was very encouraged to hear the remarks of Dr Uddesh Kohli that the ECI and the AICTE have made some progress in this regard. Unlike Mode 1 on which multilateral instruments have been enabled and which does not require significant human relocation, Modes 3 & 4 remain matters for bilateral negotiations with other countries. India has arrangements with Sri Lanka and ASEAN to some extent but is missing out a lot of opportunities in China, Brazil, Canada, Africa, Kazakhstan and Central Europe, to mention a few.

The second issue, I wish to highlight, is the supply deficit of engineers and technologists in India. There has been a considerable drop in all the engineering branches and technical specializations due to demand in the IT industry. The IT industry is growing and coping with shortages at the high global rate. It is said that in many IT campuses billboards have come up that proclaim trespassers will be recruited. Fresher in engineering colleges and technological institutions are being offered appointments for 2011 and 2012, it is certainly a significant renovation in forward contracting and advance reservation systems. At the same time, the first generation of IT professionals have plateaued

Professor (Dr) Ajeet N. Mathur *is the Director, Institute of Applied Manpower Research (IAMR)*

and many are retiring or turning to other professions, which bring to the fore the problems intrinsic to the IT industry where new technology platforms and emerging organizational structures create rapid obsolescence. Meanwhile, employers of engineering and technical professionals, who wish to recruit degree-holders, diploma-holders and certificate-holders, are complaining of acute shortages. This gives the impression that there is a shortage in supply. It is, therefore, intriguing that the National Technical Manpower Information System (NTMIS) database has recorded year after year that about half of the engineering graduates especially diploma-holders remain jobless even two years after graduating and the waiting time has increased for all the branches of engineering. The worst affected is civil engineering and the least affected is mechanical engineering. To get a sense of what is really happening since we have census data of all engineering institutions and engineering professionals in our database, in the last four months I have personally met the engineering graduates. I found civil engineers working behind hotel desks as clerks simply because their institutions didn't have placement facilities to connect them with employers in regions who were clamouring for civil engineers' shortages in the same region. In Chandigarh, where there is an institute of microbial technology, I found that they were desperately short of skilled people in biotechnology and, at the same time, the NTMIS database of Chandigarh reports that there is a surplus of supply and biotechnologists trained in Chandigarh are unable to find jobs. So, we do have peculiar problems that we need to analyse carefully to the extent that there might be structural problems or there might be problems of another dimension. I suspect that much of the supply is not employable and, therefore, more of the same is not going to solve the problem.

The third issue here is that the wages of the skilled workers and engineering diploma-holders have not been significantly above minimum wages in most cases. For example, intakes by Andhra Pradesh, Karnataka, Tamil Nadu, the skilled premium is so often negligible that it is even zero after engineering diploma graduation.

Coming to the supply side constraints, the greatest supply side constraint is teacher and the relevance of curricula. Degree-granting institutions in our country by design post graduates in engineering and technology need PhD teachers. By this logic, there is a shortage of more than 77,000 teachers in engineering and technology. These teachers in such disciplines are also professionals who are themselves employable in industry at market rates of compensation. There is no way this deficit can be filled except by changing the character of such institutions from knowledge-creating universities and colleges with non-PhDs and non-M.Tech practitioners on a part-time basis and even that would require improvement in terms and conditions of service of teachers.

1.3 Prof. Rajsekharan Pillai

I am glad to inform you that Indira Gandhi National Open University (IGNOU), particularly its Distance Engineering Council, is interacting with the various constituent bodies of the ECI for the last one year with a view to strengthening the open education system in the country. I am basically a scientist, a Polymer Technologist. I know the importance of engineering profession and, what I would like to do exactly, just to give an idea, we are thinking of linkage with the Engineering Council of India (ECI) and its participating institutions.

In the present-day world, technical breakthrough has revolutionised engineering activity. Modern engineering areas include high-rise buildings, dams, irrigation networks, energy conversion,

Prof. V. N. Rajasekharan Pillai *is a Distinguished Educationist of the Country and the Vice Chancellor, IGNOU*

industrial plants, environmental protection works, infrastructure facilities like roads, bridges, airports, seaports, etc. Engineering technology is emerging at an accelerated pace. With the use of latest framework and the state of their technology, the construction time in making buildings can be reduced to 80%. Engineering profession, I understand, is a complex function of knowledge, skills and attitude. The knowledge base of every profession keeps expanding with the passage of time. Globalisation of engineering profession is already under way. In the WTO environment, an engineer seeks to continually increase his/her technical competency together with a commitment to provide an efficient ethics-based service to the client, customer and society.

I understand that the main mission of the ECI is to work for the advancement of engineering profession in India comparable to the level of the developed countries. The Indian economy is growing fast and the trade in services, including engineering services, is going to be highly competitive with the pouring multinational companies. The equivalency of the competency, continuing development of Indian engineers and ethics and morality has to be as per the ECI's systems and procedures which are generally conforming to the Engineers Mobility Forum (EMF). As mentioned in the theme address, mutual recognition of qualifications and a national qualification framework linking engineering profession with other professions is very essential. The country is set to prepare a national qualification framework, at least, in the technical-related area. Only when there is a mutual recognition of qualifications and a national qualification framework, there may be professional mobility across disciplines, mobility within the country; and a transnational mobility is possible only when the national qualification framework is in conformity with the international qualification framework.

Australia is the only country which has developed a national qualification framework for professional education combining engineering profession with vocational education. The European Union has also developed a qualification framework which is really working and it is very important in this connection that we have to have a national qualification framework combining the higher levels of engineering education with normal levels of vocational education and related areas. So, it is our duty to bring the level of competence of engineers and standards to that of a developed country and, therefore, the roadmap of engineering education that has been mentioned. We are really enlightened with the continuous capacity-building attempts in engineering education. In this connection, Mr Mathur has mentioned about capacity-building for teachers in engineering colleges. The Ministry of Human Resource Development has brought out a new scheme: National Programme for Technology-Enhanced Learning (NPTEL) - a joint activity of seven IITs and Indian Institute of Science - which was inaugurated in IIT Madras some three years back and very recently, it was inaugurated in IIT Delhi. IGNOU has been identified as the nodal agency to develop and deliver this programme. We have developed the programme and digitised it. For an effective delivery platform of the programme to the various corners of the country including the rural areas, we are also considering networking with the larger number of technological institutions. After this work is completed, every teacher in a college in rural and urban areas of the country will be able to make use of this programme A large number of similar activities are also being taken up for the capacity-building of the engineering teachers, which is a real challenge for each and every one of us.

We have a national network of vocational education and training in the IGNOU. We have recently created a school for vocational education and training based on the recommendations of the Planning Commission. The school will primarily teach as to how technology can be effectively used for enhancing the vocational education and training capability in the country. If we look at the workforce,

we find that 5% - 6% of the total workforce in the country has got some sort of certified skills. As against this, we find that it is over 80% in South Korea or in a developed country. Our target is to increase it to 10%. We have to identify and then quantify the existing workforce with some prior learned skills and train them up to the level of knowledge and skills which the workforce of countries such as South Korea or any other developed country has and thus bring them up to the level of competency of the workforce of these countries. This will definitely enhance their capability, mobility and their acceptance all over the world.

Regarding the vocational education, the Prime Minister, in his Independence Day speech in 2006, had underscored the need of improving skills of our workforce through an appropriate skill development programme. There has also been a growing awareness about the need and importance of vocational education and training with reference to developing our human resource capital. During the last one year, there has been an exchange of ideas and views on various platforms in the country and a document has been prepared on the subject of capacity-building in vocational education

IGNOU is working with the National Council of Educational Research and Training (NCERT) and National Institute of Vocational Training. We have created a nationwide network for implementing our programmes. We are looking forward to collaboration with the various constituents of the ECI. We had one-two discussion with Mr. P.N.Shali, Director ECI in this regard. We are also interacting with the other open universities as well as the 120 distance educational institutes in the country - which are parts of the existing universities. This way, we are trying to establish a strong relation between the engineering profession and vocational education. We look forward to active cooperation from each and every one of you and the ECI in our endeavour. We have also signed a Memorandum of Understanding with the Construction Industry Development Council (CIDC) - a Member Association of ECI and we are running a number of programmes with CIDC.

1.4 Dr. Kirit S Parikh

We have targeted to have 9% plus growth of our economy in the 11th Plan. We have already achieved 9% to 9.2% growth since 2005-06 and we know that the economy is booming. This opportunity has to be utilized. It is not that just IT and IT-enabled services are growing; we have seen that we are competitive in many other sectors like manufacturing, pharmaceuticals, automobile, construction, textiles, etc. Many other manufacturing sectors are also booming. We can expect that the growth rate will continue to remain high. If we continue growing at a 9% plus growth rate for another five years, by 2016/17, i.e., by the end of the 12th Plan, we could reduce the poverty in the country by more than half and that should certainly be our target. Hence, it is quite important that we continue to grow rapidly, which does not mean just any kind of rapid growth, but growth which is inclusive so that its benefits are shared by all the sections of our society. This can be facilitated by the fact that the tax to GDP ratio is increasing and direct taxes have now become 50% of the total taxes, which is a significant improvement.

While we believe that it is indeed possible to realise this kind of growth of the economy in the 11th Plan, it will be possible only with good quality of infrastructure and availability of required power. We will have to focus our attention on these two important factors. Among other things, we will have to make

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***Dr. Kirit S Parikh** is a Distinguished Economist and Civil Engineer of the Country and Member, Planning Commission, Government of India.*

investment of about 300-400 billions of dollars in the next five years for making sure that we realise this kind of growth rate. It implies that we need to have lots of construction going on; also we need to set up lots of plants. We need to expand power plants, ports and services. The manufacturing sector will also grow. All this requires engineers and skilled workforce. And this will have to be done not by just the public sector, but also a large part of the jobs will have to be created by the private sector. So, the demand for engineers will come up more from the private sector than the public sector.

What is really important is that in today's world, the manufacturing sector does not require engineers merely to construct the plants and operate it, but also to see that the whole system of logistics and materials management, etc, operates in an effective and efficient manner. So, seamless engineering education is required for this. This is only one aspect. The other aspect is the availability of new technologies and more technologists. It is well known that technological progress in the world is rapidly accelerating, which means that the rate at which new technologies, new products and new processes are coming up is extremely rapid. What that means is that the obsolescence of technologies and products is rapid, particularly in some areas such as electronics, computers and related areas. The life cycle of technologies in some area is small and because of it, you need to recoup your investment in technology development as rapidly as possible and we need to have large markets. So, while there is a tendency for the firms to grow big and large, you will also recognize that they need to be very flexible, they need to have people coming from various streams/disciplines. But what is important from the point of view of this conference is that you will need skills which are rapidly changing. So, you can't really train engineers and say that you have been trained for life and that is the end of it. You need to have engineers with training which is such that they can refresh and reorient their skills as required. Here the importance of distance learning or refresher courses becomes very important. Distance learning is not just for getting a degree but it is really for getting high quality or up gradation of the required skills.

We have to recognize another problem here. We do find that there is a large brain-drain of engineers taking place to other professions in the country. While brain-drain to the west may have ceased, there is a brain-drain of skills going to Finance. Engineers, who do not want to go for higher degrees like M. Tech. and PhDs, become finance managers. I think this is a huge drain of training that is taking place. We need to worry about it. The quality of life of engineers has to be improved so that people are attracted to this profession.

We have also to recognize that in this rapidly changing world knowledge has emerged as one of the most important factors of production. Earlier we used to say that land, labour and capital are the three factors of production. But today technical knowledge and skills have become a very important factor of production. I do think that investing in knowledge and skills is very important for India's attaining the 9% growth rate and to continue to do better thereafter. The 11th Plan emphasizes and recognizes that we need to put a lot more money into education. We have proposed to spend four times as much money in education than we have spent in the 10th Plan. So, there is a huge and substantial step-up of investment in all levels of education and not just elementary education through Sarva Shiksha Abhiyaan, etc. We need more colleges, universities and more technical institutions after the programmes like Sarva Shiksha Abhiyaan. Getting vocational training is equally important. We have talked about innovative ideas in terms of vocational training to bring in private sectors and private institutions to work in this area. We believe that many of our Industrial Training Institutes (ITIs) need involvement of industry so that the training they give is relevant.

Private firms should also get into the vocational training business. We should evolve a scheme in which there is a provision of reimbursement of some share of training cost from the government both for the private sector and the trainees. Any trainee who obtains a certificate from a national certifying body will be reimbursed his/ her fees and the institute prescribed the costs of the training. This way, the scheme will be attractive to all the participants. The certificate of the training should be given by a high level national body that should also set uniform standards for the training to be given by such private sector vocational training institutes. Further, the government reimbursement should be based on per person passed and not on per person trained basis. So, if you train 10 persons and only one passes, you will get reimbursement for only one person. There is a need for setting up standards both for the training curricula, infrastructure and facilities. Such public-private partnership in the area of vocational training will have a very important role to play in training our workforce for meeting the new challenges of the 11th Plan.

The second aspect that I want to touch is that engineering profession and emerging technologies will play a dominant role. We need engineering skills in mining, quarrying, manufacturing, construction, transportation, electricity, oil and gas sector, healthcare, education, administration, software development, water supply and sanitation, research & development in different areas and so on. We have water supply in Delhi available for 2-3 hours a day and that is what most citizens in India have. Comparatively, the per capita water availability in Delhi is more than the per capita availability of water in Paris where they get round-the-clock (24x7) water. Where is the problem? The problem is that our systems are old and are not being properly managed. To improve our water systems, we do not need high-grade engineering skills but technical management skills.

Prof. Mathur pointed out that we are not having shortage of engineers but are having shortage of properly trained engineers. Now nearly 4.5 lakh engineering graduates and technical persons come out every year in our country. But, according to some estimates, only one-fourth of them are employable. Whose fault is this and how can we improve upon this? One can say that there is no point in pouring money into it. On the other hand, money does facilitate quality and good faculty of an institution. So, money is required but the question is how we make institutes stronger. Some suggest that we should have stricter control over institutions and stricter standards should be set up. While there can be a number of such suggestions for improvement, I believe that what we should do is that we should provide incentives to these institutions for improving their quality; and this is the way, I think, that you get the effect.

We know that controls do not necessarily work. For example, all these 4.5 lakh technically trained people are coming out of AICTE-certified institutions. So, that kind of certification of institutions does not simply work. If AICTE has done its job correctly, then all these 4.5 lakh persons should be employable. The question then arises what should we do. I think what we need to do is to provide incentives to the institutions for improving their quality; the second suggestion that I would like to make is that the professional engineering societies in India should have a role in setting the standards and in the accreditation mechanism of the engineering education in India. The third suggestion that I would like to make is that these societies should certify engineers by testing them as per their standards. So, the role reverts to the professional bodies, which would say, now you are certified engineer in the technical sense. But that may not be enough too. Professional bodies should prepare a rating system of technical education and technical training institutions. Prof. Mathur can do something in this area and the institutions like the one he is heading can do something in this.

How do we rate a technical training institution? We can consider two questions. First, what are the marks that the students get for their common university examinations? Second, what are the employment characteristics of the graduates of this institution? And then, I think, what is most important is that institutions should put this information on the website. Prospective students, who are going to engineering colleges, would like to know the probability of getting employment if he/she passes through that particular college. And the college will soon find that there are very few students taking its course; with all the high fees they are charging nobody is willing to pay; and that they would then begin to work to improve the quality of education. So, I think, we need to generate that kind of self-reinforcing mechanisms to improve the quality of education. Another aspect to this is that we can bring modern technical methods to improve the quality of education. Prof. Pillai has referred to it. It is indeed possible if we use proper educational methods, simulation models and similar IT tools to give student-engineers a kind of training in the institution that one gains by experience.

1.5 Shri Chander Verma

It is a great honour and privilege to be called upon to propose the vote of thanks to Dr Kirit Parikh, the Hon'ble Member, Planning Commission, who has contributed immensely to the development of the Indian economy. His special achievement is that he is a distinguished economist apart from being a civil engineer. He has contributed immensely to the economic sector such as education, environment, energy, agriculture, industry and science & technology, apart from many other sectors. His contribution as a member to the Economic Advisory Council to the Prime Ministers of India, namely Atal Bihari Vajpai, P. V. Narsimha Rao, Chandrasekhar, V. P. Singh and Rajiv Gandhi has been very significant. He has also accorded top priority to reform initiatives as a result of which the Indian economy is booming today. His contribution to the formulation of the XIth Plan, particularly of the energy sector is being highly appreciated. Approach Paper to the XIth Plan has been prepared. It places special focus on the availability of qualified and skilled technical workforce in the eleventh plan for realizing the higher growth target. Engineering Council of India (ECI) has seized the opportunity and it has organized the 5th Conference on this theme. His presence today is a great source of motivation to us. We are extremely grateful to him for having acceded to our request for inaugurating the event in spite of his busy schedule.

We are fortunate to have with us this morning Prof. V. N. Rajsekharan Pillai, Vice Chancellor, Indira Gandhi National Open University. His contribution to the field of technical education in India is well-known. I thank him for sparing his valuable time and giving us the benefit of his thought-provoking address a short while ago.

I thank Dr. Mathur, Director, Institute of Applied Manpower Research, for his illuminating theme address. With this, he has set the tone for today's discussions.

I thank Dr Uddesh Kohli, Chairman, Engineering Council of India (ECI), for his sustained and dedicated efforts in taking up the issues concerning the engineering fraternity.

Chander Verma *is the Chairman, Construction Industry Development Council, President, International Council of Consultants, Chairman, Indian Society for Trenchless Technology, President, Projects Export Promotion Council and Treasurer Engineering Council of India*

I thank all the distinguished guests, invitees, keynote speakers and delegates for sparing their valuable time for attending the conference. I am sure that we will get the best out of them during the course of the conference.

I thank Col Chitkara, a well known engineer, author and Consultant, Engineering Council of India for taking pains in researching and the writing the Theme Paper of the conference, which has been covered in the Souvenir. I also thank Institute of Applied Manpower Research for providing the research inputs for the paper.

We are grateful to all the sponsoring organisations who have provided the support to the conference. Last but not the least; I thank all the member associations of the Engineering Council of India for their support in promoting the conference. I thank the Director General, SCOPE, for providing such an excellent venue for the conference. I thank Shri P.N.Shali, Director, and the staff of ECI for their hard work in organizing the conference.

On behalf of ECI, I thank you all ladies and gentlemen

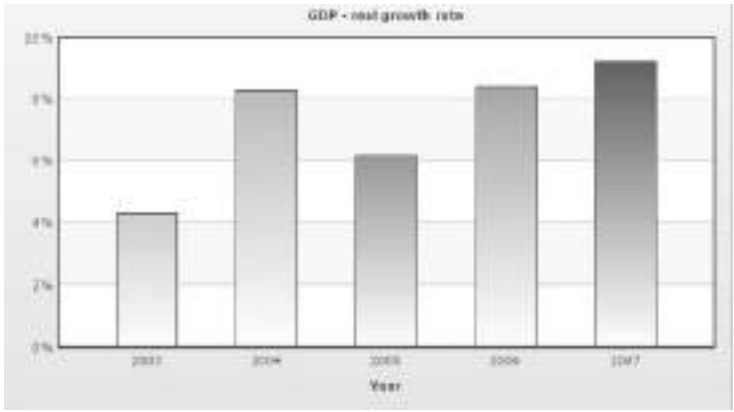
TECHNICAL SESSION I

2.1 : THE ROLE OF NUCLEAR AND POWER ENGINEERS IN THE FAST-GROWING INDIAN ECONOMY

Dr. Placid Rodriguez

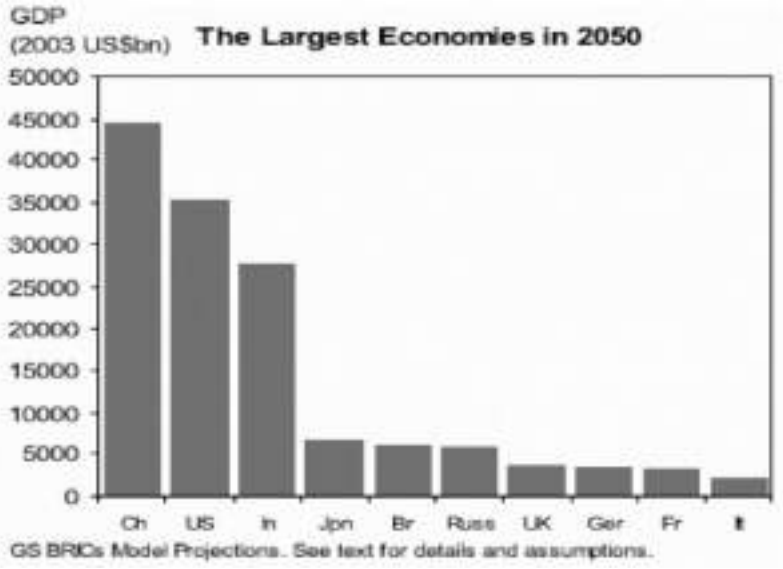
2.1.1 Fast Growing Indian Economy

"India will become a major economic power in the world by the year 2050 if not earlier." It was predicted in year 2003 in the Goldman Sachs Global Economics Report No: 99. In fact, the report predicted a growth rate of 6.5% in India, but the growth since the year 2003 has already surpassed growth prediction of the said Report.



GDP growth rates in recent years

There is unanimity among all the growth forecasts and economic analyses made in recent years that by Year 2050, India will be within the top four economies of the world:



Dr Placid Rodriguez *is the Raja Ramanna Fellow and AICTE-INAE Distinguished Visiting Professor, Department of Metallurgical and Materials Engg., Indian Institute of Technology, Madras.Past President of the Indian Institute of Metals and a Distinguished Nuclear scientist*

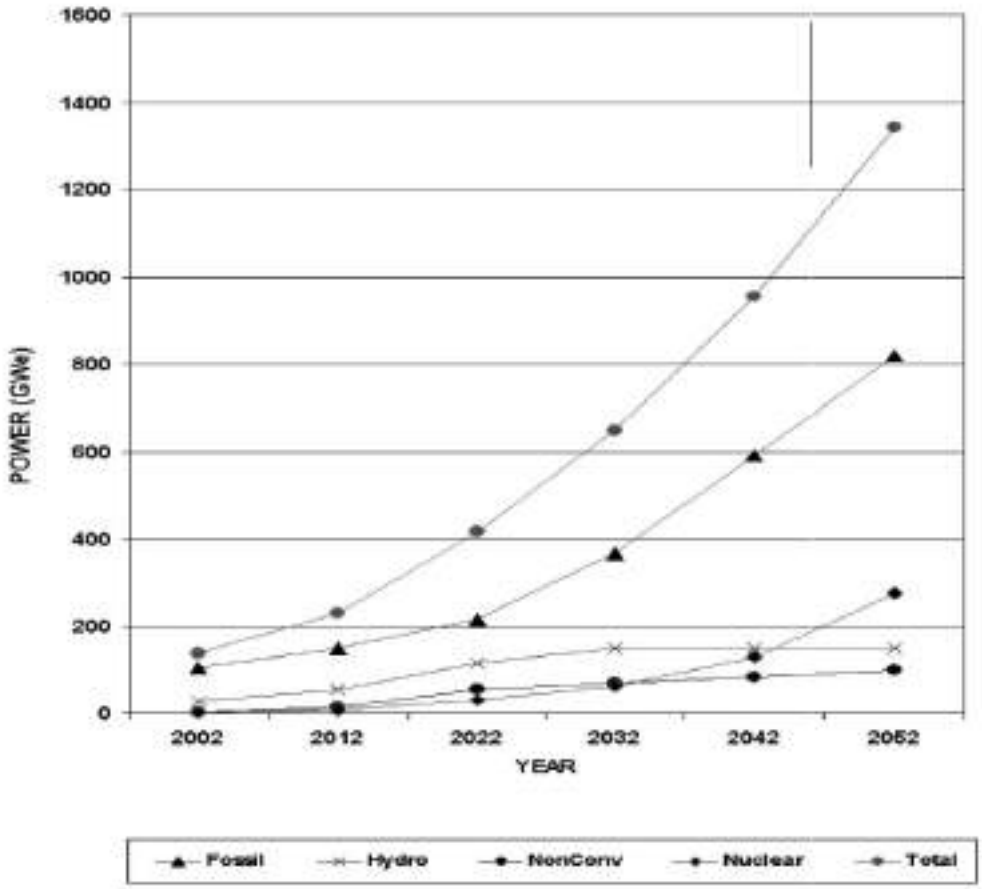
2.1.2 Estimated Growth Rates of Primary and Electrical Energy in India

Every 1% increase in GDP growth rate requires 1.5% increase in power generation capacity. This traditionally accepted ratio has now come down due to efficiency improvement and combination of other factors. The estimated growth rates of primary and electrical energy in India is indicated below:

Period	Primary Energy Growth % per year	Electricity Growth % per year
2002 - 2022	4.6	6.3
2022 - 2032	4.5	4.9
2032 - 2042	4.5	4.6
2042 - 2052	3.9	3.9

A Scenario for Growth of Electrical Energy in India
R.B. Grover and Subhash Chandra (2005)

Based on the growth rates given in the above table, the total electricity generation would reach about 8000 TWhr in the year 2052 with a per capita electricity consumption of 5300 KWhr per year. Thus the total installed capacity for electricity generation would be 1344GWe. Thus total Installed power capacity will go up from about 137 GWe in 2002-03 to about 1344 GWe in 2052-53.



Installed energy capacity distribution will be coal-46%, hydrocarbon-15%, gas-10%, hydral -11%, non-conventional renewable-7%, and nuclear-20%. Fast breeder reactors double the installed capacity every 10 years.

Cumulative Nuclear Power by Reactor Type

	PHWR, AHWR and FBR based on Pu from PHWR			LWR and FBR based on Pu from LWR			Sub Total		Gr. Total	Import
Year	Thermal (GWe)	Fast (GWe)		Thermal (GWe)	Fast (GWe)		Oxide (GWe)	Metal (GWe)	(GWe)	%
	Oxide	Oxide	Metal	Oxide	Oxide	Metal				
2002	2.40	0.00	0.00	0.32	0.00	0.00	2.72	0.00	2.72	11.76
2022	9.96	2.50	6.00	8.00	0.00	3.00	20.46	9.00	29.46	27.16
2032	9.40	2.50	33.00	8.00	0.00	10.00	19.90	43.00	62.90	12.72
2042	7.86	2.50	87.00	8.00	0.00	26.00	18.36	113.0	131.36	6.09
2052	4.06	2.50	199.0	8.00	0.00	61.00	14.56	260.0	274.56	2.91

If only the already negotiated 2 GWe LWRs from Russia are imported and the present proposed nuclear deal with USA does not materialize, then the installed capacity in 2052 will be 208 GWe instead of 275 GWe.

2.1.3 An Estimate of HR for DAE

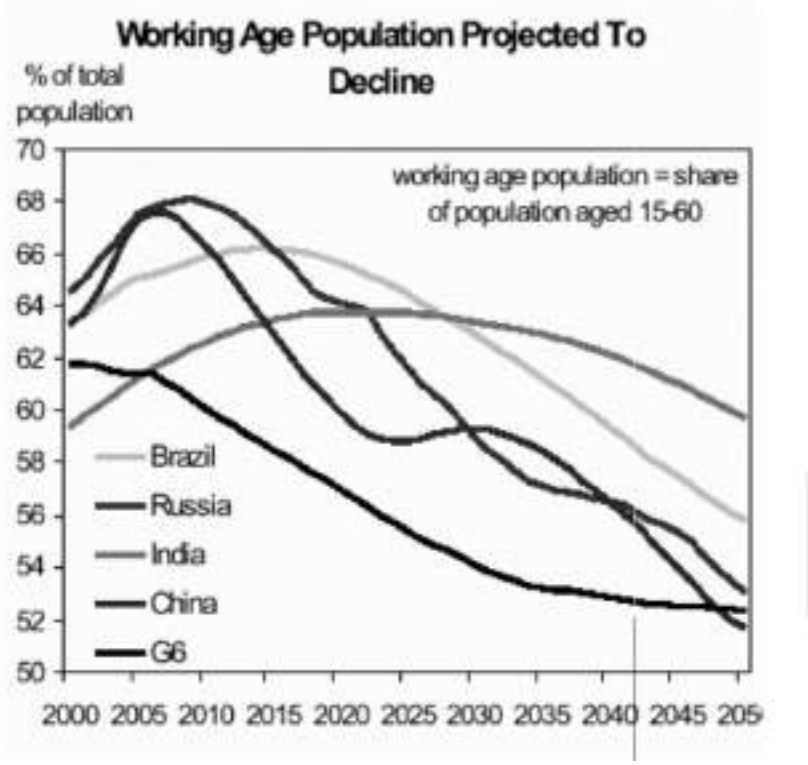
During the decade 2042-2052, increase in capacity from 100GWe to 200 GWe will require 100 reactors of 1000 MW, i.e., 80 reactors under construction at a time and one reactor start-up every other week. It will need 8000 Engineers and 12000 technicians for construction. In addition, we will require 15000 Engineers and 65000 technicians for operations and maintenance.

DAE ACTIVITY POWER GEN	2007 20GWe		2052 >200GWe	
	SC/EN	TOTAL	SC/EN	TOTAL
NPCIL	3,400	12,000	34000	1,20,000
R&D	6,000	20,000	10000	35,000
FUEL CYCLE	2,000	14,000	10.000	70 000

HR for Power Sector, based on DAE current estimates will require more than.50, 000 Engineers/ Scientists and 200,000 Technicians by 2052. Total Power Sector in India will need 200,000 Power Engineers and over 800,000 Technicians. In addition, technical manpower will be required for Construction and Fabrication Industries, and India will also have to prepare to supply to other nations. To quote example, nuclear resurgence and renaissance in USA will need HR inputs from India as no reactor has been built in USA since 1979. They have missed 3 generations of nuclear technologists. The trend in the employment in the Nuclear Power Plants in USA is indicated below:

US CURRENT 100GWe · • 14000 Engineers · • 40 000 Technicians	**US PROJECTED:2050:400Ge** · • 50000 Engineers · • 150000 Technicians
US PRODUCES ~60000 Engineers annually including 400 Nuclear	**INDIA PRODUCES** 400,000 Engineers annually including 400 Nuclear
US faces declining interest in engineering	**INDIA** attracts the best students in engineering

If the HR needs are not addressed by planning, and training on a long term basis, by 2030, the growth will be hampered by a new shortage in Human Resources. It is assessed that 30% of the current nuclear workforce would retire within the next five years and there is hardly any nuclear-specific training being conducted by the engineering institutions.



The working age population in India, will increase from 59% in 2000, peak at about 64 per cent in 2025 and start decreasing slowly to 58% in the year 2050. In contrast, except for Brazil, in other countries such as Russia and China, the working age population will shrink from 68 % in 2005 to 50 % by the year 2050.

While India struggles with a burgeoning population of educated youth, the rest of the world, especially developed countries, faces a shortage of working-age people, caused largely by lower birth rates and an ageing working population. While the requirement for skilled workers in these markets is increasing in line with economic growth, the availability of skilled people simply isn't keeping pace. In professions like IT services, medicine, and education, the problems are already beginning to be felt.

2.1.4 India's Nuclear Programme and Future Potential

The unfortunate fact is that just when we reached full maturity in the PHWR technology, the financial crunch and the euphoria of globalization and liberalization along with private and foreign investment in the power sector, almost choked the financial inputs to our nuclear power programme. The re-emergence of political support for the atomic energy programme had to wait till 1998 and Pokhran II became a matter of total national pride. By then, the country has also realised "a la Enron" that electricity through foreign private investment was not the panacea that it once was made out to be. India's nuclear programmes are as under:

Reactors	Capacity(MWe)	
• 17 Reactors at 6 sites under operation Tarapur, Rawatbhata, Kalpakkam, Narora, Kakrapar and Kaiga	4120	
• 3 PHWRs under construction at Kaiga (220 MWe), RAPS-5&6(2x220 MWe)	660	
• 2 LWRs under construction at Kudankulam(2x1000 MWe)	2,000	
• PFBR at Kalpakkam (1 X 500 MWe) (Project activity in progress)	500	
Projects planned till 2020	13,900	PHWRs(8x700 MWe), FBRs(4x500 MWe), LWRs(6x1000 MWe) AHWR(1x300 MWe)
• TOTAL by 2020	21,180	MWe

In India, there is primarily shortage of uranium because the development of domestic mining has not kept pace with the requirement. India has abundance of Thorium. Uranium Corporation of India will be investing Rs 20 billion (US $460 million) to open new mines in Jharkhand, Andhra Pradesh and Meghalaya.

India could be world leader in both skill development and supplier of technology. It also has the advantage of unique experience of building and operating small, medium and big power reactors.

2.2 : REQUIREMENT OF CONSTRUCTION ENGINEERS

P. R. Swarup

I am not going to give any numbers to you. I will not give you any kind of charts and figures also. There are a number of reports that have been presented to the government.

Construction happens to be at the top of every development project. You talk about power generation, you talk about chemical production, fertilizers, infrastructure or housing, whatever you have, and all need construction. There is tremendous requirement of construction manpower, and the numbers are holding anywhere in-between 31 billion to 34 billion and there are strings of variation here and there. Of these, almost about 4.5% or 5% are supposed to be the graduate engineers and another about 3 to 3.5% are supposed to be some kind of intermediate engineers they could be diploma engineers or must be on their way to become engineers. They are ultimately going to manage the projects and today we suffer for our own internal purposes, what to talk of export and other things. I would just not talk about the kind of other sectors which are there and which may be looking for more or less similar numbers, or may be less or more whatever, but there is a shortage of engineers. Construction industry has been growing at the pace of almost 15% per annum. At this growth rate, the construction industry alone needs about half a million engineers. We have shortage everywhere and inspite of the fact that we are a very young nation as far as the age of the working segments is concerned. I do not think that we are really making good use of it. The human resource policies, the universities and our institutions do not meet the kind of requirements which the domestic industry itself needs. We cannot think of exporting people outside till we have been able to meet the requirements internally. Take, for an example, the construction industry itself. Colloquially, we say we need several engineers to do construction. Frankly speaking, today we need construction engineers to do construction and not the civil engineers. Let us, for a moment, assume that civil engineers are needed. As a matter of fact if we look into the history of past 10 or 15 years, what we find is that all the colleges that have been accredited by the All India Council for Technical Education (AICTE), do not find civil engineering as a branch. It is just not there. In the old colleges, there are limited numbers of seats. When I graduated as a civil engineer almost about 32 years ago, I think the numbers are still the same. There is hardly any kind of intrinsic addition.

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

These are the three questions that we have to ask. The numbers are in plenty. But fact of the matter is that there is hardly any solution for this. We still have some types of roles where we have some kind of small limitations where the industry is able to develop itself fully. I think the academia and the industry both are equally responsible. But seldom have you found in the engineering institutions that there is a kind of intense intervention of industry experts for preparing students. Overall for any of the IITs for that matter, I myself graduated from IIT Kanpur and I have hardly found, except for few

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

additions here or there, any kind of direct intervention of an industry captains going there and teaching. Believe it or not, there are many who are desirous to go there and teach. But, I guess, there are substantial changes that are needed. Then only we could get the benefits we are looking for or meet the demands that we have there. The relevance of curricula, the intervention of the industries, and looking at the numbers and the urgencies for which you need these people; so, what are the solutions? Something we have been doing in the Construction Industry Development Council to meet a partial percentage of the needs that the industry has. To go and create the infrastructure and it is in the rudimentary kind of level at this point of time. It still has to go and mature but it has been started, the beginning has been made. It is the state government who has to construct the physical infrastructure and, therefore, they need to come forward and provide us with the kind of infrastructure. No regulations, but that infrastructure has been created and almost 43 centres have cropped up with the support of nine state governments.

The second thing, that is being tried now, is kind of a continued education. We have decided to join hands with the universities. As a matter of fact, this was the first time, the university decided to join hands with CIDC, Professor Kulshreshtha from the Indira Gandhi National Open University is here and probably that was the first normal experiment that we made because we knew fully well that you cannot fulfil the needs and requirements merely through direct entry into engineering programmes. That is a substantial lot of people that you need to create through extension education taking them to grass-root level or intermediate levels. Then convert them into engineers. Today, an engineer who graduates from an engineering college is not really very keen to go and serve when it comes to the kind of construction industry. We have no choice but to look at the intermediate level personnel, the grass-root level personnel, enhance their skills and bring them to a level where they can perform the roles of engineers and managers because there is absolutely no other option. That is the infrastructure which has been created, that is the system which has been brought in place. CIDC will be very happy to share the experiment that we have launched upon and we shall be able to work together through a network and see to it how exactly we can meet the demands and requirements of the industry as a whole, not merely construction industry because it is inter-connected. That is something we need to understand. I have a small story to tell you. In mid 1980s, I was working on a fertilizer construction project near Bombay, one of the mega fertilizer projects at that point of time. We had British consultants and I was the Project Manager. One evening, we were sitting and talking. He said, "Well hear, you guys are very smart. You have done B. Tech. You know all the mathematical calculations, you can calculate the traction and this and that. Tell me how high this dozer can go up the hill that is right in the front." But if you ask me, I do it in half the time. I will take the key, switch on the ignition, take the dozer and go right up to the level that it can go and say: hey, I have only reached here. That is about it.

So, my last earnest request to all of you is this: the figures are in plenty, the plans are in plenty, what we need to do now is: really get into the act of making these people, who are so badly required by the industry. Otherwise, believe it or not, we will miss the bus. If we look at one very interesting feature that China is working on it. They have a massive human resource development. More than the 55% of the graduate students today in the United States 'C' grade to 'A' grade universities, they come from China itself. This was the number that was recorded this year. The Indians or the Pakistanis or the Bangladeshis used to basically acquire that position until about two years ago. This is the fast-losing ground. That is the kind of scenario that you have. We do not have a concerted policy but we need these people and we need them fast. We are a young nation as far as the age group is concerned but that advantage will be lost. So, let us do it now, let us do it fast without looking into the policies that the government lays down. Let us try to look at it for our own benefit. If we don't do it now, it is never.

2.3 : HUMAN RESOURCE REQUIREMENTS FOR TEACHING AND RESEARCH IN ENGINEERING

Prof. C. V. Ramakrisnan

2.3.1 Introduction

We are witnessing rapid progress of Indian economy of the order of 9-10% of GDP. It has created enormous wealth and employment opportunities for engineers. Globalization and competitiveness has added a new dimension. Today products and services that are cheaper sell better. This can be sustained only by innovation, competitive products and services through research. High quality manpower is required in research and development and teaching, which are not financially attractive enough. Engineering high quality manpower is weaned away by other attractive avenues. The manpower in engineering currently available may not be sufficient in terms of quality and quantity. Industry will need research personnel in large numbers. Present institutions are insufficient, new ones need to be set up urgently to achieve goals quickly. The focus of the presentation is on HR requirements, which have already reached critical situation.

2.3.2 United Nations Millennium Development Goals

In Sept. 2005, a joint statement from international scientific, engineering and medical organizations of the world was made to the heads of states and governments at the UN assembly. It emphasised that stronger worldwide capacities in science and technology are necessary to allow humanity to achieve the UN Millennium Development Goals. A connected global effort among the world's scientists, engineers, and medical experts is needed to identify successful strategies and to help implement effective programs. Sustained progress in reducing poverty and related problems will require strengthened institutions for science, technology, and innovation throughout the world, including in each developing nation. The key statement recognizes that science, technology and innovation are essential for individual national development, use of local resources and local infrastructure and development, sustainable environment and poverty reduction in the world. It emphasizes the establishment of national structures and strategies to maintain a source of well-trained knowledgeable people. It stresses the revitalization of universities and institutions and creation of centres of excellence. It is clear that the manpower necessary for this task can be trained in rapidly developing countries. Further, it is obvious that the role of research and development is essential and establishment of global centres of excellence is necessary.

2.3.3 Indian Development Scenario

The Indian economy is growing fast 9-10% GDP. It has higher growth in services and manufacturing sectors. There is requirement of a very large higher technical education workforce. The need can be met by rapid expansion of higher technical education segment by private sector. There is uneven match/distribution between supply and demand among different disciplines in the human resources generation. Some levelling is taking place during recent years. Currently the engineering student

Prof. C. V. Ramakrisnan, *Professor Emeritus, IIT, Delhi*

intake is over 5, 00,000 per year including 2620 of IITs and 6200 of NIEs and it is still growing. But there is an uneven match between supply and demand.

Table 1-Undergraduate System:

S. No.		IITs	NITs	State Technical University and other University affiliated Colleges	Deemed University/ Deemed Technical University affiliated Colleges (Govt. and Private)	Central University Affiliated Colleges
(a)	(b)	(c)	(d)	(e)	(f)	(g)
1.	No. of Degree-level Institutions:	7 Annex-IV	20 Annex-V	1459[3][4]		10
2.	Top 10 Institutions -with postal address, e- mail address, website information	All	All			
3.	Total Annual Admission Capacity	2620[3]	6250[4]	5,69,283[2]		
4.	Method of Admission	JEE	AIEEE (State Quota)	CET+ Qualifying Exam	Entrance Exam or AIEEE	AIEEE or JEE
5.	Selectivity ratio (admission capacity/ total number of applicants	1:80 (Approx.)				
6.	Major Disciplines/ Specializations			32 Disciplines Annex-III		
7.	Faculty/Student ratio	1 : 8 to 1 : 10[6]	1 : 15[6]	Varying < 1 : 15		
8.	Structure of the Engineering System (Flow chart)	Enclosed Figures-1,2 and 3				
9.	Regulatory Agencies	IIT Council, AICTE, UGC, NIT Council				

This requires very large human resources for research and development to remain efficient and competitive. These research personnel have to be first trained in institutions of excellence. A rough estimation of 2% workforce for R&D will mean 10,000 people with Ph. Ds per year. The teaching profession alone will require 10,000 Ph. Ds per year to sustain good quality teaching. Even assuming that educational expansion through distance education may mean reduction by 50%, the requirement is enormous. The present experience is that nearly 50% of Ph.Ds are absorbed in the industry in non - R&D occupations. Conservatively we need to produce around 20,000 to 30,000 Ph. Ds. The Present Scene is shown in Table 2 and Table 3.

Table 2-Postgraduate System

S. No.		IITs and IISc	NIT	State Technical University	Deemed University	Central University
1.	No. of Postgraduate Degree Institutions	7+1	20	370		
2.	Total Admission Capacity	5500[1]	31,621[1]			
3.	No. of Govt. funded institutions	All	All			
4.	Method of Admission	GATE+ Internal Exam	GATE+ Qual. Exam	GATE+Qualifying Exam.		
5.	Faculty/Student ratio	1 : 8 to 1 : 10	1 : 15	Variable		
6.	Regulatory Agencies			AICTE, UGS, IIT council		
7.	Quality Assurance Mechanism/ Accreditation Agency		NBA			
8.	Technology-Enhanced Learning Programs	IITD, IITM, IITB + IITK have programs	Same as for UG			
9.	Total out-turn of Postgraduates	90% (Approx.)	40% (Rama Rao[2])			
10.	Major avenues of employment	Teaching, R&D, Industry				

Table 3-Ph.D. System

S. No.		IITs and IISc	NIT	State Technical University	Deemed University	Central University
1.	No. of Institutions offering Ph.D. Programs in Engineering	7+1	20			
2.	Method of Admission	Qualification degree + Personal interview				
3.	Selectivity ratio (admission capacity/total number of applicants	Variable	Variable			
4.	Total out-turn of PhDs	400*	60-70			
5.	Major avenues of employment	Industry+ Teaching+ Research	Teaching+ Research	Teaching+ Research		

The growing economy may need even more engineers which may be met by further expansion in terms of quantity. Quality may be questionable. The weakest link in the higher educational sector appears to be post-graduate and doctoral-level training.

2.3.4 Post Graduate Education and Research

(i). A rapidly growing engineering sector requires very high inputs in research and development (5% to 15% in terms of cost)

(ii). There has to be a massive expansion of the post-graduate and research through

a. establishment of new centres of excellence

b. expansion of facilities in IITs and IISc and other institutions

(iii). The Rama Rao Committee pointed out the deficiency from the point of view of teaching. This itself is an underestimate. The requirements are enormous.

2.3.5 Conclusions

The growing economy needs massive investment in teaching and research and development. The human resource requirement in R&D is anticipated to be at least ten-fold or even more from the present level. The need is urgent.

2.4 : IGNOU-ECI JOINT INITIATIVE FOR REPOSITIONING OF ASSOCIATE MEMBERSHIP QUALIFICATION

Dr. Manoj Kulshreshtha

The presentation highlights a joint initiative being contemplated by the IGNOU and Engineering Council of India (ECI) for repositioning of the Associate Membership Certificates in appropriate engineering disciplines granted by the Member Associations of ECI with that of an IGNOU degree by jointly working with these associations and with the support of ECI.

2.4.1 IGNOU A Profile

IGNOU is the second largest University in the world and has over 1.4 million students in its over 130 programmes. It has network of 68 Regional / Sub-Regional Centres; 5 are Army Command Centres, 8 are IAF Command Centres and 4 are Navy Command Centres. It has over 1500 Study Centres all over the country. IGNOU offers Distance Education Programmes in 37 countries worldwide. It has recently launched a Centre in Dubai for technical programmes. It is providing higher education as well as assisting other developing countries.

2.4.2 The University Features

It has national jurisdiction, flexible admission rules, individualized study: flexibility (in terms of place, pace and duration of study), use of the latest educational and communication technologies and student support services. The University programmes are cost- effective and modular. It has resource sharing, collaboration and networking with other well known Open Universities.

2.4.3 Why Repositioning?

It is for the benefit of large number of students who pursue engineering education informally via the Associate Membership (AM) route of the Member Associations of ECI. AM Certificates are not recognized as degrees by the industry in the matter of employment nor by the institutes of higher learning for the post-graduate courses. In the context of opening up of the trade in engineering services, it has become necessary that the AM holders should not be left out from this trade basket. These certificates are not recognized by the AICTE/DEC or any other equivalent body as such. It is generally seen that due to lack of structured training, the pass percentage of these examinations is very low. Finally, in the context of India becoming a full Member of the Washington Accord, in future, it will be possible only for the engineers holding an university degree to bid for jobs internationally and for mega projects in India.

2.4.4 The Proposal

A mechanism is to be evolved to convert the present AM certificates into the industry-specific recognized university degrees and well within the recognizing parameters of the Washington Accord - which is the need of the hour.While making AM Certificates a university degree, Washington Accord specific, laboratory work, some hours of regular contact, including adequate tutorials may have to be built in the total course package.

Dr. Manoj Kulshrestha, *Reader, Department of Civil Engineering, School of Engineering and Technology, IGNOU, Delhi*

2.4.5 The Initiation

A committee has been set up of the Member Associations of ECI conducting the Associate Membership Examinations regularly. It includes the Indian Institute of Metals, the Institution of Electronics and Telecommunication Engineers, Aeronautical Society of India and Indian Institute of Chemical Engineers, etc. ECI shall be playing the role of a coordinator or facilitator in the mechanism.

2.4.6 Approach to Programme Development in IGNOU

The stages involved in the Development of Programme are:

- Need Analysis
- Development of Concept Paper
- Rounds of Expert Committee Meetings for development of Programme Structure
- Identification of Course Writers and Editors (Content, Format & Language)
- Identification of Programme Study Centres (PSC) in Engineering Institutes
- Launch of Programme

2.4.7 Instructional System

The University follows multi-media approach for imparting instruction to its learners. It comprises of:

- Self-instructional Course Material Package
- Periodic assignments
- Supporting Audio/Video Material
- Contact & Counselling Sessions
- Library Facility
- Radio/ TV Broadcasts
- Laboratory Practicals
- Tele-conferencing
- Radio-counselling
- Work-related Field Project Work

2.4.8 Credit System

The University follows the credit system for its programmes. It includes:

- Each credit in IGNOU system amounts to 30 hours of study comprising all learning activities such as academic counselling, assignment preparation and self study.
- This helps the student to understand the academic efforts one has to put in, in order to successfully clear a course.
- Total credits for BTCM programme is 128 credits @ 32 credits per year.

2.4.9 B. Tech. Civil (Construction Management) at a Glance

- Level of Programme : Degree
- Nature of Programme : Professional
- Duration of the Programme : 4 years/10 Years
- Number of Credits : 128 cr. @ 32 cr. per year
- Weightage:

	Basic Science	-	33.33%
	Core Civil Engg.	-	33.33%
	Field Oriented	-	33.33%

- Programme fee : Total of Rs. 45,000 in four years
- Mode of delivery : Periodic contact sessions supplemented by ODL system
- Modularity : Advanced Diploma

2.4.10 BTCM - Programme Duration and its Equivalence

Sl. No.	Programmes	Duration	
		Minimum	Maximum
1.	Advanced Diploma	2 Years	5 Years
2.	B. Tech. (Civil)	4 Years	10 Years

The Advanced Diplomas are equivalent to Higher Diploma offered by the Technical Education System while the B. Tech. Degree Programmes developed are equivalent to any of the similar degrees offered by any other University in India.

2.4.11 The Implementation

For every discipline of engineering under consideration for conversion, sub-committees shall be constituted which can evaluate the existing syllabus of member association of ECI in terms of its credits for distance education.

The remaining credits from 128 which are assigned for engineering degree programmes of IGNOU, can be completed from IGNOU for the award of the degree from IGNOU. The courses for these balance credits may be developed jointly.

Finally, the nomenclature of the degrees should match the list of degrees prescribed by UGC.

B. Tech Construction Management Syllabus
BTCM FIRST YEAR

Sl. No.	Course Code	Course Description	Credits
1.	ET 101 A	Mathematics - I	3
2.	ET 101 B	Mathematics - II	3
3.	ET 105 A	Physics	4
4.	ET 105 B	Chemistry	4
5.	ET 202 A	Engineering Mechanics	2
6.	ET 202 B	Principles of Electrical Sciences	4
7.	ET 301 A	Systems Methods	2
8.	ET 301 B	Computer Applications	2
9.	ET 204 A	Materials Sciences	2
10.	ET 204 B	Engineering Materials	2
11.	ET 501 A	Soil Mechanics	3
12.	ET 501 B	Foundation Engineering	1
	Total	12 Courses	32

BTCM - SECOND YEAR

Sl. No.	Course Code	Course Description	Credits
1.	ET 521 A	Planning & Construction of Buildings	2
2.	ET 521 B	Building Architecture	2
3.	ET 521 C	Design Detailing	2
4.	ET 521 D	Quantity Surveying & Valuation	2
5.	ET 523 A	Construction Works Supervision	2
6.	ET 523 B	O & M of Construction Equipment	3
7.	ET 523 C	Repair and Maintenance of Buildings	3
8.	ET 524 A	Principles of Engg. Mgmt. & Eco.	3
9.	ET 524 B	Construction Management - I	3
10.	ET 522	Concrete Tech. & Const. Techniques	4
11.	ET 581 A	Testing for Quality Control	2
12.	ET 581 F	Mechanical Equip. in Construction	2
13.	ET 571	Laboratory - I	2
	Total	13 Courses	32

BTCM - THIRD YEAR

Sl. No.	Course Code	Course Description	Credits
1.	ET 102	Mathematics - III	4
2.	ET 201 A	Mechanics of Fluid	4
3.	ET 201 B	Engineering Thermodynamics	4
4.	ET 502 A	Strength of Materials	4
5.	ET 502 B	Structural Analysis	4
6.	ET 540 B	Flow in Open Channel	2
7.	ET 302 A	Comp Programming & Num. Methods	3
8.	ET 302 B	Technical Writing	1
9.	ET 500	Project	6
	Total	9 Courses	32

BTCM - FOURTH YEAR

Sl. No.	Course Code	Course Description	Credits
1.	ET 507 A	Pollutants and Water Supply	4
2.	ET 505	Transportation & Traffic Engineering	4
3.	ET 508 A	Structural Design - I	4
4.	ET 508 B	Structural Design - II	2
5.	ET 525 A	Construction Management - II	6
6.	ET 535 A	Elementary Hydrology	2
7.	ET 535 B	Hydraulic Structures	4
8.	ET 581 B	Building Services	2
9.	ET 581 C	Inventory and Stores Management	2
10.	ET 574	Laboratory - II	2
	Total	10 Courses	32

2.5 : ROLE OF ENGINEERS & TECHNOLOGISTS IN AEROSPACE SECTOR

Dr. Ranjan Moodithay

2.5.1 Why Aerospace?

Connectivity is vital for economic development of a country. Aerospace is rapid means of communication and transportation. The boom in aerospace sector has been phenomenal due to growth of interior regions and low cost carriers.

2.5.2 Indian Aviation

Indian aviation growth rate is fastest in the world. All the aircrafts are imported. There is wide scope for civil aeronautics development in India. India has a total of 449 airstrips of which only 61 are used. There was 41% growth in domestic passengers in the year 2006. Emphasis is on regional operators' low cost carriers. India's focus is to provide connectivity to every corner of country.

2.5.3 Some Accolades

India ranks 6th in Space. HAL notched to 34th position in list of top 100 defence companies. It has indigenous Light Combat Aircraft (Tejus) programme. NAL has successfully developed all composite trainer aircraft and ambitious multi-role light transport aircraft programmes. India has applied to join Elite Group of 10 countries with the aim of standardizing engineering education.

2.5.4 Aerospace Market Potential in India

It is estimated that India will need 5000 aircrafts in future involving $ 120 billion investment by 2020. Asia-pacific is the most important civil aviation. growth market. By 2025, India will become world's largest civil aviation market. India has floated global defence tender for the purchase of 126 numbers of multi-role combat aircraft worth Rs. 42,000 crore ($10billion). Every global player is interested in the Indian market. There is US-India aviation co-operation programme.

2.5.5 Careers in Aerospace

India will be requiring 20,000 to 25,000 engineers in the Aerospace Sector by 2025. The careers in aerospace covers varied fields. These include Systems engineers, Field service engineers and Analytical and Design engineers, Manufacturing and software engineers, Quality assurance engineers, Aircraft maintenance supervisors, Technical Specialists, Flight Research Engineers and Research Scientists.

2.5.6 Engineering Take-Off in India

India currently has 113 universities and 2,088 colleges, 1265 of which teach various engineering disciplines producing yearly approximate 3.5 lakh engineering graduates. Engineering colleges in the country have been growing at 20 per cent a year. According to the All India Council for Technical Education, India produced 401,791 engineers in 2003-04, 35 per cent being computer engineers. In

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2004-05, the number of engineering graduates increased to 4,64,743, of which 31 per cent were computer engineers. Compared to India and China, the United States produces only 70,000 engineering graduates every year. All of Europe produces just 100,000.

2.5.7 Aerospace Education in India

Aeronautical / Aerospace Engineering is the most challenging field of engineering with a wide scope. This field deals with new technology in the field of aviation, space exploration and defence systems. The knowledge areas required include Computational Fluid Dynamics, Aerodynamics, Astro-dynamics, Structural engineering, Thermodynamics, Propulsion, Celestial machines, Acoustics, Guidance and Control Systems, Structural Design, Instrumentation and Communication, and Production Methods. It specializes in the designing, construction, development, testing, operation and maintenance of both commercial and military aircraft, spacecrafts and their components as well as satellites and missiles. Aeronautical engineering does not teach you how to fly an aircraft. It teaches you 'how airplanes fly and how to make them instead'. In India: Aerospace Education is offered by:

- Indian Institute of Technology : Chennai
- Indian Institute of Technology : Kantur
- Indian Institute of Technology : Kharagpur
- Indian Institute of Technology : Mumbai
- Indian Institute of Science : Bangalore
- Punjab Engineering College, Chandigarh
- Many engineering colleges in Tamilnadu, started

We take engineers from different fields and train them to meet our requirements. We will have to increase the supply of Aeronautical Engineers.

2.5.8 Expanding Dimensions of Aerospace

Because of the demand, software giants like Infosys, TCS, Satyam have started entering in aerospace business. Alcoa is expanding in power propulsion, fastening and structural metallic. Boeing has projects worth $340 billion market in China for its new aircraft. Boeing is also opening aircraft maintenance workshop at Nagpur. Rolls-Royce is opening new UK facilities with prediction of massive growth in China for aero-engine market. Liberty Aerospace sees Asia as a huge market. Agreement for Joint collaboration activities among various aerospace industries ex. Bells with Med-Trans Corporation for aircraft support.

2.5.9 National Aerospace Laboratories (NAL)

NAL is India's Premier Aeronautical R&D Establishment. It was established in 1959 to play a key role in national programme. NAL Mission is development of technologies and facilities for aerospace infrastructure and expertise. It provides R&D support to all national aerospace programmes, i.e., fighter aircraft, gas turbine engines, launch vehicles and satellites, defence systems. It designs and develops small and medium-sized civil aircraft. It has promoted a vibrant Indian civil aviation industry. Its HANSA is all composite trainers for flying clubs. SARAS is a 14-seater light transport aircraft. TEJAS is India's light combat aircraft. NAL has major unique testing facilities and is going ahead with the design of aircraft with higher performance.

2.6 : GIST OF DISCUSSIONS

S. Ghosh

The Session had wide spectrum of presentations covering academics and training of engineers in construction, atomic energy and aerospace fields and how our technical institutions are coping up with it. Young people are very talented, what they require is training and in fact the training has to be a continuous process. I don't think that over-night education institutions are going to change their characteristics. What is needed is that all such organisations who are recruiting the young engineers must have the good training system. To quote example of nuclear engineers, in the last 50 years around l7, 000 nuclear engineers have been trained, wherever there are power stations. Professional societies can also organise such training.

Generally the private companies and the public sector undertakings, who are involved especially in construction, are facing high attrition rate due to rising salary demands. There is demand in the market for right persons. Today, a diploma-holder is in a position to get a job worth about 10,000 rupees and after three months he gets 20,000 rupees and after one year he is commanding Rs 40 to 50 thousand rupees. Unfortunately, construction industry is facing another problem. Most of the engineers coming from IITs and other institutions do not have the patience to go out and work at the construction site. They need motivation, job satisfaction and training from the experienced engineers.

When we talk about the teaching, we talk about the PhD. It is not necessary to have only PhD teachers. Teaching requires both, academic knowledge as well as on-the-ground experience of engineering practice. There can be about 70% non-PhD post-graduates. You can find excellent teachers from the industry. I think the belief that only PhDs can teach is misplaced. It needs to be discarded. We need to encourage experienced engineers from the field to teach college-level students.

S. Ghosh, *Past President, CEAI*

TECHNICAL SESSION I I

3.1 : TECHNICAL SKILLS SHORTAGE IN THE BACKDROP OF INDIA'S EMERGENCE AS AN ECONOMIC POWER

L. Pugazhenthy

3.1.1 Object of Presentation

Focus of the presentation is to voice concerns about the shortage of quality manpower and engineers. If we do not address this issue today, the country will have to face enormous problems.

3.1.2 India's Economic Growth

India is becoming a major super power. In the past, Indian approach was to achieve self-sufficiency. Since 1991, the macro economic reforms have completely transformed the country and the economy is witnessing a quantum jump growth. Since then, India is maintaining impressive GDP growth rates. The growth rate target for the economy in the XIth Plan is 9 %.

"India has emerged as the second most attractive investment destination after China and ahead of the US and Russia"

World Investment Report, UNCTAD

"In terms of Business Confidence Index, India is ahead of the US and next to China; around 45% of global investors are upbeat about India"

A.T. Kearnay Report (7 year survey, 1000 firms, 68 countries)

3.1.3 Why Engineers & What Role?

Our major bottleneck is infrastructure. We need massive investment in infrastructural sectors. The economic growth is increasingly determined by technological capabilities.

At this point of time, we need world-class infrastructure and employable qualified workforce, especially the technical workforce for meeting our growth target and the new challenges squarely. Our Institutions are producing quantities and not quality. Innovation will be the key driver of long-term growth. Our status in number of Researchers and R&D spending when compared with developing countries highlighted in the World Bank Report "Unleashing of India's Innovation Towards Sustainable & Inclusive Growth", is as under:

No. of Researchers (no per million population)		**R&D Spending 2006**	
Russia	3319		
China	708	US	$ 340 billion
India	119	China	$ 94 billion
Brazil	344	India	$ 5.4 billion

The above shows that we are not putting in enough efforts for creative and innovative development.

L. Pugazhenthy *is the Vice President and Chairman, Non Ferrous Division, the Indian Institute of Metals and Executive Director, Indian Lead Zinc Development Association (ILZDA)*

3.1.4 Major Issues

Drastic Overhaul of the Education System. A few days back, the HRD Minister remarked that the Higher Education in the Country is a 'Sick Child'. It is the HRD Ministries at centre and state levels and the statutory educational body like AICTE who have to take the remedial actions to address the issue of sickness. They have to take this message very seriously to diagnose as to what is wrong with higher education, particularly the technical education. Unfortunately, our leaders are more concerned with the reservation policy. In number of Institutions or schools, you can put the reservation category people; they need to be given all the opportunities. But how can we help them so that they can be lifted upwards? A drastic overhaul of the higher technical education system including that of its accreditation mechanism is thus required for improving the quality of our engineering education.

HRD Minister also said that he would not be very keen to allow foreign Institutions of education to come into the country. Why this kind of negative thinking when we can have the safeguard in the system. Allow them to come here to train, let the skills come out and the knowledge be upgraded. As a matter of policy, therefore, we should permit foreign institutions for higher education including technical education to invest in India so that we turn out the best skilled workforce not only for the Indian industry but also for the global industry.

The fine tuning has to be done today. Our children are studying in different countries in the world. Our students are going abroad for studies. Understandably, from China, on an average in a year, at least 25,000 PhD students go to USA with government funding and China is spending 12 to 25 million in research institutes in the USA. So, this is the type of opportunity which we should also give to our students.

Improve Quality while Increasing Quantity. Three lakhs engineers come out of the educational institutions every year but only 20 % get the employment opportunity, it means 80% take sundry jobs or become unemployed. Therefore, employability / suitability is not there. You might have numbers of engineers, technocrats, technical people, but how much they may contribute, how they can play a significant role in innovation and R&D in taking the company and country forward that is more important. Continuous drift of engineers' to InfoTech sector is leading to severe shortages in many engineering disciplines like that of metallurgy, mining, etc. Because of low priority, many seats remain unfilled, for instance in civil engineering discipline. The demand for engineers in almost all disciplines will grow many folds during the coming twenty years. We will have to gear up and match this demand. While doing so, we also should ensure that we produce engineers not only in quantity, but most importantly of the quality that the industry is looking for.

Lateral Entry. We should also see how other countries are addressing this issue. We all know that South Africa is the number one in producing coal in the world and they are not getting people to work in their mines. They called the retired people, 'please come back, we will give you the remuneration for 3 years or 5 years as long you remain healthy to work'. They decided to start the academy by taking engineers / diploma holders and others from Mining/Gold Industry, and finally they employed them in their mines. Similarly, we need to do these kinds of innovations and motivating them to do the better work.

"E" Learning. I was reading the report of the computer Society of India regarding the e-learning. You don't require going personally to attend the classes and take all notes. You all know this is the age of computer savvy or IT savvy. Everyone is familiar with the computer terminology and is able to operate it. So our country has now become computer / IT Savvy. So let us have e-learning courses in all disciplines and make them affordable and through this opportunity to the large number of people we have. Professional bodies under AICTE are doing this work.

Mergers and Acquisitions. We are taking over mines and reputed companies in other countries. Mr. L N Mittal, is controlling about ¼ of the world steel production. TATA Steel is one of the low-cost producers of steel. They all require technical manpower. We are seeing the transaction, mergers and acquisitions but we are facing many issues today. We have now to address these issues otherwise we will miss the bus for ever.

3.1.5 Conclusions

Thanks to ECI for raising these issues in this forum. This kind of forum will help the policy planners, the leaders, and the academia. They have to take this message and introduce the proper strategy to overcome the current and future problems.

3.2: AVAILABILITY OF WORLD CLASS METALLURGICAL ENGINEERS AND TECHNOLOGISTS FOR MEETING GROWING DEMAND OF THE STEEL INDUSTRY - A PERSPECTIVE

Alok Ghosal

3.2.1 India Shining

India is the 4th largest economy in the world on purchasing power parity basis. GDP growth rate of India is around 9.4%, second only to China. Economy is growing robustly, so is steel (CAGR 8.55) India's growth in steel in the world is expected to rise from 3.6% in FY06 to 11% by FY20 . India's yearly production is 44.65 million tons.

3.2.2 Steel is the Mother of all Developments

Every thing is made either of steel or using steel. Steel, which is the mother of all development, is the world's dominant material. Highly recycled and relatively easy to recycle, it is well aligned with today's sustainability requirements. It is fundamental to all manufacturing processes and is used in so many diverse markets that it is sometimes said, "Every thing is made either of steel or using steel".

So the material and the technical knowledge and skills that go to produce and further develop its applications in India are important national assets. It is, therefore, vital that the steel industry continues to develop vigorously if it is to serve the cause of nation building.

Per capita steel consumption in Kg

- Global average - 145
- Singapore - 1200
- South Korea & Taiwan - 860
- Germany - 540
- USA - 410
- Malaysia - 350
- China - 250
- Thailand - 160
- Vietnam - 50
- India - 35
- Rural India - 2

3.2.3 How Do We Propose?

The Chinese proverb goes:

- If you want one year's prosperity - 'grow grains',
- If you want ten year's prosperity - 'grow trees', and
- If you want hundred year's prosperity - 'grow people'

We require technical manpower (metallurgists and technologists) to run the plant, improve the performance, and innovate. Long-term future success in steel will require a move downstream to higher value added products, an even more highly skilled workforce and more effective communication through the supply chain.

Despite the industry's efforts to raise recruitment standards, there is a widespread perception that school standards are not meeting the needs of industry. The quality and relevance of education provision at all levels is of deep concern, because of the severe shortage of pupils studying mathematics, physics and chemistry, the key subjects for future metallurgists and materials scientists. Not only are employers looking for good levels of literacy and numeracy, they also need an education system that is capable of producing school and university leavers equipped with workplace skills such as communication, IT and problem solving.

Production of formable high strength steels for automotive applications calls for very close control of the composition of the steel in the liquid phase on parts per million levels. This is as complex as producing silicon chips with a residual element content at parts per billion levels. The main difference is that in a steel plant this has to be done in 300 ton batches of high temperature liquid steel. The function of a hot strip mill is not just to reduce the thickness of the steel. It also creates the right profile and mechanical properties. These are to a large extent achieved in the finishing mill, where strip thickness, profile and temperature have to be controlled. Given that the strip may be in up to seven stands simultaneously and that it is moving at many meters per second, a large number of parameters have to be controlled simultaneously. This makes the control algorithm as complicated as the sets of equations to calculate a moon shot.

Comparison of Efficiency Parameters

Parameter	Indian plants	International plants
Sinter plant (t/m2/hr)	1.2-1.5	>1.8
Blast furnace productivity(t/m3/day)	1.3 - 2.2	2.5 - 3.0
Steelmaking (blows/year/working converter)	4000 - 4500	6000 - 10000
Specific energy consumption (Gcal/tcs)	6.5 - 7	4.5 - 5.5
Refractory consumption (kg/tcs)	9 -12	6 - 8
Power consumption of EAF units (kwh/t)	300 - 700	200 - 400
Electrode consumption (kg/t)	2.5 - 6	1 - 2.5

Alok Ghosal, *Sr. Manager, Technical Education, SNTI, Tata Steel Ltd.*

Road Map by National Steel Policy considering SWOT

Strengths	Weakness
1. Availability of ore & coal	1. Unscientific mining
2. Low labour wage rate	2. Low productivity
3. Abundance of quality manpower	3. Low R&D investment
4. Mature production base	4. High cost of debt
	5. Inadequate infrastructure
	6. Coaking coal import
Opportunity	**Threats**
1. Unexplored rural market	1. China becoming net exporter (31%)
2. Growing domestic demand	2. Protectionism in the west
3. Exports	3. Dumping by competitors
4. Consolidation	

If a SWOT analysis is carried out on steel industry, the Strength will lie on the fact that Steel is the material of choice for many elements of construction, transportation, manufacturing, and a variety of consumer products. Traditionally valued for its strength, steel has also become the most recycled material. Weakness lies on the hard facts of life in the world of steel that have to be accepted as part of the status quo because individual companies or organisations cannot change them. These include the continuous downward pressure on prices over the steel cycle, the changes in steel's main customer industries (automotive, construction and engineering) and the ebb and flow of exchange rates. Opportunity can be looked at value innovation scope that lies at the blue ocean apart from the existing cut-throat competition in red ocean side. More than 3,000 catalogue grades of steel are currently available, not including custom grades for specific users. Most grades of steel in use today - particularly high-strength steels that are lighter and more versatile - were not available ten years ago. The threat lies in the use of more carbonaceous material (known as plastics) in the specific areas, whose life cycle cost vitiate the use of steel.

Road map of India's steel production in 2020

Name of unit	Brownfield MT in FY05	Greenfield MT in FY20
SAIL	12.86	21.50
RINL	2.91	10.00
Tata Steel	4.00	10.00
JSW (KN)	2.36	10.00
Essar	2.40	7.50
Ispat (MH)	2.40	5.00
Mittal Steel	-	12.00
POSCO	-	12.00
Tata (JH)	-	12.00
JSW (JH)	-	10.00
Essar (JH)	-	6.00
Tata (CG)	-	5.00
JSPL (JH)	-	5.00
Sterlite	-	5.10
Others	17.72	77.00
Total	**44.65**	**208**

Bridging Supply & Demand Gap

For producing 1MT of steel it is necessary to have 400 engineers of all disciplines. Therefore, India will need 5015 engineers per year spread over 13 years. This figure is not alarming as India produces about 200,000 engineering graduates every year.

- Considering requirement of metallurgical engineers as 30% = 1504. But they do not join the steel industry.
- India produces < 0.5% Metallurgical engineers = 1000
- All do not join in steel units. There will be a shortfall, not only in numbers, but also in quality

The Employers' Federation of India (EFI) foresees a "severe shortage of skilled manpower a few years ahead" which would "seriously retard" growth if left unaddressed.

The only way to forestall this possibility is a complete overhaul of the present education system to "synchronize with global technological developments," applying Dr Eliyahu Goldratt's Theory of Constraints using the following steps:

- STEP 1 : Identify The "Constraint" i.e. what is the constraint of this system?
- STEP 2 : Exploit The "Constraint" It means we need to extract maximum output from the constraint unit with the existing facility.
- STEP 3: Sub-Ordinate Everything to Support Exploitation of the "Constraint". This means deploying and supporting existing resources to remove the bottleneck.
- STEP 4 : Elevate The "Constraint".
- STEP 5 : If The "Constraint" Is Removed; Go Back To Step 1.

Training for the steel industry is being conducted and promoted as under:

- Biju Patnaik National Steel Institute (BPNSI) was established on 1st January 2002 to develop trained manpower, fully geared to handle the technology required for primary and secondary steel making industries.
- National Institute of Secondary Steel Technology (NISST) in Punjab started in 1987 to provide trained manpower to secondary steel sector by conducting short term and long term courses.
- In the seventies, Moscow Institute of Steel and Alloys (MISA), situated in Moscow, was a centre of specialty in teaching courses related to steel technology and research.
- The most current experiment is POSTECH, situated in Pohang , South Korea. The institute is fully sponsored by POSCO; it runs courses related to steel technology alone.
- TATA Steel, a pioneering industry in India, has been experimenting with BIT, Mesra, for 2- year diploma course for the selected undergraduate employees. These are the backbone of the industry and establish equilibrium in the event of exodus of the qualified technologists.

With the massive steel expansion plan ahead, lack of quality human resource should not be a hindrance. Because of resource limitations, alternate can be to introduce one year basic degree/diploma programme for the engineering graduates of the steel industry that would expose and refresh the engineers to selected subjects encompassing major divisions of the steel industry in short time. This has been already introduced in IIT, Kharagpur in the Postgraduate Diploma in Steel Technology (PGDST) programme at the behest of Tata Steel.

3.3: GIST OF DISCUSSIONS

N.T. Nair

The presentations in this session are about shortage of Quality Engineers and the difficulties faced by non-IT sector to fill the gaps. In fact, what the industry is looking forward for those who can be employed straight- away rather than trying to train them for the assigned task ahead. There is a gap between the need of the industry and the skill developed in academic institutions. To quote an example, what industry needs is readymade shirts, whereas they are getting cut pieces and they have to put these fresh engineer graduates to finishing schools. Regarding the problems of re-rolled steel raised by a structural engineer, it was mentioned that some problems do occur when an industrial unit does not conform to specified standards. The salary of engineers also needs to be addressed.

Technologies in the engineering field are changing very fast and the engineers are requiring continuing professional development. For example, with the induction of digital cameras, the traditional cameras are disappearing from the market. Another example is the computer speeding up the art work thus reducing the employment of artist. The need of hour for the working engineers is to update skills and continuing professional development.

N. T. Nair, *Chairman is the Chairman, the Institute of Electrical and Electronics Engineers. Inc., India Council*

TECHNICAL SESSION III

4.1 : NEED OF SKILLED ENGINEERS DURING THE 11TH PLAN PERIOD AND BEYOND IN NON-DESTRUCTIVE TESTING ENGINEERING

K Viswanathan

4.1.1 Major Issue Facing India

There is mismatch of scientific manpower to the emerging technological challenges.

"While India has one of the world's largest stocks of scientists, engineers and technicians, this has not enabled India to face the emerging technological challenges because of the mismatch/inadequacy of education and training"

(WORLD BANK REPORT ON INDIA)

4.1.2 Strategies to Overcome the Challenge

SWOT (Strength Weakness-Opportunity-Threat) analysis identifies the following few strategies to overcome the above

1. Creation of broad public awareness
2. Updating of S&T education
3. Attraction and selection of best suited scientific manpower for R&D
4. Quality of product and services to match international standards
5. Creation of right work-environment for the new recruits
6. Facing the challenge with the retained skilled manpower
7. Continuous improvement

4.1.3 Strength of Indian Scientific Manpower

1. Width of knowledge
2. Theoretical depth
3. Low cost of work
4. Familiarity with English
5. Focus on work
6. Diligent

4.1.4 Weakness of Indian Scientific Manpower

1. Knowledge obsolescence
2. Frequent job changing
3. Lack of training and education
4. Unmatched pays and perks
5. Frustration

K Viswanathan *is the Immediate Past President, ISNT, GM, VAST, SDSC, Shar Centre, Sriharikota and the Member of the Board of Governors, Engineering Council of India*

6. Conflicting Interests
7. Lack of Pride
8. Poor infrastructure
9. Lack of Funding
10. Difficulty in retention of talented S&T personnel
11. Poor organisational culture & environment
12. Lack of team-spirit

4.1.5 Emerging Technological Threats

1. Globalisation
2. Increasing complexity of Technologies
3. Lack of original R&D
4. Technological Obsolescence
5. Lack of suitable infrastructure
6. High investment requirements
7. Long product development cycle time
8. Increasing cost of training
9. IPR
10. Matching international quality standards
11. Automation

4.1.6 Strategies to Overcome the Challenges

1. Increase public awareness
2. Updating of S&T education
3. Improve quality to match International standards
4. Training and certification

4.1.7 Maintain and improve quality through Non- Destructive Testing (NDT)

Non- Destructive Testing involves synergy of science and engineering to create certain methods of testing where items under test remain totally undamaged and components can continue to be used. The NDT methods do no harm. The non- destructive techniques used for testing include:

1. Radiography testing
2. Magnetic particle testing
3. Ultrasonic testing
4. Liquid penetrate testing

5. Eddy current testing
6. Leak testing
7. Acoustic emission testing
8. Visual and optical testing
9. Specialised methods like magnetic resonance imaging, vibration monitoring, laser ultrasonic, holography, thermography and computed topography.

4.1.8 Indian Society for Non Destructive Testing (ISNT)

Mission of ISNT is to provide better quality of life through NDT Science and Technology. Its motto is global NDT and global friendship.

NDT Society of India was registered at Kolkata during 1972 and Indian Institute of Non Destructive Inspection 'Engg. (IINDIE)' was registered at Chennai in 1982. In a historical move, both the Societies merged to form the ISNT, during 1989. Its aims and objectives are to:

- Further the cause of Science &Tech of NDT.
- Help Indian Industry use results of R & D in NDT.
- Organize Courses/Workshops/Seminars in the field of NDT.
- Promote use of approved International & National Standards in NDT by Indian Industry in consultation with BIS.
- Help prepare new Indian Standards & Update old Standards in NDT.
- Coordinate with Universities & Government Bodies for Initiating new Projects on development of various NDT techniques.
- Interact and coordinate with NDT Societies from other countries.
- Conduct Training & Certification Courses in NDT Techniques.
- Propagate the culture of quality.
- To aid Indian Industries to compete in the world market

ISNT offers invaluable resources and information on NDT, links for Industrial Quality Development, provides Professional Development to its members (Over 6000), helps in identification of appropriate NDT techniques for Quality Assurance. It can put you in contact with International Experts for cracking your NDT related problems. It can provide specialized Training & Certification Programs, international links to improve Quality and Profitability and periodical updates on NDE through the Journal of NDE.

ISNT has 20 Chapters located all over India and has Membership of over 6000. The associate bodies include National Certification Board, Qunest Foundation. Its Working Groups are Digital Radiography Working Group (India), Neutron Radiography Working Group (India) and Acoustic Emission Working Group (India).

Major Industries using its facilities are:

- Aerospace
- Defense

- Atomic Energy
- Petroleum and Petro-chemicals
- Heavy Engineering
- Automobile
- Power Generation and many more

4.1.9 Need/Demand of Certified NDT Personnel

The current demand is 2500/ yr. The current certification rate is 1500/yr the demand projected in the 11th Plan and beyond is 5000/yr. Strategies to match the challenge / gap contemplated are:

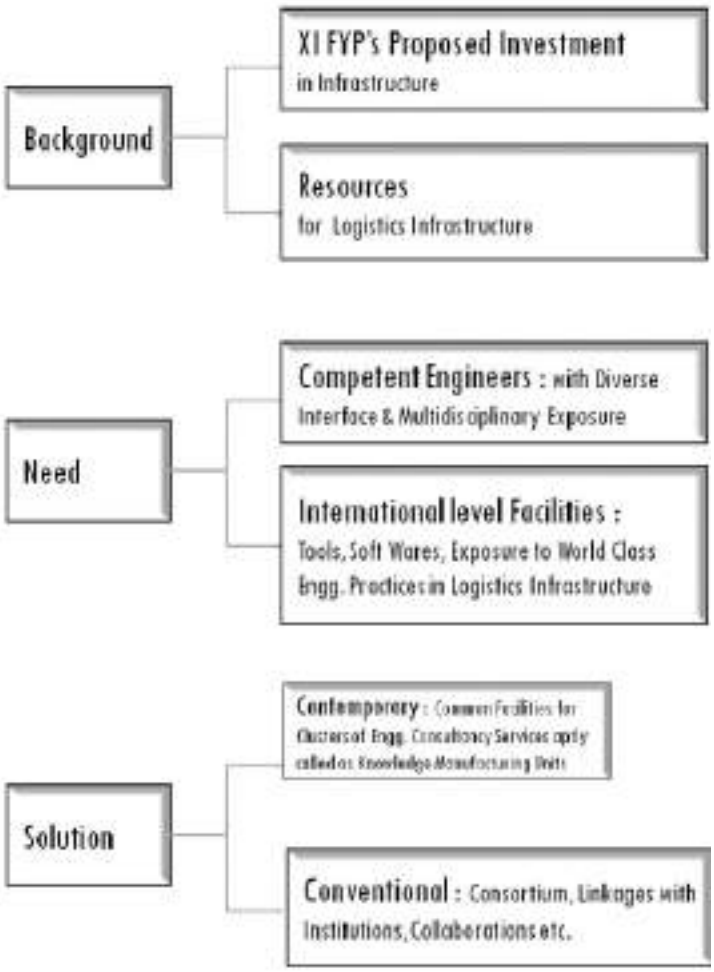
1. Accelerate training and certification programme
2. Create centre of excellence in NDT
3. Invest in original R&D and innovation in NDT
4. Frequent Industry academia interaction
5. Retain skilled manpower
6. IPR awareness, royalty, revenue sharing programmes

4.2 LOGISTICS INFRASTRUCTURE IN INDIA: NEED FOR CLUSTER-BASED CONSULTANCY

Ranjit Sinha

4.2.1 Introduction

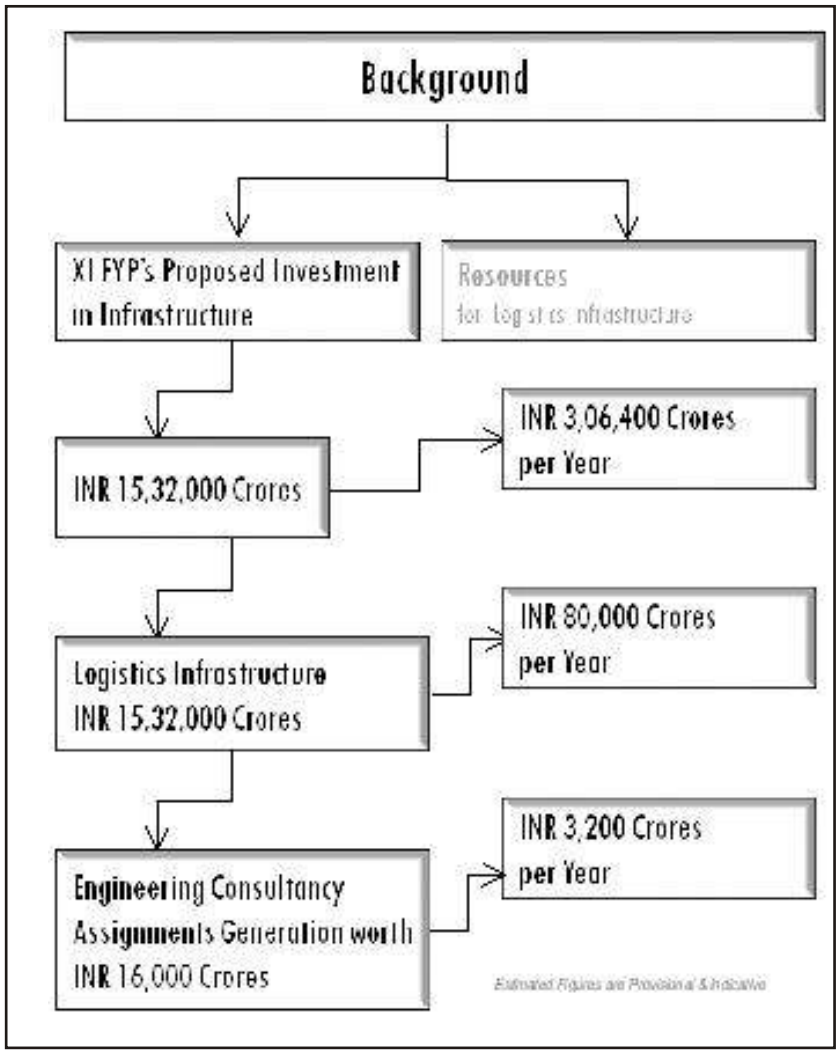
In the context of 11th Five-Year Plan, there is the need for developing a Cluster-based Consultancy for providing consultancy services in infrastructure. This presentation is divided into three parts, i.e., 'Background', 'Need' and 'Solution'. Background outlines the XI Plan proposed investment in infrastructure and resources for logistics infrastructure. Need highlights the requirement of competent engineers with diverse interface and multi-disciplinary exposure having exposure to world-class engineering practices, tools and software. The proposed Solution calls for establishment of common facilities for clusters of engineering consultancy services termed Knowledge Manufacturing Units to replace conventional consortium approach having linkages with institutions, collaborations etc.



Shri Ranjit Sinha, *Development Specialist at Kransu Qb*

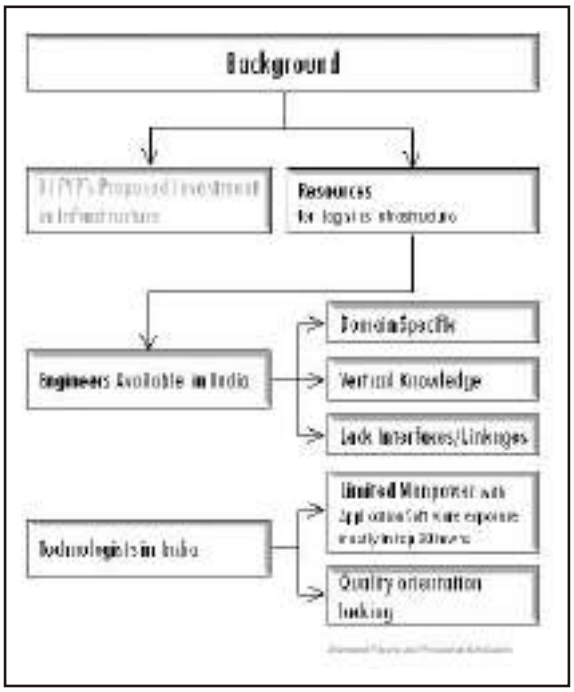
4.2.2 Background with Proposed Investment

11th Plan contemplates investments in Infrastructure of the order of INR 15, 32,000 crores, i.e., INR 3, 06,400 crores per year. The logistics infrastructure involving Road, Rail, Air and Ship facility account for more than INR 4,00,000 crores i.e. INR 80,000 crores per year. The engineering consultancy assignment at a very conservative estimate figures around INR 16,000 crores over next five years of the 11th for such investment at an average fee of 4%, i.e., INR 3,200 crores per year. It further translates into the engineering consultancy manpower requirement for logistics infrastructure, at 20,000 engineers, considering an average revenue of Rs. 15 lakh per engineering consultant per year.



4.2.3 Background with Proposed Resources for Logistic Infrastructure

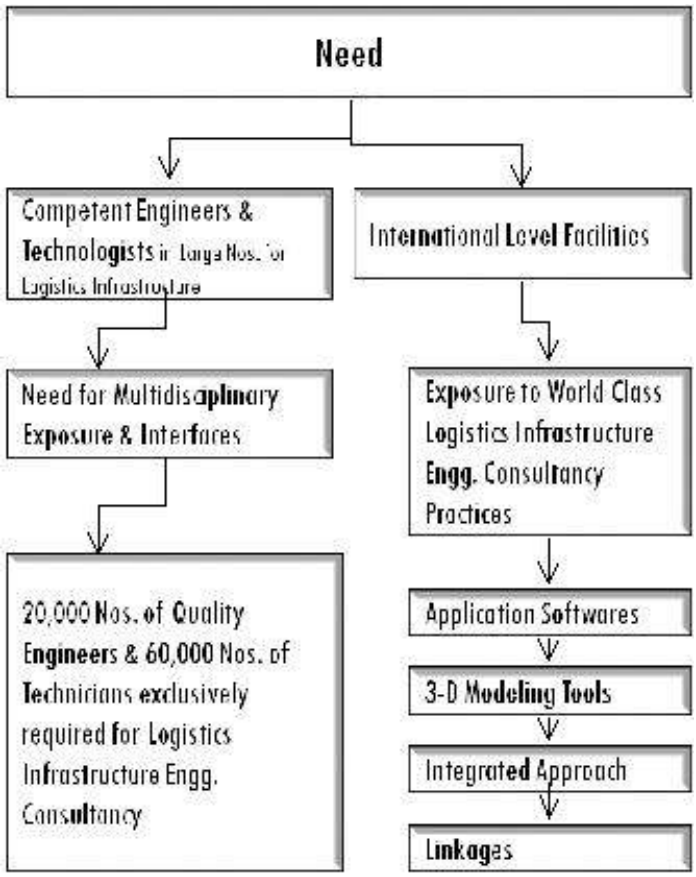
Availability of resources can be considered under than two heads, i.e., engineers availability and skills in technology. Engineers available in India are domain-specific, having vertical knowledge and lacking interfaces/linkages having multi-disciplinary exposure of traffic, transportation, structures etc. Technologists available in India with application software exposure are mostly limited in top 30 towns and generally quality orientation is lacking.



4.2.4 Need of Logistic Infrastructure

Need of Logistic Infrastructure can be considered as follows:

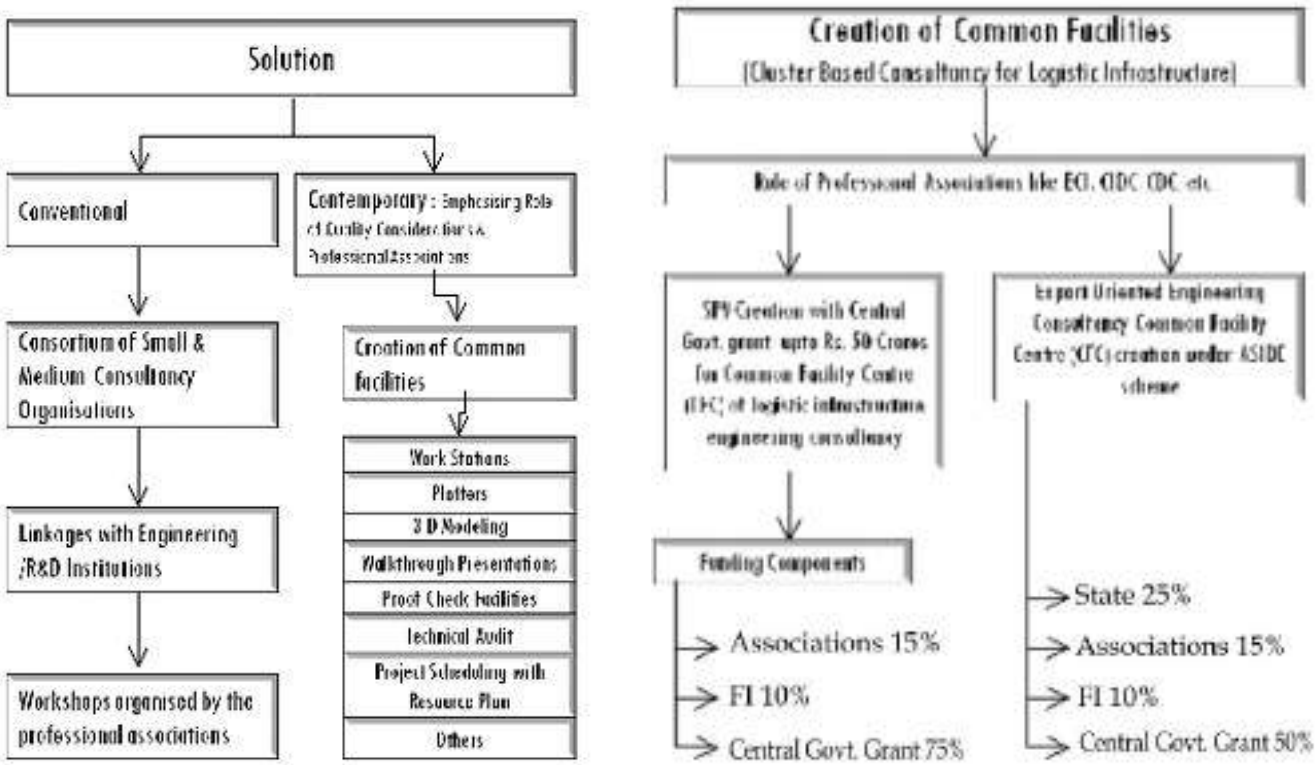
- Competent engineers and technologists in large numbers for logistics infrastructure with multidisciplinary exposure and interfaces 20,000 quality engineers and 60,000 technicians exclusively required for logistics infrastructure engineering consultancy
- International level facilities for developing world-class logistics infrastructure engineering consultancy practices including skills in application software, 3D modelling tools, integrated approach, linkages etc.



4.2.5 Solution for Logistic Infrastructure

Conventional approach is to establish consortium of small and medium consultancy organisations, who form linkages with engineering and R&D Institutions, and professional associations.

The need for such engineering consultancy in logistics infrastructure can be met with evolution of cluster-based consultancy, corollary to the clusters of small scale industries in various parts of India. Around 80% of Infrastructure consultancy is being carried out by the small consultants on sub-contract basis. Contemporary approach emphasises role of professional associations in creation of common facilities, work stations, plotters, 3D modelling, walkthrough presentations, proof-check facilities, technical audit, project scheduling with resource plan and others. The need for such engineering consultancy in logistics infrastructure can be met with evolution of cluster-based consultancy, corollary to the clusters of small scale industries in various parts of India. Proposed Common Facilities Centre (CFC) for Logistic Infrastructure engineering consultancy with support of Professional Associations can be created with central government total grant up to Rs. 50 crores having funding components associations 15%, FI 10% and central government grant 75%. Similarly, export- oriented Common Facility Centre (CFC) can be created under ASIDE scheme with funding components- State 25%, Association 15%, FI 10% and Central Government grant 50%



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4.3 : ACHIEVING EXCELLENCE IN ENGINEERING AND TECHNICAL INSTITUTIONS

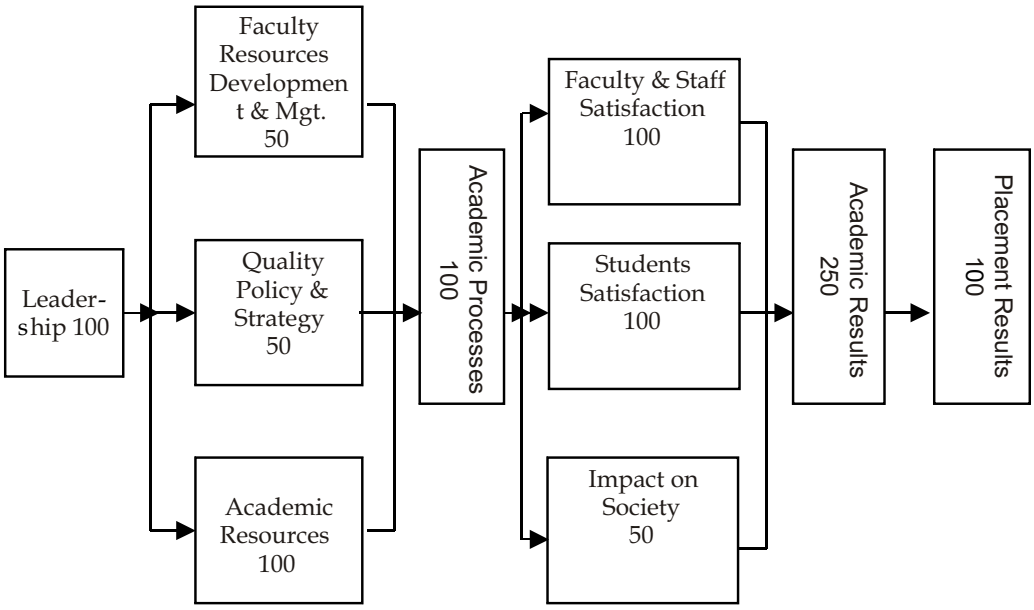
Prof. Sechadri Bose

4.3.1 Introduction

Rapid growth of technical education in the Country during the last 10-15 years, both in terms of number of institutions and intake capacity was perhaps necessary. But in the process, it is felt that some compromise were made with the quality of education. It is, therefore, necessary to consolidate and ensure quality education so as to provide world-class technical manpower and to usher in technology - driven economic development in the country. In this paper, certain parameters have been identified which are objective in nature and can be monitored regularly. Successful implementation of these parameters will lead to improved performance of engineering colleges with respect to improved quality of outgoing students.

These parameters have been divided into two categories i.e. Enablers and Results: -

- Enablers. 'Enabler parameters indicate what an institution does. 'Result' parameters indicate what an institution achieves. "Enablers' cause 'Results'.
- Results. The model is dynamic in nature and recognizes that excellent results with respect to performance, customers, people and society are achieved through leadership, driving policy and strategy and academic resources.
- The model suggested in the paper can be used not only for monitoring the quality of a particular technical institution but also as a means of self- assessment by an institution for the purpose of self-improvement.



Prof. Seshadri Bose *is from the Department of Mechanical Engineering , ABES Engineering College, Ghaziabad.*

4.3.2 Structure of Academic Excellence Model

STRUCTURE OF ACADEMIC EXCELLENCE MODEL

Academic excellence is assessed out of 1000 points as per following distribution:

A. Enablers: 400 points allocated as follows:

1. Top Management's commitment to Quality & Academic Leadership : 100 points
2. Faculty Resources Development & Management : 50 points
3. Quality Policy & Strategy : 50 points
4. Academic Resources : 100 points
5. Academic Processes : 100 points

B. Results: 600 points allocated as follows:

6. Faculty & Staff satisfaction : 100 points
7. Students satisfaction : 100 points
8. Impact on Society : 50 points
9. Academic Results : 250 points
10. Placement Results : 100 points

4.3.3 Enablers: Top Management's Commitment to Quality & Academic Leadership

The 100 Points allocated are distributed under two heads as under:

A. 50 points for Chairman of the trust

Sl. No.	Sub Factors	High 05	Very Good 04	Good 03	Satisfactory 02	Low 01
1.	Qualifications for the role being performed					
2.	Academic Commitment					
3	Perce ived will to excel and sincerity of purpose					
4.	Perceived concern for faculty development					
5.	Vision and direct involvement in realization of that vision					
6.	Involvement with quality improvement process directly					
7.	Attitude towards faculty & staff					
8.	Attitude towards students					
9.	Academic autonomy to faculty and open- mindedness towards suggestions					
10	Inspirational quality of leadership/Role model for excellence					

B. 50 points for Director/Principal

Sl. No.	Sub Factors	High 05	Very Good 04	Good 03	Satisfactory 02	Low 01
1.	Qualifications for the role being performed					
2.	Academic Commitment					
3	Perceived will to excel and sincerity of purpose					
4.	Perceived concern for faculty development					
5.	Vision and direct involvement in realization of that vision					
6.	Involvement with quality improvement process directly					
7.	Attitude towards faculty & staff					
8.	Attitude towards students					
9.	Academic autonomy to faculty and open-mindedness towards suggestions					
10	Inspirational quality of leadership/Role model for excellence					

4.3.4 Enablers: Human (Faculty) Resource Development & Management

The 50 Points earmarked and the format for evaluation is as follows:

Sl. No.	Sub Factors	High 05	Very Good 04	Good 03	Satisfactory 02	Low 01
1.	Recruitment process leading to excellence					
2.	Financial compensation package/process					
3	Perks and performance incentives People development process-					
4.	Encouragement to improve qualifications					
5.	Work culture					
6.	Faculty & Staff performance appraisal process					
7.	Networking with reputed academic institutions-encouragement & support					
8.	Ambience in offices of faculty & staff					
9.	Encouragement for industry interaction					
10	Skill-up gradation / conference Sponsorship and peer interaction encouragement					

4.3.5 Enablers: Quality Policy & Strategy

The 50 Points earmarked and the format for evaluation is as follows:

Sl. No.	Sub Factors	High 05	Very Good 04	Good 03	Satisfactory 02	Low 01
1.	Quality policy on student admissions					
2.	Quality policy on faculty recruitment process					
3	Quality policy on faculty promotion/recognition process					
4.	Student orientation					
5.	Industry (employer) orientation					
6.	Quality of physical ambience					
7.	Quality improvement policy for faculty & staff					
8.	Vision / Mission leading to quality					
9.	Core values leading to quality of education					
10	Quality Management Systems-ISO etc in place					

4.3.6 Enablers: Academic Resources

The 100 Points are allocated as follows:

(a) Library Resources: 20 Points

Sl. No.	Sub Factors	High 05	Very Good 04	Good 03	Satisfactory 02	Low 01
1.	Number and quality of books					
2.	Number and quality of journals					
3	Library ambience /computzn. etc					
4.	Adequacy & attitude of library staff					

(b) Computational Resources: 20 points

Sl. No.	Sub Factors	High 05	Very Good 04	Good 03	Satisfactory 02	Low 01
1.	Number of computers per student					
2.	Networking quality / LAN etc.					
3	Access timings & % availability of computers					
4.	Degree of modernization of computational facilities					

(c) Internet Connectivity: 10 points

Sl. No.	Sub Factors	High 05	Very Good 04	Good 03	Satisfactory 02	Low 01
1.	Bandwidth, keeping size in mind / campus networking					
2.	Availability of online-journals / learning resources					

(d) Laboratories Infrastructure: 25 points

Sl. No.	Sub Factors	High 05	Very Good 04	Good 03	Satisfactory 02	Low 01
1.	Adequacy in terms of number of labs required for the programmes					
2.	Adequacy in terms of equipment / facilities required					
3	Availability of technical support (manpower) relevant to the lab					
4.	General ambience & upkeep of equipment and space					
5.	Availability of laboratory Manuals and other instructional resources					

(e) Lecture-Hall Infrastructure: 25 points

Sl. No.	Sub Factors	High 05	Very Good 04	Good 03	Satisfactory 02	Low 01
1.	Adequacy of lecture halls with respect to students strength					
2.	Quality and ambience in lecture halls-lighting, furniture etc					
3	Educational technology / multi media and other facilities					
4.	Tutorial rooms / project rooms availability					
5.	Auditorium for special lectures, industry lectures, Training & Placement activity etc					

4.3.7 Enablers: Academic Processes

The 100 Points are allocated as follows:

Sl. No.	Sub Factors	High 05	Very Good 04	Good 03	Satisfactory 02	Low 01
1.	Effectiveness of teaching-learning process-in terms of class size					
2.	Tutorial process-size of tutorial groups & effectiveness					
3	Laboratory process-size, mechanism of report writing & interaction with instructor					
4.	Process of lecture delivery / focus on learning and interaction					
5.	Industry-interaction process					
6.	Process of projects allocation and guidance					
7.	Evaluation process for sectionals / labs					
8.	Practical orientation					
9.	Process for allocating summer training					
10.	Process to enhance commn. skills					
11.	Process to improve social skills					
12.	Personality development process					
13.	Process for value orientation					
14.	Sports orientation and facilities					
15.	Support towards Technical-symposia/festivals					
16.	Networking with academia in India/abroad					
17.	Discipline					
18.	Academic schedule regularity					
19.	Grievance handling process with respect to students admissions					
20.	Grievance handling process with respect to students results					

4.3.8 Results: Faculty and Staff Satisfaction

100 points for Conduct Surveys are allocated as under:

Rate Satisfaction on following factors on a 5 points scale

Sl. No.	Sub Factors	High 05	Very Good 04	Good 03	Satisfactory 02	Low 01
A	**Hygiene factors: satisfaction level:**					
1.	Pay					
2.	Perks					
3	Promotional avenues					
4.	Physical working conditions					
5.	Workload-Academic					
6.	Workload-Non Academic					
7.	Housing on campus/or allowances					
8.	Transport allowance / facilities					
9.	Locational convenience					
10.	Safety / security on campus					
B.	Motivational factors: satisfaction level:					
11.	Career advancements / opportunities					
12.	Self Esteem / perceived respect in the organization					
13.	Fairness in recognitions					
14.	Class room academic challenges					
15.	Professional & peer interaction					
16.	Research facilities available					
17.	Consulting opportunities					
18.	Nurturing of talent for academic growth by the institution					
19.	Conference support given					
20.	Autonomy for professional growth					

4.3.9 Results: Student Satisfaction

The 100 points are to be based on surveys and feedbacks.

Sl. No.	Sub Factors	High 05	Very Good 04	Good 03	Satisfactory 02	Low 01
A. 1.	**Hygiene factors: satisfaction level:** Lecture facilities					
2.	Library facilities					
3	Project facilities/quality of guidance					
4.	Tutorial help					
5.	Computational facilities					
6.	Sports facilities					
7.	Medical help/support					
8.	Sanitation / Housekeeping					
9.	Maintenance of buildings					
10.	Cafeteria / Canteen					
B.	Motivational factors: satisfaction level:					
11.	Teaching effectiveness					
12.	Fairness in evaluation					
13.	Intellectual learning environment					
14.	Summer projects quality					
15.	Industrial interaction					
16.	Placement levels					
17.	Creative pursuits					
18.	Co-curricular activities					
19.	Support by Administration					
20.	Inspirational academic leadership, teachers and staff					

4.3.10 Results: Impact on Society

50 points are based on feedback, databases on following 10 factors:

Sl. No.	Sub Factors	High 05	Very Good 04	Good 03	Satisfactory 02	Low 01
1.	Concern for economically poor					
2.	Concern for socially backward					
3	Gender equality and fairness					
4.	Encouraging talent in schools in the zone					
5.	Help in improving schools quality					
6.	Fellowships instituted					
7.	Fee waivers given					
8.	Environmental concerns in neighborhood					
9.	Support to NSS / NCC					
10.	Rural development initiatives					

4.3.11 Results: Academic Results Out of 250 points

These are directly based on % of Average Gross Intellectual Attainment per student.

Exceptional	: 90-100%		Satisfactory	: 40-50%	
Outstanding	: 80-90%		Marginal	: 30-40%	
Excellent	: 70-80%		Low	: 20-30%	
Very Good	: 60-70%		Very Low	: 10-20%	
Good	: 50-60%		Unacceptable	: 0-10%	

4.3.12 Results: Placement Results out of 100 points

These are directly on % of campus placement moderated by a factor given by "Average salary level / Industry average salary".

Exceptional	: 90-100%		Satisfactory	: 40-50%	
Outstanding	: 80-90%		Marginal	: 30-40%	
Excellent	: 70-80%		Low	: 20-30%	
Very Good	: 60-70%		Very Low	: 10-20%	
Good	: 50-60%		Unacceptable	: 0-10%	

Policies & Strategies

S.No	Policy/Rule/Scheme	Whether implemented (Yes/No)	A copy to be attached as annexure
1	Faculty recruitment policy		Annexure No.
2	Policy for fixing initial pay of the faculty		Annexure No.
3	Faculty Development and promotion policy		Annexure No.
4	Policy on student admission		Annexure No.
5	Service rules/ Leave rule		Annexure No.
6	Quality Management System (NBA accreditation, ISO)		Annexure No.
7	Incentive scheme for faculty		Annexure No.
8	Incentive scheme for students		Annexure No.
9	Student feedback on Academics		Annexure No.
10	Student feedback on extra academic activities		Annexure No.
11	Feedback from alumni and employers		Annexure No.
12	Faculty appraisal system		Annexure No.

4.3.13 Conclusion

The technical-institutional assessment model suggested in the presentation can be used not only for monitoring the quality of a particular technical institution but also as a means of self- assessment by an institution for the purpose of self-improvement.

4.4 : WHO IS AN ENGINEER?

R K Abrol

4.4.1 Introduction

After 55 years of varied experience in diverse fields of engineering profession, I have come to the conclusion that the term "Engineer" and "Engineering" are the most misunderstood, misused and misinterpreted nomenclatures and that no precise definition of these terms exists in India or, perhaps, elsewhere in the world. In some countries (Australia, Bahrain, Canada-Ontario, Korea, Malaysia, South Africa and USA) there is Engineers Act which defines who is an Engineer in that particular country. However, this definition varies from one country to another.

In contrast, almost all other known professions are clearly defined and identified as such. For example, in medical profession "Doctor" is well defined legally and statutorily in every country. Similar is the case with the professions of Law wherein to practice the profession the lawyer has to acquire the qualifications and experience specified by a statutory authority. Chartered Accountancy and Architecture are other examples of professions which legally debar anyone from practising the profession unless possessing the specified educational qualifications as well as experience.

In India, owing to the absence of any law to regulate the Engineering profession, the law does not recognize the profession of Engineering. As such, anyone is free to designate himself/herself as an Engineer irrespective of his/her qualifications, experience and competence.

4.4.2 What is engineering?

Before attempting to find an appropriate answer to the question of who is an Engineer, let us make an attempt to find whether an accepted definition of "Engineering" exists.

Many definitions exist. However, a commonly accepted definition is ***"Engineering is the application of mathematics & science to create something of value from natural resources"***

On the basis of this definition, it has been said that ***"Scientists discover the world that exists and Engineers create the world that never was"***

In this context, it would not be inappropriate to say that Engineering is an "invisible" profession because most people have no clue as to what engineers do.

The other simple definitions of "Engineering" in use are as follows:

- Applied science, applied with an eye toward ethical behavior.
- Designing and building things that meet customer requirements.
- Using scientific information for practical purposes.
- Applying technology toward human needs.
- The art of applying science to the optimum conversion of natural resources to the benefit of humankind.
- The bridge between science and art.

R K Abrol *is a Chartered Engineer*

Common threads in many discussions of this subject are:

- Some call it an art, some a science, some both.
- Nearly all recognize that engineering is an act performed in response to some human need or another.

Most agree that engineering cannot be performed with indifference to "ethics," or without "professionalism." Some even consider a "moral element."

Almost all agree that Engineers enhance the quality of life by inventing new ways to solve problems and mastering old ways to meet needs.

4.4.3 What Engineers Do?

The prevailing concept of what Engineers do can be summarized as follows.

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 manufacture these products, plants in which these products are made, and the systems that ensure the quality of the products as well as the efficiency of the workforce and manufacturing process.
- Engineers design, plan, and supervise construction of buildings from single storey to over 100 storey and ensure their safety and stability against hazards;
- Engineers design highways, bridges, railways and transit systems;
- Engineers design dams, irrigation canals, aqueducts, power houses;
- Engineers design ports, harbours as well as off-shore structures;
- Engineers 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.
- Engineers harness the power of the sun, the earth, atoms, and electricity for supplying the Nation's power needs;
- Engineers analyze the impact of the products they develop or the systems they design on the environment and on people using them.

With such a vast and varied nature of their activities, it is not difficult to understand why the title "Engineer" cannot be defined precisely like titles of other professions. Yet, if Engineering is a profession, then the title "Engineer" must be defined. When any one designates himself as Engineer, we should know his competence to do the engineering he is expected to do.

4.4.4 Prevailing Concept of who is Engineer

A scientist is a person with original ideas. An engineer is a person who makes a design that works with as few original ideas as possible.

An attempt was made to find an answer to the question who is an Engineer through searches in the internet. The results are enumerated below:

- Although plenty of examples of engineering from ancient times still exist, the term "Engineer", which first appeared during the Industrial Revolution, was used for people who kept the engines in factories or on trains running. Since then a number of usages of the term have appeared in various countries.
- In some countries of Europe and Latin America the title "Engineer" is limited by law to people with an engineering degree, and the use of the title by others (even persons with much work experience) is illegal. In Italy the title is limited to people who, besides holding an engineering degree, have passed a professional examination.
- In the USA, the term "Engineer" is also used to denote an operator of an engine of some sort, e.g., a railroad engineer denotes the operator of a locomotive, a ship's engineer denotes the operator of the steam engine on a steamship, and a stationary engineer is normally responsible for a stationary steam engine. Occasionally "title inflation" results in non-engineers holding jobs with "Engineer" in the job title. For example, the term "Field Engineer" is often used to describe manufacturers' (or third party) supplied installers and/or maintainers of (complex) equipment at a user's site. However, they are not commonly degree engineers.
- In firefighting, the term "Engineer" refers to a fire-fighter whose job is to drive the fire apparatus and, if it has an onboard water supply, to stay with the engine and operate the pumps so that the fire-fighters on the hose can have enough water to put out the fire.
- The term "Engineer" may also be used to describe holders of some forms of professional certification other than university degrees, such as (but not limited to) Microsoft Certified Systems Engineer, Certified Novell Engineer, Red Hat Certified Engineer and so on.
- Laws in all U.S. States, Canada and in South Africa limit the use of several engineer titles, particularly the title of "Professional Engineer," and often also titles indicating a specific, regulated branch of engineering, such as "Civil Engineer" or "Mechanical Engineer." Most U.S. states do not restrict unlicensed persons from calling themselves an "Engineer" or indicating branches or specialties not covered by the licensing acts.
- In Canada, the usage of the term "Engineer" to describe holders of professional certification is not legally permitted. The Canadian Council of Professional Engineers mounted an extended campaign to get Microsoft to renounce use of the word "Engineer" in the title of their certification. A 2001 reader survey by Microsoft Certified Professional magazine found that over half of respondents supported changing the name of the MCSE to remove the word "Engineer".
- The word "Technologist" is sometimes used synonymously with "Engineer" as it derives from the prefix techno- and the suffix-ologist. Hence, someone, who studies technology. This applies particularly to those European countries with laws regulating the use of the title "engineer." However, in Britain as well as some European countries, the term "technologist" is a certification or registration that is equal to an engineer but has a different focus than design. For example, a technologist may focus on Technical Management, Manufacturing Engineering, or an Applied Engineering practices. A technologist maybe a better choice to fill positions that require applied engineering skills than a design engineer. Regulation of the Technologist title is covered by the Sydney Accord, which is currently overseen by the Engineering Council of the United Kingdom.

- In Italy, the title 'Engineer' is reserved only for people with a degree in Engineering.
- In Britain, the term 'Engineer' is often used to describe a technician or a person that mends and operates machinery. In mainland Europe, engineering is seen as comparable to other professions such as medicine and architecture. Professional engineers registered with the Engineering Council UK have the exclusive right to the titles Chartered Engineer and Incorporated Engineer. These titles are only awarded after a rigorous formation including higher education, training and experience.

4.4.5 Definitions of Engineer on the Web

- a person who uses scientific knowledge to solve practical problems
- the operator of a railway locomotive wordnet.princeton.edu/perl/webwn
- Someone who practises the engineering profession; a professional practitioner of engineering; someone who uses scientific knowledge to solve practical problems and produce goods for society. en.wikipedia.org/wiki/Engineer
- The engineer is the person that drives the Fire Engine or Ladder Truck.
  www.riotacts.com/fire/glossary.html
- A person who uses scientific knowledge to solve practical problems.
  www.mma.nrao.edu/development/computing/docs/joint/draft/Glossary.htm
- person skilled in a branch of engineering
  wells.entirety.ca/glossary.htm
- a person who uses science and math to design, build or operate equipment, structures and systems.
  education.jlab.org/beamsactivity/6thgrade/vocabulary/
- (US): driver, engine driver, train driver (UK)
  www.answers.com/topic/rail-terminology
- Someone who applies knowledge of math. and natural science to practical ends, such as the design, construction and operation of structures.
  www.newbaybridge.org/the_builders/job_glossary.html
- person who designs, constructs and maintains works of public utility such as roads and bridges
  www.idealcity.org.au/glossary.html
- The member of the crew designated and qualified to operate a train over the territory to be traversed.
  www.railfanusa.com/info/terms.html
- Any registered engineer who designs all or a part of the Building Structural System and/or who produces all or a part of the Building Structural System Design Documents.
  www.woodtruss.com/terminology.php
- The crew member responsible for the physical operation of a freight or passenger train and for monitoring the locomotive's running condition.
  www.lionel.com/GettingStarted/Guides/a-f.html
- A person who plans and creates structures for a variety of uses.
  regentsprep.org/Regents/global/vocab/topic_alpha.cfm

- An individual who combines knowledge of science, mathematics, and economics to solve technical problems that confront society.
  highered.mcgraw-hill.com/sites/0072480823/student_view0/glossary.html
- A person dedicated to the knowing and workings of mechanical, structural or dimensional expertise. Educated in the ways of bringing about a union between different energies or materials that ultimately combine to create something new
  www.katiestanley.com/resources/dd/e.htm
- A professional in cost effective engineering
  apfilms.corradiation.net/badgeglossary.html
- Responsible for maintenance of the boat's mechanical, motors, water system, compressors, & monitoring systems. www.reefscuba.com/nauticalterms2.htm

4.4.6 Need to Protect the Title "Engineer"

In India, none of the disciplines of engineering are precisely defined or legally recognized by any statutory body. As a result, a car mechanic often designates himself Automobile Engineer, a plumber as Plumbing Engineer, an electrician as Electrical Engineer, and so on. There are no legal provisions to ensure whether they have the requisite qualifications and experience to adopt the title "Engineer".

There are a large number of professional engineering associations, societies and institutions active in India. Some cater to the professional needs of many engineering disciplines. Most are small and some confine their activities to particular regions of the country.

Can these associations, societies & institutions put their heads together and evolve a common definition of the term "engineer"? This will be a great service to the public at large who is confused as to who is an engineer and how to identify a real engineer from amongst thousands claiming to be engineer of one type or another. This common definition of Engineer should then be incorporated in the proposed Engineers Bill so as to protect the title "Engineer" just as the title "Architect" is protected by the Architects Act.

4.4.7 Engineers Bill

As we know, enactment of Engineers Bill is under active consideration in the Ministry of Human resource Development. Once enacted, this will go a long way in defining "who is Engineer" and in protecting the title "Engineer" in India. It will

- Identify those with proven competence to practise the profession of engineering,
- Introduce recognized system for licensing/certification of engineers
- Prevent unqualified/under-qualified/incompetent professionals from practicing the profession
- Ensure that Engineers follow the technical codes, standards and Bye-laws
- Enforce code of ethics and thereby improve the present distorted image of Engineers in the Society.

4.4.8 Conclusion

In the existing professional scenario in India, it is necessary to effectively tackle the question "who is Engineer". The earlier this is done, the better it will be for healthy development of the engineering profession and thereby to stimulate overall progress of the nation.

4.5 GIST OF DISCUSSION

Shri D P Misra

Let me congratulate the speakers for their presentations in the short time allotted. The topics covered included 'Need for skilled engineers in non-destructive testing engineering', 'logistics infrastructure in India', 'need for cluster-based consultancy for achieving excellence in engineering and technical institutions' and defining 'who is an engineer'.

Role of an engineer starts from the conception of an idea. It is followed by extensive analysis and systematic implementation. There can be unthinkable errors like survey work not done properly or quantity of hard rock increased due to incorrect soil investigation. Such errors generate disputes. Any creation by an engineer is beneficial if it is useful to the society and such creations are made within time and cost.

The quality of the graduate engineers has been a point of concern, as expressed in all the sessions' of this Conference. There is more of quantity than quality. Faculty shortage is producing unsuitable engineers. The private institutions do not want to pay suitably to faculty. The basic issue is that there has been a gap between the Industry and the Institutions imparting education.

It is also noticed that there are many vacancies for engineers in government and PSU, which remain unfulfilled for a long time. Regular intake of engineers and timely filling of vacancies will reduce unemployment.

It is the need of the hour to legally define as to who is an engineer and lay down its globally compatible competency standards as has been done by the Washington Accord and Engineer Mobility Forum. It is time that all professional bodies should come together under one umbrella to solve the problem. .

The basic issue is that there has been a gap between the Industry and the Institutes imparting education.

CONCLUDING SESSION

5.1 Dr. P. S. Rana

We had a full day of the session on Role of Engineers and Technologists in the Fast Growing Indian

Economy. Now, engineers have a multi-faceted role. We feel that we are large in numbers but not the right quality, right skills and right attitude. **If we do not address this issue today, the country will have to face enormous problems. Our Institutions are producing quantity and not quality. We need Quality Manpower not Quantity. We are not putting in enough efforts for creative and innovative development.**

The industry is looking forward for engineers and technologists who can be employed straight-away rather than trying to train them for the industry-related tasks ahead. There is a gap between the need of the industry and the skill developed in academic institutions. We are failing to bring directly employable engineers from our institutions. **Technologies in the engineering field are changing very fast and the engineers require continuing professional development.The need of hour for the working engineers is to update skills and continue professional development.The growing economy needs massive investment in teaching and research and development. The human resource requirement in R&D is anticipated to be at least ten fold or even more over the present level. The need is urgent**

On the other hand, we feel proud of our numbers, particularly when we see the situation in which we are in today. We, engineers, have a responsibility to create those economic activities, other than agriculture, and herein come the role of engineers most prominently because we are not only engineers but entrepreneurs also. We must create enough opportunities for absorbing the 55% unskilled labour force sitting idle. 9% or 8% og GDP is not enough to absorb all of them. We are not able to maintain this 9% unless we create adequate skilled manpower, provide adequate infrastructure and the full logistics to meet the demand of growing economy. We have a few sectors of excellence. But it has to be made much broader and the engineering community has the biggest responsibility in this area. **There is worldwide shortage of engineers and technologists at the moment and there are considerable cross-border opportunities for Indian engineering professionals and technologists abroad.** They can seize these opportunities only when Indian Engineering Degrees and Experience are recognised world-wide. For this, India will have to be a full Member of the Washington Accord and the Engineers Mobility Forum. We need to address these issues.

Even after a Statutory Body is formed when the Act is passed, our thinking is that ECI will continue to work as a Confederation of the various engineering bodies and will be the spokesperson of all the associations put together.

IGNOU and ECI's Member Associations with the support of ECI are contemplating a joint initiative for granting an overlapping university degree to the Associate Membership Certificate holders of the Member Associations of ECI in appropriate engineering disciplines; thus enabling these certificate holders getting an accredited engineering degree.

We, from the ECI, shall try to provide the full support to all our members and let us hope that year-by-year we take up this responsibility in a much better way and with this note, I conclude today's conference.

Theme Paper

by

Dr. Ajeet Narain Mathur

The Shortage of Engineers and Technologists: Some Myths, Realities and Challenges

***Dr. Ajeet Narain Mathur**

Abstract

This paper seeks to dispel five myths related to the shortage of engineers and technologists in India drawing upon empirical data from the National Technical Manpower Information System (NTMIS) of The Institute of Applied Manpower Research. The paper argues for a reappraisal of the constraints that adversely impact the role of engineers and technologists in the fast growing Indian Economy and proposes the structuring of more inquiries into researchworthy questions and challenges. The conclusion of this paper point to the need for policies, systems, structures and processes around institutions of professional advancement rather than exclusive reliance on government.

1.2.1 In 2006, Indian institutions added about 4, 30,000 engineering and technical professionals to the talent pool. During the past five years, about 42 percent of large Indian firms and 17 percent of Indian SMEs introduced 'new to world' innovations, half of which were in operations. The Engineering profession has much to be proud of and I congratulate the Engineering Council of India (ECI) and its constituents, the twenty-five professional associations, for the gigantic responsibilities in standards setting that you have taken upon your shoulders.

In choosing the theme 'Role of Engineers and Technologists in the Fast Growing Indian Economy' for this Fifth National Conference, The ECI has courageously caught the proverbial bull by the horns. However, I believe you have also landed on the horns of a dilemma. The concept of 'role' comes alive only when roles are systematically linked to tasks. Does the conference theme aim to focus on those roles and tasks where the tasks of the ECI and the tasks of augmenting the capacity of the engineering profession in India find synergy? Or does the conference theme aim to focus on new opportunities, new roles and new tasks arising in India and abroad from new value chains of cross-border flows that create opportunities for the current lot of engineers and technologists?

Clearly, there sis dome overlap between these two aims, but there can also be considerable conflict in resource allocation of time and energies between these. As you prepare to deliberate and debate on the relevant issues important for your profession, let me briefly mention five important challenges:

1.2.2 Worldwide shortage of engineers and India's presence abroad

Services constitute a large segment of national economies compared to manufacturing (54 percent in India; 50 percent in China) and the tradable scope of services has expanded. There is widespread belief that of the four GATS modes of service delivery, Cross-Border supply (Mode 1), Consumption Abroad (Mode 2), Foreign Commercial Presence (Mode 3) and Movement of Natural Persons (Mode 4), Mode 4 is the one to pursue with most vigour. Such reliance on Mode 4 is misplaced.

**Dr. Ajeet Narain Mathur,* *Director, Institute of Applied Manpower Research, Delhi*

While it is certainly desirable that labour markets be freed as much as product markets, the profitability and reciprocity in the structures of social security and immigration are formidable barriers and likely to remain so in the foreseeable future. While all four modes have their advantages for specific types of engineering services and product-services linkages, India's success has so far mainly been in Mode 1 based on IT-enabled and telematic services. Technology-based engineering work abroad continues to be led by North American and European firms worldwide despite their growing presence through subsidiaries, contractors and sub-contractors in India. Industrial services such as design, evaluations, etc. can be achieved in Mode 2 but the largest portion of revenues arises in Mode 3 which create dependent services for a firm's nationals in other countries besides creating a footprint abroad which facilitates both technology access and market penetration. Mutual recognition of professional qualifications between councils in India and abroad can open many new avenues. Unlike Mode 1 on which multilateral instruments have been enabled and which doesn't require significant human relocation, Modes 3 and 4 remain matters for bilateral negotiations. India has arrangements with Sri Lanka and with ASEAN to some extent but is missing out on a lot of opportunities in China, Brazil, Canada, Africa, Kazakhstan, Vietnam, Central Europe and Scandinavian Europe, to mention a few. There is a worldwide shortage of engineers and technologists at the moment and there are considerable cross-border opportunities for Indian engineering professionals and technologists abroad (Mathur, 2006).

1.2.3 The supply deficit of engineers and technologists in India

Having highlighted the worldwide shortage, let us turn to the situation in India. There has been a considerable draft on all branches of engineering and technical specializations by the IT industry. The IT industry is growing and coping with shortages and high turnover rates. It is rumoured that on many IT campuses billboards have come up that proclaim "Trespassers will be recruited". Freshers in engineering colleges and technology institutions are being offered appointment letters for 2011 and 2012 in what is a significant innovation in forward contracting and advance reservation systems. At the same time, the first generation of IT professionals has plateaued and many are retiring or turning to other professions which bring to the fore problems intrinsic to the IT industry where new technology platforms and emerging organizational structures create rapid obsolescence.

Meanwhile, employers of engineering and technical professionals, who wish to recruit degree holders, diploma holders and certificate holders, are complaining of acute shortages. This gives the impression that there is a shortage in supply. It is, therefore, intriguing that the NTMIS database has recorded year after year that half of the engineering graduates remain jobless for even two years after graduating and the waiting times have increased for all branches of engineering, particularly civil engineering. Since much of the supply is not employable, more of the same is not going to solve the problem.

1.2.4 The greatest supply side constraint is teachers and relevance of curricula

Degree-granting institutions need postgraduates in engineering/technologies and Ph. Ds. as teachers because they are organized as knowledge creating institutions. By this logic, there is a shortage of 77,000 teachers in engineering/technologies. Since teachers in such disciplines are professionals who are themselves employable in industry at market rates of compensation, there is no way that this deficit can be filled except by changing the character of such institutions from knowledge creating universities and colleges to centres of instruction or communities of practice staffed by non-Ph. D. non-

M. Tech. practitioners on a part-time basis and even that would require improvement in terms and conditions of service of teachers. Without a cadre of knowledge/skill creators and an adequate provisioning for curricular standards and teachers' training and infrastructures, the curricular questions cannot be addressed at all. The Prime Minister's announcement this Independence Day of an expansion in the number of knowledge and skill imparting institutions is to be welcomed and it poses a great challenge for the government and the profession to contribute towards strengthening the supply side.

1.2.5 Strategic Management of Intellectual Capital and Organisational Knowledge

No society has ever been able to develop and diffuse technical inventions and embed its ideas into sustainable innovations without its craftsmen/engineers/technologists acquiring or developing capacities in contemporary and novel methods, processes and products towards mass production capabilities. Leonardo Da Vinci's sketches remained just sketches because there were no craftsmen with tools to shape materials needed to engineer those artifacts. There is considerable awareness in India of the infrastructure engineering needs concerning energy, water, ports, transport and communications but very little concerning life sciences. Some of the most elementary tools and materials needed to sustain advances in life sciences such as micro-arrays or cryogenic containers for frozen micro organisms are not yet possible to be engineered in India. This also means that our best talent in certain technology applications will continue to have to relocate abroad to pursue those disciplines and specialisations that do not exist in Indian institutions. Can the ECI identify what missing capacities need to be created?

1.2.6 Professional Identification and Disguised Unemployment

A professional body, by its very nature and objects tends to be focused on standards-setting and, to that extent, becomes exclusive and excluding. Yet, the trajectories of human professional growth based on society's and industry's needs can seldom neatly fall into notions of basic and higher education. Greater portability of relevant and certifiable education and training is needed in a spirit of life-long learning where the capacities to learn and absorb are more important than what is learnt at a point in time. This point to the need to question whether the sharp distinctions we maintain between higher education, vocational education and professional education are justifiable. The social status and attendant social and financial benefits accorded by institutions in India to those pursuing so-called higher degree engineering education like M. Tech. is itself an incentive for disguised unemployment for many young people waiting to move to other more lucrative avenues. What can be done to make seamless transfers between different systems and levels of learning without losing standards?

Signals from the labour market clearly point to a surfeit of certain kinds of institutions and disciplinary streams in certain part parts of the country where available seats are not being taken up despite there being a shortage in those disciplines. At the Institute of Applied Manpower Research, we are puzzled when interpreting NTMIS data both by the proliferation of institutions that attract enrolment which does not lead to jobs and also by the acute shortages in categories in categories where students are unwilling to enrol. Perhaps, a greater understanding of the labour market needs to be brought to bear

on career guidance and counselling systems at the school level to enable students and parents to explore their talents and aspirations in a better way.

1.2.7 Some working hypotheses: Towards a new research agenda

Let me conclude by raising some working hypotheses to develop contours of a new agenda for policy research.

1. Professional mobility is essential for trade in services in Modes 3 and 4 of GATS. Many developed countries (particularly EU member states) are loathe to dismantle equality in protection of workers in the labour market within their territories by discriminating on nationality and, following from this, the suggestion made by some to negotiate Mode 4 temporary visas that remove a foreign employer's or a foreign state's social security obligations is defective.
2. The notion that a resident foreigner is not engaging in trade (Nayyar, 2001) is flawed without taking into consideration the period of residence and the quality of residence rights for a professional and his/her family because definitions of what constitutes residence vary from country to country and also because such a distinction overlooks whether the services are independent services or dependent services. Dependent services linked to foreign commercial presence of a foreign subsidiary are definitely trade and there is a need to research trade patterns using twinning comparisons of a pair of countries at a time.
3. Studies of local and regional labour markets in spatially demarcated territories are needed to understand what is going on because people live in real space and time. National aggregates at times conceal more than they reveal with regard to motives and power-bases that determine the supply and demand of labour, migration of labour from one sector or locality to another, and quality of work and skills needed, wage-employment trade-offs at enterprise level, and how participation in dispersed value chaos affects units and local areas.
4. In a knowledge society, the supply of labour can create its own demand vindicating the much maligned say's Law when public services provisioning and community development resources provide ways and means to create new forms of services and new product-services linkages. Measuring productivity in services is a policy research challenge.
5. The gender gap is a measure of affirmative action and reservations for women. Gender equity needs to be researched to understand how social dialogue processes, structures and systems function and to modify their designs, as needed. The politics of disharmony in the management of gender differences that perpetuate the chronic under-representation of women (Mathur and Salmi, 2006) need policy research attention as early as in child rearing practices and initiatives in families and schools to strengthen the supply side of the future labour markets.
6. There have been many national missions structured in India but none yet to promote productive and remunerative employment. Institutional innovations, that are politically and economically supportable, are needed for employment creation to be actioned in a mission mode.
7. Inclusive growth a major plank of the XIth Plan (Planning Commission, 2007) entails improved functioning of labour markets. Knowledge of the organization of enterprises for goods and services in product markets is needed, particularly the product-services linkages driven by GATS.
8. The economic and institutional factors influencing labour markets and product markets need to be researched together so that national agendas driving competitiveness and shaping international

economic relations are not neglected. The interactivity between labour markets and product markets with reference to their spatial dimensions holds the key to understanding how inclusive growth and decent work develop alongside competitiveness and communities of habitat.

1.2.8 Conclusion

The untouched agenda to which I allude remains untouched (Mathur, 1991; Mathur, 1993; Mathur, 1995). The policy research agenda needs to be expanded (Papola, 2007). It would be tragic if the policy agenda and research agenda continue to be dominated only by issues of unstable and informal employment, lack of social protection and the work-poverty relationship to the exclusion of casual factors in the path-dependent traverse that relies more on markets and less on government participation. More attention needs to be given to research the motives and power-bases underlying how people make choices over education streams and work preferences to understand how to mobilize purposeful actions of new kinds that could address the gaps between national agendas and emerging international norms.

Paper received after the conference

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