Engineering Council of India

10th National Conference

Technological Innovations in India - Retrospect & Prospect

November 29, 2012

Proceedings

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Inaugural Session in Progress

Mr. Uddesh Kohli, Chairman, ECI delivering the welcome address

Dr. K. Kasturirangan, Member, Planning Commission delivering Inaugural Address

Dr. Anil Kakodker delivering his address

Prof. E.C. Subbarao, Chief Consulting Adviser, TRDDC, Pune delivering keynote address

Prof S. Arunachalam, Scientist G & Advisor, SERC delivering keynote address

A Views of the Audience

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	Address by the Chief Guest	Dr. K. Kasturirangan, Member, Planning Commission
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1 10th National Conference Technological Innovations in India - Retrospect & Prospect

Introduction

Innovation has been defined in literature as “the act of starting something for the first time, introducing something new” and specifically in technology as “an improvement to something already existing”. The best definition on the web appears to be: innovation is the conversion of knowledge and ideas into a benefit, which may be for commercial use or for the public good, the benefit may be new or improved products, processes or services. There is some commonality in creativity and innovation.

According to Sternberg the essential requirements for creativity in a person is intelligence (synthetic, analytic, and practical), knowledge of recognizing what is genuinely new, a thinking style which questions conventional wisdom instead of passively accepting such wisdom, and a non-conformist personality. She/he should enjoy her/his work (intrinsic motivation), be motivated either through financial or non-financial incentives including increased salary, promotion, commercialization of innovation, recognition and fame, and work in an environment which allows time and freedom to think, study and experiment without obstruction.

According to Dr. Harshwardhan Gupta - an eminent practicing design engineer - "India has achieved enormous strides in the area of science and technology, but not in technological innovations. After the WW-II, countries such as Japan, South Korea, Taiwan, Malaysia embarked upon a race to become a developed nation from almost the same starting line as India, and countries such as Brazil, China, South Africa, Thailand started much later than India, and all of them have almost achieved their goal of becoming a developed nation. At the same time, thoroughly devastated European nations like Germany, Poland, Czechoslovakia, Hungary, and Italy also progressed quite impressively. The secret to developing their indigenous industry by countries such as Japan, Taiwan, South Korea and later China lied in buying and then copying by learning the underlying engineering and design philosophies behind the sophisticated machines from Europe and US and improving upon the originals and starting mass manufacturing a vast array of products in very modern factories."

"Their low cost was an added catalyst to this effervescent chain-reaction. Within a couple of decades, many of the eastern technologies overtook the western innovation engine. South Korea became the world's largest and best shipbuilder, forcing many renowned western shipyards to close down. Japan first overtook and then took over the entire world's electronic industry. Communist Russia went into space before the US. Tiny Taiwan became the entire world's machine-tool builder and globally threatened the machine-tool industry and certainly overran India's machine –tool industry. Thailand and Malaysia account for almost all of the world's microchip production. China is steamrolling the entire world's mould and die-making industry, which is the very heart of industrialization, among many other spectacular wins. China has also emerged as the world's largest single producer of consumer electronics and home appliances. Brazil has mastered the bio-fuel race. Spain is far ahead in technology of solar energy. Israel, despite its troubled existence,

has given many unique innovations to the world. India struggled and limped and showed nothing significant in the area of technological innovations. Even today, India is nowhere near winning even one of these races, a few exceptions here and there apart."

The myriad tranquillizing signs of industrial progress you see today in India are utterly and completely dependent on foreign companies, their technologies, machines and designs. Virtually nothing of their technologies, machines and their engineering designs are percolating fast enough into our own indigenous domain, except a few cheap copies in a few areas. All the newly emerged economies, except India, have quietly developed engineering design capabilities on a vast scale in a short time. Indian industry, however, has continuously failed to participate in this ongoing global engineering development process in any significant way. This is despite our policies on science and technology being there. Our liking for any thing foreign perhaps led us to the position in which we find ourselves today. There has been no encouragement for innovation in India."

This is our retrospect in innovations. What India should do to catch up is what we should consider very seriously. Why has India remained technologically backward? Technological innovation and engineering design go hand-in-hand. The former cannot take place without the latter. Our engineering workforce is very poorly trained, capable or even motivated to develop new technologies and machines. Many fresh engineering graduates abandon their profession and join a bank, a BPO, or a marketing setup or take up non-core jobs in core industries not

2 Recommendations

1. The government should strengthen the eco system for innovations by providing the enabling public interventions in education, strengthening knowledge infrastructure, creating market for innovations through stimulus of government procurement, and improving institutional collaborative mechanism.
2. The government should create a mechanism for facilitating innovations in the country which may include providing funds
3. R & D expenditure in India is only around 0.7-0.8% of GDP; while as it is 2.61% in China, 3.4%, in Japan 4.53 % in Israel. We need to increase investment in R&D to around 2.5 - 3.0 % of GDP.
4. Industry should contribute in a large measure to investment in R&D
5. It takes a long time in India to take a patent. There is, therefore, an urgent need to reform the patient regime and make it more robust, which may also include a mechanism for facilitating generation of patents and facilitating their commercialisation.
6. Innovations should be made a part of education system right from the school stage to higher education
7. Innovative pedagogical practices (IPP) should also be included in the school curricula which will provide students with latest information on competencies and skills, encourage collaborative and project-based learning, address issues of equity, and redefine traditional space and time learning configurations.
8. The government policies should lay down clear roles for schools outside their school activities which should include tie ups with industry, support groups, NGOs, voluntary capital investment firms which give funds to institutions providing education for coming up with sponsored projects
9. Most important aspect of teaching learner process should be adopted for teachers where the role of a teacher is transformed from the knowledge imparter to knowledge chaser
10. Our schools should have a clear vision and mission: to transform education and training into such activities as would improve substantially the performance of students, develop in theme creativity for innovation, and prepare them for dealing with the environmental challenges
11. We should, as a matter of national policy, encourage people with appropriate incentives to go for research and development
12. A strong institutional industry - academia interactive mechanism needs to be created, as a matter of national policy, for inter alia to give a flip to innovations
13. Opportunities need to be created, as a matter of national policy, for those people who are keen to pursue basic research
14. India should become a permanent member of Washington Accord without further delay
15. Engineering profession in India needs to be regulated. For this, the government should bring on the statute Engineers Bill without further delay

3 Executive Summary

The role of innovation is widely recognised for generating newer ideas, inspiring growth, overcoming constraint of natural resources and unleashing the potential of Indian energies and synergies. The new paradigm of innovation focuses on producing competitive solutions through innovations with minimal cost. This contrasts sharply with the conventional approach usually focussed on number of papers published and patents registered. Innovation is already contributing significantly to the growth of economy and dynamism of the industry. Indian entrepreneurs are developing global solutions for meeting the needs of Indian consumers by providing access to services and products at competitive prices. Recognising the importance of innovations, this decade has been declared as the "decade of innovations" with focus on inclusive growth.

India is not generally seen as an innovative society. Although there is a lot to be done with the education system of India, It is not the core reason for this. Indians are no less than anybody else in terms of ideas. Apparently for innovations to flourish, we have still to create a domain/ ecosystem where ideas flourish and opportunities are generated. On the scale to measure the domains of opportunities in different countries, unfortunately, we do not rank very high. Fortunately, we are now moving forward towards knowledge driven economy and development.

Technology cannot be developed by an individual; it can be developed by collective efforts of individuals and institutions. Whatever success we have achieved in the development of technologies, it has been achieved with the contribution of engineers, technologists and institutions. For example, the success in the development of fast breeder reactors in India is due to the collaborative efforts of individual engineers and technologists and institutions. And it has been possible in the work environment of full freedom to every person in the collaborative chain to do his/her best. Many other innovations also came by due to this free work environment.

There is a wide range of areas that would require innovative solutions through scientific and technological inputs. These include energy, water management, farm production, medical research, waste management, healthcare, communications, and daily usage needs and services. In order to spur the Indian innovative eco system, we also need a road map for innovations.

The economic activity has to graduate from raw material - based economy to manufacturing economy to technology - based economy and eventually to innovation - based economy. For innovations to flourish in India, we also need to concentrate on creating flexible approaches for providing opportunities for innovative minds - those who have been in power, or, those who have empowered themselves, or, who are at the top in respective spheres, and who are fairly innovative and have done a lot on the scale of innovation. The question is about the rest who have innovative minds but have not been empowered enough. It is clearly the question of creating a right ecosystem where an idea coming from any quarter can be picked up on the strength of that idea, followed through with the opportunities for people to take that innovative idea to its logical conclusion.

An ecosystem of enterprising people - researchers, finance providers, business entrepreneurs, and policy makers - working in conjunction is, therefore, required for developing

innovative solutions covering material savings , energy savings, and hence cost cutting for producing products and services for the society.

What is also important in this ecosystem? It is positively oriented leadership which is confident of itself. The ecosystem will not work if the leader is not confident of himself; if there is a chance that she / he will not be supporting the ideas which are radical, or, which come from someone who works below her / him. A desirable ecosystem, therefore, is that which enables interaction across the hierarchical verticals. Our cultural make - up is hierarchical in nature, opportunity to freely interact based on one's own initiatives across those verticals is an issue, and we need to create conditions where such things are encouraged. A positively oriented leadership will only enable it.

ISRO has emerged as the world class satellite systems developer and launching agency. This is the perfect example of successful innovations carried out by the Indian engineers, technologists and scientists. Atomic research presents a similar case where our scientists, engineers and technologists have brought in many successful innovations. This has been possible only because of the ecosystem that has been created by ISRO and BARC. This also shows that if you give freedom of work to the young minds, they can achieve excellence in whatever work they do.

Though we have taken up import substitution, it has been done with minimum in-house R & D inputs. We need to increase substantially in-house R & D inputs for import substitution projects. We need to build first rate research and development institutions such as Dell labs or GE. About 90% of our institutions providing education hardly do any research and publish papers. If India has to progress in R & D, we need a strong connectivity between the industry and academia.

Where do we stand vis-vis rest of the countries in terms of spending on R&D? In India, on an average, it has been around 0.7-0.8 % of GDP, which is one third of what, on an average, other countries spend. So it means that we are spending very less vis-vis the other countries on R&D. Out of this, three fourth comes from the government and other one fourth from the Industry; whereas it is reverse in the other countries. We need to increase investment in R & D. There is a limit to what a government can do and spend. Unless the private sector industry and business increase their spending in R&D, these figures will not improve. R & D is carried out by number of PhDs in engineering and technology in the country. All our IITs together produce only 1000 PhDs per year in India. We need to produce more PhDs per year.

We have to look at the kind of money that was allocated in the XIth Five Year Plan for R&D. This was 0.9% of GDP. We have spent less than that. About 75% of funding came from the government and 25% from the Industry. The relevant question here is: how to improve the position. One answer could be by providing opportunities for the basic research. Second, significant changes will have to be brought in the current interactions of publicly owned scientific and technological establishments with the industry both in the public and private sectors. This would inter alia result in a significant enhancement of investment by the private sector in R&D in the XIIth Plan.

We have been contributing around 3% to global scientific output. We must aim at improving on this position. We must, therefore, generate a higher scientific out put. For this, we need to create a large scientific cadre and a substantial increase in the scientific productivity. We have set a target for scientific out put at 5-6% of the global scientific output in XIIth Five Year Plan. This has been done not only because of investment but also because of our ability to generate resources

and create the kind of scientific productivity which will enable us to realize this target. We will have to fully make use of our young and creative minds and make them produce things which ultimately become front ranking products and services not only for the country but also on the global basis.

The Prime Minister has declared that in the XIIth Plan around 2 percent of GDP would be spend on R&D as against the current spending on an average of 0.8 % of GDP; around 1% would come from the public funds and around 1% would be provided by the industry- both public and private sector. This represents a paradigm shift in which funding would be done in R&D. This kind of funding would enable us to do things which were not possible in earlier Plans. The government has given a challenge to the industry – both the public and private sector- for bringing science and technology into forefront, and making it into instrument for the national development

We must start with looking at our education system. There is a lot to be done with the education system of India, as it is very important factor for developing innovative capability. It is pertinent to note here that the progressive structural expansion of knowledge will lead to developing innovative capability. The process of learning should be holistic. If we are able to provide opportunities to students for gaining practical experience by including some real life problem solving exercises in their curriculum, we will be on the right path towards developing innovative capability and skills in them. We also need to understand the factors affecting growth of education in India, particularly higher technical education.

We need to correct our education system, Innovation must be a part of teaching and training process and teaching should not remain confined to just teaching in classes, but actually it should engulf innovation as well from day one.

4 Opening Session

Welcome Address

Dr. Uddesh Kohli

ECI was formed in the year 2002 by coming together of the professional associations of engineers of all disciplines - civil, mechanical, electrical, marine, aeronautical, computers, electronics, and in other disciplines. There are 32 associations as members of ECI. It is the apex body of engineers in the country and works for the recognition of this profession and its further development. While we have been working on several areas, I will just highlight at least 2-3 important areas. First we have been working on Engineers Bill for legal recognition of engineering profession like the other professions such as medical, legal, architects, company secretaries, nurses, chartered accountants, cost accountants: they have all statutory bodies and all are legally recognised as professions in the country. We want engineers also should be recognised as professionals. Unfortunately, engineering profession does not have any such body.

A draft of an Engineers Bill was submitted to the Ministry of Human Resource Development in 2004. Since then, we have been interacting with the ministry regularly. The ministry desired that there should be a consensus on this matter in the profession. We worked together and brought out the consensus draft of the Engineers Bill in 2007; and we have been regularly following it up. This is long overdue; hopefully once it comes then all practicing engineers will have to register, and those who do not register, they will not be able to practise, as is the case in other professions. This has a major implication for foreign engineers also. Presently, any qualified foreign engineer can come here and practise without any restriction because there is no law in position here. On the other hand, Indian engineers cannot practise in a foreign country; they have to register and get license as per the law of that country. Indian engineers are at a disadvantage. Once the legal provision is adopted, a level playing field will be created.

The other area is reform of engineering education. We have organised a number of national conventions on this subject in different parts of the country where we have brought out the problems being faced in engineering education. While as the output from our engineering colleges annually is about 8 lakh, engineers, only about 25% of them are consider fit for employment by the industry, and the rest of them need to be further trained. The recommendations emerging from these conventions have been forwarded to the concerned authorities of the government of India for consideration.

Recently, we had a Round Table Conference which was sponsored by the Planning Commission on the subject of reform of engineering education. All the previous recommendations were discussed at this round table. The final recommendations that emerged from this round table conference have been submitted to the Planning Commission, Ministry of Human Resource Development and other government agencies. We hope that there will be some action on these recommendations. The problem is also that many of our educational programmes in the colleges are not accredited as

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yet. Internationally, they look for accreditation. National Board of Accreditation has already applied for the permanent membership of Washington Accord-an international body which recognises the engineering degrees of its members. They have been looking for an effective accreditation system in India.

ECI has also been working on multidisciplinary training programs. Details are available on ECI website. The Indian Engineer- a newsletter of ECI- is also circulated to concerned organisations. We have instituted an Eminent Engineer Award, to be given every year on the Foundation Day of ECI to an Eminent Engineer who will be selected by a high-power Jury. Last year, the Jury headed by Late Shri K C Pant gave the first Award to Dr. E. Sreedharan, former Managing Director, Delhi Metro Rail Corporation.

Theme Address

Shri K. K. Kapila

The Role of innovation is widely recognised for generating newer ideas, inspiring growth, overcoming constraints of natural resources and unleashing the potential of Indian energies and synergies. Recognising the importance of innovations, the President of India has declared this decade as the decade of innovation with focus on inclusive growth. Innovation is already contributing significantly to the growth of our economy and dynamism of the industry. Indian entrepreneurs are developing global solutions for meeting the needs of Indian consumers by providing access to services and products at competitive prices.

Three distinct emerging trends to the Indian approach to innovation are noteworthy. These are (a) focus on finding affordable solutions to meet the needs of the people for health, water and transport, etc. without compromising on quality, (b) desired outcomes are produced by innovations in organisational and process models that deliver to the people the benefit of technologies that may be developed inside the big laboratories, and (c) further innovate to reduce the cost of developing innovations. For example, in the open source drug discovery process, being applied by CSIR to develop drugs for treatment of tuberculosis, is based on web-based "Symantec Research Platform" which was developed by Infosys. This innovative approach has cut down cost and reduced time for drug development.

The new paradigm of innovation focuses on producing competitive solutions with minimal costs of innovations in which India may be emerging as a global leader, and this contrasts sharply with the conventional approach which is usually focussed on measurement of number of papers and patents produced. A frugal innovation focuses on the efficiency of innovations and on outcomes that particularly benefit the poor. Industrially advanced countries are also examining their innovation policies to incorporate this broader concept of innovation.

An ecosystem of enterprising people – researchers, finance providers, business entrepreneurs, and policy makers - working in conjunction is required for developing innovative solutions to issues such as conservation of materials, saving of energy, etc, and hence cost cutting for producing products and services for the society. The national strategy for innovation of United Kingdom and Sweden is essentially based on this conjunction and collaboration. This must be India's agenda too if India has to accelerate inclusive growth through innovations. There is a wide range of areas that would require

Shri K.K. Kapila is the CMD, ICT Ltd., New Delhi.

innovative solutions through scientific and technological inputs. This includes energy, water management, farm production, medical research, waste management, healthcare, communications and daily usage needs and services.

In order to play productive and appropriate role and serve the national needs, several critical decisions, which affect the scientific and technological systems, are needed to be taken. Scientific and technological systems must undergo a paradigm shift from the input-level driven model to an output-directed development strategy. This would involve communicating with user segments in various parts of Indian society and industry. It will also involve working towards finding innovative solutions to the existing problems and for developing new products that confirm to the latest quality standards and fully meet the environmental concerns. Significant changes will have to be brought in the current interactions of scientific and technological establishments - both public and private-with the industry in the public and private sectors. This would inter alia result in a significant enhancement of the private sector participation in R&D, which is currently estimated at 25% of the total expenditure in R&D, to, at least, 50% during the XIIth Plan period.

The innovations that have been carried out by the three strategic departments -atomic energy, space and defence - will lead to spin off innovations in social, industrial and other strategic sectors. There are already some of these successful spin off innovations visible in the form of automatic weather stations, fleet monitoring equipment, telemedicine systems developed by ISRO, flying inspection gauges, food processing technologies and other medical equipments developed by Department of Atomic Energy, and diagnostic kits and bio-toilets for water scarce India developed by DRDO. These innovations have enormous potential for future technology transfers to industry and service sectors.

The government has a critical role to play in strengthening the innovative eco system. It must provide the enabling public interventions, strengthen knowledge infrastructure, create market for innovations through stimulus of government procurement, and improve institutional collaborations. It must also provide mechanism for funding business innovations at all levels, especially MSMEs. It must provide vision through national level road map for innovations. In order to spur the Indian innovative eco system, the Prime Minister has set up National Innovation Council (NIC) with a mandate to formulate a road map for innovations for the period 2010-2020. Innovations should also be encouraged within the government structures and processes to enable improved service delivery and create more transparency and accountability in the system.

The AADHAR is a unique identification programme for the delivery of an efficient and transparent public service. It provides a clear proof of identity of a person. AADHAR will empower poor citizens of the country to access various services provided by the government. Innovations need financial support for which venture capital, apart from government funds, can also be a source. As the Indian economy and society grows and modernises, new needs will emerge warranting the science and technology landscape to undergo appropriate changes. Such changes will push further the efforts for innovations to meet the demands that the economy will generate.

Address by the Guest of Honour

Dr. Anil Kakodkar

Given its role and responsibilities in the development of a country, engineering is an important profession. India, being one of the leading countries in the world, does require engineers to have the right place and right authority to manage the affairs of the nation. I wish the efforts of Engineering Council of India (ECI) to bear fruit in terms of proper empowerment of engineers. This particular conference - dedicated to all important subject of innovation- is of course very timely.

We are in the year of innovations, as we move forward towards the so called knowledge driven economy and knowledge driven development. The economic activity has to graduate from raw material - based economy to manufacturing economy to technology - based economy and eventually to Innovation - based economy. This is an important area which is recognised, but we have miles to go. I, being a part of innovation revolution, there are some very deep reasons where some corrections may be necessary. If I can use the term “cultural corrections', it is necessary to go far it; and I use this opportunity to talk about it.

I refer to the You Tube video titled invisible innovations coming out of India by Nirmalay Kumar. Argument made here is: look at American MNCs, and look at their innovations that lead to innovative products. It's a well researched work; it says the large part of innovations is due to Indians working there. These are Indians who have studied in the education system in India. Then the argument is: although there is a lot to be done with the education system of India, It is not the core reason why we are not seen as an innovative society.

Let's look at the Indian establishments of these MNCs, there are many of them in numbers, and a large number of Indians are working in these MNCs. When you compare the innovations coming out of these Indian outfits of the MNCs with that of their US-based outfits, data suggests that there is no difference. Whatever happens in India, it measures to the same level to what happens in US. Indians can innovate in the US conditions in US; they can also innovate in the Indian conditions in India, but they can do it here in the US entities.

Let's look at Indians working in Indian entities of MNCs in India. We find that while the product innovation here is not at that scale (US), there are many examples which depict that process innovation and innovation in terms of management reforms here are at that scale. One can be very proud (of the fact) even on that scale we are not that bad. Indians are no less than anybody else in terms of ideas. Apparently for innovations to flourish, we have to create a domain where ideas flourish, and where opportunities are generated. On the scale to measure the domains of opportunities in different countries, unfortunately, we do not rank very high.

For innovations to flourish in India, we need to concentrate on creating flexible approaches for providing opportunities for innovative minds - those who have been in power, or, those who have empowered themselves, or, who are at the top in respective spheres, and who are fairly innovative and have done a lot on the scale of innovation. The question is about the rest who have innovative minds but not empowered enough. It is clearly the question of creating a

Dr. Anil Kakodkar is the DAE - Homi Bhabha Chair Professor BARC, Mumbai, Chairman, TIFAC, Former Secretary, Department of Atomic Energy & Chairman, Atomic Energy Commission

right ecosystem, where ideas coming from any quarter can be picked up on the strength of that idea, followed through with the opportunities for people to take that innovative idea to its logical conclusion. What is important in this ecosystem? It is positively oriented leadership which is confident of itself. The ecosystem will not work if the leader is not confident of himself; if there is a chance that she/he will not be supporting the ideas which are radical, or, which come from someone who works below her/him. A desirable ecosystem is that which enables interaction across the hierarchical verticals. Unfortunately, we have hierarchy in government as well. Our cultural make-up is hierarchical in nature, opportunity to freely interact based on one's own initiatives across those verticals is an issue, and we need to create conditions where such things are encouraged.

We need to have a reward system which encourages ideas, recognises ideas, and successfully translates ideas into final innovative products. The problem here is much deeper; in order to address this problem, we should look at our education system where we mentor young people; by education system we don't mean schools, colleges but everything that goes in educating children which includes family, society and other institutions. Our education framework is of hands-on capability built through successful training and apprenticeship. One learns through hands-on capability different subjects in different disciplines whether as a student or faculty. It is important to have activity-based education. A hand-on training is extremely important, and we call it apprenticeship training at IIT.

Then hands-on skill development training is must for everyone irrespective of age, level of education and final destination one is aiming to reach. Exposure is required to be given to procedural knowledge and training. We relate it to understanding of the procedures, whether you are able to run a plant, implement project, or carry out research well. If I am engaged in a top level research and I am not able to create and do that research in my own large experimental facility, there is serious deficiency in me. If we have many ideas and can't put these ideas into practice, there is a need for training.

Higher education is also very important for developing innovative capability. It would have to be in some specific disciplines. It is pertinent to note here that progressive and structural expansion of knowledge will lead to developing innovative capability and capacity. The process of learning should be holistic. If we are able to provide opportunities to students for all these kinds of learning experience with including some real life problem solving exercises in the process, we will be on the right path towards building innovative capacity, capability and skills.

Unfortunately today, our education system does not encourage this. Some body who teaches do not research, and many who research does not believe in teaching, they also believe in not translating research into practice. The aim of research in India, by and large, is to publish only papers. Many in industry do not believe that research can help in tackling problems that they confront in industry. All this needs to change. We need to create holistic environment where education, research, technology, its translation and entrepreneurship all happens together in a common ecosystem.

As a part of some work, I happened to visit China. A typical Chinese university has 30000-35000 students and all of them reside in campus. China actually does not provide for faculty. They do not have affiliated colleges, as we have in India. In China the higher education is carried out in the university campus. Besides, there are also diploma and apprenticeship institutes in China.

The campus area is normally around 1000 acres. Number of universities in China is larger than in India. Many of the universities, in addition to 1000 acres academic campus, have science park adjoining the campus of 4 times the size i.e 4000 acres, where many industries carry out their research and research - related development. In China there are more than 300 research parks, whereas in India we have just one in IIT Chennai. That is an ecosystem. That is the kind of infrastructure that we should also have for creating innovative society and creating innovations in Indian system. The government of India has taken a decision to create 100 such research parks in India. This is an important step that the government has taken.

The Tata Nano is a very good example of how innovation can make an impact not only in terms of commercial profitability but also in terms of power of an Idea that has been taken up to the stage of commercial product. It had impact not only in India but world over. Before Nano came, I had a conversation with Shri Ratan Tata where he said "we are working on a one lakh rupee car" and next sentence was "I don't care whether the car is manufactured in 1 lakh or not, for me what is important is that it will change the discourse". In Tata Motors the idea generated intense debate, ideas were exchanged, and the whole company focussed on this. Everybody got involved in thinking about what can be done to do this.

Our traditional approach to create things in compartments has to change. Once we task a system with a challenge and I think Indians are innovative enough to rise to the challenge. We need to correct our education system , Innovation must be a part of teaching and training process and teaching should not remain confined to just teaching in classes but actually it should engulf innovation as well from day one. I think with that happening, it will be possible for us to move forward towards innovations.

Address by the Chief Guest

Dr. K. Kasturirangan

The theme of the conference is about innovation. It is certainly most apt and timely. When we talk of innovation, we talk of a creative mind which can produce innovation. Creative mind is not a prerogative of age. Any one who can independently think and understand the scheme of things around can create. Decades back in ISRO when building a satellite for looking at earth from space, called remote sensing satellite, many questions came up. We had to find answers to these questions. A camera was to be put on the satellite. There were many questions involved in this. These were: what size of the camera, how to build capability which is contemporary in terms of technological ability of the system to look at earth at the same time, how to build satellite of a lesser weight- actually half the weight of corresponding foreign satellites-and one fourth of volume so that we can launch it with our own launch vehicle, etc. These were some of the questions. These were not simple questions. It needed innovative thinking to resolve them. It was a great challenge to build a camera system so compact and of necessary optic solutions and power to take images of the earth from 20 m, 40 m, and from 900 km altitude.

ISRO was young then, most of the scientists had only 3-4 years of professional experience; they had long discussions; and the young scientists came out with optical solutions, less volume, powerful imaging, type of electronics to be used, thermal system to be designed and host of other engineering activities to be done that goes into making the camera that we needed. The most

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striking feature was that each of these ideas that engineers were suggesting for building the camera system were unique. There was no precedence for this kind of thing anywhere in the world. These cameras are strategic items you cannot get them from anywhere; data is not available from outside. We had to start with the first basic text book principles and then came out with ideas which finally resulted in developing the camera. These were our youngsters whose innovations gave us the camera that we wanted. I still remember this, though many decades ago it was done. And the type of camera that was designed was the best. Many more innovations were carried out which were world class. We must remember that innovations should be achievable and affordable. These attempts at ISRO kept this in view while taking up innovations. ISRO emerged as the world class satellite systems developer and launching agency; and with it India is now having leadership in the satellite systems anywhere in the world including the US and Europe. Various aspects of science and technology system that we are creating in this country, especially during the XIIth Plan, it is important to keep in mind that we need to create a broad science and technology base in the country.

Our economy grew at an average of 2-4 percent annually in the earlier years of five-year plans. It has suddenly increased to 7-8% annually. There was a general recession in the world during Xth Plan and XIth Plan. Despite this, we have achieved 8.5% growth rate in the XIth Plan. Much ambitious growth rate of 8-9 percent has been set for the XIIth Plan. We are moving towards 10 trillion economy in 2020.India will become the third largest economy in the world. What does that mean? It means aspirations and expectations of the people are high and the goals are: to meet the aspirations of the society, promote science and technology and bring it to the level where it becomes relevant to the inclusive development of our people.

We need to bring in paradigm shift in which science and technology will play a central role in the areas of energy, water, health, agriculture, and environment. This is envisaged in science and technology in the XIIth Plan so that micro economic development of this country has the potential to create science and technology which matches the socio economic development. We have to look at the kind of money that was allocated in the XIth Five Year Plan for R&D.This was 0.9% of GDP. We have spent less than that. About 75% of funding has come from the government and 25% from the Industry. We have been contributing around 3% to global scientific output. The relevant question here is: how to improve the position. One answer could be by providing opportunities for the basic research.

> We have set a target for our scientific out put at 5-6% of the global scientific output in XIIth Five Year Plan. This has been done not only because of investment but also because of our ability to generate resources and create the kind of productivity which will enable us to realize this target. For generating a strong scientific output, we need to create a large scientific cadre and a substantial increase in the scientific productivity. We will have to fully make use of our young and creative minds and make them produce things which ultimately become front ranking products and services not only for the country but on the global basis.

Socio economic aspect is an important component of science and technology; as it can be utilised to improve productivity in various areas. Current productivity of agriculture needs to be increased both by using conventional technology and also through genetically modified crops. India is becoming a water scarce country. Science and technology can come out with solutions for

optimisation of water use pattern and recycling of water. This can be better done through research and development efforts. Science & technology and innovations thereof can jolly well tackle the current environment, health, etc, related problems. Removing these problems is essential in improving the quality of life.

The departments of atomic energy, space, and defence research have over the years pursued strategies which have resulted in launching vehicle, development of fast breeder nuclear reactor and building of satellites, missiles, battle tanks, etc. The spin offs technologies that came out from these departments have been used for tackling the current environment, health, etc, related problems. Unfortunately some of the technologies thus developed by these departments have not been exploited fully.

A provision has been made in the XIIth Five Year Plan for the following: to look out for the innovative component of these developments which have found its way into other applications particularly in socio economic sectors. So it has been decided that mapping of several of these capabilities would be carried out There is a room for innovation in these technologies; and this is how these technologies can spin off into various areas: atomic energy can be used in food processing, radiation technology for cancer treatment, satellite imaging can be used for finding ground water, agriculture produce and forestry.

The Prime Minister has declared that in the XIIth Plan around 2 percent of GDP would be spend in R & D as against the current spending on an average of 0.7-0.8 % of GDP; around 1% would come from public funds and around 1% would be provided by the industry- both public and private sector. This represents a paradigm shift in which funding would be done in R&D. This kind of funding would enable us to do things which were not possible in earlier Plans. The government has given a challenge to the industry – both the public and private sector- for bringing science and technology into forefront, and making it into instrument for the national development.

It must be remembered that innovation would have to be employable as well as affordable. The National Innovation Council (NIC) has been set up for drawing information from multi disciplinary research, creating platforms for global knowledge sharing, and facilitating resolution of IPR issues. The challenge before NIC is to spread its wings in several states including Karnataka. Local innovation councils have also been formed. NIC is encouraging this development; and it is also encouraging the states to further create this mechanism at the local levels. The purpose of NIC in this is to transform innovations in rural applications. Some of the targets of the NIC are improvement of service delivery in the areas of health, education, agriculture, etc.

As a part innovation initiative, the Finance Minister has announced last year that a sum of Rs 500 crore would be put under the "Indian Inclusion Innovation Fund". The purpose of the fund is to provide financial support to enterprises for developing infrastructure for research & development and innovation in the country. NIC is also aiming at providing help to micro, medium, and small industries for creating innovative clusters to create job opportunities as well as to improve the productivity. Another area is broadband connectivity which aims at covering 2,50,000 panchayats for providing various services to them. The Ministry of Law and Justice is also planning to use information technology for disseminating information about court proceedings to police stations and prisons. NIC would promote education. These are just few areas where NIC is going to play an important

role. In order to connect all these science and technology initiatives and taking advantage of new ecosystem vis innovations, the Prime Minister has declared the current decade as the decade of innovations. This shows how much importance country attaches to innovations.

Vote of thanks

Shri J. S. Saluja

I am inspired by the views expressed by the Chief Guest and Guest of Honour which have set a just right tone for deliberations of the conference. The theme of the conference relates to creativity which is translated to innovation of products, processes and systems for the benefit of people. I recall that in-house designed and developed blast furnace for Bhadravati steel plant under the

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5 Technical Session - I

Session Chairman's Remarks

Shri Mahendra Raj

The opening session has set the foundation for deliberations. Innovation essentially forms the foundation of civilisation. Without innovation there is no growth, no development, and no civilisation. What we are today, it is due to innovative thoughts of our ancestors, and those who were before us. You have heard about the power of innovation from the earlier speakers in the opening session. Innovation is very essential for any type of growth in any type of sphere may it be atomic energy, space, health, agriculture, etc. The young and seasoned brains are the innovative material; and such material is available in our country in plenty. We have to bring them together and use them for carrying out innovations.

In the whole world, most of the innovative ideas originate from India. Recognising this, most of the multinational corporations and others have set up their R & D Institutions in India; and they are using our young talent for giving them innovative ideas; and these multinational corporations and others pass on these ideas to their countries for implementation. We are helping them in their growth and hence in becoming economic powers in the world. There is no dearth of brain power in our country. What is lacking is the right eco-system which encourages creativity and nourishes it into innovations. It is very important to create this eco system in the country; and then only it will be possible for us to realise the dream of innovations.

Session Co-Chairman's Remarks

Shri B. I. Singal

While I appreciate the innovations undertaken by atomic energy, power sector, and industry and even by the government, I consider it quite insufficient and dismal. We have a long way to go. Allocation of funds to R&D is meagre when compared to other countries. Innovations with this kind of allocation of funds cannot grow. More funds need to be given for R&D. We need to generate and register more patents. We should develop the attitude of achieving things. Students should connect with the industry.

Keynote Speakers

Shri Harshwardhan Gupta

I design machines! For the past 38 years, I have designed about 100 different kinds of machines; all of them from basic first principles without copying. In today's reality, India is on a steady road to technological slavery. In the words of Dr. Mashelkar, the 'I' in India stands for inhibition and imitation, not innovation. Before liberalisation, we copied things, but we were so obsessed with cost cutting that we never bothered to improve upon what we were copying. After liberalisation, we stopped even copying. So all the progress you see today is now utterly dependent on foreign technologies. In a global scene, our contribution is zero. This is not changing in spite of all the recent hype about innovations.

Look at China, it is now a fully developed nation with largest manufacturing and machine building base, with large ownership of global

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mineral resources, mass manufacturer of communication hardware, and consumer goods. China now has many monopolies, and is systematically undermining world's critical tool- and die-making skills and all sorts of artisan skills too. China's quality and engineering sophistication are accelerating at a brisk pace. They are already dominating the world by slowly and systematically making other large nations like us utterly dependent on them for every conceivable thing that we need.

The causes of our stagnation in the field of technology development are many: inability to scale up any good development, 'jugaad' mentality, obsessive cost cutting: “cut cost at any cost!”, gross inefficiencies, indecisiveness, inhibited decision-making, perpetually fooling ourselves, rampant obstructionism, technological lethargy: “why make if you can import?”, wearing our poverty as a medal, gross obsession with entertainment and ornamentation, playing with words instead of real ideas, lazy naive faith: “sab theek ho jaayega!”, “India will soon become a super power”, etc. We as a nation are now habitually offering instant excuses as a necessary and sufficient response for our shortcomings. And we have become intolerant even to the smallest of valid criticism, etc.

What should we do to reverse this? We are actually capable of reversing this by moving out of foreign dependence on all kinds of technologies, developing mechanised systems and sensible attitudes for food-processing, garbage disposal, cleanliness, waste management, traffic management etc., and minimise our massive losses of resources and work-hours.

We should scale up good change quickly, and do things better and faster, rather than cheaper and more mediocre. We should get good practising engineers (not managers) in direct contact with young students to inspire them, and acquire skills to use, design and build advanced machines of all sorts. We should get out of the 'jugaad' mentality completely. We should cure our addiction to entertainment. We should stop playing with words, and get media to focus on technology, skills, training, cleanliness, civic sense. We should stop arguing; being habitually optimistic, and continuously offering excuses and platitudes.

Dr. P. Chellapandi

Technology cannot be developed by an individual; it can be developed by collective efforts of individuals and institutions. The success of technology has been achieved by contribution of engineers for the past 40-50 years and also multiple institutions. The success so far in the development of fast breeder reactors in India is due to the same collaborative efforts of individual engineers & technologists and institutions. And it has been in the work environment of full freedom to every person in the collaborative chain to do her / his best. Many innovations also came by due to this free work environment.

Specifically speaking, the factors that led to this development included effectively utilising the natural uranium (nearly 80%), consuming the depleted fuel discharged from thermal reactors, breeding more fissile material (plutonium) than consumed, etc. Many innovations were done for these activities. With large number of thermal reactors operating worldwide, the limited uranium available will be fast consumed. On the other hand, energy supply from the fast breeder reactors (FBRs) can be ensured over a few centuries. FBR is very important from waste management and environmental considerations, generation of metals such as Cs, Pd, etc. which have many important societal advantages and

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can be used. In FBR programme in India, many industries are involved. I would like to mention about mission sodium cooled reactor which we are pursuing. Technology for this has been imported from France. We have tuned it to suit our requirement.

Professor E. C. Subbarao

We have been accustomed to meeting our technological needs through imports. Perhaps this is due to our colonial past. All these years we have lived with one idea and this is: why to reinvent wheel. We have taken up import substitution, but with minimum in-house R & D inputs. Competition has become severe. We have not build first rate research and development institutions. We do not have Dell labs or GE. But we do have some exceptions. For instance, Tata Steel produces the cheapest steel in the world. This has been possible for them due to in-house R&D and innovations. Hindustan lever has made big difference to its operations through in-house R&D. The Steel Authority of India and Bharat Heavy Electricals Ltd have also set up their own research and development institutions.

Where do we stand vis-vis rest of the countries in terms of spending in R&D? In India, on an average, it has been around 0.7-0.8 % of GDP, which is one third of what, on an average, other countries spend. So it means that we are spending very less vis-vis the other countries in R&D. Out of this, three fourth comes from the government and other one fourth from the Industry; whereas it is reverse in the other countries. This has got to change. We need to increase investment in R & D. There is a limit to what a government can do and spend. Unless the private sector industry and business increase their spending in R&D, these figures will not improve. The government is providing tax benefits to the Industry for R & D purposes. R & D is carried out by number of PhDs in engineering and technology in the country. All our IITs together produce only 1000 PhDs per year in India.

If we compare India and China we have similar population, but GDP of China is on an average much higher than India. The first output of any research is the research publications. In this, China stands at 9.4 %, US 26.5 % and India just at 2.5%. The second output from R & D is patents. China produces five times as many patents as we do. More patents are issues for the local people, where in our case, these are issued to non-Indians. We should be proud that we are leading in important sectors like computer science, engineering and technology. This has been possible by spending on an average 3.5% of global R & D in computer science- where we are supposed to have some leading position. About 90% of our education institutions hardly do any research and publish papers. If you have to progress in R & D, there has to be strong linkages between industry and academia.

The faculty should spend some time for solving problems that are relevant to the country. Enough reasons are there for increasing spending in R & D. During the last 10 years, number of multi national companies, which are setting up R & D centres in India, have risen from 50-150 to more than 760. Reasons for setting up R & D Institutions in India are : availability of qualified researchers / consultants at comparatively lower costs, closer to expanding markets, products can be customised to local needs, etc. This is the more convincing reason for the Indian industry and business to go in for in-house R&D. Mr J R D Tata, in the year 1981 when Tata Institute for Research and Development was being inaugurated, had said that the mission of this new institute was to

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apply the existing knowledge for the benefit of industry and people. This should be our mantra for R & D.

Dr. Deepak Bhatnagar

There is a general perception that the innovation and creativity is the same thing. No, it is not. Creativity is a phenomenon where something new and valuable is created. It is an individual effort. Innovation is the application of better solutions that meet new requirements, or meet some articulated needs, or meet needs of the existing market. This is accomplished through more effective products, processes, services, technologies or ideas that are readily available to markets, governments and society. Innovation is much more than invention. Innovation must be some thing of novelty; and it should have utility. There can be a big commercial advantage for innovations. In the West, therefore, Innovations have been flourishing with the support of investors who are ready to take risks. In India we have not developed this culture yet; and we should think about this. Converting an idea into innovation needs an eco system. We all together have to create this system - institutions, individuals, investors, private sector, and the government. We must stop looking to the government for every thing.

There is a pessimism that nothing on the innovation side is happening in India. This pessimism is misplaced. The departments of space, atomic energy, defence research and development are some of the shining examples of our innovations; and there are other numerous cases where innovations have been carried out for meeting some specific objectives. As I have said earlier, the creativity is a talent which needs to be nursed and used. We must not snub our children for expressing an idea whatever it may be. We must encourage it. There are many schemes that the Ministry of Sconce & Technology has taken up to help develop innovative skills in the young persons in the country. Details of these schemes are available on the ministry's website.

Prof S. Arunachalam

Innovation is a process by which an idea is translated into a good or service for which people will pay. Innovation should be replicable at economical cost, and it should satisfy some specific need. It involves deliberate application of initiative, imagination, knowledge, and information innovatively in deriving a different or greater value from resources - by generating new ideas and using these in developing processes for producing better and cheaper finished products. The 12th Plan given importance to S&T in its sectoral out look; and we should expect very good initiatives in the field of innovations happening as we go along with implementing the Plan.

Primarily the motivation for innovations is to make money. There could be other motivations also. For example during war, you may innovate for making better use of resources that you have. Innovation is very much required to be carried out for meeting the current and urgent requirement, which may have arisen because the existing products are either very expensive; or these are not readily available; or there could be any other reason / requirement. In order to meet that requirement or because of that reason, we innovate the existing technology and produce an innovative product at attractive price compared to the original product. A product made in the US has been successfully innovated here in Bangalore and is being re- exported at almost a little over half its original price.

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There comes the question: where are the innovators? We need scientists, engineers and technologists, who are thinkers, creators, and then institutions, which are capable of facilitating innovations. As a matter of fact, as the previous learned keynote speakers have mentioned, this is for what we need to have the ecosystem for innovations. We need to build this ecosystem. Besides, we also need investors who are risk takers in this ecosystem. The policy intervention is also required to build this ecosystem. We need to reform our education system right from the school stage to higher education so that the system creates thinking and analytical minds. It is also a policy issue.

Shri Kalyan Panda

We have heard a lot about innovations. But the real issue is how to innovate! Innovation process may include connecting unconvertible, dreaming, see beyond what's visible, expect the unexpected, enjoy contradictions, shun consistency, remember experiments never fail, mind does. I quote Dr A P J Abdul Kalam who has said "dream, dream and dream and transform dreams into thoughts and thoughts into action."

The innovation pentagon includes platform, drivers, ecosystem, inclusive (innovation strategy), and discourse. We should create a platform and encourage innovations. We should develop an ecosystem which will facilitate innovations. The status of R&D in India, when compared with other countries, presents the following picture. There are about 140 persons in R&D per million of population in India; and in the USA the figure is 465, in Japan it is 5546, in Singapore it is 5713, and in Sweden it is 6139. R & D expenditure in India is only on an average 0.7- 0.8 of GDP. It is 2.61% in China, 3.4%, in Japan 4.53% in Israel. So we need to spend more on R&D.

Coming to patents filed by the educational institutes, the IITs of India have filed on an

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6 Technical Session II

Session Chairman's Opening Remarks

Shri S. Ratnavel

Unemployability of engineers is a myth. Industry is not capable of employing our bright students. Many of the industrial units are not organised in a scientific way so that our bright students could apply technology in an innovative way. Teachers should have charisma. Today you have to accept everyone as it is. If we cannot have good teachers, we cannot have good students. Colleges are only to train and counter train; colleges cannot make anyone expert. We should know our ground realities.

Keynote Presentations

Prof. Man Singh

Science should inspire youngsters. Young minds can create a lot, if we provide them the right atmosphere to create and execute. We must create curiosity in the minds of young students, why, where, and how should be the drivers. Sustaining zeal in our young minds and lighting fire in them should be the mantra. We should make ideas as analytical as possible. We should make science as new as possible. There should be hunger in us for unseen and unbelievable mysteries. No survival is possible without science; survival of creative thinking is action. Science comes out of thinking, reasoning, rejecting, and exciting and enjoyment. Madam Curie saw blackening of paper by pitchblende radioactive mineral – Uranium; and thus was radioactivity discovered. Pierre and Marie curie discovered Plutonium and Radium in pitchblende – uranium ores- in 1898. This was perhaps the beginning of production of atomic bomb.

Science, as a web and wheel, always moves forward with newness. Keen observers of a phenomena and deep response thereof led to scientific discoveries such as theory of gravity, heat energy of steam as mechanical energy to move machines, horse cart developed from observing cruelty on animals, etc. Sir Jagdish Chandra Bose observed life in plants. Benjamin Thomson discovered thermodynamics. Pythagoras saw in a fallen tree Phythagorean equation and geometry. Transportation of huge stones for Egyptian pyramids through Nile River is in fact wonders and thunders of science, and myths and mysteries of science. Science is a creation of new life; sometimes it makes life better. Science transforms ideas into realities. Science is the most action-based subject. Scientific invention is like a block buster.

Innovation cannot be created by pressure, but only by passion. We must create this passion in us. Albert Einstein has said that “imagination is more important than knowledge”. Knowledge is limited, whereas imagination can take you to places. For making young people science and technology leaders, we must inspire them; excite them for being enthusiastic and enjoying. It will develop science, engineering and technological skills in them. Thought process is the foundation of invention and innovation. World's longest road journey was done by Bertha Benz wife of Carl Benz which revolutionised the automobile industry. If you observe day- to- day processes you can also develop new ideas; and you do not need a separate lab for this. Innovations will come only when we create suitable environment for the creative mind. We should make innovation as usable as possible. We should lay a foundation for creativity by

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reforming our entire education system. We should also protect our intellectual property rights.

Prof. Gajender Jain

The academicians should play a role in developing creativity and innovative skills in the students. This should be made as part of the engineering curriculum. The duration of engineering course should be increased from the present 4 years to 6 years. The first two years of the course should be of common subjects. This used to be the practice in the past; and we should return back to this practise. Further two years should be of specialisation in the branch of engineering which a student decides to study. The 5th year of the course should be devoted to multifaceted and multi disciplinary education including management economics, communication, etc. In the 5th year of the course, practising professionals from different disciplines should also be involved in teaching, as the case may be. The 6th year of the course should be of internship in an industrial unit.

Prof. Rathindra Prasad Lahiri

Since the Vedic times, Indians have shown a lot of potential. We have got many philosophical ideas to create many things which other people have followed and progressed. In Rig-Veda, we have got the formula for making water from hydrogen and oxygen. We were first in the world to introduce zero; first to make iron, etc. We are the first ones to say that moon has got water, whereas the high technical resolution cameras of the west could not trace it. We are doing marvellous things in some areas; while as in many areas we are falling behind. In the human happiness index, India's rank is 135 in the table of 187 countries. It has been proven time and again that our human resource is best in the world; and it should be fully utilized to achieve the desired objective. When we can develop technologies abroad, the same can be developed indigenously, get patented and then sold to the world.

A reference was made of Dr Jagdish Chandra Bose a short while ago in the conference. Dr Bose had a small house and still tried to have a lab in it; he experimented on many things in this small lab; and as a result, he made a significant scientific contribution. If we have the will any thing is possible. We need to develop strength to excel in any given situation. How can we become innovative? We should have passion for understanding the basic sciences. We should have passion for innovation. We need to inculcate this passion from birth; and with the passion, we should also develop high moral values and professionalism. We should build eco system for innovations to flourish. Innovation will result in new development new projects. We should use our knowledge to innovate and solve the problems of the nation. We should make ourselves strong and ethical persons which will lead to strong society. Transformation of whole society into ethical one will lead to more transparency, less corruption and proper utilization of funds.

Mrs Pooja Tripathi

The areas of education are primary, secondary, and higher education. Then there is distance and vocational education and training. Higher education includes general stream and professional engineering, medicine and architecture, apart from traditional IITs,

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polytechnics, etc. Higher education system in India has emerged as one of the largest systems in the world, which can be seen in the total number of institutions and student enrolment that we have in this system. Among professional careers, engineering is the clear preference today in India. Private sector is playing a key role in education, especially in professional higher education. Distance and vocational education are playing equally important role.

In the Indian higher education system, there are certain loop holes due to rural urban divide, excess gender inequity, and large difference in enrolment ratios of various communities. Higher education and vocational education are typical to India due to the advantage of demographic dividend. India has the advantage of having the highest youth population in the age group of 25-37 years. At this average age, a person can start her/his career and go on working for many years.

It is very heartening to see the importance that is being given by the government to bring in reform in higher education system including higher technical education. It is high on the policy agenda of the government. Likewise vocational education and training are also receiving attention of the government. Various private industrial units are tying up with academic institutes. We have a MOU with Infosys. A lot of key areas have been identified by the government for making higher education system futuristic. Some of these include financial innovations, innovative use of ICT, reengineering the research, thrust on vocational education, various regulatory reforms in education system. Though these trends indicate a very good picture for the higher education systems, we are failing somewhere; and we are still not able to meet the future expectations of the stake holders. We have many educational institutions in the country in number than any other country in the world, hardly any institution among these features in the list of leading institutions in the world. We must think about it; and identify the reasons for this and try to deal with them.

Quality of higher education in India is not that good because of the shortage of faculty, poor infrastructure, etc. In pursuit of better quality of education, ever increasing number of students is going abroad for higher studies. We must think about it and find out what is lacking in our education system. We need to bring in required transformation in our higher education system for motivating our students to study here in India. We must take appropriate action in this regard.

What is the need of the hour? We also need to understand the factors affecting growth of education in India, particularly higher technical education. Then we should bring in a holistic transformation in the education system that can sustain us in the global knowledge market so that India takes full advantage of its demographic dividend. Who are the stakeholders who are actually involved in the higher education system? These are institutions that provide infrastructure, faculty which impart knowledge and students who are the knowledge seekers in the system. We must improve our learning environment where all activities, as required, can be done in a very conducive manner. We must transform behavioural pattern of our teachers. Our schools should have a clear vision and mission which should be of transforming education and training into activities for improving substantially the performance of students, develop in them innovation skill, and also prepare them for dealing with the environmental challenges.

To meet ever changing technological gaps, innovative pedagogical practices (IPP), which

provide students with information processes, handling competencies and skills, encourage collaborative and project- based learning, address issues of equity, and redefine traditional space and time learning configurations, should be adopted. For this, the information, communication and technology should be utilised appropriately. Most important aspect of teaching learner process is to transform the role of teacher from the knowledge imparter to a knowledge chaser. She / he has to keep himself updated to find out what are the latest ICT technologies which are available that it can be included in curricula so that students get the real life feeling that they are really working in an industry.

As an academician, I feel that while the government is providing a lot of support- both financial and directional - institutions / universities, this support is not enough and directed to right places. The government must have a re look at its support policies. The government policies should also lay down clear roles for schools outside their school activities which should include tie ups with industry, support groups, NGOs, voluntary capital investment firms which give funds to institutions providing education for coming up with sponsored projects. What should be in the curricula and how it has to be imparted? This is very important. Factors which play an important role in innovative pedagogical practices are human beings, infrastructure, internal and external factors of organisations. The first and foremost important human factor is the head of the institution i.e principal / director / vice chancellor. It is clear and proven that if the head of the institute takes interest in any of the project / activity it is successful and it gives good results.

Shri Y P Chawla

Innovation has been defined very aptly by the

Shri Y P Chawla is the CEO, Skill Enhancement Initiative Consultants and Vice President, Indian Institute of Plant Engineers

7 Concluding Session and Panel Discussion

Session Chairman's Opening Remarks

Shri Chander Verma

In order to make session more interactive, more time will be given for questions and answers from students and delegates who are attending the conference. After these opening remarks, he invited the panellist to speak for about five minutes each; after that the session will be thrown open for a discussion.

Dr. S. Pal

I have worked with the communication systems of Aryabhat. We needed a design of a system that was to be installed in the satellite. We checked with some of the western countries, they quoted Rs 57 crores for the job. We made the same system in less than 2 crore with the devices made by DRDO as per our requirements and the weight of the system was 37 Kgs. Nobody in the world did it. The weight of the system has been improvised further and brought down to around 7 kgs. This was due to innovation.

Mantra of ISRO is "If you know what you have to do and you know how to do it, 80% of the problem is solved. For the balance 20% you have to slog for 80% of your time, no book gives the solutions, you have to find it by observing and looking here and there". I have followed this mantra for 42 years of my service. When we started developing antenna systems for Aryabhat there was no precedent; there was only one book available on the subject; as you know, nobody will become expert with that; now plenty of material is available. Good policies are good on the face of it; but they are not effectively implemented. We have not standardised our education. There is degradation of our education standards. I was told that students strength has come down in technological universities; students are opting for deemed universities because they are giving guarantee for results. There is no need for tuitions in engineering colleges, because engineering itself is an innovation.

Our mindset needs to be changed regarding our dependency on the west. What they can do, we can also do it. Our atomic energy, space programmes, etc, are the examples before us. We should not blame anyone, it is our industry's mindset which is why it goes to the west and spends money there; the same can be done in India at one quarter of the money; we can do it here, and we will do it better. They spend dollars there; and it can be done in cents here. It is said that the Indian engineers are paid peanuts, and if you get the work done in peanuts why spend dollars for the same work?

IT has brought prosperity to us, no doubt, but it has not brought innovations. There is no single software that we have developed which is 100% innovative. There has to be a paradigm shift in our thinking and our mental attitude both at government, industry and education levels. When we buy a system from outside, we accept it. But when we develop some system, we have to undergo all the quality tests for the system which are designed by American/Europeans for making it suitable for the Indian conditions. Still that system is brought which will not work here.

Shri Chander Verma is the Chairman, Continental Construction Projects Limited, New Delhi, Treasurer, Engineering Council of India, Chairman, Construction Industry Development Council and President, International Council of Consultants

Dr. S. Pal is the President; IETE. Former Prof. Satish Dhawan; Professor, Senior Adviser - Satellite Navigation (ISRO) & Distinguished Scientist, Associate Director, Chairman GAGAN - PMB & Programme Director Sat.-Navvigation- ISRO

We have to work for India; and we have to work in Indian system. We have enough experience, expertise and infrastructure for this. When we design certain things and file it for a patent in the US, it is very easy for us to get it. I have got many patents in the US and Europe, but it took me 8 years in India to get my patents. After I left ISRO then only my patents were accepted. The Patent regime must be overhauld.

Computer is only a tool which everybody is using, why do you want to do BE in computer science. Every engineer should know to operate a computer. We can do specialisation in some other subject. We should have standardised books. There are agencies like AICTE which are looking into it. They are interested in changing the syllabus. We have to change the mindset that we cannot do innovations. The only thing that we have to do is innovations. Indian conditions and requirements are much different. We should develop technologies which are practically useful. We should develop a system through which a farmer can talk to a scientist and tell about her / his problems rather than go for video conferencing. This will help farmers to improve their productivity.

Dr. R. P. Verma

Innovation is derived from the Latin word Innovas which means renew or change. Innovation means development of new customer value as it goes to the market in the form of products through technologies, services, ideas, etc. Ability to see change as an opportunity and not as threat is what makes the difference. If somebody developed a computer we should see it as a challenge and not competition. Innovation is customised if it results in developing a product at a cheaper price or equivalent price which meets the need of a customer. Innovation differs from invention. It refers to conversion of novel ideas or methods in to useful applications at affordable cost.

Acquire the basic knowledge (whatever you study now at graduate level), assimilate this knowledge and apply it when it is required. This is the key to success. Knowledge is not useful unless you are able to apply it. Experience and expertise also plays a major role. Mathematical models serve as aids. You understand theory and maths behind that theory. Much software is available for the same. Dedicated and diversified teams should co-operate and not compete. Corporate R & D is necessary for absorption and adoption of foreign technologies. Absorb and adapt is the latest mantra. We should develop technologies which should be cost effective, especially through innovations.

Dr. V.K. Gupta

I am working with the association of overseas technical scholarship – one of the largest programme in the world done by Japanese government to promote technological innovations under overseas development assistance programme for the last 40 years, and I have been associated with the organisation for the past 35 years. There are 80,000 participants in this programme. Out of these, 50,000 are from India. We are working with companies of all sizes including the companies which assemble products for large companies. We are helping them to look at small things; and the whole idea is to change developing mindsets, change the way you look at things and work for perfection rather than accepting something as it is. We should leave "chalta hai" attitude. We believe in perfection; and perfection leads to innovation.

Dr. R. P. Verma is the Consultant - R&D. Formerly : Petrotech Chair Professor, IIT Delhi, Executive Director & Head - R&D, Indian Oil Corporation Limited and Chairman - Indian Oil Technologies Limited

Dr.V.K Gupta is the Advisor, International Institution of Technology & Management , Ahmedabad

We are helping the organisation in remote areas like smbhalur where people are only 8th pass and they can only make soap. They have now developed 1000 innovations in the plant; and it is one of the best plants in the world. They got excellence awards. This is because of very small innovations here and there and nothing big, nothing huge, no large technologies inducted by those people. This is the way and this is not done by consultants. It is simple and it works. The idea is to motivate people to come out with new ideas and put these ideas into practice. Here we produced soap by a simple friction machine using motor power. A small innovation put together is the key to technological innovations. Mind should be clear; unleashing is the first starting point for all of us; we know too much that is one problem; we should leave what we know and start from scratch and once we learn the process the change happens. The Maruti Suzuki has become profitable over the years by making small innovations and adopting them into their processes. These small innovations have made them the leader in the market.

It is better to do one thing and do it properly rather than attempt 1000 things and achieving nothing. It is our zeal and zest put together which really creates excellence in whatever we do. Do not worry about the quality, quality will follow? Everybody should adopt the policy that "whatever little I do, I will put my heart into it. To each one of you God has given a unique gift and recognise it and use it perfectly, don't get carried away by what your father or friend has said, but follow your heart. That will take you to much higher places.

Shri Madan Mohan Sangal

Innovation is a key to success in every field whether engineering or any other field related to human life and development. Innovation is possible with encouragement and liberty in developing technologies. Look at our rural roads, these roads are generally very bad because a low priority is given to their maintenance and improvement. The connectivity of our villages for the overall development of our rural India is very important. It is the question of civil construction which involves investigation, survey, design, construction, and maintenance; and the success lies in minimum cost and time overrun for a road project. In this area we appear to be lacking behind, though we may claim that we have the best civil, electrical and mechanical engineers. It is not the case generally. It is here that we need to innovate.

Fortunately, the government has introduced the Prime Minister's Gram Sadak Yojana (PMGSY); it has brought a sea change in rural areas. If we visit the country side of any part of India, we find an improved connectivity and in turn development. Innovative ideas have been introduced in the PMSGY Scheme- both in the original content of construction and maintenance. We are aware that to what extent we adhere to morality, given a chance we don't forego to do wrong things. In PMSGY scheme an innovative clauses were introduced whereby construction agencies were required to provide quality construction, and maintenance of a project completed under the scheme was given to construction agencies(s) for 5 years.

There are some areas in PMGSY which needs a re-look. These are audit, dispute resolution, etc. Though independent retired senior engineers, who had not worked in the state in which a project has been built under the scheme, were empanelled as monitors for quality audit, still there have been some cases where retired senior engineers from the very state in which a project has been built under the scheme were also empanelled for quality audit. This should not have been the case for a proper quality auditing.

Shri Madan Mohan Sangal is the Consultant, Former Director and Chief Engineer, UP.

The quality audit is also becoming stale and outdated. One of the best options for quality audits to be more effective and efficient is to undertake it in a programme mode with sufficient time from the beginning to end – design to maintenance, and not to give this job to local retired senior engineers .

Another area is resolution of disputes, which are unavoidable in construction. My experience in dispute resolution is that more than 50% of disputes occur due to indecisiveness. We do not take decisions in time, especially in cases of variation in many parameters of a project, dates of extension required, etc. Delay in decision making lead to huge claims. This should be addressed. For this, a mechanism needs to be created. The alternative dispute resolution mechanism - which means disputes are resolved without going to courts- also needs innovation for making it effective and efficient.

Discussion

A Delegate

We have been working for some time on how to improve water level system in the country, especially in rural India. We have done a lot of innovative work for this. We can get back to the canal systems what it was 25-30 years back by simple idea of de-silting, which was to the extent of 2-2.5 metres. This was there about 25 -40 years back. This would imply that the catchment area will be much bigger during the rainy season. The rain water will further percolate to the basement which will raise the water levels all over the rural land. It is much better way of doing it than interconnecting of rivers.

Shri Chander Verma

I appreciate the suggestion. This needs to be viewed within the frame work of government policies, political climate and other related factors. The states will also have to be consulted.

Shri Mohan Mohan Sangal

Every state irrigation department takes up the task of de-silting of canals and funds are allotted for it. We are working on the system which facilitates proper utilization of funds and it is the responsibility of the department, public and all stakeholders to perform the task, as required.

Shri O. P. Gupta

Many universities are coming up in the country and only a few are of highest standards? We should develop a university of highest standard which will take up innovations. Many patents are listed every year, and a very few patents continue because there is no law to check piracy? There is no value for Indian things; people think foreign / imported goods are better. We have to get away from that mindset. We should create awareness about the Indian things.

Shri Chander Verma

In India, we can invent a product which is more efficient and cheaper. But you cannot change the mindset of the people towards imported goods. I fully agree with Shri Gupta that we have to change our mindset. We have to learn how to market our products or patents. It will take time to achieve success in this area. We cannot have a university for it. It is our own thinking that we must change. I think that the people of Japan, Korea and Germany are much more mature and smarter than Indians. Of late, Indians are proving that they are no less in any field to any one any where in the world. The only difference is that whenever you compare something you must compare an apple with an apple, otherwise it is not a fair comparison.

Regarding transfer of technology, we have taken up many joint ventures; we have set up companies overseas in construction and consultancy field. We have learnt from these ventures many things including transfer of

technologies. We have even bettered technologies and moulded these to our system. If you see any defence procurement, you will find that we have started indigenizing defence technologies also. Our policy in this regard is very clear: if we buy any thing from abroad, whether it is an aero plane or any product, we allow imports of knock down kits only up to certain point, gaps in this are filled up here.

Dr. R. P. Verma

The government plays a role in transfer of technology through policies. In the year 1987, ministry of industries brought out a policy which stated the import of lower and medium technology is allowed subject to its absorption and adaptation plan is also developed by the importer. Now that we are a part of WTO, there is no restriction as such for import of technologies. What we should do now is increase our spending in R&D – both by the public and private sector as well as by the government; and whatever research we do, it should be for high-end technologies, and for innovations of the existing technologies for their improvement; and all this should be of world class, as I cannot say today that we are doing R&D to make technologies suitable to the Indian conditions.

Prof Man Singh

We should adapt a practical approach rather than theoretical for desilting of canals. I agree that there is no nodal body which facilitates patents. An innovator cannot become an Investor. Industry should come out to facilitate the innovations because an innovator cannot bring the patent to commercial level. There should be a mechanism in the country for facilitating commercialisation of patents. We are very capable and creative country, the need of the hour is to take up the challenge and create awareness.

Dr. V. K. Gupta

We should try our level best to create awareness regarding innovations. We should not blame the government or any other body for not recognizing your innovations. Rather than blaming the system, you should try to create awareness within the given system. Everybody is working in the same system. It is onus of the individual to showcase his / her talent; and if you do it in the right manner, you will definitely be appreciated; and you will get respect and recognition which you deserve.

A Delegate

A distinction should be made between jugaad and innovation. The jugaad is the need of the hour. It is the improvisation done under unique circumstances and, therefore, it is not likely that it can be repeated.

A Student

We are blaming technical Institutions for not encouraging innovations. The question is: how to integrate technical institutions- innovations and industry? Once we finish the degree, we are looking for a job in the industry; and we are not interested in innovation. As an engineer we are a product; we are trying to market ourselves for a job; we are not inclined towards innovation. This is the problem. We must find a solution to this problem.

Dr. Harshavardhan Gupta

Innovation is simply what is obvious once it is done. We need to change focus from industry to individual practicing engineers, who are available, and a suitable mechanism needs to be devised for interacting with them on a regular basis so that the innovative spirit is maintained. There are lot of engineers available for sharing their knowledge and expertise with young

students / graduates and if regular interactions are arranged, it will help in encouraging innovations.

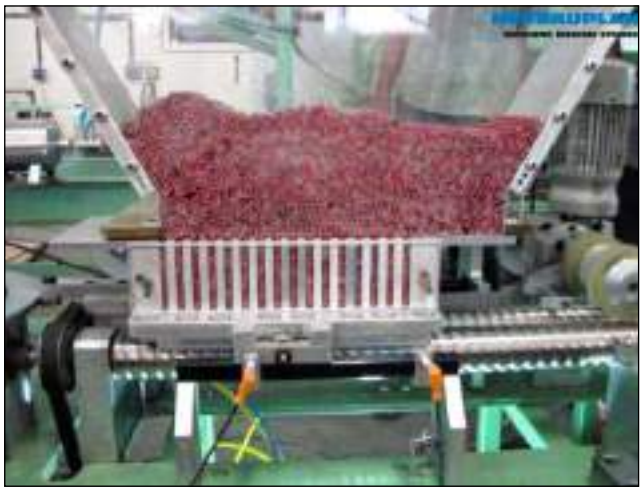
A Panellist

Practical training is the only solution for improving the state of innovations in the country, lot of engineers are having the potential, but due to lack of congenial environment they are not able to get into this field. Practical training will help in giving different perspective to thinking and encourage innovations.

Col. K. K. Chitkara

We have gone through technological innovations. Using the technology, I have developed E-book which is easy to disseminate. We need to work on tools for measurement of performance. If a product is produced, it should be quantified and the performance should be measurable. We need to ensure that the product is delivering at its optimum capacity. For example the CAG use auditing tools for performance. If we read the guidelines for evaluation of PP projects, it is a book in itself, which is worth reading. We have Indian standards now for construction project management. It deals with audit of construction project management for construction

8 Technical Presentations




Technological Innovations in India,
Retrospect and Prospect
In reality, India is on a steady road to technological slavery!
a. Retrospect


What's a "Developed" nation?
• Working, clean, reliable, efficient infrastructure.
• High degree of industrialization.
• High levels of indigenous Research, Design, Engineering and Development in all fields.
• High levels of all citizens' professionalism, well-being and comfort.
• Steadily increasing self-sufficiency in technologies, machines and hi-tech products.

World after WW-2

- Japan, S. Korea, Taiwan, Malaysia, later Brazil, China, S. Africa, among others, raced to achieve "Developed" Status.
- European Nations raced to get back on their feet after the devastation. Look at Europe today!
- USSR and US went into space and to the moon.
- All these and many more nations actually became first world nations in the last 65 years.

13

How did they do it?

- Japan, Korea, Taiwan, China etc started copying machines and technologies from the more advanced ones.
- ALL of them quickly learned the *underlying* engineering principles of what they were copying, and started IMPROVING upon them on a VAST and accelerating scale!
- How ? By inviting professionals and academics from all over the world and quickly learning from them.

14

The Result?

- South Korea became the world's largest and best shipbuilder, forcing many renowned Western shipyards to close.
- Japan overtook and took over the entire world's electronic industry.
- Communist Russia went into space before the US.
- Taiwan became the entire world's machine-tool builder and globally threatened machine-tool industry.
- Thailand and Malaysia now account for almost all of the world's microchip and computer hardware production.

15

And what did we do in this period?

- Before liberalization, we too copied things, but were so obsessed with "cost cutting" that we never bothered to IMPROVE upon what we were copying.
- **After liberalization, we stopped even that copying!**
- **So today, ALL the "progress" you see today is now UTTERLY dependent on foreign technologies of various kinds.**

19

Technological Innovation? In India?

- On a world scale, our contribution till today is ZERO, given our vast numbers of engineers; however much we may fool ourselves to the contrary.
- And this scenario is NOT changing, despite all the recent hype about "innovation"!

20

It's even worse!

- The Western engines of "Technological Innovation" are slowly losing steam as their economic and demographic scenarios change.
- So, soon we will have no one left to learn from, even if we now want to start.

21

Look at China!

- The newest Fully Developed Nation in the world.
- Largest manufacturing and machine-building base.
- Already cornered all rare-earth minerals of the world, production of communication equipment, consumer goods, besides creating many other monopolies.
- Systematically undermining world's crucial tool-&-die-making and all sorts of artisan skills.
- China's quality and engineering sophistication is accelerating at a blinding pace.

22

Is this the Game Plan?

"All we need to do to dominate the world is to enslave our adversaries by slowly and systematically making them utterly dependent on us for every conceivable thing they need"

23

b. Causes of our stagnation?

1. Inability to scale up any good development
2. Glorification of Jugaad mentality
3. Obsessive cost-cutting *(at any cost, ANY cost!)*
4. Gross inefficiency
5. Indecisiveness / inhibition
6. Perpetually fooling ourselves
7. Rampant obstructionism
8. Aversion to machinery and automation
9. Technological lethargy: Why make if you can import?

24

10. Wearing our poverty and squalor as a medal: "It's okay to be poor and filthy!"
11. Gross obsession with entertainment and ornamentation
12. Playing with words as a substitute for new ideas
13. Lazy, naive faith: "*Sab theek ho jayegaI*", "India will soon become a Superpower"
14. Forever offering instant excuses as necessary and sufficient response for our shortcomings.
15. Intolerance even to the smallest of valid criticisms

c. Prospect?

- Technologically (discounting ALL "foreign" dependence) we are quietly falling behind farther and farther, and faster and faster.
- Earlier we realize this and take quick and effective action, the better it will be for our long-term future.

d. Remedies?

1. Scale up good change quickly.
2. Do things better and faster rather than cheaper and more mediocre.
3. Get practising engineers in continuing direct contact with students.
4. Acquire skills to use, design and build *advanced* machines of all sorts.
5. Completely get out of the *jugaad* mentality.
6. Reduce addiction to entertainment.

7. Stop playing with words.
8. Start keeping our word.
9. Get Media to focus on engineering, skills, training, cleanliness, civic sense.
10. STOP arguing, being habitually optimistic, and offering excuses.

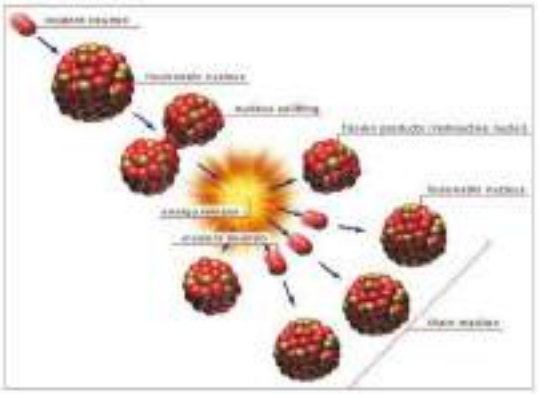
Unless we get seriously alarmed about our future being bleak, we will not change.

Design and Development of Sodium Cooled Fast Reactors: Current Status & Future Directions

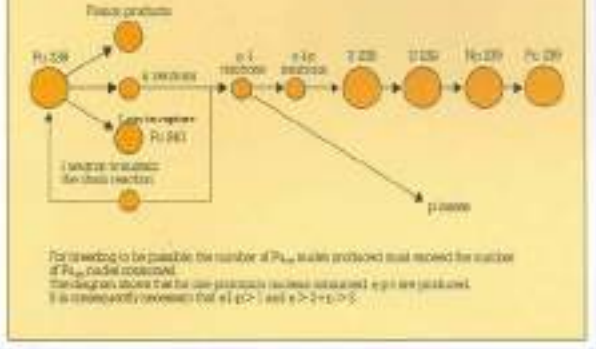
P.Chellapandi
Outstanding Scientist & Director
Reactor Design Group
Indira Gandhi Centre for Atomic Research
Kalpakkam, India

Engineering Council of India
!0 th National Conference on Technological Innovations in India - Retrospect & prospect
November 29, SCOPE Complex, Lodi Road, New Delhi -110003

Principle of Chain Reaction

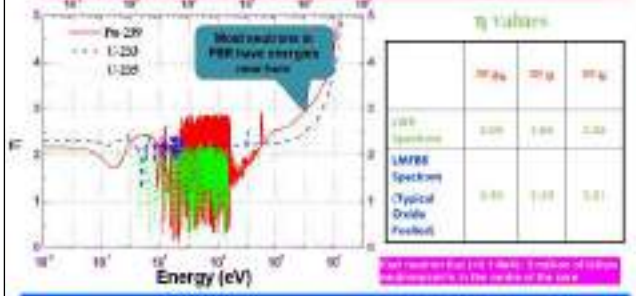


Condition for breeding



Breeding in Nuclear Reactors

For every neutron absorbed, neutrons need to be produced,
for sustaining chain reaction = 1
for capture in fertile nucleus for breeding > 1
Neutrons produced per neutron absorbed (η) > 2
Capture to exceed unity for breeding of Pu (new fissile)



Pu-239 is the undisputed fissile nuclide for fast breeder reactors

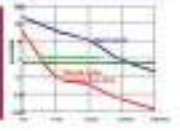
FEATURES OF FAST BREEDER REACTORS

- Effectively utilizes the natural uranium (nearly 60 %)
- Consumes the depleted fuel discharged from thermal reactors
- Breeds more fissile material (plutonium) than consumed

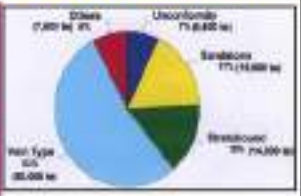
- With a large number of thermal reactors operating and planned worldwide, the limited available natural uranium would be consumed very fast. On the other hand, with FBRs, energy supply can be ensured over a few centuries.
- FBR is important from waste management and environmental considerations.
- Burns actinides and long lived radioactive fission products. Generation of precious metals such as Cs, Pd etc which have many important societal applications and can be extracted from its waste (wealth from waste).

Current trends in oil prices and available uranium resources bring FBR with closed fuel cycle to focus

Energy Potential

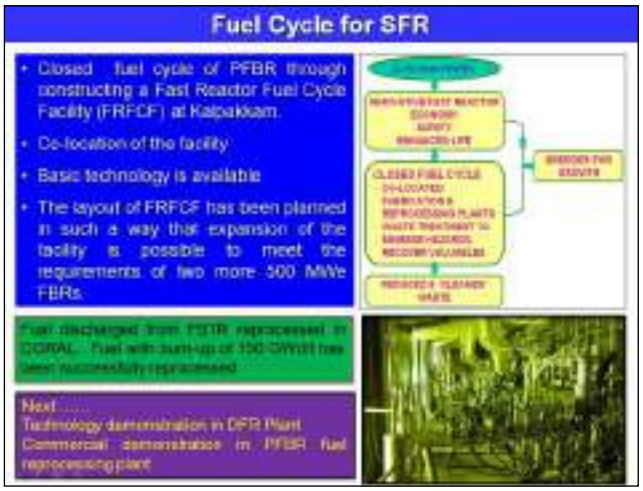


India's Nuclear Roadmap : Overwhelming National and Overseas Interest



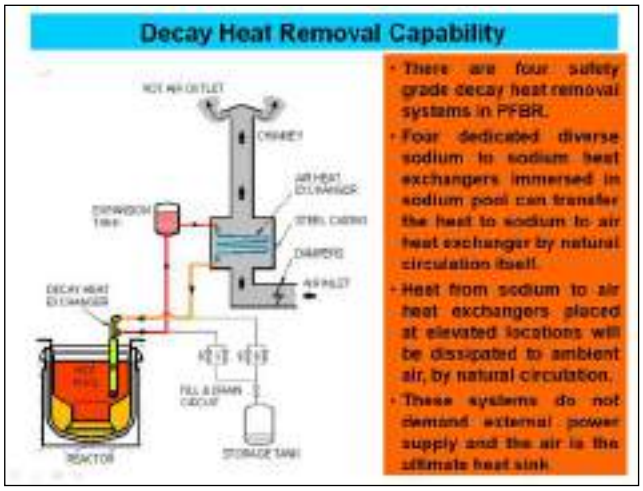
- India has indigenous nuclear power program (4780 MW out of 19 reactors) and expects to have 20,000 MWe nuclear capacity on line by 2020 and 63,000 MWe by 2032
- Now, foreign technology and fuel are expected to boost India's nuclear power plans considerably. All plants will have high indigenous engineering content.
- India has a vision of becoming a world leader in nuclear technology due to its expertise in fast reactors and thorium fuel cycle.

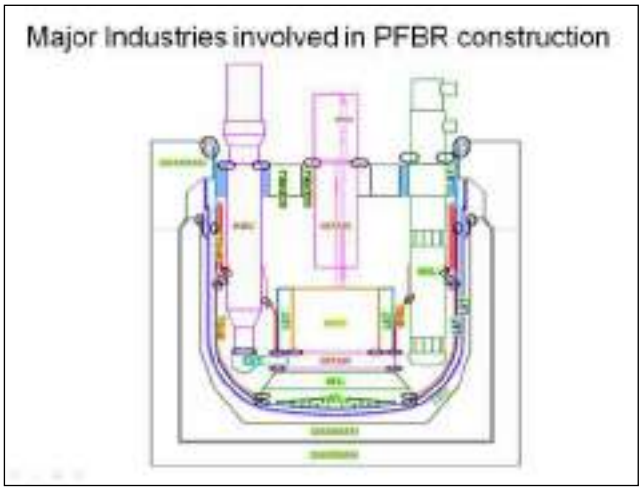

FBR Programme in India
FBTR
40 MWt (13.5 MWe)
Loop type reactor
PuC – UC
Design: CEA, France
Since 1985
PFBR
1250 MWt (500 MWe)
Pool Type
UO2-PuO2
Indigenous design and construction
To commission in 2013
CFBR
500 MWe
Pool Type
UO2-PuO2
Six units (3 twin units)
To commission in 2020
Future FBR
1000 MWe
Pool Type
Metallic fuel
Serial construction
Beyond 2025
Mission
Sodium Cooled Reactor


Fuel Cycle for SFR
Closed fuel cycle of PFBR through constructing a Fast Reactor Fuel Cycle Facility (FRFCF) at Kalpakkam.
Co-location of the facility
Basic technology is available
The layout of FRFCF has been planned in such a way that expansion of the facility is possible to meet the requirements of two more 500 MWe FBRs.
Fuel discharged from FBTR reprocessed in CORAL. Fuel with burn-up of 100 GWd/t has been successfully reprocessed
Next .....
Technology demonstration in DFR Plant
Commercial demonstration in PFBR fuel reprocessing plant


Fast Reactor Fuel Cycle facility (FRFCF)
FRFCF
CFBR
PFBR
The co-located facility will be self contained and have all facilities for recycling the fuel from PFBR, including fuel fabrication & assembly plants, reprocessing and waste management facility
Layout of FRFCF planned in such a way that future expansion would be possible to meet the requirements of two more 500 MWe FBRs that would be built at Kalpakkam site at later date.

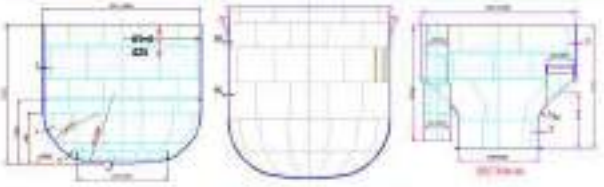

FBR Challenges
Design for long reliable operation of components operating at high temperature (550°C) for design life of 40 years and more
Design of mechanisms operating in sodium and argon cover gas space
Design to accommodate Sodium leak and sodium water reactions
Seismic design of interconnected buildings
Seismic design of pumps, shutdown systems and thin shells with large sodium mass and fluid-structure interaction effects
In-Service Inspection and repair of reactor internals
Manufacturing of large size thin walled vessels made of stainless steel with stringent form tolerances(<1% thickness)
Erection of the vessels maintaining tight tolerances on verticality and concentricity.
Structural material to withstand high irradiation (structural material limits the energy extraction)
Limited numbers of reactor years (400) of operating experience world wide
Design to achieve economy with enhanced safety


Decay Heat Removal Capability
There are four safety grade decay heat removal systems in PFBR.
Four dedicated diverse sodium to sodium heat exchangers immersed in sodium pool can transfer the heat to sodium to air heat exchanger by natural circulation itself.
Heat from sodium to air heat exchangers placed at elevated locations will be dissipated to ambient air, by natural circulation.
These systems do not demand external power supply and the air is the ultimate heat sink.


Major Industries involved in PFBR construction

Form Tolerance Achieved for Large Diameter Thin Shells

Component	ASME	Form Tolerance on Radius (mm)		
	$(ID_{Max} - ID_{Min})$	RCC-MR	PFBR	
			Specified	Achieved
Main Vessel	±78	±58	±12	
Safety Vessel	±78	±58	±12	
Inner Vessel	±67	±58	±12	



MATERIAL : SS 316 LN

Erection of Large Dimensioned Vessels

Confidence on PFBR Project

- Technology with strong R&D backup
- Manufacturing technology development completed prior to start of project
- Capability of Indian industries to manufacture high technology nuclear components demonstrated (main vessel, safety vessel, steam generator grid plate)

PFBR will be commissioned in 2013

Strategy of Construction of Future FBRs

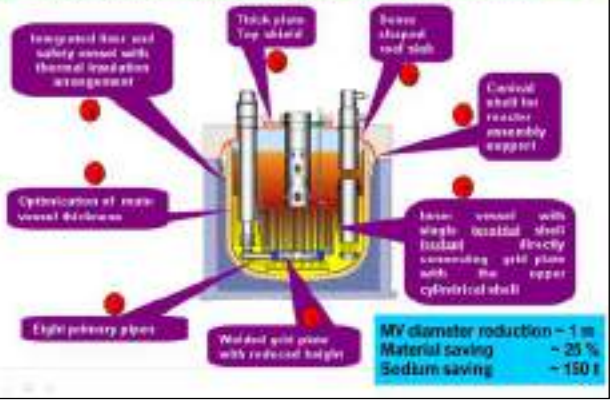
- Enhanced safety and improved economics are twin objectives
- Means to achieve economy quantified: Increased design life to 60 yrs., design load factor of 85%, construction time 5 yrs., reduction in special steel specific weight requirement by ~ 25%, enhanced burn-up in a phased manner (Target: *Unit Energy Cost comparable to that of fossil power plants*)
- Mechanisms to achieve enhanced safety are being assessed: Elaborate in-service inspection and repair provisions, increased reliability of shut down systems and decay heat removal system & innovative post accident heat removal provisions.
- Science based technologies and breakthroughs at interfaces in science & engineering to be harnessed for sustainable technological solutions
- Extensive involvement of Industries from developmental stages
- Giving due considerations to the innovative features conceived in the FRs under international projects (GEN IV and INPRO)

Capital Costs for Typical SFR NSSS

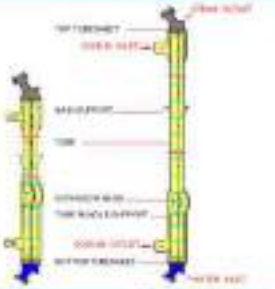
Type of equipment, coolant	Metal content		% of total equipment cost
	tons/MW	% of metal content	
Reactor with in-vessel/ex-vessel elements and equipment	8.87	76	81
Auxiliary primary circuit systems	1.23	~17	8
Other equipment, including standby (main circulation pumps, IHXs and fittings)	0.4	5	9
Sodium (730 tons)	-	-	2

Innovative Features of Future FBRs to Improve Economy

Improvements Proposed For Reactor Assembly



Steam Generator with Longer Tubes



- Tube length increased from 23 m to 30 m.
- Reduction in the number of butt welds of tube to tube sheet raised spigot. This reduces manufacturing time, favourable impact on reactor schedule and enhances safety.
- Number of steam generators reduced from 8 to 6 (3 SG/loop for CFBR)
- Operation flexibility - to run with 3 + 2 SG of affected loop

PFBR	CFBR
547 tubes	475 tubes
17.2 OD X 2.3 WT	17.4 OD X 2.4 WT
Mod Gr 91	Mod Gr 91
No of welds	No of welds
547 X 16 = 8752	475 X 12 = 5700

Innovation: Reduced Manufacturing time, Improved Economy, Enhanced safety & reliability

Towards Enhancing Reliability of Shutdown System

Reliable Drop Time Measurement

Multiple techniques (Eddy Current, Kalman Filter & Acoustics) developed

Safety enhancements

(i) Stroke limiting device in CSRDM to minimise probability of occurrence of inadvertent withdrawal of Control & Safety Rod

(ii) Temperature Sensitive Electro Magnet in DSRDM to minimize failure of SD system due to instrumentation failure

(iii) Additional Liquid Poison Injection System

OBJECTIVE : Enhanced reliability by one order of magnitude

Major Components Undergone TD Exercise

	Component	Industry
1	Tri-Junction Forging for Roof Slab	Bharat Forge, Pune
2	Large Diameter Bearings (Top shield)	Vivith Hi-Fab & Krishna Gears
3	Thick Plate Welding (Rotatable Plugs)	L&T Hazira
4	Welded Grid Plate	L&T Powai
5	Inner Vessel with Single Torus	L&T Hazira & KRR Industries

Economic Assessment of SFR

Parameter	LWR 1000 MWe		CFBR: 2 x 500 MWe*		
	AP 1000	EPRI	7 % ER	8 % ER	9 % ER
Overnight capital cost (ONC), INR (Cr)	22233	21124	11820	13000	14220
Specific ONC, $/kW	4210	4000	2238	2462	2693

* PFBR ONC of 3600 INR (2002 basis) for Diff. Escalation Rates (ER):

- A common saving of 10% is assumed for the systems of twin units
- 25% savings in the cost of reactor assembly systems
- 30% saving in fuel handling system

Towards Reducing Construction Time

- RA and Civil Construction of reactor vault along with safety vessel are constructed in parallel in matching time schedule that RA will be erected without time delay
- Subsequently other reactor internals kept ready in SAS will be introduced

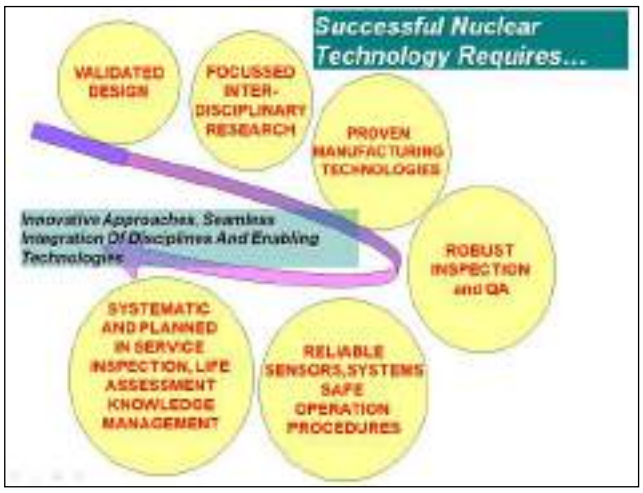
- Completion time for RA: PFBR ~5 y and ~ 3 y for CFBR
- Scheme arrived at jointly with BHAVINI and Industries

APPLICATION OF VIRTUAL REALITY

- A digital mock up of reactor design review is performed looking for any errors and inconsistencies.
- Complete walkthrough of nuclear power plant including many human centered activities are simulated in full one-to-one scale, such as navigation, orientation, and object identification and manipulation.
- The various sequences of equipment installation are tried out to find out and finalize the optimal installation and commissioning method of the various equipments.
- Engineers / operators could be trained in the complete walkthrough of the virtual 1:1 scale model of the plant for better understanding of the plant.
- Various thermal hydraulics and structural mechanics analysis of the reactor components can be viewed in 3D for easy interpretation of the analysis.


Concept of Mega Nuclear Parks with Fast Reactors
Nuclear Mega parks – in coastal areas
Possibility exists to manufacture the entire RA components as a factory-made single package item
Industry consortium catering to parks
SFRs with imported enriched uranium for quick realisation of nuclear power through FR (8-10 GWe in 5 coastal areas)


Introducing Innovations: Approach
Concepts that have significant impact on economy and safety
Manufacturing Capability in India
Operating Experiences of SFRs
Consideration of Construction Experiences of SFRs and PFBR in particular
Analysis and Synthesis of Emerging Safety Concepts and Designs (Example: GENIV)
Multiple concepts from various collaborators to choose the best
Extensive Analysis and Design Validation of concepts
High Emphasis on Scientific Breakthroughs
Emphasis on high quality human resources and creating environment for enabling innovations


Successful Nuclear Technology Requires...
VALIDATED DESIGN
FOCUSSED INTER-DISCIPLINARY RESEARCH
PROVEN MANUFACTURING TECHNOLOGIES
Innovative Approaches, Seamless Integration Of Disciplines And Enabling Technologies
ROBUST INSPECTION and QA
SYSTEMATIC AND PLANNED IN SERVICE INSPECTION, LIFE ASSESSMENT KNOWLEDGE MANAGEMENT
RELIABLE SENSORS,SYSTEMS SAFE OPERATION PROCEDURES

Innovation and R&D in Indian Industry – Time to Leapfrog

E.C. Subbarao
Tata Research Development and Design Centre, Pune

10th National Conference on Technological Innovations in India – Retrospect & Prospect
Engineering Council of India, New Delhi, 29thNovember, 2012

Introduction

- Early Period
  - Technology Imports
  - Import Substitution
  - Minimum R&D facilities
- Exceptional Examples
  - Tata Steel
  - Hindustan Lever
  - SAIL
  - BHEL

R&D Personnel and Budgets

Country	Year	Amount ($ million)	% GDP	Share of expenditure		R&D Personnel per million people
				Business	Government	
India	2007	24,439	0.76	33.9	66.1	119
China	2009	154,167	1.7	71.7	23.4	715
Japan	2009	137,908	3.33	75.3	17.7	5300
S Korea	2008	43,906	3.36	72.9	25.4	3732
Brazil		21,649	1.08			
US	2009	401,458	2.88	59.7	31.3	4628

R&D Personnel and Budgets

- R&D expenditure as % GDP is very low for India . Large share of R&D budget from Government. Business provides less.
- Government R&D expenditures goes to Govt. labs, DRDO (34%), Space (17%), DAE (11%), etc.
- Not enough incentives for industry to spend on R&D.
- R&D Personnel per million population is very low for India, compared to Japan, South Korea, U.S. and even China.

Number of Ph.D. Engineering and Technology

Country	Population, in billion (2009)	GDP in Thousand $ (2010)	No. of Ph.Ds. in Engineering and Technology	
			1995	2008
USA	0.31	14.1		8110
China	1.33	5.0	1659	15073
India	1.15	1.5	348	1058

Current Status of Ph.D.s in India

- Fewer Ph.Ds in India relative to population and GDP.
- China surpassed even U.S.
- We are crawling.
- Our 7 IITs graduate 1000 Ph.Ds only
- Ph.D. – Engineering to Science ratio is
  - 1:4 in India,
  - >2:1 in Japan

Publications & Patents : Output from Research

Country	Publications		2009 % world total	Patents (issued to residents in brackets)		No. of patents per 1 million population
	1999	2009		1999	2006	
World	610,203	783,397	-			
India	10,190	19,917	2.5	2160 (29.3)	18,232 (32.3) in 2006	5
China	15,715	74,019	9.4	7637 (40.6)	93,706 (49.7)	
Japan	55,224	49,627	6.3			944
South Korea	8,476	22,271	2.8			779
US	186,004	206,601	26.5			289

Publications & Patents : Output from Research

- India's contribution to world publications is a meager 2.5% compared to 9.4% for China and 26.5% for U.S.
- In CSE, India is expected to be an emerging leader, but only 3.5% of global research output is from India in 2010
- India's contribution to high impact papers less than 1%; 80% of publications from India from less than 10% of institutions
- China grants five times as many patents as India – half to locals in China and one-third to locals in India
- Only 5 patents per million population in India and nearly 1000 per million in Japan.

Industry – Academia Interaction

- World Economic Forum (2008) Ranking

U.S.	1
U.K.	9
Korea	12
Japan	21
China	23
India	43

- Summer Industrial Opportunities Programme for Faculty - IITK model
- Industry deputing Engineers for PG Programme and thesis research jointly supervised

MNC R&D CENTERS IN INDIA

- Number of MNC R&D Centres in India is increasing
  - 2002 50
  - 2006 150
  - Now >760
- Why?
  - Availability of qualified, young researchers
  - Lower costs
  - Closer to expanding markets
  - Products customized to local needs
- This is a convincing reason for Indian companies to expand their in-house R&D.

Our Mission

TRDDC was established with a mission:

"To apply existing knowledge for the benefit of our industry and our people"

- J.R.D. Tata (1981)

SOFTWARE FACTORY

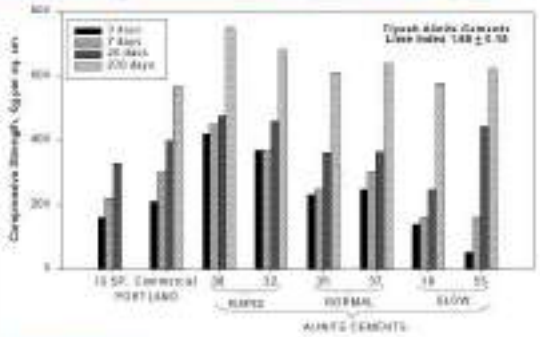
- Similar to Machine Shop with Flexible Tools
- Software Tools which can be mixed and matched
- Y2K Software Factory
  - Flexible, Fast Solution
- Innovative software tools revolutionized Software Industry in speed, reliability, flexibility and cost

Key Benefits to our Industrial Partners

Energy	18% ↓ : Carburization
	5% ↓ : Coal consumption in sponge iron production
Productivity	15% ↑ : Annealing furnace
	3% ↑ : Iron ore pellet induration furnace
	18% ↑ : Copper smelter
Environment	Eco-cements, LCA of industrial components, iron ore slimes, RHA
Process Scale-up	Cement, Plant-wide control (mineral processing), Bioreactors
Quality	98% ↓ : Cracks in continuous casting
Design	2% ↑ : Efficiency of a compressor
Societal Impact	Tata Swach, Bio-methanation
Novel Chemicals	Reagents for paints, mineral processing and agrochemicals
Asset Life	18% ↑ : Refractory life of Kalde furnace
Software Tools	DRAS, Virtual Industrator, Wiredrawsim, PREDICT, SimLS, LFGR

Eco – Cements from Fly Ash

A Comparison of Compressive Strengths of Eco- Cements with Ordinary Portland Cement (OPC): From Fly ash



Innovation Initiatives – Process Engineering

Green Initiatives

- High Ash Coals
- Sustainable Manufacturing

ICME

- Integrated Computational Materials Engineering
  - Stamp (Tools for ES Automotive)
  - Steel PSC demonstrated
  - Materials Informatics (PSC demonstrated)
- Productivity Enhancement

Advanced Materials

- Nanocoatings
- Polymer Processing

Health Care Initiatives

- Drug Release through Polymer Hydrogels
- Polymer Scaffolds for Tissue Engineering
- Materials for Surgical Devices
- Biosensors

SOCIETAL BENEFITS

FRUGAL INNOVATIONS

- **Doing More with Less for More.**
- **Deliver More Value at Lower Cost to More People.**
- **Starts with specific needs and opportunities near the 'bottom of the pyramid'.**
- **Works backwards to develop appropriate solutions which may be significantly different from existing solutions designed to address needs of up-market segments**

Examples:

- **Safe Drinking Water**
- **Adult Literacy**

Safe Drinking Water (Sujal)

- Main reason for half the hospital beds with patients with water borne diseases.
- Highest cause for Infant Mortality
- Four Million Children die every year with Diarrhea.
- Innovation
  - Filter based on Rice Husk Ash (RHA), widely available waste
  - No electricity needed
  - Simple technology, can be used in villages
  - Costs between Rs. 499 and Rs. 999
  - Filter replaced for Rs. 299 after filtering 3000 litres of water

Percentage of Literacy in India (1951-2001)

Year	Overall	Males	Females	Male-Female Gap
1951	18.3	27.2	8.9	18.3
1961	28.3	40.4	15.3	25.0
1971	34.5	46.0	22.0	24.0
1981	43.6	56.4	29.8	26.6
1991	52.2	64.1	39.3	24.8
2001	65.4	75.8	54.2	21.7

Literacy rate is low particularly, in low income and Rural Population

Role of Literacy in Development

Parameters	India		China		South Korea	
	1990	2000	1990	2000	1990	2000
Literacy (%)	52.5	66.5	73.0	92.0	98.0	99.0
Per capita income (in US$)	299.6	449.8	321.9	855.4	5523.4	9671.5
Telephone Lines per 1000 people	0.6	3.2	0.6	11.1	31.0	46.4
Personal Computers per 1000 people	0.3	4.5	0.4	15.9	37.2	100.3

Adult Literacy

Problems with Conventional Approach to Adult Literacy:

- Shortage of Schools and dedicated Teachers
- Paucity of Funds
- Lack of Infrastructure including ICT

Computer Based Function Literacy - CBFL

Innovative Approach – Computer Based Functional Literacy (CBFL):

- Target audience – Working Adults who can speak their native language but cannot read or write.
- To teach reading in 30 to 45 hours
- Leverage Technology, deployable quickly any time, any where.
- Need to read only 500 basic words to meet daily functional needs.
- Use familiar local folklore e.g., puppets.

Spread of CBFL

- Nine Indian Languages
  - Bengali, Gujarati, Hindi, Kannada, Marathi, Oriya, Tamil, Telugu and Urdu
- Nine States
  - Andhra Pradesh, Tamil Nadu, Madhya Pradesh, Maharashtra, Uttar Pradesh, New Delhi, Rajasthan
- Jails, Industries (ACC, ITC, Goa Shipyard etc.)
- Beyond National Boundaries
  - South Africa

Recent Developments - CBFL

- CBFL expanded to include
  - Writing
  - Arithmetic
  - So, now 3 r's are available

GOAL

- R&D and Innovation rooted in India should reach a stage when Indian companies include in their annual report:
  - **Patents obtained and exploited during the year.**
  - **The fraction of current earnings derived from products which the company was not producing 3 years ago.**
  - **Awards for innovations and R&D**
  - **Active Academic Linkages**
- Indians in India solving problems facing Indian society will lead to breakthroughs and will bring due recognition to India
- Road map:
  - **Technology Innovation – Engineering – Business Model**

Engineering Council of India

TATA

Technological Innovations in India - Retrospect & Prospect

Innovation @ Power Sector

Presented by : Kalyan Panda 29 Nov. 2012

TATA POWER

Innovation Process

TATA

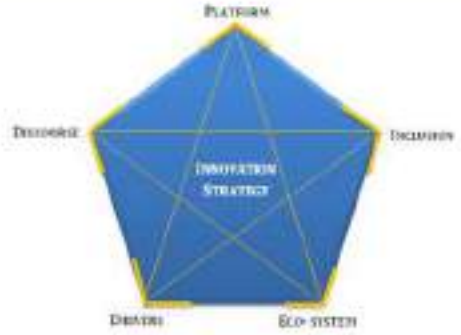
- Connect un-connectable
- Dream, Dream, Dream
- See beyond what is visible
- Expect the unexpected
- Enjoy contradictions, shun consistency
- Remember: Experiments never fail, mind does

INNOVATION PROCESS

TATA

Innovation Pentagon - Organizations

TATA



Status of Innovation in India

TATA

- The Researchers in R&D (per million people):
  India (140), US (4651), Japan (5546), Singapore (5713), Sweden (6139)
  Source: - UNESCO Institute for Statistics, World Bank R&D Statistics
- R&D expenditure (% GDP):
  India (0.88%), US (2.61%), Japan (3.4%), Israel (4.57%)
  Source: - The Hindu, 2009
- Patents in Educational Institute:
  IITs 3-6 patents a year, Stanford (64), MIT (102)
  Source: McKinsey
- Overall Patents:
  India: 7,509 patents, China (67,848), Korea (1,23,705), US (1,57,263), Japan (1,64,854)
  Source: WIPO statistics (2008)

Global Innovation Index & Innovation Efficiency Ranking

TATA

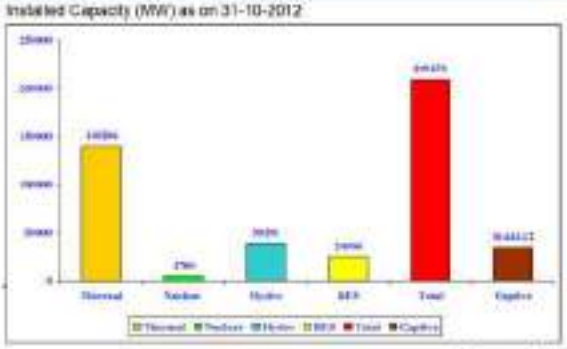
Country	Global innovation Index		Efficiency Index	
	Score	Rank	Score	Rank
Switzerland	66.2	1	1.01	5
Sweden	64.8	2	0.88	18
Singapore	63.5	3	0.69	83
Finland	61.8	4	0.83	30
United Kingdom	61.2	5	0.80	44
Ukraine	36.1	63	0.90	14
India	35.7	64	1.10	2
Colombia	35.5	65	0.68	92

Higher efficiency index indicates stronger innovation outputs despite weaker innovation environment and inputs.

Source: - GII 2012

Power Sector update - India

Installed Capacity (MW) as on 31-10-2012



*Source : CEA

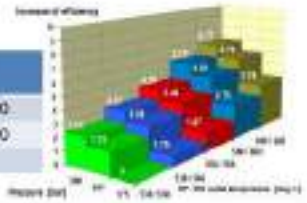
Innovations in Thermal Power

- Evolution of supercritical, Ultra Super critical & Advanced Super critical Technology
- Upgraded Brown Coal (UBC) technology for low rank coal
- Effective Preventive Maintenance for power plant boilers
- Upgrading & Life Extension Technology for existing Steam Turbines
- Energy saving Technologies for Coal fired Thermal power station
- MEEP (Moving Electrostatic Precipitator) Technology
- Energy saving technologies for coal fired TPS
- Water Canon Technology
- Design of Boiler for enhanced fuel flexibility

Supercritical, Ultra-Super Critical (USC) & Advanced USC Technology

- Improvements in Steam Generator Technology
  - Optimizing the heating surface arrangement
  - Keeping the excess air coefficient in the firing system less than 1.2
  - Reducing the exhaust-gas temperature
  - Minimizing pressure drops.

SAVING (compared to Subcritical unit of 500MW)	
Coal Saving (Tons/Year)	68600
CO2 Reduction (Tons/Year)	88270
SO2 Reduction (Tons/Year)	385



Supercritical, Ultra-Super Critical (USC) & Advanced USC Technology

- Improvements in Steam Turbine
  - Barrel type outer casing with axial casing split – Optimum thermal deformation behavior and small radial clearances between inner casing and blades
  - Material development (9-12%CrMoV Steel) for high temperature components inlet barrel, rotor and inner casing
  - Active cooling system - HP & IP casing to avoid thick wall
  - Advanced blade profile and blade path technology - 3DVTN (3 dimensional design with variable reaction)
  - Development of optimal last stage blade families - reduced exhaust losses
  - Advanced sealing technology: Brush Seal, Spring backed seal segment for blade path with abradable coating

Technology Upgradation in Thermal Power Plant

Source: Siemens

References for USC Technology

Wai Gao Qiao 3, China

Source: Siemens

Upgraded Brown Coal Process (UCB)

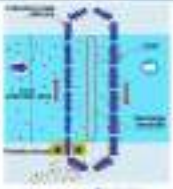
- Unique technology that upgrades lignite by effectively removing the moisture with " Coal – Oil slurry dewatering" method
- Mixing crushed coal with oil, heating the mixture to 130-160°C under 19-19.5 Bar pressure, separating the slurry cake from the oil by a centrifuge and then drying and briquetting it
- M/s Kobe Steel Ltd is the leading supplier in technology

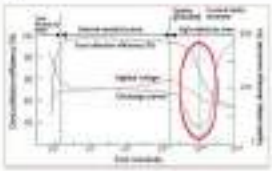
Briquetted UBC

Source : KSL

Moving Electrode Electrostatic Precipitator (MEPP)

- High resistivity dust (10^11 ohm cm or higher) characterized by excess sparking and back corona, affecting collection efficiency.
- Moving Electrode Electrostatic Precipitator (MEEP) prevents back corona by removing the collected dust using rotating brushes and movable collecting plates
- ESP Collection performances regardless of the dust resistivity.

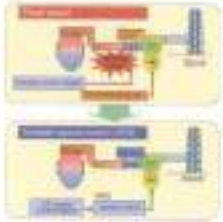


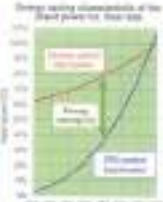


Source : Hitachi Plant Technologies Ltd

Energy saving technologies for coal fired TPS

- Fans used for boilers of coal thermal power plants are usually controlled with vanes or dampers. VFDs used for these installations reduce energy losses and hence improves Auxiliary Power Consumption (APC)
- Combustion optimization control technology with boiler model and self learning algorithm technology will contribute to energy saving by improving boiler efficiency



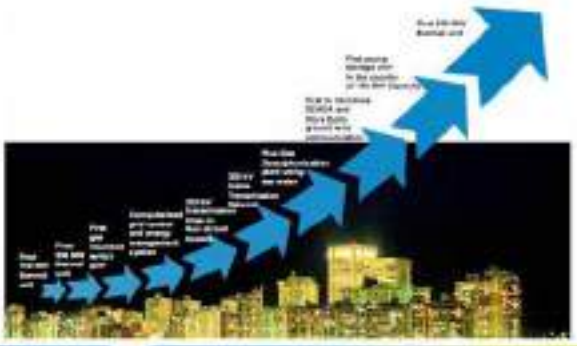


Source : Hitachi Ltd

Enhanced Fuel Flexibility

EXISTING	SHIFT
Fuel/ Mine specific design - Linked mine/ Single rank/Single location	Unlimited fuel flexibility - Multiple mines/Multiple ranks/ Multiple countries
Fuel security perception - Single Contract (CIL) - Acquire Mines domestic/overseas	Fuel security perception - Strategic tie-up for multi location sourcing
Contracts- Guarantee centric - Efficiency/APC/BMCR	Contracts – Function Centric - Reliable/Safe/Optimal operation
Cost Centric Design	Optimal Design

Pioneer in Power Sector



Water Cannon Technology

Golden Fruits of Technological Innovations for National Growth

10th National Conference on Technological Innovations in India-Retrospect & Prospect on Nov 29, 2012, Scope Complex, New Delhi

Prof. Man Singh
Dean, School of Chemical Sciences,
Central University of Gujarat, Gandhinagar
Email: mansingh50@hotmail.com

Science is a Joy & Technology is a Toy

Analytical thinking leads to invention

Graham Bell

Creations have been made out of curiosity

Curiosity is abnormal thinking & action

Survival of science & innovation pyramid

Make 'why where how act' as vibrant as possible

Idea & action as potential & kinetic energies:

Science & innovation

Sustaining zeal & fire: Invention

Make idea as analytical as possible: Science
Make Science as new as possible: Innovation
Make Innovation as usable as possible: Technology

Make action as frequent as possible: Creation
Persistent & consistent efforts: Foundation of creativity

IPR: Intellectual Property Rights
CPR: Creative Property Rights
IIF: Interacting & Inspiring Forum
ITFAC: Technology information forecasting assessment council

Hunger for unseen & unbelievable mysteries: Innovation

No survival without science
Survival of fittest is turned to
Survival of creative (thinking) action
Innovation is foundation of survival
Science as a web & wheel always moves forwards with newness
Ideas evolved from bottom & sacrifice succeeds
As a natural law of energy conversion
from one form to another
Fricohesity: From Cohesive to kinetic with FF
Fricohesity of life

Hunger to know science mysteries

Teachers who design & do experiments inspire in a better way as 'seeing is believing'
Idea generation & focus do not depend on exam marks but emerges out of spontaneous thinking, dreaming & doing
Newton sitting under apple tree
gave law of gravity
J.C. Bose that plants are sensitive
Robert Boyle: $PV = K$
Fricohesity = M_c (t.n)

Inspiring hinges

Imagination is more important than knowledge. Knowledge is limited, where an imagination embraces the entire world stimulating progress, giving birth to evolution: Albert Einstein

Science is ever growing & never ending revolving wheel: Man Singh

Idea is like a seed: Man Singh

Science comes from within & grow globally: Man Singh

Hit & Fit: Abhishek Chandra, SCS, CUG

Never ignore idea or innovative steps ahead

Ask questions: Can a visually challenged test quality of your toothpaste

Yes, trapping & trying with science of molecules

Don't miss laboratory research

Lever concept most fundamental & useful

Initially, lever, a basic tool was used for macro-objects

1st time, in 260 BC, ancient Greek mathematician Archimedes described levers & said:

Give me the place to stand, & I shall move the earth

Lever is most scientific invention

Tree's roots spreaded in soil hold whole tree

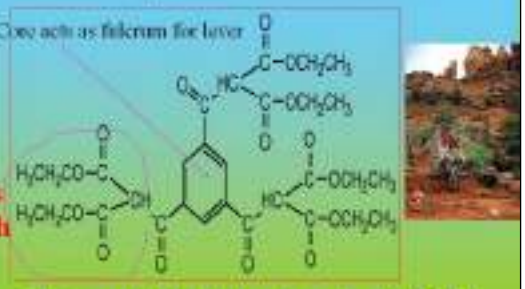
House foundation holds multistoried houses

Dentures fixing, surgery tools, scissors, wrench

Theme Thought Theory = T^3

Concept concise concretize: Hypotheses

Lever & tentropy have mutual relevance



Tentacles do stretch vibrate oscillate

Trimesoyltriethyl malonate= TTDEM

Science comes out of thinking, reasoning, rejecting, exciting, enjoyment

Madam Curie got excited to see a blackening of paper by pitchblende- Radioactivity

Pitchblende is radioactive mineral is uraninite, uranium ores

In 1898, French scientists, Pierre & Marie Curie, discovered polonium & radium in Pitchblende a uranium source for production of atomic bomb

Pitchblende deposits are in South Africa, Czechoslovakia, Canada, Germany, France, in USA, Marysvale, Utah, Connecticut, North California, Colorado

Keen observers & deep response

Newton excited to see apple falling downwards??

James Watt cruelty on animal, horse cart ???

Flaming thumb rule for electricity generation through Magnetic flux cut

Sir J.C. Bose, observed life in plants, they breath

Cork borer experiment: Benjamin Thomson: Thermodynamics

Pythagoras saw fallen tree & gave Pythagorean equation & geometry

Stone transport for Egyptian pyramid through Nile river

Quick & witty approach to wonders of science that spark interest in new ways

Wonders & thunders of science

Myths & mysteries of science

Friccohesity: Transthermo property within infinitesimal IMMFT webs

Science is a creation of new life, sometimes it makes life better or worse

Computers made lives so easier & better, but the monster that victor created made his life worse

Science never hides & ever rides

Science transforms ideas into realities
Science is a most action based subject
Scientific invention is like a blockbuster
For making young people to be science & technology leaders, inspire them in exciting, enthusiastic, enjoying
It builds science, engineering, technology skills,
Inspire innovation & foster well-rounded life capabilities including self-confidence, communication, & leadership
Culture to celebrate mind's creation
Eureka : Archimedes

Thought process is a foundation of invention

Idea-action-execution chain acts as a wheel which revolves & strives out of a bottom of a pyramid

For example, ideas of survismeter, Oscosurvismeter, visionmeter, econoburette, tentropy, IMMFT & fricohesity were initially thought off within a workable frameworks and intuition

But the success science stories be essentially brought to the notice of stake holders

This could lead to a big beginning for creativity & inventions

World's 1st long distance road trip by automobile

- In Germany in August 1888, Bertha Benz, wife of Karl Benz, inventor of 1st patented motor car, travelled 106 km from Mannheim to Pforzheim
- Bertha Benz drove motor car (max speed 10-16 mph) & back, with her 2 teenage sons without consent & knowledge of her husband
- Benz pretended to visit her mother but she wanted to generate publicity for her husband's invention (used on short test drives before)
- It was succeeded as the automobile took off greatly afterwards

Science: Ideas exploring philosophy

Optimistic & faith in laboratory work

Competence & analytical ability in designing experiments

Distant & deep vision
Free & frank flow of knowledge
Be away from superfluous touch
Be creative & bold to express something novel
Failure most receptive science
have high hopes in you not in others
Search everything in yourself not in others

For example, green & blue revolutions, floating agriculture

Physicochemical properties illustrate significant molecular science in supporting medium

Shared electron pair shift (SEPS)

Intramolecular multiple force theory (IMMFT)

Interacting & binding activities
Mixing & moderating potential
Hydrogen bond monitoring activities
Surface & bulk phases reorientations
Liquid-liquid interface (LLI) sciences
Phase extraction & partition across immiscible phases
Optimization and stabilization of molecular interlocutor potential

Most critical insides of molecular science

Solid-liquid interface engineering (SLIE)
Intermolecular forces (IMF) among dissimilar molecules
Viscosity
Fractional forces
Newtonian & non-Newtonian liquids
Solvent binding & carrying
Shear stress
Entropy-activation energy (EAE) relationship
Structural illustration of interacting molecules
Approaching & deviation from ideal system analysis
Potential energy & liquid distribution equilibrium in closed & open systems

Man - molecules interface

$-\Delta E^{*}\Delta S = nRT$

History: Invention of usual burettes

- In 1791, Francois Antoine Henri Descroizilles developed 1st burette
- **In 1824, Joseph Louis Gay-Lussac** gave an improved burette version, with a side arm
- In 1824, Gay-Lussac coined Pipette & Burette paper for indigo solutions standardization
- **Karl Friedrich Mohr,** made a remarkable breakthrough in volumetric analysis methodology **Karl** redesigned the burette by placing a clamp & a tip at the bottom

Invention & patent: Burettes & pipette

- **Knudsen Burette**: In 1899, Knudsen introduced this burette 1st time & is a most used instruments in world for salinity determination of a water sample
- 1st record of a handheld pipette in U.S. patent office dates back to 1925
- Rodrigues pipette, patented in 1961, & Gilson Pipetman, 1974
- Two of the earliest & most successful pipettes were
- The advanced developments in pipettes were began in 1970s

Econoburette: Clean & green titration

- The SCS, CUG has developed Econoburette, a pipette & conical flask less **Semimicro Titrating Method**
- It eradicates the serious drawbacks associated with usual titration methods & make them clean & green
- Econoburette makes the chemistry learning a most interesting & student's friendly science
- Titration with Econoburette makes the chemistry a most attractive profession

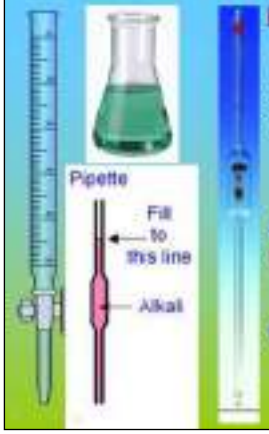
Idea is a seed & grows as a banyan tree

- **Initially, Econoburette was a idea now it is a reality**
- Such laboratory creations inspire the students
- Lab experiments set direction for dreaming unseen
- unbelievable theories & thoughts
- Science is a revolving wheel of thoughts
- ***Self generated laboratory database build confidence*** Science information are generated from experiments Fundamentally, laboratory experiments are pillars for growth of science

Few examples of novel sciences out of ideas

- James Watt-Scottish Scientist, noted boiling water in kettle uplifting lid (1763): Idea of railway engine
- French engineer Sadi Carnot (1824) theoretical input for high efficiency
- Rumford (Col Benjamin Thompson) Cannon Boring Experiments led Thermodynamics by connection between heat & work
- Fleming's rule: Thumb rule for electricity
- Alexander Graham Bell: Telephone
- Indian invention Borosil mansingh survismeter
- US patented Oscosurvismeter

Old method: With pipetting mechanism

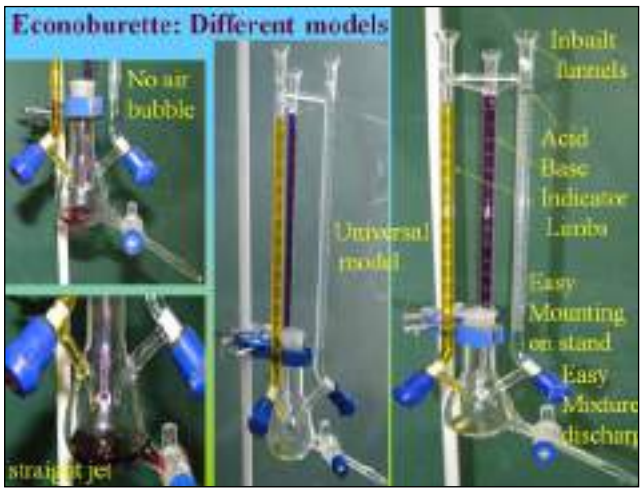


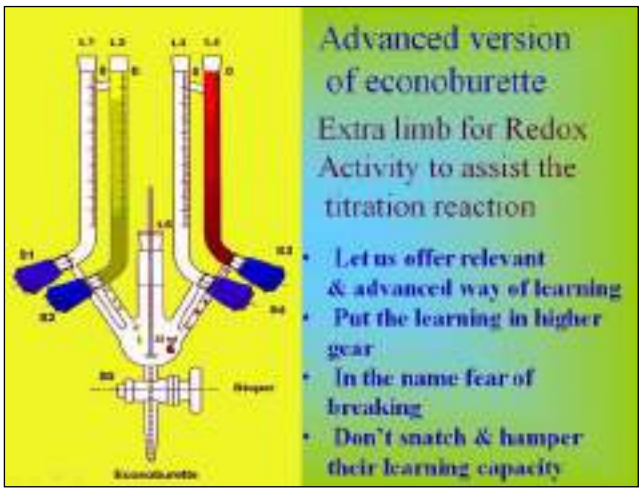
Demerits of old titration device

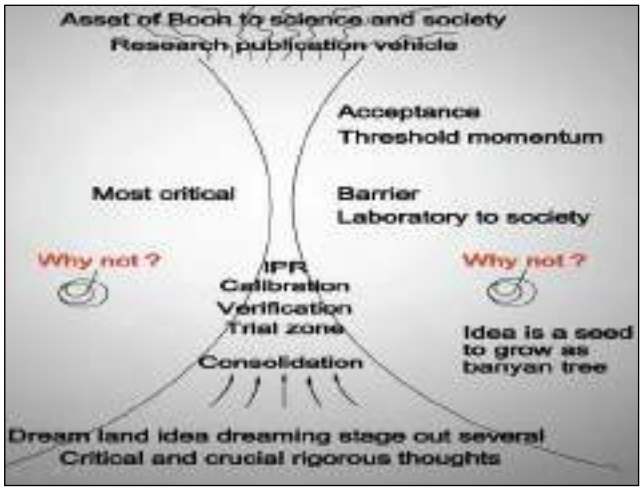
1. Multiple operational steps
2. Evaporation of materials
3. Pipetting out allows acid & base vapor to enter mouth in pipetting out
4. **Excess use chemicals**
5. **Repeated science never inspires**
6. **Something new makes learning charming & fascinating**


Econoburette: Cutting edge over usual
No trapping Of air bubble
No touch of pendant drop: straight jet
Easy mounting on ordinary stand


LOBA Chemie
Econoburette
Catalogue No. 1110011
Now history is turned to new titration Science
& to deal with explosive Inflammable
Reactions: Beckmann
Inbuilt funnels
Acid
Base
Indicator
Limbs
Easy Mounting on stand
Reaction chamber
Mixture discharge


Econoburette: Different models
No air bubble
Universal model
Inbuilt funnels
Acid
Base
Indicator
Limbs
Easy Mounting on stand
Easy Mixture discharg
straight jet


Advanced version of econoburette
Extra limb for Redox Activity to assist the titration reaction
Let us offer relevant & advanced way of learning
Put the learning in higher gear
In the name fear of breaking
Don't snatch & hamper their learning capacity


Asset of Book to science and society
Research publication vehicle
Acceptance
Threshold momentum
Most critical
Barrier
Laboratory to society
Why not ?
IPR
Calibration
Verification
Trial zone
Why not ?
Idea is a seed to grow as banyan tree
Consolidation
Dream land idea dreaming stage out several Critical and crucial rigorous thoughts


Borosil historic decision for Survismeter
Technology Transfer to users
For quick, multitasking, economic facility to users
No import of cost intensive & time taking instruments
Brookfield, Cannon, Ubbelohde: Viscometers
Wilhelmy Plate, Kibron & Du Nouy Ring: Tensiometer
No hassle for clearance & foreign shipment expenses
Promoting maintenance free indigenous technology
Inspire researchers to do novel research
Opening employment opportunities in country
Asset & affordable facility to every institutions
No sophisticated infrastructure & maintenance required
Kyowa Interface Sci. Co. Ltd. & SITA Messtechnik GmbH

Nomenclature & Genesis of Survismeter
n-in-1 natural science

Sur: Derives from surface tension, interfacial tension, cohesive force, wetting coefficient, thin film & coating

Vis: Viscosity, frictional forces, Newtonian & non-Newtonian liquids, solvent binding & carrying, shear stress, thixotropic

Meter: Quantity assessment for non-ideal analysis

Theory: Potential energy & liquid distribution equilibrium (PELDE) in closed carburetor

Friccohesity (s m^{-1}): Frictional & Cohesive forces critical ratio

Friccohesity, Dual force theory for integrated profile of fluid dynamics, architecture molecules

Friccohesity: Supramolecular engineering, IMMFT

Eco, environ & users friendly analytical equipment

BOROSIL MANSINGH SURVISMETER

New inventions inspire

- Patented Device :
  - *Singapore Patent*
  - *Indian Patent*

Survismeter would stop import of Brookfield , cannon viscometer LAUDA, Tensiometer German Kibran Teniometer, Finland

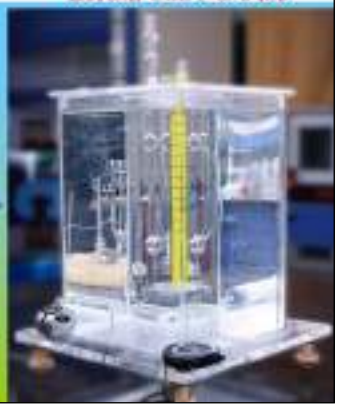
BOROSIL MANSINGH SURVISMETER

Borosil Cat. No. 3453

Smart green science for study of PCPs

Will stops import of

- Brookfield Viscometer-USA
- Cannon Viscometer-USA
- LAUDA Tensiometer-German
- Kibran Tensiometer Finland
- Kyowa Tensiometer Japan



Accuracy & Precision: Comparison

Data of Survismeter, compared with Wilhelmy Plate (Platinum-Indium) Tensiometer

Graduate School of Engineering

Kyoto University, Japan

Accuracy & precision are 10 times greater than Wilhelmy

Highest reproducibility & resolution

Liquid-Liquid Interface Study of Hydrocarbons, Alcohols, and Cationic Surfactants with Water

Singh M. & Matsuoka H., Surf. Rev. & Lett. 16(2), 599, 2009

Effect of ionic sizes of halide anions of potassium salts on surface and interfacial tensions of benzene and water interfaces for mutual mixing

Singh M. & Matsuoka H., Surf. Rev. Lett. 16 (05), 743, 2009

Laboratory research to society

Initially, on 1st April 2007

MoU for Indian patent (Type I) was signed with **Spectro Analytical Pvt. Ltd. New Delhi**, for 02 years & then it was withdrawn

On 18 Nov. 2010

MoU for Govt. Singapore Govt. patent (Type II) was signed with **Borosil Glass Works Ltd**

Daihan Labtech (Korean Co.) is launching its digital version

MoU for this effect is signed on 22nd March 2012

Accidental invention by PhD student

- Stephanie Kwolek invented Kevlar in anticipation of a gasoline shortage
- In 1964, Kwolek began looking for a strong fiber for lightweight & strong tires
- Kwolek was working on Poly-p-Phenylene-terephthalate & polybenzamide (PPTP)
- In solution PPTP formed liquid crystal which was unique as compared to those polymers
- Solution was "cloudy, opalescent upon stirring & of low viscosity" & usually was thrown away
- Kwolek talked Charles Smullen, technician, who ran "spinneret", for testing the solution & was amazed
- As it unbreakable fiber, unlike nylon

Drug molecules create localized environment

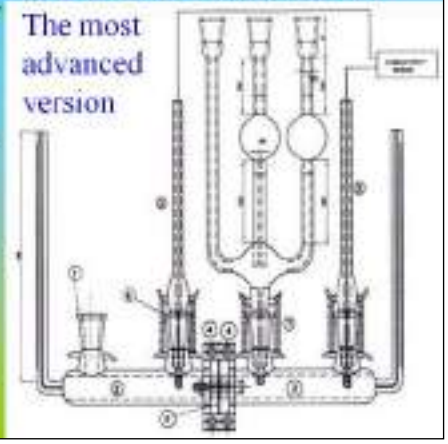
- Cohesive force: Surface tension
- Expensive/stretching: Viscosity
- Conductance: Ionic mobility
- Potential/pH: Localized environment
- Activities: Non-equilibrated energy zones
- Physicochemical gradient: Micro phases
- Concentration gradient: Thermodynamics
- Osmotic pressure: Friccohesity

CF holds water being absorbed by roots from soil
the water forms cohesive & continuum layer in roots & is only responsible for supply of water molecules from the soil

Man Singh US Patent no.: US20090229350A1

Oscosurvismeter
for
1. Osmotic pressure
2. Conductance
3. Potential
4. pH
5. Surface tension
6. Interfacial tension
7. Viscosity

The most advanced version



Oscosurvismeter US Patent No. 7,987,700 B2 granted on Aug. 2, 2011 superseding

1. FR 665409 France granted on **09.18.1929**
2. FR 2373050 France granted on **06.30.1978**
3. DE 3014705A1 Germany granted on **10.22.1981**
4. US 4361032 granted on **11.30.1982** Leesing et al
5. JP 02226045A granted on **Sept. 1990** Nabeya et al
6. US 5905403A granted on **April 1999** Steudle et al
7. US 6085577 granted on **7.11.2000** Christensen et al
8. DE 19963686A1 Germany granted on **07.19.2001**
9. US 6298713B granted on **Oct. 2001** Nandu et al

They have been dealing with diffusion chamber only but not with genesis & science of diffusion

Contribution to Science – A Brief Timeline

My Chemistry Teacher Shri S.R. Gupta at 12th Std. taught me chemical kinetics & explained work of Waage & Guldberg
Norwegian Chemists, who proposed
Law of mass action (1864-1879)
Van't Hoff experimentally had proven its validity for dynamic equilibrium
Their work inspired me for proposing a new theory
Law of activation energy action
It is energy which involves mass into action
Singh M., J. Chem. Therm. 39, 240, 2007
Molecular reorientation, collisions, interactions.
Everywhere demonstration of activation energy action

Architectural & dendrimer molecules

Distinct spatial division of core & branching
Dreder's concept of molecular nanotechnology from Richard's There's Plenty of Room at the Bottom (1959)
Taniguchi (1974)
Why not theory for trapping a potential of core & branching of molecules bottom up approach
Thus I have developed Intramolecular multiple force theory (IMMFT) for dendrimers &
Tentropy as of entropy proposed by Rudolf Clausius
Densimetric and viscometric study of Gly-PVP interactions and EPA of water fitted with IMMFT at 293.15, 298.15 and 303.15 K
Man Singh et al, J. Mol. Liq., 163, 83, 2011

German Chemist Friedrich Ostwald

Ostwald (1853-1932), Noble Prize in Chemistry,1909, for work on catalysis, chemical equilibria, reaction Velocities & invented Ostwald Viscometer

Ostwald, Van't Hoff, Arrhenius, modern founders of Physical Chemistry studied interactions using PCP data: viscosity, density, surface tension

& I have conducted experiments on Viscometric Studies of Poly(N-vinyl-2-pyrrolidone) in Water & Water and 0.01% Bovine Serum Albumin at 283.15, 288.15, 293.15, 298.15, 303.15, 308.15, and 313.15 K. Singh M. J Appl. Polym. Sci. 87: 1001, 2003

Entanglement of solvent with proteins & PVP: CF & IMF

The theme : For ST & viscosity studies

Newton studied: Velocity gradient (dv/dx) for viscosity

Stokes & Mills applied hydrodynamic law on viscous flow

Gibson & Jacob: Falling sphere method with Ostwald Viscometer

Einstein & Huggin studied specific viscosity of polymers

Wilhelmy & duNouy used a capillary pull

Jaeger, Sugden, Ferguson focused pdn device

Falkenhagen emphasized drop size with surface force

All these approaches have been individual

But Survismeter has come up as a wonder in measuring several PCPs together

Paradigm Shift in Solution Chemistry

Ostwald Viscometer (German chemist)

Ubbelohde Viscometer (German chemist)

Cannon Viscometer (USA)

Brookfield Viscometer (USA)

Ludwig Traube Stalagmometer (German physicist)

Lecomte Tensiometer (French biophysicist)

Wilhelmy Plate, Kibron (Finland), Du Nouy Ring Tensiometer

Mansingh Survismeter (Indian----)

R4M4: ▶Reduce ▶Reuse ▶Recycle ▶Redesign ▶Multipurpose ▶Multitasking ▶Multitracking ▶ Multifaceted

CONCEIVED AND DESIGNED

BY

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Engineering Colleges fail Industry Link test : AICTE-CII Study(Ref:-Hindustan Times, Delhi, November 03, 2012)

Only one in every five established engineering colleges in India is in synergy with industry, a joint survey by CII and the government suggests, fuelling fears of a disconnect that threatens the employ- ability of the country's youth.

On a score of 100, 19% of participant engineering schools secured even 46 marks in the survey conducted by the industry chamber & AICTE, India's apex technical regulator.

"It is a big worry,"AICTE chairman SSMantha said, calling the findings a " benchmark". The survey is the first comprehensive effort to analyse the quality of linkages between the country's engineering schools and industry, he said . Mantha added," The results will help us understand where we need to intervene." India has over 3,000 engineering schools, and the survey looked at those which have existed for at least 10 years. Of the 1,070 schools , which are at least a decade old & are approved by the AICTE ,156 responded to the online survey conducted in September.

The findings buttress evidence that is fuelling a growing concern within the government , and a theme that Rahul Gandhi has identified as key- how to find jobs for India's youth. India has the largest under 25 population in the world (540 m n) which the government has long spoken of as a demographic dividend. But of late, concerns are growing over if this number could turn into a curse. ' Finding gainful employability for the youth is a priority to prevent them from picking up guns, "junior minister for human resource development (HRD) Shashi Taroor said on Friday.

HRD minister MM Pallam Raju and Jitin rasada ,other junior HRD minister, have also spoken about bridging the gap between higher education and employability.

University system not producing well-educated graduates: Shashi Tharoor, said on Monday (November 5,2012)

New-Delhi: University system not producing "well-educated" graduates to meet needs of Indian companies, giving an opportunity to firms to enter the sector in the "guise" of training, minister of state for higher education Shashi Taroor said on Monday. He also said that the national education policy in the past has been out of step with the items.

" The major problem remains that our national education policy in the past has remained out of step with the time. Where as countries in the Middle East & China are going out of their way to WOO foreign universities to set up campuses in their countries, India turned away many academic suiters who have come calling in recent years," he said.

Speaking at a two-day Higher Education Summit, Tharoor said " Companies are entering the higher education space in the guise of training. Our university system simply is not producing well educated graduates to meet the needs of Indian companies today."

The HRD minister said there will be no need for many Indian students to go abroad to study if good higher education institutes were set up in the country. " We will also work towards putting our reform agenda back on track," he said.

Tharoor said there is a proposal to establish 50 centers for research in frontier areas of science, design innovation centers in different universities & also research parts of IITs & other technical institutions." If finally established, it would tranform the research environment in our country," he said.

Tharoor favored expediting setting up of National Mission for teachers and recommendations of the Narayana Murthy Committee and the Kakodhar Committee besides increasing the spending of 2 % on research. The minister said with the ranks educated unemployed in the country swelling in the absence of adequate employment opportunities, there is possibility of their falling prey to the activities of terrorists and Maoists." We must give them a better chance of employment through more and improved educational possibilities. My message is it is time to let a thousand educational flowers to bloom," he said.

He said even though India with 621 universities and 33,500 colleges has one of the largest network of higher education institutes across the world and second in terms of student enrolment, our gross enrolment ratio of 18.8 % in 2011 is still less than the world average of 26 %. He said there was need to develop higher levels of education & skill development and an environment must be created in which not only the economy grows rapidly but also enhances good quality employment. Tharoor said as India aims to grow at 8.2 to 8.5 % GDP, the country needs to invest in education and help to improve the quality of education.

Referring to a few World-class institutes like IITs & IIMs and some colleges, the minister said, "There are still islands in a sea of mediocrity."

Citing a UGC survey 1,471 colleges and 111 universities, he said 73 % of the colleges and 68 % of the universities are found to be of medium or low quality. He also said that a FICCI survey has revealed in 2009 that 64 % employers are " somewhat satisfied" with the quality of new graduates coming of engineering institutes. The minister lamented that spending on education is only 1.22% of GDP, against USA's 3.1%or South Korea's 2.4%. He also said that the student-teacher ratio in India was 26.1% against the global average of 15.1%. He said the rapid expansion of higher education sector has also led to shortage of faculty.

- Besides better training & imparting soft skills, management institutes must ensure better interaction between students & industry. This would help in conveying the expectation of industry to future managers. It is necessary to have the skill set that companies are looking for. IIM alumnus Neel Shah said " I always wanted to understand various aspects of the business, which I could not have achieved with a technical degree. What I got after investing 2 years in MBA from a reputed school was fruitful in terms of money but there have been many more intangible gains & benefits. "Recruiters believe that while MBA's are better at making presentations & negotiating terms of employment, they should be open to unlearning, be self motivated & have an open mind in order to be more employable.

Faculty crunch hits Indian Edu.system (Times of India,Ahmd.August04,2012)

- The Indian education system –from school to higher education, including IIT's & IIM's –is plagued by a massive manpower crunch. In the case of higher education, 42 Central Universities with sanctioned faculty strength of 16,602 have 6,542 vacancies. Fifteen IIT's have 1,611 vacancies against the total strength of 5,092 faculty positions. Thirteen IIM's have to fill 111 vacancies out of 638 positions. Four IIIT's have almost 50% vacancy as 104 out of 224 positions are vacant.

- NIT's across 30 states have 1,487 vacant of the total 4,291 positions. Even less than a decade old Indian Institutes of science Education & Research with five branches has been afflicted with faculty crunch-131 vacancies out of total strength of 518. But it is the school education that is facing the real heat. Throughout the country there is a vacancy for 12,59,000 teachers in primary & upper primary schools. UP leads the way with 3,12,000 vacancies against the sanctioned strength of 8,18,000. Bihar with 2,62,000 & West Bengal with 1,80,000 vacancies are also not in a better position. For its size, Chhattisgarh has 62,466, MP has 89,000, Gujarat has 11,695, Karnataka has 18,253, Delhi has 10,074, Andhra has15,379 & Kerala 3,013 vacancies. " What a pitiable situation exists ."

State has more coaching institutes than schools (Ref.:- Times of India, Ahmedabad,06-09-2012)

- Gujarat has 10,000 secondary & higher secondary schools .
- The number of coaching institutes, however, has increased to 15,000 .
- The role of a teacher today has changed dramatically from what it was only a few decades ago . The change has added new elements to the student-teacher relationship . Emotional bonding that existed a few decades ago has been replaced by professionalism .

How to tackle this grave situation of faculty crunch at all levels of education

- From the above data it seems about 35-40% posts are vacant at majority of places from school level to top levels of IIT'S & IIM'S.
- In that situation how is it possible to have more % of employable than the present one of 20-21%!
- Over & above the less availability of qualified & trained people there is always shortage of funds both in Govt. run institutions & privately run institutions. Due to this also the situation becomes further critical at all levels of education.

The available solution of this faculty crunch problem at all levels

- In India we have a big pool of practicing professionals at all levels. They are either retired from their active jobs or having their own practice at present through out India & are available in order to solve this problem of faculty crunch at all levels economically.
- AICTE & ECI should work together & make it mandatory for all educational institutions whether Govt. run or Privately run at all levels to employ minimum 33-35% faculty from practicing professionals either retired or having their own practice at present from a big pool as per Sl. No. 1, above. They may be available either honorary or with minimum charges per month.

- ECI have to work very hard in this direction in the same manner as the Engineers Bill , which is at a very advanced stage of consideration in the Ministry of HRD, the same way ECI should prepare the complete list of practicing professionals at all India level whether practicing at present or retired including B.Sc's , engineers, other professionals etc. & may take help of other Government institutions for the same & submit to the Ministry of HRD for further action at their end for enforcing & making mandatory to employ at least 33-35% of this available pool at all levels of educational institutions. This will help in doing away with faculty crunch at all levels.

- In order to achieve success as per above AICTE & ECI have to work hard to change the present "MINDSET" of Academia at all levels of education towards Industry & Practicing Professionals & bridge the gap between them at the earliest.
- Therefore, integration of industry & academia is a must at all levels such as revision of teaching methodology & syllabi, exchange of faculty, technology transfer etc. in order to make Multi-faced & Multi-dicipline education.
- Synergy between the industry , academia & practicing professionals of various professions on a regular basis.

- We have to consider the ever changing needs of the country, economy & society which demands change in education of old functional paradigms because prevailing academic practice do not give the scope to be looked from " user driven" rather than a discipline perspective. Therefore, there is a wider view that the education sector should not remain in the hands of Government but it should be free enterprises with minimal intervention.
- Special new methodologies need to be developed to teach the teachers & education should be based on the consensus of academics, industry & practicing professionals.

- Further Ministry of HRD should not enforce on educational institutions to work on no profit or no loss at all levels of education but should left it on them how! They would like to run their institutions so that they are in a position to employ best available talents as their faculties from both academia as well as practicing professionals & come out their own syllabi with minimal intervention of the Government & it should be free enterprises which is able to deliver, which the current admin-regulatory establishments have not delivered.

- "A mentor should be a bilateral thinker, an ideal mentor- mentee relationship" By BETSKA K-BURR.
- " The true sign of a good teacher is a good student because MENTOR-MENTEE duos who share their experiences of learning from ach other"
- The relationship between a mentor and mentee has paved the way forward for many successful careers.
- Is your teacher your friend too! With formal barriers between teachers & students gradually diminishing, the new age teachers can help your child grow mentally stronger.

ENHANCE YOUR EMPLOYABLITY OR OPPORTUNITIES FOR SELF EMPLOYMENT

THE INDIAN EDUCATION SYSTEM HAS TIME AND AGAIN BEEN CRITICISED FOR THE SKILLS IT INCULCATES IN ITS STUDENTS AND THE SKILLS THAT CORPORATE EXPERTS LOOK FOR.

THE NEED OF THE HOUR IS TO BRIDGE THIS GAP BETWEEN CORPORATE NEED FOR SKILLED MANPOWER AND UNEMPLOYED GRADUATES AND POSTGRADUATES, THROUGH STRUCTURED ASSESSMENT AND TRAINING.

TEACH HEAD,HAND AND HEARTS

- "Judge a tree by its fruits," said the great teacher of Palestine . Judged by its fruits, our current education system has failed miserably.
- A new type of education is needed, an education which should be related to life, real life.
- An education which will not merely develop brain power, but an education which will give a triple training of the head, hand and heart.

Reference:-Dada J P Vaswani,Vaswani Mission Pune

TRINITY STRUCTURED TRAINING

Innovative Courses

- Old, traditional courses of "MBA" programmes are "outdated" and "not enough"in a highly competitive marketplace.
- We cater to the burgeoning new industries and plug the demand – supply gap.
- These new courses are likely to be more popular then the existing ones and should enhance employability or opportunities for self employment.
- These new courses will lead to good placements and impressive pay packages too .

International Award

- Best Jury Award for Interface Between Academia and Industry in higher Education wins by GTU Innovation Council at the summit held at New Delhi from July 13 to 15, 2011.
- The initiative of bringing Engineering students in Gujarat face to face with the real life issues of Micro, small and medium enterprises(MSME's) has gained recognition at the "World Education Summit 2011".
- The GTU Vice Chancellor Mr. Akshai Aggarwal said "The idea of GTU Innovation Council is to rekindle passion for innovation in the young minds, encourage them and make them the agents of change.The Initiative need not be limited to the state but shall be spread through India.

COLLEGES NEED TO ADDRESS THE SKILL-GAP ISSUE AND TAKE STEPS TO CORRECT IT BY UPGRADING AND ADDING TO THE CURRENT ACADEMIC CONTENT. THEY OUGHT TO PROVIDE A PLATFORM TO ENABLE THE STUDENT COMMUNITY'S 'LEARNING THROUGH INTERACTION' BETWEEN THE ACADEMIA AND THE CORPORATE WORLD. STUDENTS NEED TRAINING IN INDUSTRY-SPECIFIC, FUNCTIONAL AND BEHAVIOURAL SKILLS; AND SUBSEQUENT EVALUATION TO MEASURE THEIR PROGRESS IN THE TARGETED SKILL SETS. AND CORPORATES SHOULD BE ABLE TO ACCESS, EVALUATE AND SELECT 'READILY EMPLOYABLE' TALENT IN A COST-EFFICIENT MANNER.

THIS WOULD RESULT IN A TRIUMPHANT SITUATION FOR ALL CONCERNED, WITH COLLEGES UPGRADING THEIR FACULTY OR COURSE CONTENT AND PROVIDING BETTER PLACEMENTS FOR ITS STUDENTS-BOTH QUALITATIVELY AND QUANITITATIVELY-WHICH WOULD INVARIABLY LEAD TO ITS BRAND ENHANCEMENT; STUDENTS GETTING EMPOWERED WITH AN IMPROVED EMPLOYABILITY QUOTIENT THAT WOULD RESULT IN SUCCESSFUL AND SATISFYING CAREERS; AND CORPORATES BEING ABLE TO EMPLOY AN EFFECTIVE WORKFORCE OF THEIR CHOICE.

- 1.Making industrial training mandatory for all engineering students.
- 2.Instead of branch specific education system, multi-disciplinary education system should be adopted for engineering.
- 3.Present engineering education be made more industry specific.
- 4.Diploma engineering education be reformed & vocational engineering education system at the workers level be upgraded to standard ten plus two educational level.

- 5. Present four years period may be enhanced to six years period for a combined degree of 'MBBE' at all engineering institutions. The first three years will be for general engineering for all branches of engineering including one month workshop training after first year, two months industrial training after second year & six months industrial training in second half of third year. After three years if some one would like to leave without specialization he may leave with diploma in general engineering only. Others may pursue the fourth year in a specialization branch of engineering. At this stage also if some one would like to leave he may leave with degree in specialized branch of engineering. Others may pursue the fifth & sixth year from now onwards & may be awarded the combined degree of 'MBBE' after sixth year, which means bachelor of management & bachelor of engineering.

- 6. One year internship mandatory for all passing out students so that they get industry exposure before they are handed over their degree of 'MBBE'.
- Presently, engineering or management education in the country is by & large theory based only.
- In order to improve efficiency of engineering & management graduates there is a need to make internship a mandatory part of engineering & management education in the country.
- An MBBS course of 5.5 years include one year of internship, in the same way one year internship also should be there for a 6 year course of MBBE.

Syllabus Of Common Engineering First Year

Paper no.	Subject	Total (M)	Marks(Ist.D)
1	Mathematics	100	66.67 %
2	Physics	100	66.67 %
3	Electrical Engineering	100	66.67 %
4	Heat Engines	100	66.67 %
5	Applied Mechanics	100	66.67%
6	Engineering Drawing	100	66.67%
7	Inorganic Chemistry	100	66.67%
8	Practical's (Phy.& Ino.Ch)	200	66.67%
9	Workshop & Sessional Records Etc.	200	66.67%
10	Civil Engineering	100	66.67%

Syllabus Of Common Engineering Of Second Year

Paper no.	Subject	Total (M)	Marks(Ist.D)
1	Mathematics	100	66.67 %
2	Applied Mechanics, Hydraulics	100	66.67 %
3	Electrical Engineering	100	66.67 %
4	Heat Engines	100	66.67 %
5	Physical Chemistry	100	66.67%
6	Machine Drawing	100	66.67%
7	Organic Chemistry	100	66.67%
8	Practical (Phy.Chem.& Inog.Chem)	200	66.67%
9	Practical (Organic Chemistry)	100	66.67%
9	Workshop Practice & Hydraulics	125	66.67%
10	Sessional Records Etc.	075	66.67%

Syllabus Of Common Eng. OF THIRD- YEAR

Paper no.	Subject	Total (M)	Marks(Ist.D)
1	Economics & Accounting	100	66.67 %
2	Applied Mechanics	100	66.67 %
3	Metallurgy of Engineering Materials	100	66.67 %
4	Practical's (Tech. Analysis)	100	66.67%
5	Industrial Training (Six Months)	100	66.67 %

Syllabus of Fourth(Final) Year Specialised Branch(B.Ch.E)

Paper no.	Subject	Total (M)	Marks(Ist.D)
1	Fluid Mechanics, Storage& Mech. Oprn.	100	66.67%
2	Mass & Heat Transfer Operations	100	66.67 %
3	Heat Transfer , Fuels, Furnaces & M O C	100	66.67 %
4	Processes of Organic & Inorganic Chemicals	100	66.67 %
5	Thermodynamics	100	66.67%
6	Equipment Design & Drawing	200	66.67%
7	Business Management, Org. &Chem. Econ.	100	66.67%
8	Works Construction	100	66.67%
9	Practical (Chem.Eng. Fluid Mech. & H.T.)	100	66.67%
10	Practical (Mass & Heat Transfer Oper.)	100	66.67%
11	Sessional Records Etc.	100	66.67%
12	Project Report	200	66.67%

Khoon Pasina & Practical Training

- First Year:-
- One month hard work in workshops of college namely Foundry, Machine-shop, Carpentry-shop,
- Black-smith which we feel we utilize regularly in our careers .
- Second Year:-
- Two months training in Chemical Industry which we feel any one of us had taken seriously but finished some how or others.
- Third Year:- Six months in some Industry .

Syllabus of fifth year of 'MBBE'

- 1. In first three months of fifth year instead of academia faculties only practicing professionals of that specialized branch should take classes for different subjects with actual case studies & due participation of all the students in different groups .
- 2. In next nine months of fifth year only soft skills such as finance management ,accountancy, project management, investment management, marketing , etiquette, law, table manners, inter-personnel behavior, communication ,production etc. with actual case studies may be taught by academia & practicing professionals only in order to cover theory as well as practical aspects of all the skills.

- 6. One year internship mandatory for all passing out students so that they get industry exposure before they are handed over their degree of 'MBBE'.
- Presently, engineering or management education in the country is by & large theory based only .
- In order to improve efficiency of engineering & management graduates there is a need to make internship a mandatory part of engineering & management education in the country.
- An MBBS course of 5.5 years include one year of internship, in the same way one year internship also should be there for a 6 year course of MBBE.

- At present in our country in developed state like Gujarat, Maharashtra, Rajasthan, Tamil-Nadu, Andhra, MP etc. are having more coaching institutes than schools. This indicates the clear preference of students & parents for new 'gurus' who have supplanted the gurus of classrooms .
- In the age of cut throat competition, studying in classrooms is not enough . Earlier, tuition teachers were a luxury that only rich parents could afford but now they are sought after even by middle & lower middle class parents who burns holes in their pockets to give that extra edge to their wards. By following new system the situation may reverse .

1. Objective

TO GIVE COMPLETE KNOWLEDGE IN SHORT DURATION OF FIVE MONTHS (ABOUT 250 HOURS OF EXPOSURE).TO DIVIDE THE TOTAL COURSE OF FIVE MONTHS INTO FIVE DIFFERENT GROUPS. THIS GROUPING WILL FACILITATE THE PARTICIPANTS TO SELECT EITHER THE TOTAL COURSE OF FIVE MONTHS, IF THEY ARE ABLE TO SPARE THIS MUCH TIME ON A REGULAR BASIS OR THE PARTICIPANTS MAY SELECT THE MONTHLY GROUP OF THEIR CHOICE IN WHICH THEY HAVE MAXIMUM INTEREST AND WOULD LIKE TO ENHANCE THEIR KNOWLEDGE IN THOSE GROUPS.

MONTHLY GROUPS (SUBJECTS)

1. COMPANY FORMATION, COMPANY REGISTRATION, R O C WORK,BANK ACCOUNT,PAN NO., INCOME TAX, F B T , FINANCIAL MATTERS (INVESTMENT AND TAX PLANNING),ACCOUNTING, FEASIBILITY REPORT, PROJECT FINANCING,VAT,CENVAT, PROFESSONAL TAX, MUNICIPAL TAX ETC.

MONTHLY GROUPS (SUBJECTS)

2. COMPANY LAW, FACTORY'S ACT, INDUSTRIAL ACT, LEGAL MATTERS, EXCISE MATTERS, SERVICE TAX MATTERS, EXIM POLICIES(IMPORT & EXPORT PROCEDURES), LOGISTICS MATTERS, COMMERCIAL CONTRACTS DOMESTIC & GLOBAL, INTECTUAL PROPERTY RIGHTS SUCH AS PATENTS, COPY RIGHTS, TRADE MARKS, DESIGN & KNOW-HOW,INTERNATIONAL LAW ETC.

MONTHLY GROUPS (SUBJECTS)

3. HUMAN RESOURCES DEVELOPMENT,PERSONNEL DEVELOPMENT POLICIES, PERSONALITY DEVELOPMENT, BODY LANGUAGE,ENGLISH SPEAKING, COMMUNICATION SKILLS,ETIQUETTE,TABLE MANNERS, INTER PERSONNEL BEHAVIOUR, INFORMATION TECHNOLOGY(I. T. RELATED KNOWLEDGE) ETC.

MONTHLY GROUPS (SUBJECTS)

4. PROJECT PLANNING,PROJECT MANAGEMENT,COSTING AND BUDGETING (UNIQUE PURTA SYSTEM OF BIRLA'S), PROJECT COSTS CONTROL DURING PROJECT EXECUTION, MONITORING AND DEVELOPMENT OF PERFORMANCE CRITERIA ETC.

MONTHLY GROUPS (SUBJECTS)

5. MATERIAL MANAGEMENT, PRODUCTION PLANNING AND CONTROL, PRODUCTION NORMS FOR SMOOTH AND TROUBLE FREE PRODUCTION TO PRODUCE QUALITY PRODUCTS,QUALITY CONTROL NORMS FOR TESTING / APPROVAL, POLLUTION AND ENVIRONMENT CONTROL, MARKETING AND AFTER SALES SERVICES.

Factors effecting the adoption of innovative pedagogical practices using technology: Indian university perspective

By
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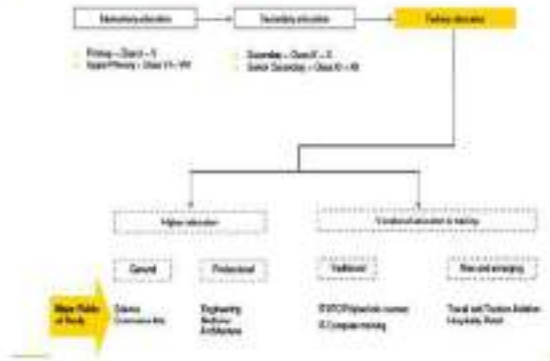
Indian Education Structure

The educational structure in India is generally referred to as the Ten + Two + Three (10+2+3) pattern. The first ten years provide undifferentiated general education for all students. The +2 stage also known as the higher secondary or senior secondary, provides for differentiation into academic and vocational streams and marks the end of school education. In +3 stage, which involves college education, the student goes for higher studies in his chosen field of subject. (http://www.highereducationinindia.com/).

Indian Education Structure



Higher Education In India: Current Scenario

- The Indian higher education system has emerged as one of the largest in the world, in terms of number of institutions as well as student enrolment
- Student enrolment in higher education has grown significantly over the last few years, with engineering being the clear reference among professional courses
- The private sector has played a key role in the growth of the higher education system, especially in professional higher education
- Distance education and vocational training have grown to acquire an important role in India's tertiary education system
- The Indian higher education system suffers from a large rural-urban divide in access, gender inequity, and large differences in GERs in various communities
- **Higher education and vocational training are critical to India reaping the 'demographic dividend' from possessing a young employable population which can not only drive domestic growth to overtake the developed economies but also address global manpower demand-supply gap**

Growth and reforms in Higher education

It is heartening to see that higher education reforms are high on the agenda of the government with emphasis on expansion, inclusion, and excellence as the pillars of higher education.

Lots of key areas have been identified for making the Indian Higher Education system future ready such as Financial Innovation, Innovative Use of Information and communication Technologies (ICT), Reinvigorating Research, Thrust on Vocational Education & Training (VET), and various Regulatory Reforms in education system by the Indian government.

Issues regarding Higher Education

- Though these trends communicate a positive picture, the Indian higher education system ails from significant structural shortcomings and faces huge challenges in meeting future expectations.
- Despite having more higher education institutions than any other country in the world, hardly any feature in the leading institutions in the world.

Issues regarding Higher Education

- Quality of higher education in India is impacted by shortage of faculty and poor infrastructure. However, India's education system is bogged down by the fundamental challenges of access, equity and quality
- In pursuit of better quality education, an increasing number of Indian students are studying abroad

Transformation required in Higher Education

- The need of the hour is to understand the factors that are affecting the growth of the Education in India.
- There is a need to bring a holistic transformation in the Indian Higher Education system such that it is able to sustain the existence in the global knowledge market so India can truly realize the prophesized 'Demographic Dividend'.

Involvement of various stake holders

- Educational change is a compound of complex and dynamic processes.
  - **Involving the transformation of Teachers' Behavioral Patterns,**
  - **Changes in the school's identity,**
  - **improvement of student performance and adaptation to environmental changes.**
- Many researchers deal with the study of factors assisting or inhibiting the success of educational change in general (Fullan, 2001; Kinzler and Gamble, 2002), and specifically with relation to ICT Berman and McLaughlin, 1974; Maloaf and Schiller, 1995; McLaughlin, 1991). Some emphasize organizational aspects and the means by which the organization, the school in this case, prepare itself for the implementation of change in its structure and activities (Underwood and Underwood, 1990; Tyack and Cuban, 1995; Cuban, 1999). Others emphasize the teachers factor and the means by which teachers cope with the demand to change (Lortie, 1975; Leary, 1977; Crotton, 1981; Hall and Hord, 1987). Still others examine the contribution of factors outside the school to the implementation of ICT-based innovations (Venezky and Davis, 2001).

Through the use of Innovative pedagogical practices

It is defined as pedagogical practices that promote active and independent learning processes that provide students with information-handling competencies and skills, encourage collaborative and project-based learning, address issues of equity and redefine traditional space and time learning configurations (Mioduser *et al*., 2003).

Configuration of Factors involved in innovative pedagogical Practices using Technology

Factors effecting Innovative pedagogical practices

Mainly:

- human,
- infrastructural,
- organizational,
- internal,
- external involved in the application of educational innovations using technology.

Human

A major factor in the adoption of change is the Institution **Principal** (Fullan, 1998; Sarason, 1993). Studies found that projects receiving the principal's support were more likely to succeed, since the principal's involvement indicates that the project is being taken seriously, and it helps in recruiting both material resources and psychological support (Marsh, 2001; Berman and McLaughlin, 1977). In addition, the principal or leader of the project supplies the vision, which clarifies the joint goals for the benefit of the staff, and allows resource allocation to be conducted in the agreed directions (Rosenholtz, 1989; Meier, 1995).

Teacher

Teachers are an additional important factor in the introduction of changes in schools. Teachers' resistance may be the result of unsuccessful previous experiences, lack of adequate rewarding, contradictory messages, fear of the unknown and pressure of different interest groups (Fullan, 2001). Therefore, researchers claim that teacher training is a vital component in the introduction of innovation and improvement in institutions (Goodlad, 1991; Sarason, 1993).

Institutional Structure

Without major change in the school structure (allocation of classes and teaching units) and in the learning processes (teaching and assessment methods) no significant change in educational process can occur (Sizer, 1993; Tyack and Cuban,1995).

Vital components of this change are organization of time and space, role distribution, communication patterns among teachers and school policy. In specific relation to ICT, a crucial factor contributing to the promotion of the innovation is the availability of infrastructure resources' hardware, in terms of the number of computers in the school available for students and teachers for educational purposes, and the quality and functioning of equipment (speed of processors, OS-operating systems, peripherals and access to the Internet); as well as available software, general and educational (Yerocky and Davis, 2001).

However, availability of ICT alone is insufficient and must be accompanied by technical as well as pedagogical support (Pelgrum and Anderson, 1999).

Open Organizational System

- Conceiving of the institution as an open organizational system with reciprocal relationships with its surroundings allows for adequate space for external intervention that fosters tendencies of change, even if this is not always very efficient (Gibton, 2001; Scheurich and Fuller, 1995). Among the salient intervening factors are the Ministry of Education, municipalities, academic supervisors and consultants, or private agents (e.g., software houses, educational services suppliers).
- Significant change is becoming more comprehensive and complex over time, with their implementation demanding government involvement, commitment of leaders as well as a large variety of resources. At the same time, these processes often refer to unrealistic timetables, unfit demands, simplistic solutions, and involve unsuitable resources allocation and inconsistency in performance (Fullan, 2001; Gibton, 2001). Hence the importance of systematic attempts to study the generation, development and implementation of educational innovations, with emphasis on the factors affecting these processes.

Recommendations

- The need of the hour is to condition the mind of the youth to work hard, to behave well and adhere to high standards and for this they should be groomed by the parents consistently. while skills can be taught easily attitudes and general knowledge cannot be taught.
- We are required to develop a conducive culture that converts the arrogance in to humanity , the weakness in to strength, desperation to emerging hope. Love and respect to have minimized the conflict and happy minds are enjoying the process as they see their goals being realised .Ultimately the higher educational institutions should functions like finishing institutions.

Recommendations

- The talent crises of the Ph. Ds can be filled by the Industry stalwarts who can offer the breadth of the subject with real life applications and case studies. Thus having strong Industry tie ups.
- Parents can be involved in the loop by informing about their ward attendance and monthly progress and thus brought in loop for the grooming of the students

Technological Innovations in Oil & Gas Industry

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10th National Conference on "Technological Innovations in India– Retrospect & Prospect"

Engineering Council of India, New Delhi

Nov.,2012

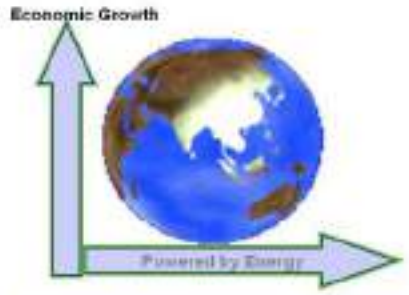
1

Contents

- India's Economic Profile
- Energy Scenario
- Innovation
- R&D - R&D Areas
- Knowledge Base
- Typical Example- CFC
- Conclusions

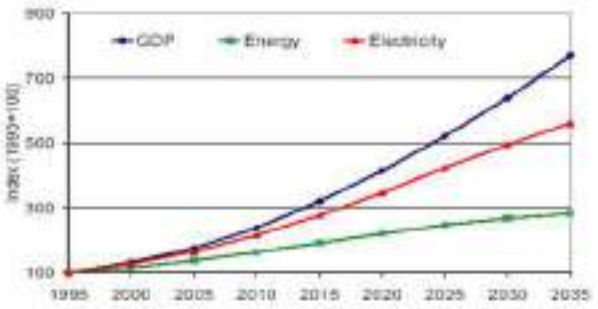
INDIA AT A GLANCE

- 4th Largest Economy of the World
- Skilled Human Capital
- Well Developed Capital Market
- Established Legal and Audit Systems
- Huge Untapped Natural Resources
- Huge Market Potential



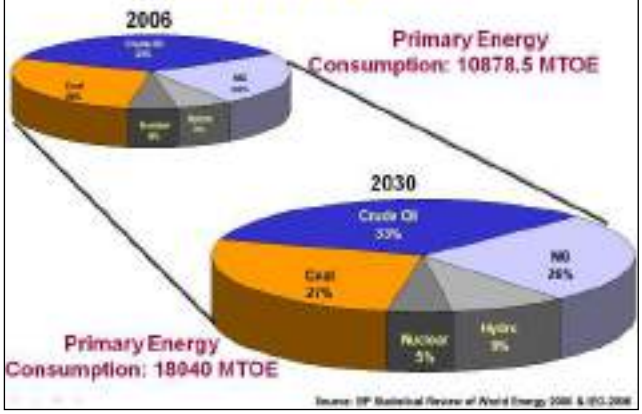
Energy is a Key Enabler for Economic Growth

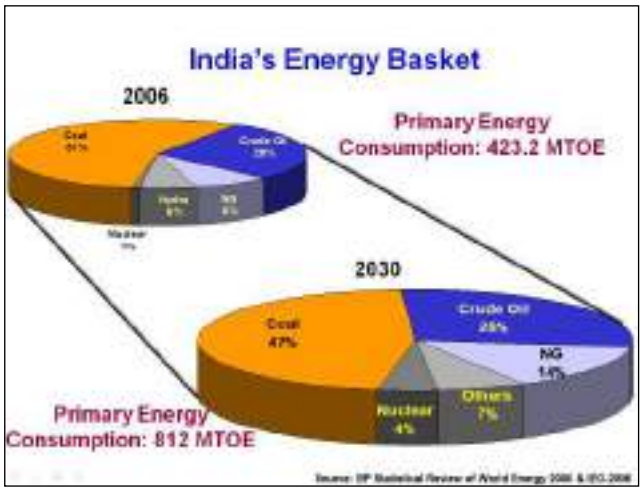
India's Growth Forecast

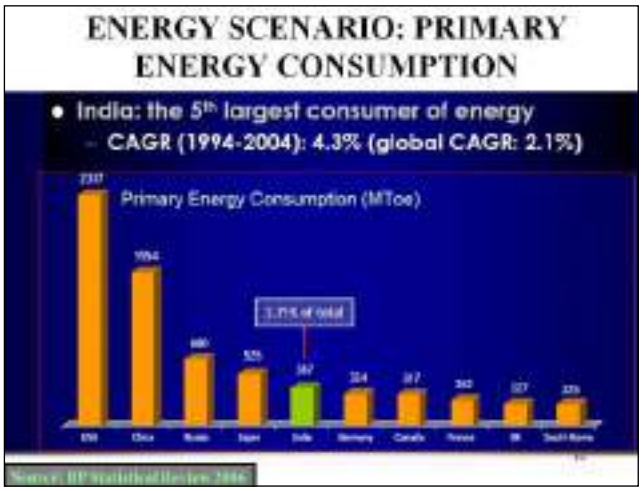


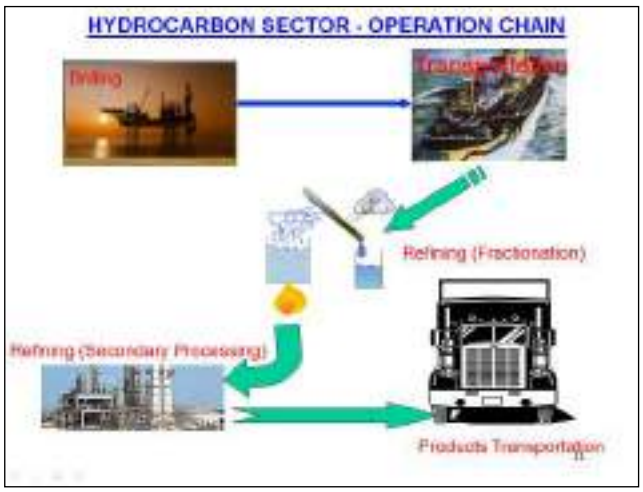
India is a fast growing economy in the region

World's Energy Basket









INNOVATION

- Innovation - derived from the Latin word 'Innovatus' (A noun form of 'innovare' meaning to renew /change)
- Innovation - development of new 'customer value' through more effective products / processes / technologies / services / ideas,etc.
- 'Innovation - ability to see change as an opportunity – not a threat' (Steve Jobs)
- Innovation - rooted in the customer needs

Contd.

INNOVATION

Contd.

- Innovation - differs from Invention
  - Innovation refers to use of better or novel idea / method
  - Invention refers more directly to creation of novel idea / method itself
- Unlike other industries, Oil & Gas industry faces more governmental regulatory requirements - Innovation / R&D requirements (?)

Contd.

Innovation-Major Requirements

- Basic Knowledge
- Experience / Expertise
- Literature
- Mathematical Model/s
- Dedicated & Diversified Teams
  - Expertise in Scientific Research & associated details
  - Expertise with Market Research & strategy
  - Expertise in Innovation process & big picture
- Corporate R&D – A Necessity

Corporate R&D- A Necessity

- Ongoing integration of world economies- Opened up an array of business opportunities & challenges to our corporate enterprises to access new markets on one side and increased competition on other
- Intense competition pushing corporate leaders to increasingly recognize the need to focus to new business opportunities and/or improved products/ processes
- Organizations, world wide have been compelled to make their operations R&D driven and/or to increase focus on their R&D to have improved quality at lower cost
- Despite substantial capacity & capability, our Oil & Gas industry still largely dependent on foreign sources for technical/process know-how, specific plants & equipment,etc.

Corporate R&D- Advantages

Direct Benefits

- CPSEs to have 5% weightage out of 50% for non-financial parameters for R&D activities from year 2011-12
- Weighted 200% deduction from total corporate income on R&D expenditure except land & buildings (for DSIR recognised R&D)
- Tax deduction @ 150% on investments made on sponsored research programs (for DSIR recognised R&D)
- Accelerated depreciation @ 40% for indigenous technology based units
- Improvements in products & processes
- New products & processes

Contd.

Corporate R&D- Advantages

Contd.

Indirect Benefits

- Absorption / adaptation of Foreign technologies
- Technological & business support to enterprise
- Show casing of technological strength to help in building / improving customers' confidence
- Getting further name & recognition internationally through IPR, publications, awards,etc. resulting out of scientific work
- Providing advanced technical training to operating & marketing professionals of the organisation
- Making strong knowledge base with in organisation

Major R&D Areas

Research in Mainstream Technologies

- Seismic Mapping
- Reservoir Management & Enhanced Oil Recovery
- Drilling
- Deep water Exploration
- Refinery Technologies
- Pipeline Trasportation
- Gas Processsing
- Petrochemicals & Polymers

Contd.

Major R&D Areas

Contd.

Research in Unconventional Oil & Gas Technologies

- Shale Gas & Oil
- Coal Bed Methane
- Tar Sands
- Gas Hydrates

Contd.

Major R&D Areas

Contd.

Research in GHGs Emission Reduction Technologies

- Carbon Capture & Storage (CCS)
- Gasification
- Bio-Fuels
- Automotive Enhancements
- Gas to Liquid
- Renewable Resources

OIL & GAS INDUSTRY – DISCIPLINES INVOLVED

- Scale independent
  - Chemistry, Biology, Physics, Mathematics,Geology
  - Thermodynamics
  - Physical Transport Phenomena
- Micro Level
  - Kinetics
  - Catalysis on molecular level
  - Interface Chemistry
  - Microbiology
  - Particle Technology
- Meso Level
  - Reactor Technology
  - Unit Operations, Drilling
  - Scale-up
- Macro Level
  - Process and Technology Development (including Cost Engineering)
  - Process Integration and Design (including Materials Science)
  - Process Control and Operation (including Information Science)

Contacting Device (CFC) for Efficient Sulphur Removal

- Novel and efficient technology for better quality LPG
- Commercialized at various IOC and Non-IOC refineries

Inde Treat / Inde Sweet Commercialization Status

- Commissioned / Under design/construction
  - ✓IOC GR
  - ✓KRL
  - ✓BRPL
  - ✓HMEL
  - ✓MRPL, CPCL
  - ✓IOC, DIGBOI
  - ✓HPCL (VIZAG & MUMBAI)
  - ✓IOC Paradip (Two Units)
  - ✓IOC BR (One Unit)

INDE TREAT UNIT

CFC UNIT AT KRL

INDE TREAT / INDE SWEET

Technological Innovation / Environmental Awards

- ✓ICMA Award (2002 – 03)
- ✓FICCI Award(Research in Sci.&Tech.) (2003 - 04)
- ✓NPMP Award(Creativity & Innovation) (2003 - 04)
- ✓NRDC Award (First Prize) (2006)
- ✓WIPO Gold Medal (2006-07)

Conclusions

- Challenging scenario in Indian Oil & Gas Industry: No single solution for 'Green Fuels' for sustainable Environment and Profitability
- Environmental regulations, Deteriorating Fossil Fuels availability and Higher cost, Tougher Competition ... Liquid Hydrocarbons to remain the major fuel
- Strong Knowledge Base required in Aligning Innovation / Research to Commercial Advantage.
- Innovative conversion processes are being developed to meet the Energy Requirements of the Country.
- Innovative approach & novel cost-effective technologies through continuous R&D efforts: Conversion of challenges into opportunities

Continuous Innovation / Technological Breakthroughs and 'Out-of-Box Thinking' – Necessary for Sustaining Environment and Profitability in O&G Industry

INNOVATION IN INDIA

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To be discussed...

- Innovation
- Entrepreneurship
- Process
- Specialization
- Scope of research in India
- What we have??
- Need to change
- Focus on open source
- Focus on new technology
- Exposure to the outer world

INNOVATION

It refers to

- Renew or change.
- Notion of doing something different.

Needs:

- For development
- For economic growth
- For the progression of human well-being

Entrepreneurship

- Another key to innovate and move towards the growth and development is entrepreneurship.
- Innovation creates new businesses and is the fundamental source of growth in business and industry.
- Both innovation and entrepreneurship requires specialization in particular domain.

"ONLY INNOVATIVE CAN DARE TO BE AN ENTREPRENEUR"

PROCESS

SPECIALIZATION

It refers to the process of becoming specialized in a particular domain of a particular subject.
E.g.
To get specialized in Genetic Algorithms rather than computer engineering.

Important aspect in innovation...

Scope of research in India

It can not be doubted as we have many researchers who have their origin in INDIA.

But ,they are not motivated...

- Scholarships awarded are so less that they do not prefer it to choose
- Research needs funds.

What we have...??

- Its not that we are not having innovativeness but still there is something that is hindering the growth.

Need is to classify them...

Need to change...

Curriculum of 4 years in graduation:

- First year should be generalized based on the stream.
- Second and third year should be domain based/specialized.
- Training period should be of 6 months.

To improve the present situation some steps can be taken :

- Open book tests in internals.
- One Research paper to publish should be mandatory.
- Subjects like 'Operating Systems' ,'Digital Image Processing' should be completely practical.

Focus on Open Source

- To meet the needs and be in tune with the technology and development *'Open Source'* plays an important role.
- It can be added in the curriculum .
- Labs of colleges should be configured such that use of open source software is maximized.

Focus on new technology

- Course that is being offered should have subjects which emphasize on the new and updated technology.
- It helps to be in tune with the world.
- Technology changes at a rapid rate and innovation can only be done when both are synchronized.
- Cloud Computing is also one of the emerging area.

Exposure to the outer world

- To be up-to-date outer world exposure is important.

<u>Industry plays a key role...</u>

- Industry and Educational Institutions should be well connected so that student will know the needs and the requirements .
- Can make students industry ready beforehand.

Innovate for What ?

To Make Money

Or Need Money to Innovate !!

Innovation – Reverse Innovation - Exonovation

What is Innovation

- Innovation, an idea must be replicable at an economical cost and must satisfy a specific need.
- Reverse Innovation - Mexico Procter & Gamble's Vicks Honey Based, GE's MAC 800- ECG – Low Cost exports to USA
- . Concept of Exonovation developed more in IT Sector software (Innovation of others), where the Innovation of Others is leveraged. operational strategy identified by John Seely Brown and John Hagel in 2005
-

Where are the innovators?

- The Scientists with long hair, beard, lost in thoughts !!
- The Scientists in the labs behind boiling Chemicals!!
- A Worker at Plant location !!
- A Jugadu !!
- Young Children !!
- Infect any one – You and me !!

Innovation from Young

- Innovations' from young minds took India by storm; the innovations were pragmatic, sensible and can find wide prevalence in India and across the globe.
- Hopeful of striving to bring them to existence, may be in the future.
- National Innovation Foundation India (NIF), Ahmedabad with Central Board of Secondary Education (CBSE), Society for Research and Initiatives in Sustainable Technologies and Institutions (SRISTI), announced 29 award winners of the IGNITE 2012

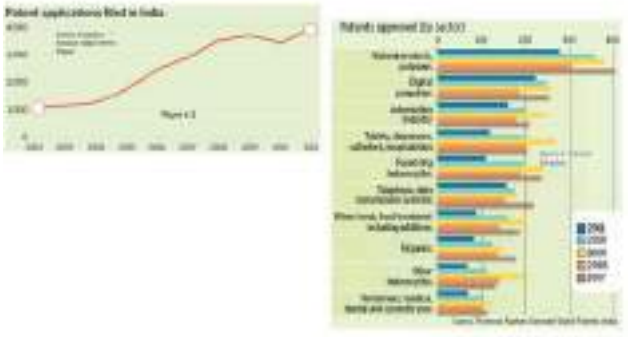
Children's Contribution

- **Gloves with built in Mobile Phones – Snow bound Kashmere.**
- **Blue Tooth Charging of Mobile to Mobile**
- **Spray on gloves and socks** A fast-drying, non-abrasive, water-proof solution filled in a spray can. Just spray on hands or feet to get snugly-fitted gloves or socks & easily peel-off
-

Children's Innovation ...Contd.

- **Preventing driving without a license/valid documents**
- **Headphones with sensors to detect external sounds**
- **Solution for traffic congestion**
- Retractable toilet fitted with sensors
- Modified Paint Brush

India's Patents



India's Innovation Rank

- *India has been ranked the sixth most "innovative" country in the world in multinational conglomerate GE's Annual Global Innovation Barometer for 2012. This study is driven by financial support from public authorities and long-term support from investors.*
- *2,800 senior business executives based in 22 countries voted various countries with 65% votes by the global respondents in favour of US, Germany (48 %), Japan (45 %), China (38 %), Korea (13 per cent) and India closely behind at (12 %) of the global votes.*

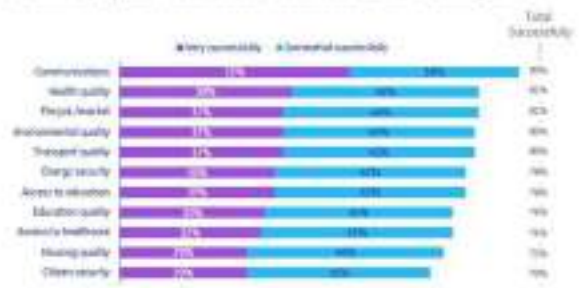
2010 Global Manufacturing Competitiveness Index

Current Rank	Country	Index Score	Rank in 2015
1	China	10.00	1
2	India	8.15	2
3	Republic of Korea	6.79	3
4	United States of America	5.84	5
5	Brazil	5.41	4
6	Japan	5.11	7
7	Mexico	4.84	6
8	Germany	4.80	8
9	Singapore	4.69	11
10	Poland	4.49	9
New add*	Thailand	-	10

Source: Deloitte and US Council on Competitiveness

Innovation and competitiveness

How optimistic business feels that innovation will result in better life (by area)



Recommendations :

The professional associations of Engineers and Technologists like ECI have to keep on reminding and provoking professional members to work on Innovative route for further development in the areas of Technology multipliers to bring in Evolutionary innovations by continuous incremental advances in technology or processes may be numerous small steps in number . The continuous evolutionary innovation should lead to an alteration in product characteristics.

Making the Organizations work together in co-operative environment for the Innovations

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200. Shri S. K. Das, SRM (RT)
IOCL, RND Centre
Faridabad, Haryana

201. Shri S. K. Harinath
Sr. Manager(PDG)
BHEL, EDN, Bangalore

202. Shri S. K. Madan
Consultant, New Delhi

203. Shri S. K. Sethi
Engineering Projects (India) Ltd.
New Delhi

204. Dr. S. Pal
President, IETE
Former Prof. Satish Dhawan Professor,
Senior Adviser- Satellite Navigation(ISRO)
& Distinguished Scientist ,Associate
Director, Chairman GAGAN -PMB &
Programme Director Sat.-Navvigation-
ISRO

205. Shri S. Ratnavel
CEO
Sceba Consultancy Services
Member, Association of Consulting Civil
Engineers (India) & Member, BOG,
Engineering Council of India

206. Shri S. K. Chaudhary
Senior Executive Director (Projects)
Housing & Urban Development Corpn. Ltd
New Delhi

207. Shri Sachin Sori
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Research, Ghaziabad, U.P.

208. Shri Sameer Kumar Jha
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Research
Ghaziabad, U.P.

209. Shri Sandeep Kumar Gupta
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210. Shri Sanjay Goel
Addl. GM
Engineering Projects (India) Ltd.
New Delhi

211. Shri Sanjay Rautela
DGM, Head office
The National Small Industries Corpn. Ltd
New Delhi

212. Shri Sanjay Sharif
MGR, HEAD OFFICE
The National Small Industries Corpn. Ltd
New Delhi

213. Shri Sanjiv Layek
Management Department
Institute of Advanced Management &
Research
Ghaziabad, U.P.

214. Shri Sanjoy Bhattacharjee
CM (Terminal Automation), HO.
Indian Oil Corporation Limited
New Delhi

215. Shri Santosh Kumar
Engineering Council of India

216. Mrs. Sapna Saini
Engineering Projects (India) Ltd.
New Delhi

217. Shri Saurabh Singh
SMSO, Indian Oil Corporation Limited
New Delhi

218. Ms. Shagun Tripathi
Student, Inderprastha Engineering College,
Sahibabad, Ghaziabad, Uttar Pradesh

219. Mrs. Shaheen
Sr. Manager,
Engineering Projects (India) Ltd.
New Delhi

220. Shri Shamim Ahmad
Addl. GM, Engineering Projects (India) Ltd.
New Delhi

221. Shri Shantanu Mishra
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Ghaziabad, U.P.

222. Shri Sharat Chandra Gupta
Ex-IRSE & Retd. Commissioner of Rly. Safety
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Ghaziabad, U.P.

224. Ms. Simpy Madan
Student, Inderprastha Engineering College,
Sahibabad, Ghaziabad, Uttar Pradesh

225. Ms. Sonia Gouri
Applied Science Deptt.
Institute of Advanced Management & Research,
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226. Ms. Sufiyan Ansari
B-Tech. (Student)
IAMR College of Engineering
Meerut (U.P.)

227. Prof. Sumit Goel
IAMR College of Engineering
Meerut (U.P.)

228. Shri Sumit Yadav
Int.M-Tech ETC (Student)
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Ghaziabad, U.P.

229. Shri Sunil Bhardwaj
SM , SJVN Limited

230. Ms. Surbhi Bharadwaj
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Ghaziabad, U.P.

231. Shri Sushil Chaudhary
Consultant & Designers
Jalandhar, Punjab

232. Shri Sushil Kumar
AGM
Engineering Projects (India) Ltd.
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233. Shri T. T. Dines
DGM(Proj.)
Housing & Urban Development Corporation Ltd
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234. Shri Tanveer singh
Student
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Sahibabad, Ghaziabad, Uttar Pradesh

235. Shri Udai Prakash Singh Raghav
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Institute of Advanced Management & Research
Ghaziabad, U.P.

236. Shri Udayan Sen
New Delhi

237. Dr. Uddesh Kohli,
Chairman Emeritus
Construction Industry Development Council, Chairman, Engineering Council of India, and Senior Advisor, UN Global Compact

238. Shri Uma Chandolia
PRO

239. Shri V K Nayyar
Assistant Manager(Retd.)
Delhi Transco LTD.
New Delhi

240. Er. V. K. Anand
Former Director (Projects), NBCC
New Delhi

241. Shri V. K. Chaudhary
R&D
Indian Oil Corporation Limited
New Delhi

242. Dr. V. K. Gupta
Advisor
International Institution of Technology & Management
Ahmedabad

243. Dr. V. M. Mayande
President
Indian Society of Agriculture Engineers

244. Dr. V. P. Appan

245. Shri V. P. Sardana
Noida

246. Shri Vaibhav Gupta
New Delhi

247. Ms. Vandana Singh
PGDM-Mgmt.(Student)
Institute of Advanced Management & Research
Ghaziabad, U.P.

248. Er. Vijay Gupta
Senior Highway Consultant

249. Shri Vijay Kumar Gupta
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250. Shri Vikas Rathore
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Institute of Advanced Management & Research
Ghaziabad, U.P.

251. Shri Vikrant Jayant
DM, BO Noida
NSIC

252. Shri Vinod K. Tyagi
Technical Director
M. N. Dastur & Company (P) Ltd.
New Delhi

253. Shri Vishesh Kumar
PGDM-Mgmt.(Student)
Institute of Advanced Management & Research
Ghaziabad, U.P.

254. Shri Vivek Mittal
FIMA, Founder & Chairman
R. K. Foundation India
Noida

255. Shri Y. P. Chawla
CEO, Skill Enhancement Initiative Consultants and Vice President, Indian Institute of Plant Engineers
New Delhi

256. Prof. Y. P. Kathuria
Dr rer nat
x Visiting Professor
AIT Toyota (J); IITB Mumbai (I)

257. Shri Yograj Singh
Office Assistant
Engineering Council of India

10 Engineering Council of India (ECI)

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

Objectives

The main objectives of ECI are to work for the advancement of engineering profession in various disciplines and for enhancing the image of engineers in the society. To this end, ECI is focusing on quality and accountability of engineers, professionalism and their mobility for delivering engineering services in other countries, with expertise of Indian engineers developed, recognized and accepted at the international level.

Tasks

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

Engineers' Bill

ECI has facilitated formulation of a conscious draft Engineers' Bill for the consideration of the Govt. of India. Which lays down the criteria for the process of registration of Practising Engineers and provide necessary statutory framework for the same. The draft is being processed by the Ministry of Human Resource Development.

Membership

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

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

Board of Governors

Chairman	
Dr. Uddesh Kohli	Chairman Emeritus, Construction Industry Development Council
Vice Chairman	
Shri Mahendra Raj	Past President, Indian Association of Structural Engineers
Treasurer	
Shri Chander Verma	President, International Council of Consultant Chairman, Construction Industry Development Council & Chairman, Indian Society for Trenchless Technology
Members	
Dr. S. S. Mantha	Chairman, All India Council for Technical Education
Shri S. Ratnavel	Chairman of Task Force, Engineers Bill Committee & Promotional Development Committee Association of Consulting Civil Engineers (India)
Prof. S. V. Raghavan	Vice President, Computer Society of India
Dr. P. R. Swarup	Director General, Construction Industry Development Council
Dr. S. Chatterjee	President, Consulting Engineers Association of India
Shri J. S. Deepak	Joint Secretary, Deptt. of Commerce, Ministry of Commerce & Industry
Dr. Jose Kurian	President, Indian Concrete Institute
Prof. D.V. Singh	Member, Indian National Academy of Engineers
Dr. K. S. Rao	President, Indian Geotechnical Society
Lt. Gen. (Retd.) A. K. Puri PVSM, AVSM	Chairman, Indian Institution of Bridge Engineers (DSC)
Shri J. S. Saluja	National Vice President (NR), Indian Institution of Plant Engineers
Dr. V. M. Mayande	President, Indian Society of Agricultural Engineers (ISAE)
Dr. R. Murugesan	President, Indian Society For Technical Education
Prof. Niranjan Swarup	Executive Director, Indian Society for Trenchless Technology
Shri Dileep K. Nair	Chairman, Institution of Automobile Engineers (India)
Shri Vijay Motwani	Chief Engineer, New Delhi Zone-1, Ministry of Urban Development
Dr. Vinita Kumar	Sr. Adviser (Transport), Planning Commission
Shri M. Narayana Rao	Past President, The Indian Institute of Metals
Dr. Surendra Pal	President, The Institution of Electronics and Telecommunications Engineers (IETE)
Shri Ashok K. Sehgal	Member, The Institute of Marine Engineers (India)

Executive Committee

Dr. Uddesh Kohli *Chairman*	Chairman Emeritus Construction Industry Development Council
Mahendra Raj *Vice Chairman*	President Indian Association of Structural Engineers
Chander Verma *Treasurer*	President International Council of Consultants
	Chairman Construction Industry Development Council, Indian Society for Trenchless Technology & Continental Construction Projects Ltd.
Members	
Dr. S. Chatterjee	President Consulting Engineers Association of India
Dr. P. R. Swarup	Director General Construction Industry Development Council
Dr. Surendra Pal	President The Institution of Electronics and Telecommunication Engineers
P. N. Shali	Director Engineering Council of India

Office Bearers of ECI

Dr. Uddesh Kohli
Chairman

Mahendra Raj
Vice Chairman

Chander Verma
Treasurer

ECI Member Associations

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

1. Association of Consulting Civil Engineers (India)
2. Broadcast Engineering Society (India)
3. Computer Society of India
4. Construction Industry Development Council
5. Consultancy Development Centre
6. Consulting Engineers Association of India
7. Indian Association of Structural Engineers
8. Indian Buildings Congress
9. Indian Concrete Institute
10. Indian Geotechnical Society
11. Indian Institute of Chemical Engineers
12. Indian Institution of Bridge Engineers (DSC)
13. Indian Institution of Industrial Engineering
14. Indian Institution of Plant Engineers
15. Indian National Group of IABSE
16. Indian Society for Non Destructive Testing
17. Indian Society for Technical Education
18. Indian Society for Trenchless Technology
19. Indian Society of Agricultural Engineers
20. Institute of Urban Transport (India)
21. Institution of Mechanical Engineers (India)
22. International Council of Consultants
23. The Aeronautical Society of India
24. The Automobile Society of India
25. The Indian Institute of Metals
26. The Institute of Electrical and Electronics Engineers. Inc.
27. The Institute of Marine Engineers (India)
28. The Institution of Civil Engineers (India)
29. The Institution of Electronics and Telecommunication Engineers
30. The Institution of Surveyors