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Future of Engineering

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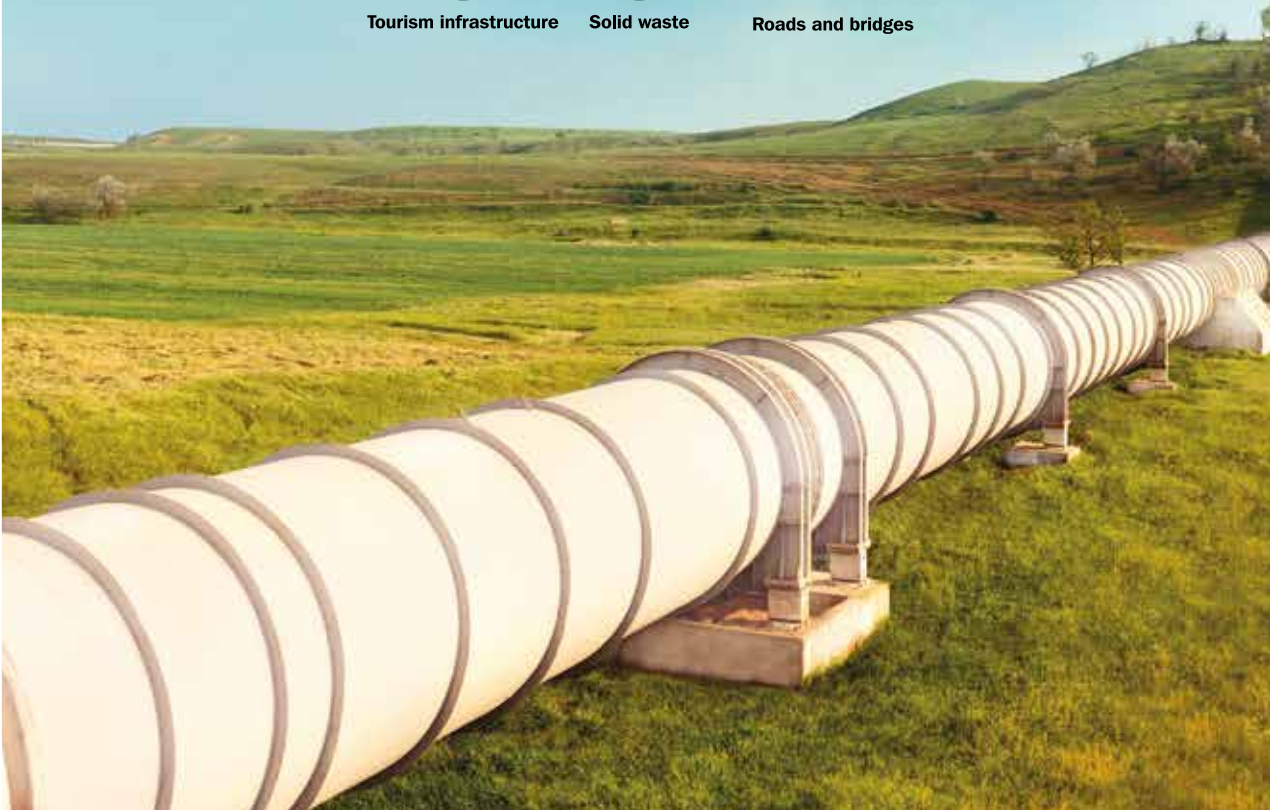
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SHAH TECHNICAL CONSULTANTS PVT. LTD.

Mumbai

#407, Raheja Centre,
Nariman Point, Mumbai – 400 021.
+91 22 22871061 | stc@stc.co.in

Chennai

Old No. 43/2, New No. 24/8,
Vijayaraghava Road (Adjacent to Andhra Club),
T. Nagar, Chennai – 600 017.
+91 44 28150573 | stc.chennai@stc.co.in

Jaipur

#32, Lions Colony, Opp. Morani Motors,
Sitabari Tonk Road, Jaipur – 302 018.
+91 141 2552981 | stcjaipur@stc.co.in

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MESSAGE FROM CHIEF EDITOR

Dear Fellow Consulting Engineers,

The country has a government with a good majority. It is therefore up to the Engineers now to put forth their views and suggestions for the consideration of the authorities concerned. These should encompass all the branches of hardcore engineering while linking them to the ubiquitous digitization. The latter is essential to reduce the mundane work but must be used judiciously for complex work. The major disciplines of engineering have spawned multiple specializations and many of them are involved as a necessity as projects become bigger, complex, spread over large areas and even divided into phases.

When one sits back and thinks as to what the future would be, then that implies little planning and control; more of a submission to happenings in and around ones welkin. However, if one contemplates as to what the future ought to be, then it implies that one is in control and guides the way. That's what Engineers ought to be – the torch bearers of the Nation's tomorrow.

The canvas is very large so only a few areas which impact society and the nation are addressed.

The most important is Engineering Education. The intent of education is to *inter alia* develop the mind and the thought process of the student and in a professional education like engineering to be able to think rationally, logically and analytically. That would prepare the student to tackle and solve any problem that the student may have to face in the course of practicing the profession. Engineering is an applied science whereas technology per se teaches one by delving into why and how of all concerned. That was the reason that the Indian Institutes of Technology were established – to create technologist and not merely engineers. However, over the course of time that founding principle has got way laid and the IITs are inculcating students in the same manner and with the same contents like any other engineering college. That is a path that needs to be corrected and brought back on track. Only then would India have engineers who would be knowledgeable to fulfill the nation's dreams.

Moving on to the engineering disciplines, the Aviation sector needs proper planning and monitoring so that cases of airlines flying into the dusk do not repeat in this business sector. Engineering wise that would mean better conceptualization of new aircrafts to obviate cases like the Boeing 737 Max. It would also mean improved routine and preventive maintenance of not only the aircraft but all facilities at all airports, and better engagement with the passengers for safer and comfortable travel. Charging ports for devices on each seat plus Wi Fi during the flight would

be routine in the future. Check-in baggage would also be automated and eliminate long queues.

Agricultural engineering is essential for survival. Organic farming to be given greater thrust so that manmade illnesses are curbed. Use of drones for large collective farm areas would be encouraged. Measuring instruments to determine the manure content of the soil would be provided in each village so that natural fertilisers and pesticides would be disbursed when necessary and in a controlled manner.

Civil engineering sector is by far the largest and most widespread, affecting ones everyday lives from the homes that one lives in, the office or factory or plant that one works in, the roads, the rail, water supply, waste water collection and disposal, etc. that one uses. Sustainable and long lasting habitation with a 100 years design life would be mandatory. In fact any and all type of construction would be for a minimum 100 years of design life albeit keeping sustainability in mind. Automation for safety and security plus optimizing of electrical power consumption would be incorporated as a defined requirement. Added to that would be the 24 hours supply of pressurized potable water and coupled with it the waste water collection and disposal with proper treatment. Extraction of water for potable purposes would be controlled with greater emphasis on rain water harvesting. Near farm areas the waste water would be used for agriculture after ensuring that it has no chemicals, etc. that are banned from entering the food chain or even capable of causing harm in any way. All treated water would be used for industrial and horticulture purposes. Assured power supply would be a given with no interruptions, since 100 percent uptime for automated systems would have to be guaranteed. Transportation also affects daily lives and is necessary for the economy to survive and grow. Sustainable modes, less dependent on fossil fuels and more on renewable ones would be the order of the day. Autonomous vehicles could see the light of day in extremely regulated and disciplined traffic, hence that's the challenge that countries like India would face. The people would have to learn to abide by a set of inviolable our code or rules of movement and behaviour outside their home, office, factory, plant, etc. Waterborne transport systems would be more prevalent in the country. They would be cheaper and carry more volume than that done by road or rail or air. Interlinking of rivers by means of canals or tunnels would enable drought areas to be provided with water apart from recharging the ground water and be a means to generate vegetation.

Pollution – all elements of nature from the depths of the oceans to the top of mountains are being stressed to the limit – plastic pollution (macro and micro) is ubiquitous. The seas would need to be filtered of the muck that mankind has created over the ages and then pledge not to let that happen again. It would a herculean task and need a lot of planning and agreement by all countries.

Electrical engineering brings to mind power supply. It is now an essential requirement of life. The fossil fuel sources would in time give way to renewable sources such as wind, solar, tidal, geothermal, run of the river hydro plants, and of course nuclear. On grounds of reliability, nuclear power would become the main source. Instrumentation and Control, which is now more commonly understood as automation, would become more pervasive and with digitization would become far easier. All communication is now in digital mode only and as chips become smaller but faster the devices would shrink to the size of wrist watch, with voice commands and virtual imagery to operate them.

Mechanical engineering would still be providing the prime movers but their size would tend to reduce. With nuclear power replacing fossil fuels, plant and equipment would be more efficient and reliable. They would also be easier to operate and be cleaner with the use of better nano lubricants.

Chemical and Metallurgical engineering which form the backbone of material science would keep introducing new materials – more fit for the new the world.

Bio-engineering would advance to great extents and be able to provide body parts made of nano materials thus making organ failures history.

The above are some thoughts on where “**Future of Engineering**” would be. The issue has papers which reflect the desires of engineers in different sectors.

After all that hard core professional projection of concepts, ones thought goes back to the status of the Engineer in society. It is still not a legally recognized profession. Hence, for the good of the society and the nation in order that engineers recognize their responsibility and accountability and also have a professional body to resolve and regulate the practice of engineering, **Legislation for Engineers** is essential.

Happy Reading and Learning



A P Mull

FUTURE OF ENGINEERING - THE INDIAN PERSPECTIVE



Amitabha Ghoshal
Chief Advisor to the Board of Directors
Stup Consultants Pvt Ltd
President CEAI

PREAMBLE

Human civilization has developed slowly, and systematically, over the ages. However, at certain times in its calendar, there had been quantum jumps, that have moved humanity with a jolt, but always forward.

The earliest such event had been the ability to light up FIRE and control the same. That made humans distinct from animals – they acquired the capability of making bricks out of clays, metals from ore, tools from metals, and eventually weapons.

The next big break was development of AGRICULTURE - that changed humans from nomads to settled resident groups. The changes were revolutionary from social and economic angles. Families developed, ownership of land and property followed, humans had leisure to develop art, culture, literature, science, and all that are valued today as civilization.

The next game changer was the INDUSTRIAL REVOLUTION. Starting with the modest Jenny's Wheel and the Steam Power, human life became altogether different. Steam power was soon followed by development of the Internal Combustion engines that used oil, and then electrical power, that revolutionized the way humans live and develop. There have been spurt of inventions and utilitarian technology development, that still continues.

Engineering science and technology development have been following closely on the heels of development of science and knowledge, throughout this continuously changing scenario. The Industrial Revolution made engineering an essential feature of human life. Today engineering science encompasses all aspects of human life and is now deeply entrenched in ensuring sustainable development with limited resources.

Today, we are in the throes of one more disrupting stage of technology development that started with the use of Electronics and gained strength with the spread of Digital Technology. New developments like Artificial Intelligence, Machine Learning, Internet of Things, use of Nano Materials and focused use of Big Data are rapidly changing the way of life.

Engineering science and its uses will create major changes and the present generation of engineers need to prepare for these oncoming changes and make the younger professionals aware, ahead of their onset. In this paper the intention is to examine this situation in the Indian perspective and device future strategy.

NEW CHALLENGES FOR ENGINEERS

One of the biggest challenges for humanity today stems from the happy fact that in the last two hundred years, the population has grown manifold to seven billion, thanks to the technological advances, and much of that is contributed by engineering achievements. Availability of safe water, vastly improved sanitation, improved living condition, safe and reliable communication, faster spread of technological inventions and dispersal of knowledge have all contributed to this accomplishment. However, enhanced lifestyle by a larger population has depleted natural resources at a rapid rate and the same people are looking at a forthcoming shortage of many of the earth's resources, including Energy, potable water and building materials.

The redeeming feature is that the new technological developments are aimed towards reversal of this climate of crisis. Some of the sectors are examined and the positive gains, the new developments can offer are analysed.

TRANSPORT INFRASTRUCTURE

The Transport sector offers the most visible benefits of new technological developments. Commercial production of Electricity driven Vehicles (EV) have started in the country as well and eyebrows are not raised when EV buses are seen on the roads. Change over to EV from liquid fuel vehicles is a Big Bang change for country like India, which have to import fuel and with rapid growth of Road Transport, are facing massive environmental issues in urban as well as rural areas. The infrastructure for servicing such vehicles is not yet in place but this handicap would soon be removed. Apart from saving on fuel and reduction of pollution, EV s are lighter on maintenance cost, as they need much fewer parts to make a car, compared to the conventional vehicles.

The next logical development in road transport sector is the Automated Vehicles (AV), which are already in restricted use in many developed countries. Canada is using streams of automated cargo vehicles in the petroleum sand fields in Alberta, much like trains of wagons used on rail tracks. The sensors allow the vehicles to move at a clear gap of 5 to 10 cm and also allow vehicles to be laterally close to each other, raising the capacity of the Roads manifold.

Chances of accidents are reduced and safety on roads assured with elimination of human error. AVs are going to make major impact on use of cars and even social behaviour. Ownership of cars would reduce, transport would become a service, there would be savings on time with parking and garage needs eliminated. Most of the states in US and countries like Singapore have permitted use of AV s on road on trial basis and restrictions are being liberalized.

AV may arrive in India sooner than being planned and may catch everyone unprepared. Engineers would have to get trained on the myriads of issues that would need



Automated Vehicles (AV)

to be tackled with this modal change. Bridges safe by today's Codal requirements would prove unsafe with the intensity of vehicles going up. Sensors would have to be accommodated as road furniture and the present system of traffic control would lose relevance.

Research and follow up development of technology is well ahead in the areas of sensors, mapping, data capture, simulation and validation equipment in developed countries - India needs to catch up. The unfortunate thing is that awareness programs for such forthcoming technologies have not yet started, whereas in developed countries conferences on such subjects have become routine. Far Infrared (FIR) technology capable of detecting and classifying all living and non-living objects in the surroundings of an AV is well ahead in developmental scale, for solving the challenges to use of AV together with non-AV traffic.

Disruptive changes are taking place in the Maritime industry with the exploitation of Autonomous Vessels. Deep-Water search has been revolutionized by use of autonomous vessels. Navies across the world are using the technology for mine countermeasure tasks. Unmanned maritime systems are reducing cost of remote inspection and operations in offshore oil and gas industry. The challenge now is to achieve safety levels equivalent to manned conventional ships and develop operations inside congested port areas.

In the Aviation sector, people are getting accustomed to see use of AI in operating the drones that are doing multiple tasks. The potential of this technology is very wide-spread in different sectors of human use, like delivery of medicine and food to isolated areas, communication, responding and reaching help after disaster and the like. Further development would lead to use of Personalised Air Transport (PATs) that would complement civil aviation in a big way.

Another major innovative mode of transport infrastructure is looming in the use of HYPERLOOPS. Hyperloops are an underground transport system where vehicles are moved in a near vacuum atmosphere inside a large tunnel, at a high speed with least aerodynamic resistance. Trial tracks are already operational in Europe and UAE, and reports so far have been positive. It is interesting that NITI AAYOG and Ministry of Transport are examining the potentials of this revolutionary mode of transport for its suitability in the Indian condition. Awareness, among the technocrats, needs to be much more.

The exact calendar, of such innovations getting in regular use, are always uncertain, but preparations in good time are a must, so as not to be left behind as a nation. The universities and academic societies in developed countries have already prepared future development plans, like the School of Engineering of MIT, USA has published *'The global*



Hyperloops

state of the art in Engineering education' and the American Society of Civil Engineers (ASCE) has brought out, '*Achieving the VISION for Civil Engineering in 2025*', in 2007. They have set their road map ahead. Indians have to do the same in their centres of academic excellence and by bodies like CEAI and IEI.

POWER SECTOR

Very major changes are happening in this sector for India. India had been dependant on power generation from fossil fuel, and that also based primarily on locally available lower grade of coal with high ash content, creating environmental hazards. Development of Alternative Energy had been restricted to Hydro and Nuclear power, together contributing small percentage of the total need.



Adani Solar Plant at Kamuthi, Tamilnadu

Solar power development has, of late, got a positive spurt with the development of Concentrated Solar Power (CSP) that allows sun's energy to be collected with focused mirrors enabling suitably located turbines to be operated. This is proving to be more efficient to the earlier Photo Voltaic (PV) cells and can make Solar a viable long term option to fossil fuel, with further developments in storage technology.

It is estimated that with available technology, the entire need for USA could be met, by setting up a solar farm in the desert areas, of the size 100 miles x 100 miles. It is understood that Indian government has identified and reserved a land area of 3,500 sq km in the Thar Desert for setting up a solar farm capable of generating 1,000 Giga Watt. In India, with plenty availability of sun for most part of the year, it should be possible for communities to set up their own solar farm for generating power to meet their needs. One of the world's largest solar plants, for generation of 648 MW of clean energy, has been set up by ADANI Green Energy in Tamil Nadu.

For a country like India, that spends almost all its foreign exchange earnings in importing petro products, substantial part of which goes towards meeting energy needs, development of alternative power is an important necessity. Government has targeted achieving 40% of its cumulative electric power capacity from non-fossil fuel sources by 2030. The interim target is to produce 100 GW of solar power by 2022. Even if the targets are not met fully, the demand on engineers towards their fruition is going to be very high.

There are requirement of many areas of dedicated input by engineers for making these plans successful. While researchers are still busy in innovating and improving storage system for power produced intermittently, there is scope for engineers to improve on proven methods like Pump Storage. Change in systems for distribution and networking of grids are going to provide challenges.

There would be gradual phasing out of existing fossil fuel power plants, and reuse of those infrastructures and the assets would be a demand on the engineering capabilities.

Development of solar power across the shoreline of the country could lead to another important benefit. It is widely realised that the world would soon run into shortage of potable water requirement for the growing population. Availability of adequate power on the ocean shores would open up the potential of desalinating sea water and use it for human needs. Technology for this process is already in hand and the requirement would be one of engineering to meet this massive need. Availability of water would be a boost for developing organised agricultural firms in lands, earlier considered unproductive-- and that would take care of the problem of feeding the billions.

USE OF NANO TECHNOLOGY

Use of Nano technology is already prevalent in the Industry, world-wide, and new developments are taking place on a continued basis.

One of the major problems in the construction industry is the depletion of Earth's natural resources that affect sustainability. Use of Manufactured Nano Materials (MNM) could advance the efficacy of construction materials like stone, sand, cement and steel by enhancing their structural properties, and also physical properties like resistance to corrosion.

Use of Nano materials can improve the strength, fluidity and durability of concrete, an often used construction material and thereby reduce total consumption, and also deterioration after construction. Use of Nano particles can alter physical properties of steel, another material of multiple use, and change its corrosion resistance as also improve ductility and thereby augment fatigue characteristics.

There is limited work going on in our country, for use of Nano technology in engineering field and this is an area where more emphasis is necessary, both in research and in engineering use.

THE FUTURE OF ENGINEERING – IMMEDIATE EFFECTS IN INDIA

Based on the present state of knowledge and the development around, one can see that despite slow movement of our economy there would be changes.

- There would be great changes in the way engineering is done. Unlocking of the potential of technology and digital engineering would get faster with the implementation of Building Information Modelling (BIM). In the increasingly digitized environment, all the decision making should be faster.

There would be a shift towards assessment of Life Cycle Cost in place of Capex and Opex for the purpose of prioritization.

Use of Artificial Intelligence, faster communication and improvements of communication technology would enable all design and planning jobs to be done more accurately and yet faster.

- Very major changes would take place in the power sector infrastructure. With increasingly greater emphasis on alternative energy generation, near the usage point, the transmission and distribution network would shrink and be of totally different configuration. The existing plants of conventional build would need to be tapered off gradually.
- Building planning would have to be changed to accommodate stricter green building norms.
- Problems of pollution and environmental degradation may be somewhat addressed with the shift to alternate power source and use of Electricity driven Vehicles. Emphasis would be more on long term effects of Climate Change, as have already taken place.
- Remodelling of roads and highways would be taken up to make them compatible with the gradual increase of EV and automated driverless vehicles. Road furniture's responsive to vehicle sensors would be installed. Pedestrian pathways and crossings would have to be generated as carriageways would become totally inaccessible for them.
- Emphasis would be on desalination of sea water for generation of potable water in the coastal areas. Water transmission mains would have to be built for supply of water to urban areas away from sea coast.
Treatment of water would benefit from application of Nano technology.
- Changes in construction technology with application of Nano materials would have to be understood and documented. Changes in codes and specifications would be a challenge during interim period. Extensive training and education would need to be organized during this period.

CONCLUSION

Prophesies for the future are always fraught with uncertainties. New developments, and any slippage with ongoing research, can affect well intentioned projections.

Every rosy hope may not be fulfilled as imagined. Many such game-changing developmental researches are stalled to satisfy the commercial interest of the then Industry leaders, specially when they bring relief to the economically weaker section or emerging countries.

During the intermediate stage, when conventional power would still be used for running EVs, there would be considerable waste generation. However, may be with little more time a brighter dawn would emerge for the world.

Despite such uncertainties, it is important for planners to foresee the future and make appropriate provisions in planning. Investments in infrastructure are massive and, therefore, greater caution needs to be in place for proper assessment of the future needs. Inability to read the future has proved to be disastrous for well managed and financially successful organisations like AT&T (for not being able to foresee the success of mobile phone) and NOKIA/ BLACKBERRY (for not moving to Touch Phones). Similar experiences are rife with Nations as well. It is therefore prudent to analyse the future based on happenings in the past and the path breaking developments happening around. It is hoped that the positive predictions would be well utilised.

FUTURE OF ENGINEERING IN INDIA



Pradeep Chaturvedi, FNAE, FIE
Chairman
Inter Disciplinary Coordination Committee
The Institution of Engineers (India)

‘Future of Engineering’ needs to be considered at all levels by engineering professionals and organizations. The Consulting Engineers Association of India deserves compliments for taking the lead and discussing it in View Point. This also comes at a time when The Institution of Engineers (India) {IEI} is entering its Centenary Year which shows that the engineering fraternity as a professional society has come of age. As most of the Members of the CEAI are also Members of IEI, there is a common linkage and the inputs from one organization will certainly be of value to the other.

Future of Engineering has always been the center-stage of development. The global effort is now being focused on Sustainable Development Goals 2030. That means the engineers have the opportunity to link their efforts with the global development goals to be achieved in about a decade from now. It is necessary to envision the future and to predict the role that engineers would play in the future. The exercise on future of engineering should also be intended to provide a framework that could be used in subsequent work to position engineering education in India for what lies ahead, rather than waiting for time to pass and then trying to respond. Some other professional groups have similar efforts underway. To name the two major organizations in India - the Indian National Academy of Engineering and The Institution of Engineers (India) are engrossed in creating scenarios for the future. The Consulting Engineers Association of India has a unique opportunity to be a part of this total exercise in the field of engineering and develop operational strategies for the growth of its clients or stakeholders and in turn create its brand “as the organization which through its consultancy efforts can reach out the emerging knowledge for the wider benefit of the society, obviously on professional lines”. CEAI will have to consider the issues with respect to all diverse branches of engineering and examine them from the broadest possible application perspective. The changing scenario in manufacturing and services due to automation, artificial intelligence and robotics is shifting the focus from undergraduate engineering education to technician level and Post Graduate education. With rapid advancements in artificial intelligence there will be a major shift where men and machinery interface will grow taking away a large number of jobs of repetitive nature requiring little intellectual input from graduate engineers. Technician level knowledge will be sufficient as the other part will be taken care by intelligent machines; and the highly intellectual knowledge application will be handled by postgraduate and doctorate level engineers.

Developmental scenarios for infrastructure as well as the industry and services are changing at a very fast pace. Gone are the days when infrastructure development could be supported at a low growth rate and still expect a high GDP growth from the industry and services sector. As the topic is being discussed at a time when the new government has just come in, there is an opportunity for the Consulting Engineers to reflect, develop and present a framework to the policymakers so that future government ‘policymaking’ and ‘strategy development’ can benefit from the practical experience and the thinking of the Consulting Engineers. Governments do not decide policies in isolation. The bureaucrats and professionals in Government Ministries and NITI Aayog create scenarios on the basis of information

available to them. If the engineering fraternity, and especially the Consulting Engineers, can take the lead then their view - point would reflect in the future policies.

LINK FUTURE OF ENGINEERING TO NATIONAL DEVELOPMENT THRUST AREAS

A discussion on Future of Engineering in India should be linked with areas of focus for future growth of the country. There is no point in trying to cover everything on the earth and distribute our resources thinly. Rather, it is necessary to first identify the areas of development that are crucial for sustainable socio-economic growth of the country. While considering the future focus areas, and, subsequently the engineering education to match those requirements, it is also necessary to consider whether the engineering education proposed is in keeping with the technological changes. One sample can be considered that whereas most of the control systems have now moved from pneumatic and mechanical to electronic based systems, the engineering curriculum and text books still provide details of those control systems since they are still widely used in the lesser developed parts of the country.

The select focus areas of development in the country could be defined as:

- i. High speed freight movement.
- ii. Connectivity through highways and other transportation systems.
- iii. Development of cities – impact of smart cities.
- iv. Integration of Automation and Artificial Intelligence (including control systems) in industry and in infrastructure.
- v. Robotics in manufacturing and service sectors.
- vi. Decarbonization in major sectors like cement, steel, and civil aviation.

Opinions may differ and experts may present different sets of focus areas of development in the country. By-an-large these are the areas that have been identified by experts in recent discussions. These are also the areas which open new avenues for the Consulting Engineers to contribute.

CONCERNS OF CONSULTING ENGINEERS

Let's consider what all is necessary for the engineers from the consulting community to focus so that they can present themselves ahead of engineers and professionals from the industry and services sectors to whom they would be providing their consultancy services. The Consultants need to be thoroughly aware and be willing to discuss the impact of connectivity, globalization, digitization and artificial intelligence on work, skills, incomes and growth. Whereas on one hand wealth creation at the top would be the first priority for the business and industry, India would still have to consider as to how poor people can be pulled into what is normally termed as the middle class. The idea here is to eradicate poverty and pull as large a number of persons out of the poverty into the next stage of middle income group. Focusing on engineering interventions in Corporate Social Responsibility (CSR) could be a low-cost option of promoting inclusive growth.

It is extremely necessary to focus on the industry to tell them as to how to operate like a technology company. To stay ahead of digital disrupters, companies need to create cross-functional platform teams. The companies will have to take action to create new work culture and bring around operational changes.

The perspective of 'engineering practice' and 'engineering education' needs to be considered in the global context

and not only in the Indian context. There have been lots of discussions about qualitative and quantitative growth of engineering education but the whole process has moved in a sinusoidal wave only. Going by the number of committees set up by the Ministry of Human Resource Development, it would appear that the planning in the education system, as a whole, and, especially Engineering Education has been undertaken without studying the future market. The result has been a sudden mushrooming of engineering colleges in private sector churning out students who were offered jobs at meager salaries, thereby subjecting lakhs of engineering graduate to traumatic hardships which has been and is unbecoming of the profession. It has also led to the sudden shut down of many engineering colleges. A look at the budget proposals from 1919-1920 brings out the fact that there have been low increments in budgetary allocation for Education as a sector.

Under these circumstances the engineering fraternity has to still develop a statement of aspirations for the engineers of 2030 and identify attributes considered suitable for the engineer of 2030 that match the aspiration. The engineers have to live with bold optimism for the engineering profession if they are willing to confront the possibilities in the future and prepare for that.

ATTRIBUTES OF ENGINEERS

The word engineer has its roots in the Latin word ingeniator, which means ingenious, to devise in the sense of construct, or craftsmanship. Several other words are related to ingeniator, including ingenuity.

Many of the key attributes of engineers in 2030 would be similar to those of today but made more complex by the impact of more complex requirements, new technology and the most essential need - sustainability. In reviewing these enduring attributes for engineers, the Engineering Academies worldwide have also identified the essential characteristics that connect engineering's past, present, and future. As with any profession the experts recognize the imperative to 'remain flexible' and to 'embrace necessary changes that allow for constant success'.

The National Academy of Engineering has framed certain guiding principles that would shape engineering activities, as follows:

- The pace of technological innovation will continue to be rapid (most likely accelerating).
- The world in which technology will be deployed will be intensely globally interconnected.
- The population of individuals who are involved with or affected by technology (e.g., designers, manufacturers, distributors, users) will be increasingly diverse and multidisciplinary.
- Social, cultural, political, and economic forces will continue to shape and affect the success of technological innovation.
- The presence of technology in our everyday lives will be seamless, transparent, and more significant than ever.

Engineers in 2030 would possess strong analytical skills. At its core, engineering employs principles of science, mathematics and domains of discovery and design to a particular challenge and for a practical purpose. This would not change as the world moves forward. The core knowledge base on which engineers develop products and services may shift as technologies involving the life sciences, nano science, optical science, materials science and complex systems become more prevalent. Besides, information and communications technology would be embedded into virtually every structure and process and vital to the success and usefulness of all engineered products. Just as important would be the imperative to expand the engineering design space such that the impacts of social systems

and their associated constraints are afforded as much attention as economic, legal and political constraints (for example, resource management, standards, accountability requirements). Engineers would also concentrate on systemic outcomes in the same ways that focused outcomes are considered. Even though the scientific knowledge that defines operating principles is expected to be more fluid and more complex, the core analysis activities of engineering analysis and design – establishing structure, planning, evaluating performance and aligning outcomes to a desired objective – would continue.

Engineers in 2030 would exhibit practical ingenuity. Engineering would be synonymous with ingenuity – skill in planning, combining and adapting. Using science and practical ingenuity, engineers identify problems and find solutions. This would continue to be a main stay of engineering.

As digital technology continues to increase in complexity and the world becomes even more dependent on it, the magnitude, scope, and impact of the challenges that the society would face in the future are likely to change. For example, issues related to climate change, the environment, and the intersections between digital technology and social, public policies are becoming increasingly important.

Creativity (invention, innovation, thinking outside the box, art) is an indispensable quality for engineering, and given the growing scope of the challenges ahead and the complexity and diversity of the technologies of the 21st century, creativity would grow in importance. The creativity requisite for engineering would change only in the sense that the problems to be solved may require synthesis of a broader range of interdisciplinary knowledge and a greater focus on systemic constructs and outcomes.

Communication skills would be important for enhancing good engineering. Multiple stakeholders – government, private industry and the public – are continuously engaged with engineering process. In future, the parties that engineering ties together would increasingly involve interdisciplinary teams, globally diverse team members, public officials and a global customer base. The future world may see communication being enabled by ability to listen effectively as well as to communicate through oral, visual and written mechanisms. Modern advances in technology would necessitate the effective use of virtual communication tools. The increasing imperative for accountability would necessitate an ability to communicate convincingly and to shape the opinions and attitudes of other engineers and the public.

Engineers who master the principles of business and management are rewarded with leadership roles. A study of qualification of directors of hundred top leading listed companies in Bombay Stock Exchange, 3 years back (in 2016), showed that the largest proportion of directors were with engineering qualification. This would continue to be the shape of things in the future. Involvement of engineers in business and management would be the major concern of CEAI, and therefore it is necessary to focus on this aspect. However, with the growing interdependence between digital technology and the economic and social foundations of modern society, there would be an increasing number of opportunities for engineers to exercise their potential as leaders, not only in business but also in the non-profit and government sectors. Policy decisions in technological societies would demand the attention of leaders who understand the strength and limits of science and technology. New levels of sophistication would be needed as choices - that affect physical, human, and political infrastructures and decisions that define priorities and objectives for a community, region, or mission - are made.

In preparation of the opportunities, engineers must understand the principles of leadership and be able to practice them in growing proportions as their careers advance. They must also be willing to acknowledge the significance

and importance of public service and its place in society, stretching their traditional comfort zone and accepting the challenge of bridging public policy and technology well beyond the roles accepted in the past.

Strong leadership ability necessitates mastering a working framework upon which high ethical standards and a strong sense of professionalism can be developed. These are to be supported by boldness and courage. Engineers would have to develop a culture which involves dynamism, agility, resilience and flexibility. This is necessary as the technology would change quickly, and the social – political – economic world in which engineers work would also change continuously. This, in other words, is developing a culture to learn new things quickly and the ability to apply knowledge to new problems and new contexts. In this context the engineers would have to be lifelong learners and there can be no break in Continuous Professional Development (CPD). They would have to adopt the Continuous Professional Development culture as they would have to take on many more directions – directions that include different parts of the world and different types of challenges that engage different types of people and objectives. An engineer would have to learn not just about engineering but also about history, politics, business and so forth.

CONCLUSION

The Engineers in 2030 would have to work under extremely demanding situation where they would be expected to assume leadership positions from which they can serve as positive influences in the making of public policy and in the administration of government and industry. Engineering profession would have to effectively recruit, nurture, and welcome unrepresented groups to its ranks. They have to undergo engineering education and skills development programme for preparing them for the future. The engineering educators and practicing engineers would have to work together and undertake pro-active efforts to prepare engineering education to address the technology and societal challenges and opportunities of the future. New strategic engineering education planning would have to be undertaken to reconstruct engineering curricula and related educational programmes to prepare today’s engineers for the careers of the future. The engineering curricula would have to undergo a rapid pace of change in the fast changing world with its intrinsic lack of predictability. The future engineering profession would include diversity in terms of geographical locations, human resource and opportunities. A universally acceptable standard engineering education only could make engineers successful in future. Their employability would largely depend on their engineering education and the matching skills development.

Consulting Engineering fraternity has to keep ahead of the technological developments to remain useful and valuable to different sectors of economy. The Consulting Engineering fraternity would have to be fully involved in the process of engineering education, skills development and employability enhancement.

ENGINEERING A BETTER TOMORROW



Dr. Rajashekhar R Malur
 Vice President & Chief Technology Officer
 TATA Consulting Engineers Limited

Abstract

Disruptive technology is an oft quoted term at present. Newer technologies are not only disrupting traditional businesses but the pace at which new technologies are developing has never been so fast. Engineering aids in bringing these technologies to reality. With the changes in technologies and emergence of digital engineering, engineering needs, skills and competencies are also changing. In this paper, an attempt is made to discuss a few of the emerging technologies based on published research. A few of the emerging technologies for future are briefly described along with the changing needs from an engineering standpoint.

INTRODUCTION

Engineering a better tomorrow requires an understanding of future technologies which determine future industries and markets. Engineering as a discipline aids to implement such technologies to solve real world problems through analysis and design of processes, machines and structures. It is often stated that the only thing constant is change and it is pertinent to note that the rate of change appears to be ever increasing. Engineering therefore is constantly evolving, and organizations need to be agile enough to respond to the changing technologies, markets and customer requirements. Charles Darwin had said “It is not the strongest of the species that survives, nor the most intelligent. It is the one that is the most adaptable to change.” Alvin Toffler, a Futurist and Philosopher, once wrote: “The illiterate of the 21st century will not be those who cannot read and write, but those who cannot learn, unlearn, and relearn”.¹ In this paper, an attempt is made to describe the changing trends of future technologies, customer requirements, market needs and therefore engineering imperatives.

TECHNOLOGY TRENDS

Imperial College London has published a table of disruptive technologies which according to them is “a dashboard of 100 wonderful, weird and possibly worrying ways the world might change in the foreseeable future”.² Various technologies are classified into different horizons, viz., those that are already happening at present (such as autonomous vehicles, robotics, wireless energy transfer), those that are at experimental/ pilot phases which are likely to happen in near future of next 10 to 20 years (such as mega-scale desalination, air-borne wind turbines and 3D printing of food, pharma and human organs), those which are in exploratory phase and are likely to happen in distant future over next 20+ years (such as planet colonization, low cost space travel, pollution eating buildings and vacuum tube transport) and finally some ghost technologies which are highly improbable but not impossible (such as asteroid mining, space solar power, self-reconfiguring modular robots, etc.).²

Frost and Sullivan publish an annual list of Top 50 emerging, most valuable and disruptive technologies which

according to their research are “multi-billion-dollar technologies ready to energize industries and transform the world”.³ A combination of these technologies can impact the world as early as over the next couple of years and these technologies are currently under intensified R&D with huge investments and high market potential. They classify these technologies under environment & sustainability (such as clean coal and battery recycling), energy & utilities (such as distributed power and energy storage), chemicals & advanced materials (such as self-healing materials, high performance polymers), information & communication technologies (such as hybrid blockchains, extended reality), advanced manufacturing & automation (such as metal 3D printing, collaborative industrial robots) and further other areas that include sensors & instrumentation, microelectronics, health & wellness and medical devices & imaging.³

Markets & Markets, which provide a cloud-based market intelligence platform that enables their customers to take advantage of emerging market opportunities, have held webinars on Top 20 technologies that include internet of things, 3D metal printing, blockchains, electric vehicles, augmented reality, grid scale batteries, self-healing materials, energy as a service, etc.⁴

What is pertinent from the research is the fact that the emerging and future technologies cut across industries. Technologies such as 3D printing, artificial intelligence, industrial internet of things, big data & analytics, robotics, blockchains, nanotechnologies, smart infrastructure, smart manufacturing, wearable technologies, etc., impact across industries of energy, power, chemicals, materials, transportation, defense, aerospace, etc.⁴ Irrespective of industrial sectors or verticals, the technology trends are converging, and this demands competencies and skills that are more and more interdisciplinary and multidisciplinary. Engineering that is needed to implement these technologies is evolving with cross-domain expertise appearing to be a necessity.

In the following sections, a few of the technology trends are briefly discussed with a view to understand them and the disruptions they are bringing in the engineering domain.

INDUSTRY 4.0 AND PLANT OPERATIONS

Industrial internet of things, often referred to as Industry 4.0 is the 4th industrial revolution that is currently causing disruptions in markets and services. The first industrial revolution around 1780 involved mechanization, steam power and weaving looms followed by the second revolution in 1870 which brought in mass production, assembly line and electrical energy. Around 1970, the third industrial revolution was with automation, computers and electronics and today, we have cyber-physical systems, internet of things, networks referred to as the fourth industrial revolution. From hands and assembly lines in 1700s to integration of sensors, machines and data analytics, real time decision making is becoming a possibility. The future is more integrated and interdependent and, calls for cross discipline collaboration.

Industry 4.0 technologies are helping industrial plants to achieve enhanced performance and better utilization of resources. As capital investments (Capex) are becoming lesser and lesser, focus is on enhancing efficiencies in existing plants to get as much as possible out of what is already there – referred to as asset sweating. Asset performance management ensures enhanced performance and reliability and reduced downtime through streamlining operations and maintenance utilizing real time data. Across industries, focus therefore is on optimizing operations and operational expenditure (Opex).

Realtime monitoring and health management of a tailing dam in a mine, health monitoring of equipment, piping, conveyors, reduction of losses (power, fuel, heat, steam, water, emissions, gases, materials etc.), and safety enhancement (for e.g., self-ignition of coal in a yard) in industrial plants, are few examples that provide enhanced

performance through utilization of historian and real time data. Competencies and skill sets needed for such operational enhancements are different than what is needed for design of a new plant.

Need is being felt across industries to enhance understanding of operational plants. Operating personnel know their equipment better than anyone else and therefore the first step in any operational enhancement initiatives is to have detailed discussions through workshops with them. Understanding cause and effect relationships through FMEAs, data analysis/ analytics, study of existing systems and process and instrumentation diagrams (P&IDs) and need for any additional sensors and instrumentation in an existing plant and further implementation of the same and continuous monitoring and diagnostics are some of the emerging requirements to enhance plant operations. In such scenarios, the need for consultants is to evolve from a service to a solution mindset as the customers would look for one stop solution provider.

CLEAN AND GREEN ENERGY

Traditionally electricity value chain consisted of generation, transmission and distribution in which the flow of electrical energy as well as information was unidirectional, and customers were consumers who received electricity at their door step and did not have any major role to play other than consuming the energy. The emerging trend in electrical energy industry involves flow of electrical energy and information in multi-directions.⁵ This is due to the focus on renewables across the world; the generation is going to be more and more distributed. In future, investments in power plants of larger capacity (e.g., 800 to 1000 MW) would become lesser and lesser and distributed generation along with energy storage and e-mobility is expected to play a major role.

Wind energy, roof top solar plants, fuel cells and battery driven electric vehicles would enable consumers to become generators. Smart grids would permit these consumers to play active role in the electricity value chain. The entire value chain operates in such a way that the system performance as well as asset utilization is optimized.⁶

Large fossil-fuel fired power plants have negative impact on the environment. The current focus is on climate change, decarbonization, sustainability and environment friendly solutions. From an industrial risks' perspective, there is a perceived shift globally from economic to environmental risks during the last decade. In India as well, the emission norms for gaseous pollutants (viz., particulate matter, NO_x and SO_x) along with norms for water consumption and ZLD (zero liquid discharge) have undergone a major change and become more stringent. This is bringing in new technologies for de-SO_x, de-NO_x and water conservation. From an engineering perspective, solutions that result in circular economy (make – use – remake – reuse – recycle – make) from the existing linear economy (make – use – dispose – pollute) would be future requirement across industries.

Modularization is often used to reduce the complexity of a system – through deconstruction to a series of independent units or modules that can function as one system when integrated. Large fossil fuel fired power plants involve complexities in multiple disciplines and larger structures, equipment and layout designs. In a solar plant, other than the solar energy yield analysis, there is hardly any complex engineering that is needed. It is much easier therefore to develop standard, modular and plug play engineering solutions. The same approach would be needed even in smaller power plants for distributed generation based on gas engines, diesel engines or smaller gas turbines. Smaller plants are easy to standardize and modularize. Modular approach results in faster delivery enabling tighter schedules and results in faster return on investments. Ability to develop standard solutions retaining flexibility to customize based on site and customer needs is the emerging trend in engineering.

Another important factor is the development of material technology that is needed for solar panels, batteries and

fuel cells. Over 80% of installed capacity of solar plants in the world are of Mono and polycrystalline silicon based solar cells, referred to as the first-generation PV materials. CdTe (cadmium telluride), CIGS (copper indium gallium selenide) or amorphous silicon based thin film solar cells belong to the second generation. Third generation solar cells are emerging concepts that include perovskite (largely calcium titanate), organic (organic polymers), dye-sensitized (titanium dioxide, tin dioxide, platinum) printable solar cells.⁷ Materials for battery technology are also evolving with the focus on energy storage and e-mobility. Lithium-ion batteries are the most preferred technology as on today; however, technologies such as lithium air, lithium sulphur, sodium ion and multivalent (Zn^{2+} , Al^{3+}) aqueous batteries are also being developed.⁶ Though hydrogen-based fuel cell is the favored green energy source, several technologies are available with ongoing research on materials. From an engineering perspective, the developments in material technologies in clean and green energy require understanding of the specific material requirements of chemicals regarding storage, handling, and life-cycle and recycling.

SMART INFRASTRUCTURE AND DIGITAL ENGINEERING

India has an ongoing program of 100 smart cities, each at varied stage of development. It is expected that 40% of population of India would be living in cities by 2030, contributing 75% of the overall GDP. The objective is to provide water, power, solid waste management, minimize pollution levels, green energy, e-mobility, e-governance and robust IT and digitization framework. Industry 4.0 and Clean and Green Energy that were discussed in previous sections are the means to provide smart infrastructure in megacities of the future. Cities would be governed through command and control centers.

Finland was the first country in the world that made 3D digital models of buildings as a regulatory requirement for approvals. UK and Singapore followed. In India, the new capital city of Amaravati has mandated that 3D models need to be submitted for approvals. This would enable the city administrator to have complete building information of the entire city and enable better governance, planning and faster response to bottlenecks and emergencies based on real time data. It would also enable control on violations to regulations by citizens be it a traffic rule violation or a burglary or a physical violation to a bye-law.

Building Information Modeling (BIM) is the digital representation of physical and functional characteristics of a facility. BIM can be utilized during the complete life cycle of any built environment project. 3D tools are available to develop integrated 3D models which may be located on a GIS platform. BIM is utilized to design advanced Building Management System (BMS) where the digital twin of the building can be located at a Central Monitoring Station and utilized for real time monitoring of climatic conditions, access control, security monitoring, utility tracking, lighting management, outage management and maintenance requirements.⁸

Importance of Digital Engineering is growing day by day and most of the regular engineering services would be productized solutions in future. Productization of a service involves packaging a service with a recurring offer enabling reuse and customization at faster pace to meet stringent schedule demands. Tools are available to complete entire engineering and design activities of a building at the click of a button. A London based startup has developed AI (artificial intelligence) based tools that use BIM models that can perform entire pre-construction activities. The tools use data from BIM models and provide quantity estimates, cost estimates, construction schedule and add the fourth dimension of visualizing construction – which may be used in the bidding process. Another tool provides ready to use BIM models for both residential and commercial buildings, that perform entire design; and if there is any change due to customization in the plan, the designs are automatically altered.⁹

Engineering solutions for future would be mostly digitized, standardized/ productized and modularized. While thought leadership, depth and expertise in each engineering discipline would certainly be needed, majority of engineering activities would be digitized, and solutions would be available at the click of a button.

SUMMARY

Technology is developing at a fast pace and what is relevant yesterday would not be relevant tomorrow. Emerging technology trends are discussed briefly, and it is noted that irrespective of industrial sectors or verticals, the technology trends are converging, and the future is more integrated and interdependent. Engineering needs going forward are more and more interdisciplinary and multidisciplinary. With the Capex investments undergoing challenges, need is felt across industries to enhance understanding of operational plants and optimize operations. Asset performance management, asset sweating, capture of essential data and data analytics are the trending engineering needs for future. There is a need to evolve from a service to a solution mindset as the customers would look for one stop solution provider. Solutions that result in circular economy (make – use – remake – reuse – recycle – make) from the existing linear economy (make – use – dispose – pollute) would be future requirement across industries. Ability to develop standard solutions retaining flexibility to customize based on site and customer needs is another requirement for future engineering. The developments in material technologies in clean and green energy require understanding of the specific material requirements of green chemicals regarding storage, handling, life-cycle and recycling. Engineering solutions for future would be mostly digitized, standardized / productized and modularized.

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ROLE OF R&D - IN SHAPING FUTURE ENGINEERING PROFESSION



S. K. Mazumder
*Former AICTE Emeritus Fellow
and Professor*



Rakesh Mehrotra
Former Associate Professor

*Department of Civil Engineering,
Delhi College of Engineering (DCE/ DTU)*

INTRODUCTION

India made history on 24th September 2014, when it became the first country to place a space probe- Mars Orbiter Mission– fondly called Mangalyaan in India- in the first attempt. After Independence, India has made phenomenal progress in the engineering sector. As on 2012, India had 10,949 engineering colleges with about 15,76,500 of graduates and post graduates. Majority of the boys and girls in India opt for either engineering or medicine as their first choice. Unfortunately, most of the talented engineering students from India prefer to go abroad for higher engineering education in developed countries where they find a congenial environment to nurture their talent and flourish. Apart from higher remuneration, they get due recognition through research, publications, patenting, etc. This has resulted in a big vacuum in R&D activities in scientific and engineering sector in India (Rama Rao, 2013). Unless the trend is reversed, developed countries would monopolise and the existing gap in R&D between the developed countries and India would continue to remain the same and India would continue to purchase superior products from abroad at exorbitant cost. There is therefore a need to deeply introspect and take appropriate measures to bring future engineers in the R&D sector at par with those from the developed countries.

The country is undergoing industrialization and working towards self-reliance in almost every sphere. The Indian government rightly deserves full credit for advancing meaningful research in engineering and science in India. Modern initiatives like ‘Make in India’ and ‘Skills India’ are providing a great platform for developing the industrial base of the country by promoting indigenous technologies and research as well as advanced skills required by foreign companies and other organizations that are eyeing investments in this country.

India has already pioneered several technologies in agriculture, pharmaceutical, and chemical industries that are now being utilized by countries in South East Asia and Africa to attain self-sufficiency. Indian engineering colleges- students and faculties as well as researchers- are working arduously towards reducing the existing gap in R&D to make Indian products competitive and globalized.

In an earlier paper (Mazumder, 2017), the first author, discussed about the challenges facing engineering education in India. The purpose of this paper is to highlight the R&D activities with a view to shape future engineering profession in India.

TYPES OF R&D WORKS

Broadly, all R& D activities can be classified in to three broad groups, namely,

- Fundamental or Basic Research
- Applied Research
- Adaptive Research

Fundamental or basic research leads to invention/ discovery of new things hitherto unknown. It is very costly and time consuming and needs resourceful and most talented faculty. Usually, such research works can be carried out in educational and research institutions with the help of young, energetic and dedicated faculty members.

Applied research is carried out with the objective of developing new products using the new laws/inventions/ discoveries made through fundamental/ basic research. It can be carried out in academic and research institutions as well as in industries for developing new products.

Adaptive research is meant for further study based on fundamental and applied research outputs developed indigenously or abroad so as to make it possible to use the latest knowledge for solution of local problems being faced by the society under prevailing circumstances. It needs less money and time compared to basic and applied researches.

While most of the fundamental researches are carried out presently in USA, UK, France and, Germany, Japan makes use of them through applied and adaptive research.

R&D INSTITUTIONS IN INDIA

After Independence, the Government of India established a large number of R&D institutions/ agencies like CSIR, DRDO, DBT, DST, DAE, DOS, ICAR, ICMR, ISRO, NPL, etc. A national survey (FICCI, 2014) on the status of R&D in the country shows that India's Gross Expenditure on R&D (GERD) has increased more than fourfold from Rs 24,117 crore to about Rs 1,00,000 crore during the period 2004-2005 to 2016-2017. The survey, conducted by the National Science and Technology Management Information System (NSTMIS) under the Department of Science and Technology has also shown that the per capita R&D expenditure in India increased from Rs 300 in 2004-2005 to Rs 659 in 2014-2015 (DST, 2017). The GERD growth was driven mainly by the Government – refer table.

Agency	GERD %
Central Government	45.1%
State Governments	7.4%
Public Sector Industries	5.5%
Institutions of Higher Education	3.9%
Private industry	38.1%

Many of the public sector institutions in India e.g. BHEL, DRDO, EIL, NHPC, NTPC, NCDC, ONGC, SAIL, etc. have inbuilt R&D centers for carrying out regular research for improvement of the quality of their products. The Percentage of GDP spent on R&D in India vis-à-vis some of the countries in the world as in 2016-17 are given in the table alongside. According to the 2018 Global R&D forecast (Waldorf, 2018), India is now the sixth largest R&D spender in the world, and it is set to overtake Korea and Germany to reach the third spot by 2018. To put this in perspective, India is expected to invest \$71 billion this

Country	% GDP spent on R&D
USA	2.79%
China	2.05%
Brazil	1.24%
Russia	1.19%
South Africa	0.73%
India	0.69%
Pakistan	0.29%

year (2019) on R&D, including public and private investments. The US is expected to invest \$514 billion and China \$396 billion. Japan, Germany and South Korea expect to invest \$166 billion, \$109 and \$77 billion respectively.

R&D IN ACADEMIC INSTITUTIONS IN INDIA

In a world increasingly propelled by technology, R&D is the foundation of any nation’s economic growth. Topmost engineering institutes and universities in India e.g. IITs, IISc, IIITs, IEST, NITs, BITS, JU, JNU, BHU, AMU, are focusing more on research and development rather than mere studies. Consequently, engineering students and faculty now conduct more research in various technologies than any time earlier in the history of this country. The Elsevier report to DST (2017) states-

‘Improving India’s international and cross-sector collaborations could be key to further growing the impact and visibility of India’s research. The trend is continuing as more and more scientific research papers from India are being published worldwide. A large number of these research papers speak of ground breaking work in new fields of engineering and technology’.

Many of the higher educational institutions in India posses Centers of Excellence for carrying out sophisticated high level research in diverse disciplines in engineering, science and technology e.g. Aeronautics and Aerospace, Applied Electronics, Architecture & Planning, Automotive, Bio-genetics, Bio-informatics & Bio-system, Biomedical, Chemical, Civil, Computer science & Technology, Electrical, Electronic and Instrumentation engineering, Electro-mechanical System, Applied Mathematics, physics and Chemistry, Environment, Industrial, Instrumentation and Control, Integrated Manufacturing, Materials, Mechanical, Metallurgical, Mining, Nano science & Nano Technology, Production, Software, Structural System, Telecommunication, VLSI Design, etc.

Some of the IITs/ Institutes carrying out specialized research study in core engineering disciplines are given below:

	Aerospace Engineering	Chemical Engineering	Civil Engineering	Computer Science & Technology	Electrical and Telecommunication Engineering	Mechanical Engineering
IEST (Kolkata)			✓			✓
IISc	✓		✓	✓	✓	✓
IIT (Bombay)	✓		✓		✓	
IIT (Delhi)		✓		✓	✓	✓
IIT (Kanpur)	✓			✓		✓
IIT (Kharagpur)	✓	✓	✓	✓	✓	✓
IIT (Madras)			✓		✓	✓
IIT (Roorkee)			✓			
Institute of Chemical Technology		✓				
ISI (Kolkata)				✓		
NCL		✓				
Vikram Sarabhai Space Centre	✓					

R&D IN INDIAN INDUSTRIES

A country of India's size should invest at least 2% of GDP on R&D; but this cannot be achieved without the private sector enhancing its investments in technology development (FICCI). Furthermore, despite global economic turmoil, India remains one of the fastest growing economies. Thus, a huge opportunity lies for the businesses in India to enhance their R&D and commercial efforts. Incentivizing R&D would also lead to employment generation and creation of knowledge economy. Therefore, development of technology parks, knowledge incubators and patent-management corporations, smart cities, etc. should be encouraged.

India represents a very diverse market, even amongst Asian countries and there are numerous pull factors that make India a lucrative destination for R&D. Access to technical competencies, young talent pool, cost savings, proactive government support and presence of an indigenous market are some of the significant factors attracting multinational companies to expand their R&D base and production operations in India. One of the major problems facing the private sector in India vis-à-vis R&D is the fact that most of Indian private business lies with small and medium enterprises and those sectors which have very limited capital to invest in R&D.

The Indian private sector has done creditable work in technology services, but it is now up to them to boost the country's R&D capability. By sheer luck, the large number of R&D centers of multinationals in the country has created an excellent talent pool for them to draw from. These centers can attract the best of scientists and technologists from India and abroad, facilitating greater interaction between industry, educational Institutions and national R&D centers. It can help the flow of funds from industry to R&D activity in these centers which might lead to better and newer products and services. India is proud of private research institutes like TIFR, IBM, Texas Instruments, GE, Motorola, etc. Private R&D has shown signs of improving but the growth has either come from public sector companies or from MNCs. In fact, it is the MNCs that accounted for 90% of the patents filed in India today. Indian's consider that the innovation or development done by them in the course of their day to day work is routine and thus forgo opportunities for filing copyrights, patents, etc. They need to be educated on this count.

Overall India-based R&D services market reached US\$ 20 billion in 2015, up by 9.9 per cent over 2014. R&D services market stood at US\$ 7.76 billion and R&D globalisation market (Captives) stood at US\$ 12.25 billion. India's R&D globalisation and services market is set to almost double by 2020 to US\$ 38 billion. The encouragement for research in India gave a significant opportunity for multinational corporations across the world as it is having the availability of intellectual capital. Legions of Indian engineers working across the globe highlight the highly trained manpower available at competitive costs.

RESEARCH PUBLICATIONS

Indian research publications increased from 16,000 papers to 40,000 papers a year increasing world share from 2.2% to 3.4% during the period 2004-05 to 2016-17. Citation impact of papers has increased during the decade from 40% of the world average to 60%. In several critical fields, India maintained a higher share than its average of the world's most cited papers. China's research output grew 22.3% compared to India's 14.3%, but Indian researchers have higher citations per paper-2.7 compared to China's 2.2. (DST, 2017)

Unfortunately, most of the research works carried out in educational and research institutions in India end in publishing of thesis and research papers. One of the major shortcomings of the Indian university system has been the focus on basic research (rather than applied research) that has limited value to industry and hence industrial support is lacking. The industry needs to realise that unless the basic research advances, the applied would stagnate after sometime.

However, there is a visible change now and many of the industries are coming closer to the educational institutions of higher learning through creation of chairs, centers of excellence, development of laboratories, sponsoring industrial research and consultancy, etc.

ROLE OF PROFESSIONAL SOCIETIES TO IMPROVE R&D

There are a numbers of Professional societies like the, Consulting Engineers Association of India, Aeronautical Society of India, Computer Society of India, Institution of Electronics and Telecommunication Engineers, Indian Institute of Chemical Engineers, Indian Institution of Industrial Engineering, Society of EMC Engineers (India), Indian Society for Technical Education, Indian Science Congress Association, Indian Society of Hydraulics and numerous other societies in every discipline of engineering. These societies publish journals and newsletters periodically and organize conferences to disseminate knowledge. They also encourage scholars by giving several awards for best papers, best thesis, best projects, etc. They organize short time courses and seminars on advanced topics, key note talks/ memorial lectures from experts from India and abroad with a view to expose/ inspire attendees in advanced R&D works being carried out in India and abroad Some of these societies arrange regular training program for young engineers from industry and institutions for updating of latest knowledge in different specialised subjects/ disciplines with the help of faculties drawn from educational, research, consultancy and industrial institutions. Inter-institutional collaboration is a key to success in R&D activities (Mazumder, 2008, 2014).

THE FUTURE SCENARIO

After independence, India has made significant progress in R&D in almost all disciplines in engineering. The quality of our engineers, however, needs further improvement. One of the biggest problems in this respect is that most of the talented engineers are going abroad for higher study and research resulting in a big vacuum in engineering and research institutions in India. India has made substantial progress in R&D however, to take it world class level, it has to be further strengthened through collaboration between educational/ research institutions and industries at all levels - departmental, institutional, industrial, and international. The existing gap in R&D between India and other developed countries needs to be bridged so that India becomes independent and not have to source foreign know how and be compelled to purchase superior products from abroad at high costs. The Government is seized of this and hence the emphasis on “Make in India”, which in the future will change the tide and make India an exporting nation not just of talent but highly sophisticated products, all developed indigenously in all spheres.

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KEY CHALLENGES FOR FUTURE GENERATIONS OF STRUCTURAL ENGINEERS



Alok Bhowmick

Managing Director

B&S Engineering Consultants Pvt. Ltd.

International Professional Engineer (India)

President – IAStructE

Member – Governing Council CEAI

Vice Chairman – ING-IABSE

Abstract

The paper highlights some of the challenges and opportunities facing the profession of structural engineering in India today. Leaders in the profession must help young engineers to develop skills and to set right the direction in which the profession is going. The industry is being rocked by a sizable earthquake of changes right now. Traditional engineering tasks are increasingly automated, which allows structural engineers to spend less time on the profession's mundane chores, and focus more on what has always been core value of structural engineering - that is creativity and innovation. Many practicing structural engineers (SE's) looks at the current scenario as a crisis moment as the younger generation is losing grip on the subject and becoming computer dependent. But many pundits consider this situation as an opportunity to broaden the horizon and take a leadership role. Another major concern is that the profession is not able to attract the best and brightest students. Leaders in the profession must take this opportunity to inspire young people to join this esteemed profession and bring about radical changes and communicate to the public what structural engineers do. The paper addresses these burning issues of concern for the future of the profession. The paper also highlights the primary and root causes responsible for creating a sort of disconnect between structural engineers and the society.

INTRODUCTION

Structural engineering has enjoyed a brilliant and iconic past. It is one of the most amazing professions that humanity has ever created. As a tourist, when we go around the world sightseeing, what we see are mostly even today, the works of structural engineers. Signature bridges (like Golden Gate Bridge at San Francisco, Sydney Harbour Bridge at Australia) or Tall Buildings (like Burj-Khalifa, Dubai, Petronas Tower, Kuala Lumpur) or Heritage structures (like Colosseum and Pantheon in Rome) or many Churches and Temples (like Lotus Temple, New Delhi, The Sagrada Familia Church in Spain, Cathedral of Notre Dame in Paris,) stand as testaments to the work of structural engineers. However, despite the overarching presence of structural engineering works around us, it is unfortunate that they are rarely thought of as leaders of society. Instead of being perceived as leaders of the society who run things, engineers are seen as those who make things run. It is time to change this narrative for the future generation of structural engineers.

Challenges faced by present generation of Structural Engineers

The present generation of structural engineers is faced with unprecedented challenges, both technical and societal, which would affect the future of their profession. Many things have changed over the years about the way we do our business. 'Uniform working hours' has changed to 'flexible hours'; 'clearly defined tasks has changed to 'individual working'; 'dedicated office spaces for staff' in office is fast changing to 'work from home' and remote working;

work-life separation has changed to work-life integration and to top it all, pens and papers are fast vanishing as we are now moving to a paperless society. In addition to these generic changes, there are many issues in which the present generation is challenged, one of the key ones being global warming and the consequent climate change. In order to adapt to a post climate change environment, the traditional approach to design needs to be radically altered.

It is important to understand that presently structural engineers do not control changes but generally respond to the changes brought about by politicians, bureaucrats, planners, architects, and others. This has happened mainly because the engineers have not asserted their position and taken up the leadership role in the society. It would be easy for the profession to lie low and continue to do business as usual and play a subservient role in the society. However, being reactive does not help us to control the future. The engineers need to be pro-active to educate, train, and accredit the young engineers in this changing global environment and engage themselves too positively, to impact the future of the profession, and to improve the built environment, in which structural engineers play a predominant role.

It is high time, the senior members of the structural engineering fraternity should be really doing something for younger professionals – to make them not only survive these radical changes, but also utilise the opportunity to ensure that the profession takes a dominant leadership role in the society in near future. The profession must stay robust and relevant for the future engineers. Some of the areas requiring attention are discussed in this paper.

Focus area for Existing and Future Structural Engineers

The role of structural engineers today and the role they are likely to play in the future are quite different. This can be explained diagrammatically (Figure 1). The blue line in this diagram represents the existing scenario where the structural engineers gives far more emphasis on design and analysis over concepts and validation, while the orange line represents the future scenario where, under digital environment, it is likely that the future structural engineers would have a far greater involvement in development of concepts on the left hand side and validation on the right hand side rather than design and analysis. It is important that the education system understands this change in the

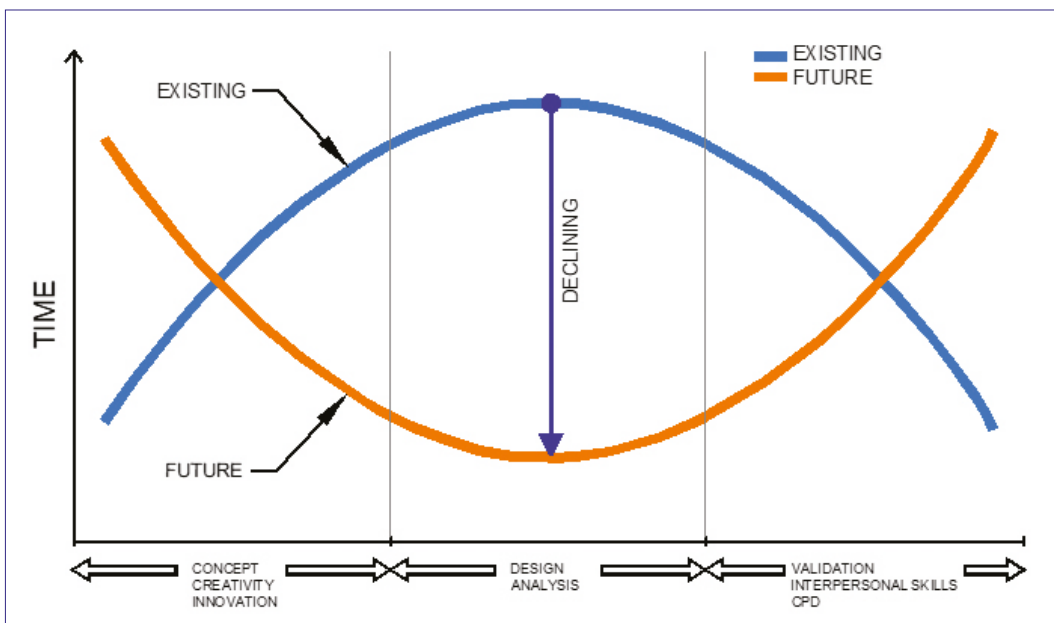


Figure 1: Diagrammatic Representation of role of Structural Engineers

focus area of importance and adjust the curriculum accordingly. While the analysis and design may get relegated to the background yet the onus of the correctness would still lie with the structural engineer who signs off the document.

KEY CHALLENGES FOR FUTURE STRUCTURAL ENGINEERS

An opportunity now exists for the role of structural engineers to significantly expand beyond their traditional expertise. However, to step into that expanded role, structural engineers themselves have to expand. They have to learn new skills so that they can build more elegant, safer, and more resilient structures. In effect, SE's have to set their sights to higher goals. Structural engineers should embrace new skills and build their capabilities and capacities. They have to embrace the digital technology quickly but cautiously. Unskillful use of computer tools could result in failures that would be blamed on structural engineers. Many failures in future could be "computer-caused failures". Some of the key challenges that would impact the young structural engineers professionally would be:

- a. Increasing use of artificial intelligence, bringing both opportunity and threat.
- b. Rapid advances in digital technology that could end up replacing some of our conventional skills;
- c. Increasing complexity in the codes and standards;
- d. Increasing use of data as a tool for design & construction.
- e. increasing need and demand for continuing education;
- f. changes in global access to structural engineering technology and skills;
- g. overarching concerns for global warming and climate change
- h. our increasing responsibility in the design and construction industry.

Increasing Demand for Competent Structural Engineers

The World population is projected to reach 9.8 billion in 2050, and 11.2 billion in 2100, from the current 7.8 billion. 18% of this additional 2 billion population growth will be in India. The current population in India is 1.36 billion. India's urban population is expected to grow from current 450 million to 814 million by 2050. The impact of such a huge growth is overwhelming and the opportunities for structural engineers to help meet the needs of this transformation are there to be seized.

Problems faced to attract the best and the brightest to Structural Engineering profession

Increasingly poor quality of structural engineering talent that the profession is able to attract is a matter of grave concern to the society at large. While the profession needs the best and the brightest, what we get is just the opposite. The first choice of most of the engineering student is not Civil Engineering. It is not surprising to find that majority of them wants to join Computer Science (Engineering)/ IT based sector. The reason is quite obvious since these professions offer a much higher salary package and better working conditions. Civil Engineering is not viewed as a 'happening field'. Even those who join the portal of Civil Engineering face considerable provocation during the four years of graduation course, to disengage from the civil engineering profession he is pursuing. This is a vicious circle which is negatively impacting the profession greatly. **There is certainly a need to change the way we teach engineering to bring out its inherent creativity.**

Reforming Engineering Education

The tools available to structural engineers are rapidly replacing workforce with automation. This presents an opportunity to the decision makers, if not a mandate, to transform structural engineering education, training, and practice in ways that will foster an enduring and creative profession. Some of the steps that are envisaged are:

- a. Rethink on education for engineering courses: University education would have to adapt to changing requirements, including the curriculum and selecting from a broader and more diverse pool of students. The education system would need to integrate both digital and artistic skills into the curriculum,
- b. Greater engagement with the construction industry and contractors,
- c. Greater links between research and practice,
- d. Develop a broader outlook and engagement across the built environment industry,
- e. Enable better progressions of technicians, and
- f. Broaden Initial Professional Development (IPD)/ Continuous Professional Development (CPD) requirements to include education on areas of future disruption. Outline a comprehensive approach to education after graduation, including expectations for mentoring and formal courses.

Regulation of Structural Engineering Profession

Increase in complexity of structural design responsibility, including advances in structural engineering codes and standards, design aids and tools such as computer programs, project delivery methods, and construction materials, could undermine the profession's ability to protect the health, safety, and welfare of the public from unqualified and inexperienced professionals designing inadequate structures. There is a dire need to regulate the profession of Engineering. An Engineering Council needs to be set up that is a legal entity.

Engineers and Technologists form a key component of the human resource. In order to derive maximum benefit from this resource, it is important for the country to ensure that Engineers and Technologists have high levels of competence and high levels of professional integrity. The engineering degree does not necessarily equip engineers and technologists with the requisite competence, and integrity. Such competence can be acquired after graduation through a process of intensive training, and sustained through a process of continuing education and up-gradation of skills. A mechanism needs to be set up to ensure that every engineer and technologist whose decisions impact the health and safety of the society, goes through this process and is tested for having acquired the requisite skills and is accorded a status of Professional Engineer (PE). Any time an engineer or a technologist does not measure up to the high level of technical competence, professional honesty and integrity, this status of Professional Engineer (PE) could be withdrawn. Such a mechanism of regulation of the profession is possible only with the help of an Act of Parliament. The structural engineering fraternity must put an all out effort to get an engineers' bill passed by the Parliament.

Given the county's dire need for rapid industrialization & development, depleting natural resources coupled with the vulnerability profile of India, Civil Engineers and Structural Engineers who are practitioners in the Built Environment for our large human capital, particularly Infrastructure and Buildings, and connected with safety with respect to natural and man-made disasters, an Engineer's Bill is of utmost importance.

THE WAY FORWARD

1. The way forward would be to bring about a complete change in the way we work is carried out. The immediate priority as structural engineers should be to use ones knowledge and skills to contribute to a safer, more sustainable, inclusive and resilient society. Future engineers must develop a more holistic view of engineering design, which is commonly referred to as sustainable design. Achieving more sustainable design would require a concerted effort from practitioners, researchers, and educators.
2. There is a need to change the education system and the curriculum for Civil Engineering. The profession must be made more attractive for the young and bright students. It must be job centric. The academia and the industry must join hands to work towards this goal.
3. Profession of Structural Engineering must be a regulated profession. The need for Engineers Bill is utmost and there must be an authorised body created by the Government of India with legal mandate to regulate the profession.

To conclude there is a quote of Albert Einstein:

“The world as we have created it is a process of our thinking. It cannot be changed without changing our thinking.”

—Albert Einstein

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EUROPEAN HYPERLOOP PLAN MOVES FORWARD

All core elements are now in place for the development of what is aiming to be the first European hyperloop system.

Hardt Hyperloop announced that Europe’s first hyperloop is a step closer to offering an alternative to short-haul flights following completion of a system that includes all elements, including lane-switching technology.

The system is being developed through collaboration between Hardt Hyperloop and its international partners, which includes Tata Steel, Royal BAM Group, Goudsmit Magnetics, Busch, Continental, Prysmian Group and ABB.

Hyperloop is envisioned as a network of low-pressure tubes in which autonomous vehicles glide at high speeds. A combination of magnetic levitation and a low-pressure environment allows express travel with little energy. Various groupings around the world are working on development of the technology.

Hardt Hyperloop said that the Hyperloop Lane Switch (HLS) technology would allow vehicle to change from one lane to another without additional or moving components. This enables the vehicles to retain their high speeds, effortlessly switch routes, and merge in and out of the network, said the company. “After 2 years of research and hard work we are the first in Europe to complete a functional hyperloop system,” said Hardt Hyperloop chief commercial officer Mars Geuze. “Not only that, we have developed a lane-switching mechanism that allows us to build a hyperloop network in the near-future.”

Hardt Hyperloop has also revealed new information about its next phase, creation of the European Hyperloop Centre. The facility, which includes an R&D workshop, is equipped with a 3 km track that will allow for the high-speed testing of vehicles. <https://www.theconstructionindex.co.uk/news/view/european-hyperloop-plan-moves-forward>

FUTURE OF ENGINEERING



K. K. Kapila
*Chairman & Managing Director, Intercontinental
 Consultants and Technocrats Pvt. Ltd.
 President (Emeritus), IRF*



Dr. Mahesh Kumar
President, ICT Pvt. Ltd.

INTRODUCTION

Future of Engineering is a like a technology dream which one sees today and would come true in a few decades. Thanks to the advances in research and development of engineering field and the dedicated infrastructure that have built over the past few decades, this is a technology age. Every year the number of developments are marking milestones in the engineering field.

It is also interesting that the Services/ Products which have higher value today are somewhere the most advance ones; they would have the latest technology inbuilt in them.

Similarly, it is seen that at this age of human race, a lot of global issues are being faced related to environment and human well-being, and one should be just as thrilled to see how engineering in future is going to change the world for the better with Artificial Intelligence, Robotics and of course the close study of space.

GROWTH OF ENGINEERING

The day to day routine has certainly changed over the past few decades with the advances in the field of Engineering, which has evolved over time with the continuous efforts of engineers worldwide.

Engineering development has been the most significant player in development of society since the ancient era. These advances have been a boon to our lives and it continues to carve the world to be a better place. If one looks at the broad scope, there are hardly any strings of life, which have not undergone massive changes with the advancements in engineering.

World economies are now valued over the technology and technical know how they possess. This has created a vision for most of the Engineering driven institutions for advancements in growth and research.

VARIED FIELDS OF ENGINEERING

Engineering has now expanded its horizon into vast number of disciplines. For instance Biotechnology, Nanotechnology, Artificial Intelligence and Robotics are some of them. Engineers are innovating new and modifying old technologies both at a fast pace due to the increased competition between the developed and semi-developed Economies. However, the nature of these inventions and the impact would not be as of the past, it would be much more impactful and less time consuming.

Crypto currency, Space missions, automated driverless vehicles, unmanned aerial vehicles, Medical science/robotics

and artificial intelligence, are the game changer for the industry and one would be seeing the future of engineering revolving around these.

In the late 90s, for instance one saw the big, heavy mobile phones; these were technology marvels, changing the ways of communication. In the following decades, the camera mobiles became the new standard. These advancements came at a pace that the use of mobile phone from merely providing call services has moved dynamically to host additional other uses like photography, social media, gaming and payment tool. The display of phones, televisions and laptops have also seen this advancement, now one must look forward to holographic displays in the future moving away from the three dimensional screens.

HEAVY INDUSTRIES AND ENGINEERING

Automobiles

When one looks at heavy industries like automobile, the future is beyond imagination. Automobile companies are now facing intense competition and new feature to enhance comfort and security are being introduced to enhance passenger satisfaction. These may vary from Safety of the car, to the entertainment systems, better air-conditioning, lesser fuel consumption, etc. Besides to be an enabler to reduce global warming, companies are becoming more concerned with the emissions from vehicles.

The future of Automobile is very interesting as it holds surprises and engineering marvels. Vehicle crash detection and prevention system, for controlled emissions, Electrical powered vehicles have been introduced, and heavy research and competition would lead to an era where each household would have an electric car or alternative fuel operated car and the conventional fuel operated cars would become obsolete.

Driver less Cars

Who imagined the adjacent car would have no driver? These would slowly become common. Similarly in the future there would be driver less trucks, making movement of logistics simpler and efficient. This would not only reduce the number of road accidents but also increases reliability on delivery timings. It would streamline the whole logistics industry. Although if one looks at the other side, driver less truck means unemployment for drivers? But it is crucial to understand that these goods carrying vehicles would always have a human to ensure the safety of material from theft or loss. Just the fact that driverless trucks and equipment would work tirelessly without breaks and optimise the traffic conditions, would create a revolution in the industry.

Railways

Railways are one of the most used means of transport where a new future is foreseen. Certain companies are working on making travel at 1,223 kmph (760 mph) possible through usage of vacuum tube and other hi-tech infrastructure. Future is clearly going to be very exciting as one travel's at such speed.

DISASTER MANAGEMENT

Technology Intervention in Disaster Management

Moving over to how Engineering helps disaster management and disaster prevention. In this field, the future has endless possibilities with the upcoming drone era, which helps one reach places where human access gets restricted.

UAV's (Unmanned Aerial Vehicles) can access areas by flying and driving. Further adding technology like camera, Lasers, Arms & ammunition has pushed the industry further to new dimensions. UAV's can now deliver material for relief, do 3D mapping of areas and help in immediate disaster reports and providing relief material.

Innovative Concepts of Internet

These technologies run with internet access. Internet has changed the world, but still there are places where internet is not available due to multiple reasons. To cater to these areas, companies like Google are planning to deploy helium balloons to beam and provide internet to inaccessible areas. There are also concepts of deploying micro satellites into earth's orbit which would act like modem and deliver data when the satellite crosses an area.

It is essential to point out that technology can access areas where humans cannot reach easily. In event where rescue work is required, Technology can be way beneficial than sending another human for rescue, at risk of their lives.

Role of Robots and Unmanned Aerial Vehicle

Robotics and unmanned aerial vehicles have brought in rigorous improvement in rescue efforts. Assessment of damage has become easier and the future of the same has limitless possibilities from providing medicines to taking medical samples and analysing the same instantly. This would change the health care industry as well. This would also help eradicate moving a patient in critical conditions and provides cheaper mobility and efficient response.

Similarly, in case of accidents, analysing location of survivor and then taking requisite measures, besides informing additional team, etc. could be easily done with this engineering tool. The technology exponentially increases the percentage of success in rescue missions.

Role in Environment

Even to minimise pollution, robots called "Taxi-Bots" have been introduced at airports which tow aircraft to save fuel and cut pollution. Such systems and technologies are being developed which would aid in reduction of fuel consumption and maintain low emissions from human activities.

WAY FORWARD

It is crucial to point out that future of engineering is bright and unpredictable. There are millions of engineers, researches, technologists working across the globe to change the world into a better place. These are continual developments with endless potential.

Moreover, industrialisation has changed from being labour dependant to information and data dependent. The Research and Development which is happening is to make sure new products and services laden with technology making lives easier are provided. The measure of wealth is moving away from the gold reserve to technology and data reserve. The prestige of a nation would be based on exhibiting what it is developing as new scientific knowledge, new technology, and new innovative products through R&D activities.

All the growing companies are investing in Research and Development, everyone now encourages inventions and thinking out of the box. Now the competition has come between brains and not the possession of natural resources. It is required to attract more efficient brain and then provide them adequate infrastructure to get enhanced results from Research and Development, which would take the future of engineering beyond imagination.

FUTURE OF ENGINEERING IN HIGHWAY INFRASTRUCTURE



Pramod Kumar Jain
Vice President (Highways)
Consulting Engineers Group Ltd.
Jaipur



Siddhartha Sekhar Mishra
Assistant Manager (Highways)
Consulting Engineers Group Ltd.
Jaipur

Abstract

In the present scenario, the infrastructure sector undoubtedly acts as the flag bearer for the economic prosperity of a rapidly growing country like India. Among the different sectors of the infrastructure, the road sector bears a very important role as it provides connectivity to different parts of the country which further enables transportation of freight as well as people. Hence, the above sector needs a greater effectiveness and efficiency in its techniques and methods for faster and safer implementation of plans. However, in a country like India where the construction industry has been a bit reluctant in terms of adopting to innovative ideas and technologies and prefers to stick to the old conventional methods, which leads to compromise in innovation, performance and timely completion of project. Adoption of advanced materials like solar roads, eco-friendly roads, recycled materials, foamed bitumen etc. and technologies like automation in maintaining a better public database along with provision of digital traffic signs would speed up not only the complete construction considerably but also comply with sustainable development. In addition to this, construction of green highway should be emphasized to prevent the ill effects of environmental adversities and to enable minimum use of scarce natural resources. Also implementation of better quality management process such as Six Sigma would ensure faster completion of project activities.

Key Words: Porous Pavement, Solar Road, Digital Road Sign, Six Sigma Technique, Sustainable Developments

The provision of latest technologies/innovation should be listed during the planning phase of any road project and should be developed with proper implementation strategies. This article elaborates the latest technologies related to mainly road pavements. Some of the useful technologies adopted in different parts of the globe are discussed.

POROUS PAVEMENT

Porous Pavement or Pervious Pavement is a type of pavement where the mix contains greater amount of aggregates as compared to the bitumen content. This results in higher percentage of air voids which further enhances the permeability of the paved surface. This kind of pavement is more useful in areas with scarcity of water as it prevents surface runoff and allows the rain water to percolate through the pavement resulting into ground water recharge which enables to reinstate the hydrological balance.



Figure 1: Porous Pavement

PLASTIC ROADS

Provision of pre-fabricated plastic panels in place of regular asphalt pavements would decrease the carbon emission as well as construction time period considerably. It ensures quick completion of the project road as light weight plastic panels manufactured in factory are directly laid over the compacted ground surface and hence causes less congestion or disruption to traffic during construction stage. Moreover, the hollowness of such plastic panels enables easy installation of utility pipelines and cables. It can resist adverse weather conditions and requires less maintenance.



Figure 2: Plastic Road

NOISE-REDUCING ASPHALT

Quiet asphalt or Noise reducing pavement options fall into four general categories i.e. fine-graded surfaces, open-graded friction courses, rubberized asphalt, and stone-matrix asphalt. Basically, it works on the concept of expulsion of entrapped air and water within the pavement surface which helps in reducing the noise in the range of 4 to 6 dB. By keeping in view the factors like weather, traffic, importance of the road and proximity to residential areas in urban/semi urban areas this technology is recommended as it may result in increase in project cost.

SOLAR AND WIND ENABLED ROADS

Non-conventional technologies like solar and wind energy can be put to use in the form of paved surface for generating power/ electricity through traffic movement over it. The solar panels that are to be used as the paved surface should be covered with silicon based resin that allows the panel to withstand the heavy traffic load coming over it. In China, the solar panel used over the road is divided into three parts i.e. transparent concrete on the top, photovoltaic panels in the middle, and insulation on the bottom which is further used for illumination of street lights and surrounding areas. With the increasing demand of electric vehicles such kind of pavements should be used for charging of the vehicle to enable uninterrupted journey.



Figure 3: Solar Road

Highway lighting could be enabled with arrangements to make the maximum use of wind energy in open country areas or from passing vehicles to generate electricity as per the latest technology. However, the success of the solar and wind energy enabled pavement heavily rely on the weather of a particular area and hence, the arrangement should be provided with a proper power backup facility.

PIEZOELECTRIC ROADS

Piezoelectric Energy Harvester (PEH) could be generally used in pavement in order to convert the mechanical energy of moving vehicle to electrical energy. This technique uses the strain energy caused by moving vehicle over asphalt road surface and harnessing kinetic energy or vibrations from moving vehicles. The vibrations from

moving vehicles are nothing but imbalance caused by strain of a tire on gravel road (asphalt road). In order to capture and harness such energy, use is made of a piezoelectric transducer which by nature is a perfect device since piezoelectric materials react to “compression” to produce electrical output which can be further used in highway lighting.

DIGITAL ROAD SIGNAGE/APP

Digital road signboards or an Application (App) showing all the relevant data to the commuters which includes speed limit, weather conditions, traffic jams, vehicle concentration on the road ahead, break down assistance, charging station, etc. could be installed along the road or provided through an App to alert and guide the road commuter about the upcoming facilities/ hurdle ahead. The signboards could be provided with radar gun /video cameras in order to measure the speed of the moving vehicle and monitor traffic could be linked to a control station so that anybody violating the traffic rule could be penalised accordingly and also provide assistance where needed. These would enable better flow of traffic and proper enforcement of traffic rule.



Figure 4: Piezoelectric Road

DYNAMIC PAINT

Provision of Luminescent paint over the road markings which is charged by solar energy during the day and then glows for up to 10 hours when it gets dark. This means that the road markings have higher visibility than those using standard paint. These paints don't even require electricity for illumination.

INTELLIGENT NETWORK HIGHWAYS/ SMART HIGHWAYS

Intelligent Network Highway or Smart Highway is the future prospect of highway engineering which is an integration of modern technologies such as self-driven vehicle, power generation using solar/ wind/ vertical strain, enhanced safety features, and automated monitoring systems. One potential example of smart highways would be engineers or an AI system utilizing real-time data to analyse traffic flow in a specific area in relation to lane mergers and freeway exits, optimizing roadways to ensure the least amount of time a car is stopped at any specific traffic choke point. This would also enable free flow of fast moving vehicles without stopping even at toll stations by generating an automated receipt.

SIX SIGMA TECHNIQUE

It is a Project Management technique which is a systematic method to reduce the deviations and variations by eliminating the non-value adding and waste activities. Six Sigma methodology provides a structured framework DMAIC (Define, Measure, Analyse, Improve, Control) for continuous process improvement. By that it ensures improved quality of construction and reliability on construction process, reduction in cycle time, wastage and hence, construction cost.

CONCLUSION

From the different technological aspects/ innovations discussed above it is evident that, people involved directly or indirectly with highway industries need to upgrade their working by adopting the latest inventions. Use of non-conventional resources and innovative ideas in paved surface would result in cost effectiveness and improved performance of the road project. The concept of smart highway should be adopted by a developing country like India where peak traffic and accidents are a major concern.

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FICCI URGES FINMIN TO RE-LOOK INTO GST REGIME FOR CONSULTING, SERVICE SECTOR

Press Trust of India | New Delhi June 27, 2019

Industry body Ficci Thursday urged the Finance Ministry to have a re-look at Goods and Service Tax (GST) regime for consulting and service sector.

“Ficci’s National Committee on Transport Infrastructure and the Consulting Engineers Association of India (CEAI) has urged the Union Ministry of Finance to have a re-look at its Goods and Service Tax collection regime for Consulting and service providing sector and urged to put the onus of depositing of Goods and service tax on the Client (Service Receiver) including both the government and Private sector,” it said in a statement.

At present, the consulting and service community which provides service to the government and private sector is being coerced into payment of GST on behalf of the employer, whereas, their role is that of a mere collector of tax on behalf of the government, the industry body said.

“Ficci Infra Committee and CEAI on various occasions have written to ... Minister of Finance and to GST Council that the GST payable by the employer of consultant and service sector should be collected by Government directly from the employer or service receiver. “At present, the Consulting community continues to be made liable for payment of GST on behalf of the employer, even before the consultants receive their remuneration from the employer,” K K Kapila, Co-Chairperson, Ficci Infra Committee and Chairman advisory committee CEAI, said.

This practise places an enormous burden on the service providers, as most of the service seekers are various government departments...where payment invariably gets delayed, many times 4-6 months and even beyond a year in a few cases, Kapila said.

“This effects the cash flow of service providers and many have become defaulters in settling the GST dues for no other reason but due to lack of resources, as the payment is being sought even before receipt of the money for the services rendered,” Kapila added.

https://www.business-standard.com/article/pti-stories/ficci-urges-finmin-to-re-look-into-gst-regime-for-consulting-service-sector-119062701341_1.html

FUTURE OF ENGINEERING WITHIN THE ECOSYSTEM



Er. Ronald Valledor Gomeseria, PhD

MCEAI, PE, PEng, CEng, CEnv, CBuildE, ASEANEng, ACPE, IntPE

Bachelor of Science in Mechanical Engineering

Bachelor of Science in Fire Protection and Life Safety

Master of Science in Mechanical Engineering

Master of Science in Construction Management

Ph.D. in Building and Construction Engineering

INSIGHT

The principles of future of engineering ought to be derived through the Environmental Possibilism evolution, in order that future generations benefit from it. It has been said that the scientific and the technological innovations provided by the scientists and engineers have been resulting in economic prosperity and that's verily so. However, due to the economic growth that has been enjoyed by the society, the environment has been setback as discussed in the author's articles in CEAI's ViewPoints, (*"Environment and Climate Change"*, March 2018; *"Built Environment-Energy Conservation for Utilities"*, September 2018; and the *"Engineering Consultancy for Nation Building"*, December 2018). The consequences have been climate changes across the globe.

Moreover, the future of engineering is inter linked to the conceptual needs within the competitive landscape, and one of these examples is the innovative designed urban planning implemented in Dubai evolving high technology applied in most of the buildings skyscrapers that have been constructed within their building-built environment.

Because of developing technology which as known today and the future generation with the increasing usage of the Internet of Things (IoT), through innovative machine learning and augmented reality, it could transform how organizations capture and use project data. Those are just some of the features in the competitive landscape being introduced today.

However, within the built environment, the future of engineering would focus on the importance of energy conservation with the use of the Treated Sewage Treatment System, Renewable Energy, Chilled Water Plant District Cooling, District Heating, and using the Building Information Modelling within the Energy Conservation and Sustainability platform. Energy conservation would play a significant role in reducing the effect on global climate change. Replacement of non-renewable resources with renewable ones can impact the environmental possibilism in the competitive landscape, which are now being practiced as part of the future engineering scenario within the ecosystem.

In the author's articles in the CEAI ViewPoint, March 2019 on "Remote Sensing and Remote Monitoring" it is brought out that it would become an indispensable part of the future through the Building Management and Control Systems to enable all building operations to be monitored for precise building controls and services in time of emergency constraints and solving building maintenance issues even without the presence of any human.

With all the above mentioned as part of the future, the essential thing to innovate and understand would be the

implications of manufactured, bottled water, the electronics and the creation of seed vault for the preservation within the ecosystem as part of the competitive landscape. These are discussed in the following sections.

BOTTLED WATER

In today's generation, production and usage of plastics is ubiquitous with their advantages and disadvantages being debated. Most of the plastic is becoming an environmental hazard since 80% of it is discarded haphazardly and is not recycled - it is just dumped and / or burnt. In the future, stricter regulations would be in place for the processes for plastics that would be designed for the dump - emphasizing the process of extraction, production, distribution, consumption, and disposal. It would create jobs, help families and contributes to economic progress for the community, while safeguarding the Earth.

It is being gradually realised that the use of plastics must be limited to only where it is necessary and essential. On the other hand, Nestle advertises that *"bottled water is the most environmentally responsible consumer product in the world."* Organisations such as Nestle must realise and acknowledge that in reality, they are trashing the environment for their profit. They say that they are **"environmentally responsible"** does not gel, they need to take care of the products they produce so that they are biodegradable. Rivers, water bodies and seas are full of plastic in macro and micro form. The scientists, engineers, and technologists must address this pollution issue post haste before it gets out of hand. Plastic producers must eventually develop effective collection and recycling processes.

Based on statistic, 80% of the plastic production has been disposed through landfills, and the fact is, the water bottled plastic is non-biodegradable and therefore, the water bottled plastic will live in the dumps, and that will lead to toxicity of the environment. Alternatively, if incineration is resorted to it will also cause an environmental problem as it releases toxic fumes and that will cause sickness due to the unhealthy air.

Thus **"recycling"** could be a viable mode. Besides it conveys a positive impact.

ELECTRONICS – USE BY INDIVIDUALS, FAMILY, AND COMMUNITY AT LARGE

Another concern in today's generation is the electronics which is everywhere and gives everyone an advantage as well as allied disadvantages to individuals, family and even the community. It is an advantage in the sense that one can do and apply what one needs since it has simplified everything and made life easier. On the other hand, electronic materials contribute to use of unsustainable materials in the world's economy. The implications of the increasing use of electronics in everyday life because of technological innovation happening around the world and upgrading of devices results in the older version adding to the toxic electronic dumps. Dump design is proffered as a solution – it emphasises the process of extraction, production, distribution, consumption, and disposal of electronic items.

However, with all the innovations, today's electronics are hard to upgrade, but are easy to break and impractical to repair because of the competition in the market place. The consumers are thus forced to buy new ones, which eats into the peoples wallets the amounts they earmarked for sustaining their basic needs. Overall, the innovations are creating a global toxic emergency, and as mentioned, many of them are made from over 1000 different materials that cause environment issues because of the toxic chemicals used in their production - like PVC, mercury, solvents and flame retardants that have been poisoning the community and the world. They all could be causing health problems.

While technological innovation is part of the future of engineering it must take care of the environment and sustain it for the future generations.

ARCTIC SEED VAULT

Agriculture is a very important sector and to provide the means for growing the plants in the future also scientists have created “*The Arctic Seed Vault.*” Some journalists, refer to it as the “*Noah’s Ark of Plant Diversity.*” It is a global seed vault, located at the Longyearbyen, Svalbard, Norway, where copies of seeds from gene banks from all over the world of about 4million different seeds crops have been stored. The vault can hold a maximum of 2.5 billion seeds. The vault was created as a backup system for the world’s gene banks to protect humanity against catastrophes that could potentially wipe out the world’s agricultural diversity. The vault is the world’s most extensive collection of genetic diversity of crops and currently covers 13,000+ years of agricultural history. The genes existed in the natural flora in the Middle East 10,000 to 15,000 years ago. The farmers have started to use those seeds from the vault and have improved the crops.

There are 70,000 different varieties of barley at the seed vault, 150,000 samples of rice, and 140,000 samples of wheat. Moreover, the work at the gene banks is done every day to conserve the seeds and provide the genes for future food supplies. It is good to conserve for future food supplies in the “The Arctic Seed Vault” since it may be needed in the future. At present most of the seeds are from Russia, Ukraine, and North Korea.

In the recent news update, “*UK seed vault preserves endangered plant species,*” June 7, 2019 edition; another underground concrete vault has been established and designed in the West Sussex, UK as part of the Millennium Seed Bank which aims:

- To preserve endangered 40,000 plant species from 190 countries that contain 2.3 billion seeds gathered from 35 biodiversity around the world, which are at risk due to the climate change happening around the globe.
- To preserve the Earth loss of genetic diversity caused by the crops which are less resilient to disease, invasive species, pests, habitat loss, and climate change.
- To care what is relevant to the communities like Botswana Morama bean that have turned into milk and butter as one of the nutritional plants used in everyday lives.

With all happening around the globe is due to environmental possibilism and humankind’s relentless economic growth that suffers our environment. Moreover, engineers and scientists have essential roles which are on collaboration in terms of vault design in the preservation of seeds with the following function in aligning with our future of engineering.

- The Civil/Structural Engineer designed the vault that lasts up to 500 years.
- The Mechanical Engineer designed the refrigeration process within the vault environment at - 20°C for preservation of valuable seeds from around the world.
- The Fire Protection Engineer designed the vault for the protection of radiation, bombs, floods, and also installed alarms to guard against thieves.
- The Electrical Engineer designed the power and illumination for the vault.
- The Agricultural and Environmental Engineers/ Scientist are responsible for all the seeds being cleaned, x-rayed to check for insect larvae, dried and sealed into airtight glass containers as well as the importance of research and development.

CONCLUSION

With all the innovations happening around the globe which impact climate change, future of engineering would need to meet the requirements demanded by a competitive society. Engineers and scientists must focus more on energy conservation and reduce carbon footprint using renewable energy within the infrastructure and building built environment for innovative engineering resulting in a green environment.

Reducing the production of plastic bottled water and preventing toxicity from electronics production is another very important agenda for the future. Thirdly, the preservation of plant and crops seeds will help the habitants of the globe in innovative agro-farming for future generation.

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GADKARI HAS BIG PLANS TO PUSH INDIA'S INFRASTRUCTURE

Source: The Economic Times; June 09, 2019

To further give a push to the country's infrastructure, big plans are lined up that include roping in an advisor for asset monetisation and offering attractive schemes to private players, including identified 3,000 kms of projects, Union Minister Nitin Gadkari said.

Plans are also afoot to make the vehicle scrapping policy more attractive, besides expediting the land acquisition process to create a network of expressways and highways.

"We are planning to rope in an Indian expert with experience in global economy for advising NHAI on asset monetisation," Road Transport and Highways Minister Nitin Gadkari told in an interview.

The advisor, apart from asset monetisation, will guide the National Highways Authority of India (NHAI) on innovative ways to meet funding requirements, he said.

After the huge success of the maiden bundle of nine highway projects under TOT (toll, operate and transfer) totalling 681 kms of roads in Andhra Pradesh and Gujarat in 2018 that fetched NHAI Rs 9,681 crore, the second tranche of 586 kms was cancelled in February 2019 due to lukewarm response.

TOT is a model for monetising operational national highway projects. The investor makes a lumpsum payment in return for long-term toll collection rights backed by a sound tolling system. The concession period is 30 years.

Up to 49 per cent divestment is allowed till two years of the concession period while up to 10 per cent change in ownership is allowed after two years.

The government now plans to offer 550 km of roads under TOT.

Apart from asset monetisation, Gadkari said the government will attract private players into highways building and has already identified 3,000 kms to be bid out under the build operate and transfer (BOT) mode.Read more at <https://economictimes.indiatimes.com/news/economy/infrastructure/gadkari-has-big-plans-to-push-indias-infrastructure/articleshow/69710797.cms>

CHALLENGES IN ENGINEERING EDUCATION IN INDIA



Rakesh Mehrotra
Former Associate Professor



S. K. Mazumder
*Former AICTE Emeritus Fellow
and Professor*

*Department of Civil Engineering,
Delhi College of Engineering (DCE/ DTU)*

INTRODUCTION

India has been evolving the educational system for over the past seven decades taking into consideration its priorities and global trends. The major issues to be addressed in the Indian Education System are quality and scale. Post Independence, India started off with quality as the primary factor in establishing the Indian Institutes of Technologies (IITs) and the National Institutes of Technologies (NITs). That was followed by a phase with focus on large scale increase in educational institutions. India has been trying to expand higher education from its present enrolment of 25.8% to target the World average Enrolment ratio of 33%. As per the All India Council of Technical Education's (AICTE's) latest notification (m.hindustantimes.com, dated 18 May 2019) there were 3,241 institutes offering Undergraduate (UG) and Post Graduate (PG) courses in Engineering disciplines with an intake of 15,87,097 seats in 2018-19. The expansion sans job opportunities saw seat vacancy in 2018-19 at 49.3%. It has also resulted in a recommendation not to allow any new Institute in the next two years.

Before 1990, technical education was largely Government funded however over a period of time the Government was unable to find resources for meeting the growing demand. The private sector saw it as a lucrative opportunity when the Government policy allowed setting up of self financing Technical institutions. That resulted in more than 10 times increase in number of UG/ PG Engineering education Institutes and available seats. In the current situation a large number of the self financing Institutions may close down in future due to lack of demand and consequent financial viability.

The single minded pursuit for inclusion and growth in enrolment took quality aspects to the back seat and led to a situation where higher financial outlays are resulting in negative outcomes in terms of quality deficits and inappropriate human resource development. The repeated statements by industry captains that only 10-25% of the engineering graduates have chances of getting employed needs to be heeded by the higher education regulators, policy makers and the administrators of the Technical Education Institutes. There is much to be modified in the system to improve the Technical education in the country.

PREVAILING EDUCATION SYSTEM

The present system is focused on encouraging rote learning, and preparation with no value for nurturing creativity. The students and the school administration measure success of an individual or the school in terms of their students getting high marks in Board exams and cracking competitive exams that are largely designed to test rote learning and have little to do with creative thinking and application of knowledge. These patterns continue in higher education

institutions including engineering colleges as well. There is excessive importance on marks for seeking admissions to higher classes and for jobs. Due to huge variability of standards and decreasing reliability in public examinations, admission tests and competitive exams for jobs have become a normal practice. All the above have resulted in exam focused study instead of knowledge and learning orientation not only at secondary education stage but even at UG/PG level and beyond. Coaching centers have mushroomed for cracking such tests. Therefore the whole educational ecosystem has become exam centric particularly where paper setting and question paper evaluation is not done in-house/ internally.

OBJECTIVE OF HIGHER EDUCATION

There is a big difference between perceived objectives of higher education and ground realities in India. Today, it is common to acquire an academic degree to qualify for a job or to fulfill a prerequisite for a higher degree. For many it may just be for time pass. Lofty objectives like intellectual growth, developing knowledge, competency in certain subjects and quest of knowledge touch very few among those pursuing higher education degrees. It must also be understood that the purpose of higher education and the training requirements vary widely depending upon the programme being pursued such as Academic- BSc, MSc, BA, MA in pure Sciences or Humanities; Vocational/ Skill or Professional- B Tech, M Tech in Engineering and Technology.

- The Professional degree programmes require all the theoretical concepts and knowledge of standard imparted in BSc/ MSc along with experiential learning, industry relevant practices and skills and practical application of knowledge. For Engineering degree holders, there is a possibility of a predetermined future. Therefore appropriate exposure, proficiency and adaptability can improve suitability for the job.
- The Academic degree programmes do not have any task other than academic coursework. Unlike professional courses/ job oriented courses there is hardly need for anything except academic rigour.
- In Vocational degree programmes there is very little theory and large part is related to practical training.

POLICY AND ADMINISTRATIVE DEFICIENCIES

Forces of globalization and liberalization have cast their influence on the higher education system in India. While joining the rat race for QS or Times, World University ranking the focus is on parameters and weightages used in getting scores. In view of the above, lopsided importance is being given to PhD, research papers, attending courses, etc. for faculty recruitment, appraisal and promotions.

- The Indian higher education system has been operating on assumptions that academicians are honest, hardworking, dedicated, not prone to monetary inducements, etc. This may have been true 40 yrs back but today most people are compelled to deriving benefits by gaming the system. Various criteria as given below have been evolved over the years: A higher education desk in Delhi thought that PhDs would increase the quality of Indian higher education system and it became an essential qualification. Consequently, all and sundry started doing PhDs and M.Phils.
- When number of seminars and conferences became a criteria for fetching marks during assessment, all colleges started conducting national and international seminars.
- When ‘articles published’ became one of the norms, a number of article publishing industries sprang up serving the poor and needy teachers who otherwise can’t write and publish.
- When publishing an article in a UGC approved journal became the norm, almost all the journals managed to get the stamp of approval from UGC and the publishing industry thrived.

- When honours and awards became the norm and began to be recognised, people in Higher Education Industry made it so simple that one can get a D.Lit. degree for a paltry sum.
- When Higher Education in India started recognizing ‘member of editorial boards’ or Editors, many serving and retired Professors either started their own journals, especially online journals with a prefix of ‘international’ or became members of editorial board on quid pro quo basis.
- Likewise, being a member of BOS (Board of Studies) is an honour for a professor which can be tacitly got by ‘understanding’ and ‘influence’.
- When ‘books published’ started getting marks during selection process of Assistant Professors, many aspiring teachers became authors, overnight.
- When minor and major research projects became to be recognized as merit, clamour started building around them, and people started getting them.
- 25 yrs back, low pass percentage meant higher quality. Sometimes, in a class, only a few used to secure the passing minimum. Marks scored by students truly reflected their quality and erudition in the subject. Students got the Marks that they really deserved. However, after the advent of National Assessment and Accreditation Council (NAAC) and recently National Institutional Ranking Framework (NIRF), when pass percentage became one of the criteria, pass percentage of several colleges shot up.
- After the advent of NAAC and NIRF, all the colleges are obsessed with securing ‘A+’ grade by NAAC and a decent ranking in NIRF. The objective of UGC, NAAC and NIRF is to improve the quality of Higher Educational Institutions by measuring the institutions using a set of Performance Indicators.

However, the indicators created to judge have not served their intended purpose; the solutions became problems. No matter how well intended and brilliant a scheme was/ is to improve the quality of Indian higher Education, it would in all likelihood backfire because of loopholes in the system. Hence better instruments of quality assessment need to be devised since mechanical methods are prone to manipulation.

IMPROVING ENGINEERING EDUCATION FOR FUTURE

Various review reports have pointed out that there exists a misalignment between engineering education and practice. Engineering educators hardly understand engineering practice beyond design and technical theory. The large gap that exists between engineering education and practice has become traumatic for young engineers resulting in lack of confidence. Some of the critical issues that need to be addressed have been brought out by different agencies, they are:

- Students at school level be exposed to multiple vocations/ alternatives so that they could discover professions of their own liking rather than head towards the engineering or the medical profession.
- Knowledge and capabilities of engineering graduates and post-graduates need great improvement. Routine engineering jobs would be reduced in the future as automation and AI become more pervasive in the future.
- Various application oriented skills and innovative approaches must be addressed in the design of engineering curriculum. The system of instruction, examination/ evaluation has to undergo drastic change for inculcating critical, analytical attributes and higher order thinking.
- The twelve desirable attributes of engineering graduates as per the Washington Accord (WA) should be addressed for engineering educational institutions. Namely: Engineering knowledge, Problem analysis, Design/

development of solutions , Conduct investigations of complex problems, Modern tool usage, The engineer and society, Environment and sustainability, Ethics, Individual and team work, Communication, Project management & finance and lifelong learning.

GAs, particularly the professional skills, should be integrated and embedded in engineering education. Universities should interpret subsets of the graduate attributes as requirements for each course, rather than a requirement to be satisfied only once or twice during the overall curriculum delivery

- Greater use to be made of the web-based engineering course materials and open-source learning materials.
- The tools/ software available in the industry should also be made available to the academics. There may be a good number of collaborative assignments that expose the students on various interdisciplinary requirements. The tools should be used for familiarity and not to substitute the “learning” side of defining and solving problems manually from first principles.
- Engineering accrediting authorities must be created on the lines of NAAC/ National Board of Accreditation (NBA) to get the engineering educational institutions to modify their program.
- Qualification levels, experience and expectations from teaching staff for engineering/ professional degree programmes should be different from those with non professional degree programmes run in general Colleges and Universities. The best talent in engineering have good job opportunities after graduation and do not need to spend more time to pursue higher degrees. Therefore, those who initially go upto PhD are most often the ones who while trying for jobs, keep on acquiring degrees. Teaching and research are no longer the preferred career option of job seekers in engineering and at times it is the last resort. One cannot expect great quality in engineering education unless faculty is top quality and is motivated to inspire, involve and transform students into outstanding engineers with great minds and positive mind-sets.
- There needs to be an active orientation of students towards R&D, designing and creating their own thought processes or solutions. The industry may need to share their persistent issues/ problems with the academics and the students should be encouraged to come up with their own thinking about providing solutions.
- Engineering education systems are part of the supply chain for the industry. There needs to be industry wide cognizance of these aspects. This could potentially pave the way for larger investments by the industry in the education systems. Ways to enhance the industrial sponsorships and investments may also be explored at policy levels e.g. tax incentives, etc to fund Industry relevant research and courses.

CONTINUING EDUCATION FOR PROFESSIONAL ENGINEERS

Technology landscape is evolving fast, driving the ever changing demand in the skill/ competency level of engineers. The engineering education should also be dynamically adaptive to these changing requirements. Changes in the engineering education need to be continuous and agile to serve the industry better. Hence the drive for competency improvement should also be continuous. There needs to be concerted, focused and coordinated efforts by all related stakeholders, to maintain relevance and alignment of engineering education, with the new technological requirements. This big task cannot be accomplished by the engineering institutes alone; there is a requirement of proactive participation of the industry as well.

Merely ensuring a good talent pipeline to the industry through good engineering degree education is not enough. The engineer has to apply the knowledge acquired in real life and there needs to be learning, un-learning and re-learning processes as well - life-long learning needs to be inculcated in all. That is the only way to keep up with the pace of technological changes.

The education system must equip all the students to become proficient in independent study and learning. Educational institutions should also gear themselves to offer refresher courses and advanced continuing education programmes for updating the academic base of professional Engineers. Engineering educators also need industry internships to stay relevant.

Re-validation and re-certification of engineers engaged in professional fields would ensure requisite learning efforts by all working engineers. It would ensure that they remain updated and abreast in latest technologies. It may necessitate a system of registration and/ or licensing for practising engineering profession as being followed in many other countries e.g. Professional Engineer (PE) in USA.

CONCLUSION

- If India's Higher Education establishment desires to rise up to international level, some rigorous norms of faculty recruitment and promotion followed by reputed universities in US and Europe must be followed. In the Indian context, there should be a National Qualifying test (on the lines of NET but more comprehensive and tougher) to get entry level faculty positions in Engineering .Firstly, hiring faculty should be on Tenure or contract basis(> 50 % of total strength), these faculty members should be paid 20% higher emoluments. Promotions should be granted only after independent Peer review/ appraisal of reputation and not by a mechanical administrative criteria.
- To encourage research, the funded Research projects should have a remuneration component for the Principal Investigator. To have relevance of research for industry, all Engineering Post graduate research Projects should be Industry funded.
- The student intake should be aligned with projected market demand.
- Pay scales of Faculty to be linked to knowledge and capability of the person and the demand of that discipline and subject. Further, General Science and humanities faculty and those imparting Professional education cannot be equated. AICTE need not replicate UGC norms for faculty recruitment, promotion and pay.

BUDGET 2019: INDUSTRY BODY CALLS FOR GST RATIONALISATION, SIMPLIFIED REGISTRATION PROCESS

NDTV: 1 JULY 2019

Stating that the Goods and Services Tax (GST) had been a “huge success”, industry body Confederation of Indian Industry (CII) on Saturday called for implementation of its next version. The call for further evolving GST comes as it completes two years in operation.

“The Indian model of dual GST is unique in the world and represents a paradigm of partnership between the Central and state governments, and between the government and the industry,” CII President Vikram Kirloskar said.

According to CII, India, with a strong federal polity, managed to get two GSTs to flow together in a unique structure which was not seen in other countries and one which succeeded without many hiccups.

“The GST Council is proactively examining all issues facing the industry and providing solutions. GST 2.0 will take the Indian economy to the next growth level,” Mr Kirloskar said.

According to the industry body, further rationalisation of taxes and simplification of registration process among others will usher in GST 2.0.

<https://www.ndtv.com/business/budget-2019-industry-body-calls-for-gst-rationalisation-simplified-registration-process-2062035>

SELF-REGULATION AUTHORITY FOR ENGINEERS IN INDIA – A CRITICAL ANALYSIS



Vr. Mainak Ghosal

*PhD (Pursuing), ME (Struct.), PGDM,
MBA (HR), MIE, MSc (Pursuing), FIV*

1.0 INTRODUCTION

By self-regulatory authority of a profession is implied a select body of its members which is responsible for the growth and development of the profession in keeping with its responsibility towards the society and the State. The functions of such a body inter alia are:

- (i) issues of professional education, development of curriculum, setting up of teaching standards, institutional infrastructures, recognition of degrees, etc, and
- (ii) matters concerned with licensing and ethical conduct of the practitioners.

Currently there are seven major self-regulating professional bodies operating in India.

1. Institute of Chartered Accountants of India (ICAI) - formed under the Chartered Accountants Act, 1949.
2. Medical Council of India (MCI) – formed under Indian Medical Council Act, 1956.
3. Institute of Cost & Works Accountants of India (ICWAI) - formed under the Cost & Works Accountants Act, 1959.
4. Bar Council of India (BCI)-formed under Advocates Act, 1961.
5. Press Council of India (PCI) – formed under the Press Council Act, 1965.
6. Council of Architecture (CoA) – formed under the Architects Act, 1972, and the
7. Institute of Company Secretaries of India (ICSI) – formed under the Company Secretaries Act, 1980.

Then, there are organizations like the Institution of Engineers (India) which have been formed purely by voluntary action by respective members of the profession but don't have any statutory authority although they have a Royal Charter and its membership recognized and acknowledged by local bodies as being a prerequisite for being acknowledged as a professional engineer.

One of the major tasks of self-regulatory authorities is to manage and regulate professional education. The National Knowledge Commission (NKC) which was constituted in 2005 with a mandate to prepare a blueprint for transforming the country into a knowledge society has gone into issues of higher education in the country (e.g. management, law, and medicine). One of its major recommendations was that Professional Education should be taken away from the domain of the existing Regulatory Bodies like UGC and AICTE and recommended a single independent regulatory authority for higher education, but at present the HRD Ministry has put the idea on hold.¹

2.0 INDIAN DEVELOPMENT


The matter is available on CEAI's website but is being herein for completeness and ready reference. Several years ago in 1970, the Barve Committee, which was set up by the Planning Commission, had identified the need to fulfill two essential requirements – statutory recognition of the profession of engineering through consulting and registration of engineers for proper growth and development of the engineering profession in the country. But even after more than 48 years of setting up of the Barve Committee, the plight of engineers remains the same. Shri Barve made a number of recommendations, two of the most important of which were formation of one or two **Associations of Consulting Engineers** which should be given **recognition by the Government**, which is still due and the second was to **enact legislation for regulation of the profession of engineering**. The first draft of the “**Engineers Bill**” was made in 1985 by the Association of Consulting Engineers (India). However, it was only in 1990 that the Ministry of Human Resource Development (MHRD) was identified as the nodal Ministry for this bill. In 1991 the Hon'ble Minister of Human Resource Development Shri Raj Mangal Pande directed his Ministry to process the draft Bill. But it got strangled in PIL with the court judgement directing the Engineers to form a consensus.

A confederation of all the Engineering Associations & Societies representing different disciplines was formed and was called “**Engineering Council of India**” (ECI) under the patronage of the then Vice Chairman of the Planning Commission, Shri K C Pant. ECI prepared a second draft of the **Engineers bill** and presented it to MHRD for its review, approval and for processing it further in 2004. MHRD instead of processing the draft bill presented by ECI, decided to give the responsibility of **regulation of the engineering profession to the All India Council of Technical Education (AICTE)**.

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भारत का राजपत्र

The Gazette of India

असाधारण
EXTRAORDINARY
भाग III—खण्ड 4
PART III—Section 4
प्राधिकार से प्रकाशित
PUBLISHED BY AUTHORITY

सं. 187] नई दिल्ली, सोमवार, दिसम्बर 4, 2004/अग्रहायण 13, 1926
No. 187] NEW DELHI, SATURDAY, DECEMBER 4, 2004/AGRAHAYANA 13, 1926

अखिल भारतीय तकनीकी शिक्षा परिषद्
अधिसूचना
नई दिल्ली, 24 नवम्बर, 2004

राष्ट्रीय इंजीनियर्स रजिस्ट्रिकेशन एवं अनुज्ञापन बोर्ड
(एनईआरएलबी) के सृजन के लिए विनियम

सं. एफ. क्यूए/इंजी.-रजि./051/2002.—अध्यादेश
अधिनियम, 1987 (1987 का 52) की धारा 23(1) के तहत प्रतिष्ठित अधिनियम की धारा 10, खंड (ए) और (क) के अधीन प्रदत्त शक्तियों का प्रयोग करते हुए, अध्यादेश द्वारा मूल्य संतुलन विकास मंत्रालय, भारत सरकार द्वारा उनके दिनांक 9 अगस्त, 2004 के पत्र सं. 1-25/2003-टीएस्.-II में दिए गए परामर्श के अनुसार तथा कंसल्टिंग इंजीनियर्स एसोसिएशन एवं अन्य द्वारा भारत संघ एवं अध्यादेश के निम्नलिखित दस्तावेज, पी. (सिपिल) सं. 755-756/2004 में मानवीय दिल्ली उच्च न्यायालय के दिनांक 15 जुलाई, 2004 के आदेशों के अनुसार में राष्ट्रीय इंजीनियर्स रजिस्ट्रिकेशन एवं अनुज्ञापन बोर्ड (एनईआरएलबी) के सृजन के संबंध में परिचर द्वारा इसकी दिनांक 19-04-2004 की अधिसूचना द्वारा अधिसूचित एवं 22-04-2004 को प्रकाशित विनियम एनईआरएलबी द्वारा वापस लिए जाते हैं।

अनुज्ञापक गुप्ता, सदस्य-सचिव
[विनियम III/IV/162/2004-असाधारण]

ALLINDIA COUNCIL FOR TECHNICAL EDUCATION
NOTIFICATION
New Delhi, the 24th November, 2004

Regulation for creation of National Engineers Registration for Licensing Board (NERLB)


No. F. QA/ENGRS-REG/051/2002.—In the exercise of powers conferred under clause (f) and (v) of Section 10 of AICTE Act, 1987 (52 of 1987) read with Section 23(1) of the Act, the AICTE, as per the advice of MHRD, Govt. of India vide letter No. 1-25/2003-TS.-II dated 9th August, 2004 and in pursuance of the Orders dated 15th July, 2004 of Hon'ble High Court of Delhi in W.P. (Civil) No. 755-756/2004 filed by Consulting Engineers Association of India and Another Vs. Union of India and AICTE, the regulations notified by the Council vide its notification dated 19-04-2004 published on 22-04-2004 regarding creation of National Engineers Registration and Licensing Board (NERLB) are hereby withdrawn.

ANURADHA GUPTA, Member-Secy.
[ADVTIII/IV/162/2004-Exy]

3601 G/2004

Printed by the Manager, Govt. of India Press, Ring Road, Mayapuri, New Delhi-110064 and Published by the Controller of Publications, Delhi-110054.

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GOVERNMENT OF INDIA
MINISTRY OF HUMAN RESOURCE DEVELOPMENT
LOK SABHA
UNSTARRED QUESTION NO- 4142
ANSWERED ON 21.04.2010
SETTING UP OF INDIAN COUNCIL OF ENGINEERS

4142. Shri E.G. SUGAVANAM

Will the Minister of HUMAN RESOURCE DEVELOPMENT be pleased to state:-

(a) whether the Government has any proposal to set up Indian Council of Engineers in the country;

(b) if so, the details and functions thereof; and

(c) the time by which these colleges are likely to be set up?

ANSWER

MINISTER OF THE STATE IN THE MINISTRY OF HUMAN RESOURCE DEVELOPMENT (SMT. D. PURANDESWARI)

(a) to (c): Setting up an Indian Council of Engineers is part of a proposed draft Engineers Bill which is still at the conceptual stage and no final decision has been taken in the matter.

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The Engineering Consultants fought the move of MHRD in the court and won it. The court decreed that AICTE had no mandate to regulate the Profession of Engineering and that a separate body had to be created for that purpose. MHRD set up a Committee under the Chairmanship of Dr. D.P. Aggarwal, a member of the Union Public Service Commission. The Committee had representatives of ECI, CEAI, IE(I) and AICTE. After a number of meetings this committee produced the **third draft of the Engineers Bill** in 2005. In 2007, MHRD also appointed Sh. R.V. Shahi, Retd. Secretary to Government of India, Ministry of Power to head another committee, which also had representation of ECI, CEAI, IE(I), etc. and prepared a **fourth draft of the Engineers Bill**. The **fourth draft was finalized in 2008** and presented to MHRD. This was circulated by MHRD to all the other Ministries and their comments obtained. On the basis of their comments the fourth draft was modified, finalized and put in the pipe line for presentation to the Parliament and subsequent enactment but somewhere down the line a view was presented that the Royal Charter which was given to the Institution of Engineers (India) was adequate. A statement was made on the floor of the Parliament that the Engineers Bill was not required and the matter was closed. After clarifying the issue and great persuasion the draft Engineers Bill was revived and MHRD is currently looking into it.²

3.0 Regulation and Licensure in Engineering³ is established by various jurisdictions of the world to encourage public welfare, safety, well-being and other interests of the general public and to define the licensure process through which an engineer becomes authorized to practice engineering and/ or provide engineering professional services to the public. As with many other professions, the professional status and the actual practice of professional engineering is legally defined and protected by law in some jurisdictions.

In the **United States**, registration or licensure of Professional Engineers and Engineering Practice is governed by the individual States. Each registration or license is valid only in the State where it is granted. Some licensed engineers maintain licenses in more than one State. Comity, also known as reciprocity, between States allows engineers who are licensed or registered in one State to obtain a license in another State without meeting the ordinary rigorous proof of qualification by testing.

The practice of engineering in **Canada** is highly regulated under a system of licensing administered by a self-regulated Engineering Association in each province. These bodies were established by Canada's 13 Provincial and Territorial governments through legislation.⁴ In Canada the designation "Professional Engineer" can only be used by licensed engineers and the practice of engineering is protected in law and strictly enforced in all Provinces. Thus it is illegal to practice engineering or use the title "Professional Engineer" or "Engineer", without a license, albeit with two exceptions—Stationary Engineer and Power Engineer. The regulation and licensing of Engineers is done through each Province's own Engineering Association which were created by Acts passed by the Legislature of the Province.

In general there is no restriction on the right to practice as an Engineer in the **UK**. However, there are a small number of areas of work, generally safety related, which are reserved by statute, regulations or industry standards to licensed or otherwise approved persons. The title "Engineer" is not regulated, but certain engineering titles are. There is no system for licensing, but registers are held of qualified persons. The Engineering Council is the UK body for its engineering profession.

In **Iran**, registration or licensure of Professional Engineers and engineering practice is governed by the Ministry of Science, Research and Technology (Iran).

In **Pakistan**, engineering education and profession is regulated by the Pakistan Engineering Council (PEC) via

PEC Act 1976. PEC is a federal government organization. Any person with an engineering degree (BE/ BS/ BSc Engineering) from PEC accredited universities/ institutes is legally allowed to register with the Pakistan Engineering Council (PEC).

In **Sri Lanka**, the title “Engineer” is not regulated. However, as per the *Engineering Council Act No 4 of 2017*, all engineering practitioners in Sri Lanka need to be registered with the Engineering Council to practice. Failing to do so would result in an offence and can be convicted by a summary trial before a Magistrate.

The **European Engineer** (Eur Ing, EUR ING) is an international professional qualification for Engineers used in many European countries. The title is granted after successful application to a national member of the European Federation of National Engineering Associations (FEANI), which includes representation from many European countries, including most of the European Union. It allows a person who has an engineering degree and usually an engineering professional qualification in one of the member countries to use the qualification in others, but this also depends on the local legislation.

In **Australia**, licensing currently exists at State level only in Queensland, but this model appears likely to be adopted by other States.

Getting back to India where hundreds of complaints against the self-regulatory regime have been lodged, the moot question that arises is whether the so called ‘self regulatory regime’ in India as proposed by the Second Administrative Reforms Commission, 2005 would help to bring in the desired results or end up with more lopsided economic standards leaving the moral conditions marginalized. The Delhi High Court recently dubbed the Medical Council of India (MCI), as a “den of corruption”. The MCI President, Dr. Ketan Desai was caught red-handed by the CBI in 2010 for taking a multi-crore-rupee bribe allegedly in exchange for granting recognition to a private medical college. Chartered Accountants (CAs), for many years, have been opposing a regulator proposed in the Companies Act, 2013 and the Institute of Chartered Accountants of India (ICAI) thinks the body would encroach on its own turf. Criticizing ICAI’s (which is the second-largest professional accounting and finance body in the world) disciplinary record, the Prime Minister had said some months ago, that 25 rogue auditors had faced action in over a decade and around 1,400 cases were pending. The IL&FS case is another instance pointing to collusion. It is suggested that these instances should be taken as a learning on how the Government should monitor such bodies so that hand-in-glove deals are nullified.

Engineers play a crucial role in community safety as they design the systems that ensure that the society runs smoothly with constructed dwellings, clean water supply, waste water treatment and disposal, solid waste management, uninterrupted supply of electricity at the correct voltage, means of transport and its infrastructure, to mention a few.

Being an Engineer implies a lifetime of dedication, after years of learning and then gaining experience day in and day out. However, the current environment fails to recognize the time and tireless effort necessary for becoming a professional engineer. Legislation is therefore necessary to provide self-regulation for Engineering and Valuation professionals, and create a body for monitoring that they discharge their responsibility and are accountable through an effective disciplinary mechanism.

In case of Valuers, the introduction of **Companies Act, 2013** has introduced the concept of ‘**Registered Valuer**’ to cover all valuation of assets. The net worth of a firm or its liabilities under the Act is to be done by a **Registered Valuer** which almost covers the 15 areas of the Act. However, unlike the Wealth Tax Act, 1957 it says that basic Engineering degree like B.E is not compulsory to be a Real Estate Valuer. The question that arises is as to how non

technical persons can judge the type of construction and rates of construction. Objectively, it is really injustice to the profession and is very unfair for persons with a technical background. Another cause of concern is that non technical people are doing MSc Real Estate Valuation are the future Real Estate Valuers, since there is no Act which regulates Engineer or Valuers as for other professions mentioned earlier. In the fitness of things only an Engineering Degree ought to be the qualification for the registration of Valuers, However, since as per the Companies Act, 2013, the qualifications vide 'C row' in says that without Engineering but with MSc Real Estate Valuation, a person can become Real Estate Valuer.

3.0 CONCLUSIONS

At present people are working as “Engineers” in highway projects presenting certificates of questionable authenticity; “Consultants” are presenting CVs which are also questionable.

Indian Engineers are not being considered as Engineers as per GATT provisions. They cannot practice while Philippines, Nepalese, Bangladeshis, Sinhalese can practice as Engineers, Key Personnel. Anomalies, as mentioned above, happen only for engineers, they never happen for Accountants, Doctors, Advocates, and Architects. The question is

WHY?

There must be an Engineers Act too, for regulating all matters related to the engineering profession. Mr. T M Gunaraja, President, the Institution of Engineers India (IEI) while inaugurating the Nagaland State Chapter in Kohima in February, 2019, informed that the Union Ministry of Road Transport and Highways was taking the initiative to place the Engineers Bill in Parliament. He stated that the “Engineering profession is not regulated in the country whereas the regulation exists in other parts of the world.” He further added that after the passage of the bill, engineers would have to clear certain levels of examinations to be acknowledged as a Professional.⁴

As per report in Viewpoint of March 2018, the AICTE has been appointed by the Ministry of Human Resource Development, Government of India to draft the Professional Engineers Bill. The outcome is awaited.⁵

The Government of Gujarat had enacted “Gujarat Professional Civil Engineers Act” in 2006, but it has not been acted upon. It is imperative that such an Act be put in practice and also cover all engineering disciplines on a pan-India basis. After the 2013 holocaust of Uttarakhand, the devastating Tsunami in Tamil Nadu in 2004, Earthquakes, the yearly Floods, Storms and the continuing rampant construction leading to loss of precious property and lives the Consumer Protection Bill, 2018 which has been passed in the Lok Sabha is awaiting Rajya Sabha’s approval, includes in its ambit ‘construction of homes or flats’ having product liability action. The earlier it comes into force the better since as per reports between 2001 to 2015 an average of 7 structures collapsed everyday killing over 2000 persons every year in the country. Though now there is some consensus among professional engineers about generally accepted approaches, methods and procedures, there remains a need for education, training, regulation and standardization of prevalent practices in engineering.

India on the threshold of 21st century is still a developing country. For all the habitants of the country to benefit from the development and to prosper it is imperative that Engineers be a part and parcel of decision making so that rationality is not lost sight of for short term gains which may not sustain in the long run. So to give statutory recognition to the Engineering profession, The Engineers Act is the right solution in sight and must be set forth by the Parliament.



“The world will not be destroyed by those who do evil, but by those who watch them without doing anything”

– *Albert Einstein*

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PSLV-C46 SUCCESSFULLY LAUNCHES RISAT-2B

May 22, 2019

India’s Polar Satellite Launch Vehicle (PSLV-C46) today successfully launched RISAT-2B satellite from Satish Dhawan Space Centre (SDSC) SHAR, Sriharikota. This was the 72nd launch vehicle mission from SDSC SHAR, Sriharikota and 36th launch from the First Launch pad.

PSLV-C46 lifted-off at 05:30 Hrs (IST) from the First Launch Pad and injected RISAT-2B into a orbit of 556 km, about 15 minutes and 25 seconds after lift-off. After separation, solar arrays of RISAT-2B were deployed automatically and ISRO Telemetry Tracking and Command Network (ISTRAC) at Bengaluru assumed control of the satellite. In the coming days, the satellite will be brought to its final operational configuration.

RISAT-2B is a radar imaging earth observation satellite weighing about 615 kg. The satellite is intended to provide services in the field of Agriculture, Forestry and Disaster Management.

ISRO Chairman Dr K Sivan congratulated the launch vehicle and satellite teams involved in the mission. “With this launch, PSLV lofts 50 tonnes to space by launching 354 satellites, including national, student and foreign satellites.”

Dr. K Sivan also commended the efforts of the team involved in the realization of the piggyback payload carried onboard this mission namely, Vikram processor and low cost MEMS based Inertial Navigation System (INS) developed by Semiconductor Laboratory (SCL), Chandigarh and ISRO Inertial Systems Unit, Thiruvananthapuram respectively. He also quoted “RISAT-2B is an advanced Earth Observation satellite with an advanced technology of 3.6m radial rib antenna”

A total number of 5000 visitors witnessed the launch live from the Viewer’s Gallery, which is opened to the public.

ISRO is now gearing up for the launch of Chandrayaan-2 onboard GSLV MkIII during the window of July 09, to July 16, 2019, with an expected Moon landing on September 06, 2019.

<https://www.isro.gov.in/update/22-may-2019/pslv-c46-successfully-launches-risat-2b>

CEAI NEWS

ADVANCED WORKSHOP ON STEEL DESIGN

CEAI-Western Region Centre jointly with Institute for Steel Development & Growth (INSDAG) and the Centre of Excellence in Steel Technology at the Indian Institute of Technology Bombay very successfully conducted the “*Advanced Workshop on Steel Design*” at Mumbai on 14th & 15th June 2019 as a sequel to the two in 2012 and 2015. It was planned on the basis of the feedback received for the earlier two.

During the inaugural session Mr. A P Mull, Past President CEAI and Former MD & CEO Tata Consulting Engineers accorded a warm welcome to all the dignitaries and participants, briefed them on CEAI, its activities, the responsibilities and accountabilities of engineers and the need for legislation for engineers. Dr. H Subbarao, Chairman CEAI-WRC and CMD Construma Consultancy also welcomed everyone and introduced the themes for the course. He stressed on the need for proper design especially for seismic forces and also to treat fire as a load. Mr. Jeffrey Nambiar, Hon. Secretary cum Treasurer and Director Chempro Expertise Pvt Ltd. thanked the participants many of whom had come from the north, south and east of the country; the speakers and the IIT Bombay team who had helped organize the workshop.

To bring everyone on the same wave length vis-à-vis the workshop started with the behavior of structures and manner in which loads are taken up by structures. Thereafter there was a quick recap of the basic principles of Limit State Design of Steel Structures.

The sessions then moved on to the design of steel structures treating fire as a design load on the structure. This is essential in view of the numerous FIRE incidences that have occurred in urban and industrial areas. Design for SEISMIC forces - analysis and design aspects were dealt with. WELDING was the third area. Discussions were also held on Ethics and Quality. The engineers were exhorted to design and construct as per codes and standards at the least and go beyond them when necessary and be true and honest to the profession.

Around 140 participants from all over the country, comprising individual persons and those from different organisations encompassing Consulting & Contracting firms, Government Departments, Public Sector Undertakings, Faculty and Students from Engineering Institutions/ Colleges, et al attended the workshop. The topics covered and the faculty who made the presentation were:

- **Behaviour of Structures**
Prof. Siddhartha Ghosh, IIT Bombay
- **Metallurgy of Steel**
Mr. Sanjay Nandanwar, Associate VP, JSPL
- **Basics and Recap of Limit State Design**
Dr. Harshavardhan Subbarao
Chairman, CEAI-WRC
CMD, Construma Consultancy Pvt. Ltd.
- **Structural Design for Fire**
Dr. S R Satishkumar, IIT Madras
- **Design as per American Institute of Steel Design (AISC)**
Mr. Charles F Simoes,
Former Associate Director, Aker Solutions
- **Fire Resistant Design of Steel Structure**
Dr. Suvir Singh
Group Leader & Chief Scientist, Fire Research Group, CSIR-CBRI, Roorkee
- **Osdag - Software for Steel Design and Detailing**
Prof. Siddhartha Ghosh, IIT Bombay
- **Carbon Footprints of Steel Structures**
Mr. Subhasis Pradhan
Product Development & Application Engineering Group, JSPL
- **Advances in Design under Seismic Conditions**
Prof. Meera Raghunandan, IIT Bombay
- **Welding Procedure Specification**
Mr. Jeffrey Nambiar
Hon. Secy cum Treasurer, CEAI-WRC
Director, Chempro Expertise Pvt. Ltd.
- **Case Study (Composite Structure)**
Mr. M M Ghosh, Asstt GM (C&S), INSDAG

- **Ethics & Quality**

Mr. A P Mull

Past President CEAI, Co-Chairman CEAI-WRC

Former CEO & MD Tata Consulting Engineers Ltd

- **Design of Connections**

Dr. S R Satishkumar, IIT Madras

- **Connections for Seismic Conditions'**

Mr. Yogesh Pisal

Manager (CSA), Aker Solutions

Participants keenly followed all the sessions and sought clarifications plus shared their knowledge and experience during the sessions as well as during the breaks. The Q&A session on the second day went on way way past the closing time. The workshop was very well received by all the participants. The speakers were happy with the quality of queries and the participants with the explanations given.

Snap shots of the workshop are given below.



Dr. H Subbarao and Mr. A P Mull starting off the Workshop



Views of Audience-1



Standee



Views of Audience-2



Prof. Siddhartaha Ghosh – 'Behaviour of Structures'



Mr. Sanjay Nandanwar – 'Metallurgy of Steel'



Dr. H Subbarao – 'Basics and Recap of Limit State Design'



Prof. S R Satishkumar – 'Structural Design for Fire'



Mr. Charles F Simoes – ‘Design as per American Institute of Steel Design (AISC)’



Dr. Suvir Singh – ‘Fire Resistant Design of Steel Structures’



Prof. Siddhartha Ghosh – ‘Osdag-Software for Steel Design and Detailing’



Mr. Subhasis Pradhan – ‘Carbon Footprints of Steel Structures’



JSPL at Display Counter



Prof. Meera Raghunandan – ‘Advances in Design under Seismic Conditions’



Mr. Jeffrey Nambiar- ‘Welding Procedure Specification’



Mr. M M Ghosh – Case Study (Composite Structure)



Mr. A P Mull – ‘Ethics & Quality’



Views of Audience-3



Views of Audience-4



Views of Audience-4



Q& A Interaction-6



Q& A Interaction-2



Q& A Interaction-7



Q& A Interaction-9



Handing over Certificates



Handing over Certificates



Mr. Yogesh Pisal – ‘Connections for Seismic Conditions’



Q& A Interaction-1



Q& A Interaction-8



Q& A Interaction-3



Q& A Interaction-4



Q& A Interaction-5

WEBINAR PRESENTATION ON QUALITY ASSURANCE FOR STRUCTURAL ENGINEERING FIRMS – CHALLENGES AHEAD

CEAI organised a webinar presentation on “**Quality Assurance for Structural Engineering Firms - Challenges Ahead**” on **7th June 2019**. The webinar meeting was attended by 38 participants.

Mr. Alok Bhowmick, Member of CEAI Governing Council and Chairperson of Membership Committee, delivered the presentation. Mr. Bhowmick has more than 38 years of rich and relevant experience in the field of Bridge & Structural Engineering. He is presently running a very renowned and widely acclaimed consulting firm by the name of “B&S Engineering Consultants Pvt. Ltd.”

Mr. Bhowmick in his presentation highlighted the components of a model QA program and review various procedures, tips, techniques and strategies for conducting in-house quality assurance reviews on structural design and drawings.

FIDIC ASPAC CONFERENCE IN NEW DELHI

CEAI is hosting FIDIC – ASPAC 2019 Conference for the first time ever in New Delhi from 7th to 9th July 2019 on the theme “*Quality Infrastructure for Clean and Sustainable Development*”.

TENTATIVE PROGRAM

Monday, 8th July 2019

- Inaugural Session
- Plenary Session: Infrastructure Industry Revolution
- Focus Session 1: Urban Mobility
- Focus Session 2: Coastal & Marine Development

Tuesday, 9th July 2019

- Focus Session 3: Energy and Quality of Life
- Focus Session 4: Young Professionals Open Forum
- Focus Session 5: Business Opportunities with Regional Cooperation
- Focus Session 6: Technological Developments

In addition to the well known Indian speakers, eminent experts from USA, Korea, Japan, Hong Kong, Morocco, France, Switzerland, Spain, Romania, Ghana, China, Indonesia etc. have confirmed their participation and will present their views on the above themes during the conference.

Registration Fee: Indian/ Domestic

- **CEAI Members** ₹12,000
- Non-Member ₹ 15,000
- Accompanying Person ₹ 5,000
- Young Professional ₹ 6,000

Plus GST @ 18%

10% discount would be given if there are 5 or more participants from the same organization.

For more details about the conference, please visit Conference website <http://www.aspacdelhi2019.com>

B2B MEETING WITH FOREIGN INVITED BUYERS/ CLIENTS

The FIDIC ASPAC Conference is being held in partnership with the Services Export Promotion Council of the Ministry of Commerce, Govt of India and is supported by the Department of Scientific & Industrial Research (DSIR), Ministry of Science and Technology and the Ministry of Shipping, Government of India. We expect support from more Infrastructure Ministries and Multilateral Development Banks.

As part of the FIDIC-ASPAC conference, there will be a B2B meeting on 8th July 2019 (full day). The B2B meetings will be organised in association with Services Export Promotion Council (SEPC). SEPC is part of the Ministry of Commerce and its objective is to help export of services from India. SEPC will be formally conveying to us the modalities of the B2B meeting, but in general, following are the main points:

- The B2B meeting will be organised in parallel to the Technical Session on Day 1 of the Conference in an independent hall at Le Meridien.
- The purpose of the B2B is to enable and encourage

export of services to **Overseas Customers** (or **BUYERS**). The Customers or **BUYERS** could be from Overseas Government Agencies, Public or Private Sector Undertakings, NGOs or Individual Entrepreneurs.

- The BUYERS could be from the **developing** countries in Asia, Africa or Europe with large potential for Indian companies. Some could also be from select **developed** countries.

This is an excellent opportunity for companies, both big and small, to explore the Overseas Market.

- The SELLERS would be Indian companies (both CEAI member and non members) who wish to offer their services to the buyers.
- The SEPC and CEAI invites SELLERS or Indian Companies who are exporting or wish to export services to participate in the B2B meetings on payment of a registration fee to SEPC (that will be conveyed).
- Indian Companies will have to register with SEPC on their website and also provide IC No. Companies, who do not have an IC No., can obtain the same easily.
- The SELLERS are encouraged to give the names and contact details of BUYERS they wish to do business with. The SEPC will partially sponsor those BUYERS who they select.
- SEPC reserves the right to select the BUYERS based on Govt Policy. To indicate seriousness in their intent, SEPC encourages BUYERS to send their Top Officers.
- For Partial sponsorship of BUYERS, SEPC will arrange economy class air tickets for the Foreign BUYERS up to Rs. 50,000 per person.
- Provide free of cost accommodation in the Le Meridien/ other Hotel subject to availability for 2-3 days

We request all who are interested to participate in this B2B meeting to prepare lists of possible BUYERS.

BUYERS could be Clients, Contractors, Consultants, etc. who wish to collaborate with Indian companies.

Registration:

Interested Indian companies and individuals who are interested to participate in B2B meetings as Indian Exhibitors/ Sellers at **EnggIN 2019** - please register with the SEPC website, at <http://www.servicesepec.org/enggin2019/>

CEAI REGIONAL CENTRE REPORTS

EASTERN AND NORTHEAST REGION

CEAI Eastern and North Eastern Region held its AGM on 28th March 2019 at Kolkata. The first meeting of the newly elected Committee members of Eastern and Northeastern Region was also held on 13th May 2019 at Kolkata.

New Committee of Eastern and Northeast Region:

- Sri. Amitabha Datta, Chairman (STUP Consultants)
- Sri Syama Prasad Datta, Co-Chairman (Independent Professional)
- Sri. Mainak Ghoshal, Secretary (Independent Professional)
- Sri. Samiran Sen, Treasurer (E to E Consultants)
- Sri. Parthajit Patra, Jt. Secretary (Independent Professional)
- Sri Ayanangshu Dey, Member (Independent Consultant)
- Sri. Pulak Kumar Munshi, Addl. Member (Dasturco)

Future Activities: In continuation of the future action plan that was discussed during the last AGM, further discussion was held and it was agreed that the New Committee will undertake the following activities, for which discussions in detail will take place at an appropriate time.

- Training on FIDIC by professional trainer from abroad
- Organizing Lectures on various issue, inviting

specialized speakers. It was decided to have at least six such lectures in 2 years' time

- Organizing Seminar either on Drinking Water Related Sector or Bridge & Flyover maintenance in urban areas.

Lecture Meeting

A Technical Talk ‘Holistic and Sustainable Planning of Urban Water Utilities’ held jointly with ICE-UK Kolkata Unit at The Lake Club on 30th March 2019 was delivered by Dr. Klaus Kirchenbaur, Director, Apezcon SRL, Dominican Republic. It was well attended and a number of CEAI members participated.



SOUTHERN REGION

A meeting of the CEAI Southern Region was held on 22nd May 2019 and decided to organise the following activities in the Southern Region:

- Interacts with various authorities, regulators, ministries and financial institutions on behalf of its members/ member organisations
- Organise technical seminars, workshops, interactive sessions on subjects of interest
- Plan to hold a Conference on “Sustainable Smart Cities – Challenges and Opportunities” in Bangalore on September 20, 2019.

Key Contacts of CEAI Southern Regional Chapter:

Dr. Rajashekhar Malur
 Chief Technology Officer
 Tata Consulting Engineers Limited, Bangaluru.
 Ph: 080-66226485
 Email: rmalur@tce.co.in

Mr. A T Samuel
 Director
 STUP Consultants Pvt. Ltd., Bangaluru
 Ph: 080-25269565
 Email: at.samuel@stupmail.com

Dr. M S Sudarshan
 Chief Executive Officer
 STEDRANT Technoclinic Pvt. Ltd., Bangaluru
 Mob: 9880926064
 Email: mss.ctpl@gmail.com

Mr. J B Ravishankar
 President – GRIPSINDIA
 Bangaluru
 Mob: 9845012425
 Email: jbr@gripsindia.com



Dr Rajashekhar Malur presenting on CEAI activities at the National Seminar & Exhibition on “Global Trends in Concrete-Steel Composite Structures Design & Construction”, held as part of ACCE(I) foundation day celebrations on 11th May 2019 at NIMHANS Convention Centre Bangalore.

FIDIC NEWS

FIDIC INTERNATIONAL INFRASTRUCTURE CONFERENCE

The *FIDIC International Infrastructure Conference 2019* will be held at Mexico City from 8 to 10 September 2019.

Registration details are as below:

Registration Category	Second Deadline (Late Bird)	Onsite Deadline
	From 1st June 2019	From 6th September 2019
FIDIC Member	1150	1350
Non-Member	1400	1600
Member of YPF	1000	1200

(All fees are in US dollars)

For more details, please visit FIDIC Conference website <http://fidic2019.org>

INTER-AMERICAN DEVELOPMENT BANK SIGNS FIVE-YEAR AGREEMENT TO USE FIDIC STANDARD CONTRACTS

FIDIC has secured a major agreement with the Inter-American Development Bank (IDB) that will see the international funding organisation adopt the use of six FIDIC standard contracts for the next five years.

Under the terms of the agreement, FIDIC has granted the IDB, the leading source for development financing the Latin America and the Caribbean, a non-exclusive licence to refer to the following six major FIDIC contracts for projects they finance and the documents will be used as part of the bank’s standard bidding documents:

- Conditions of Contract for Construction for Building and Engineering Works Designed by the Employer (“Red book”), Second edition 2017;

- Conditions of Contract for Plant & Design-Build for Electrical & Mechanical Plant & for Building & Engineering Works Designed by the Contractor (“Yellow book”), Second edition 2017;
- Conditions of Contract for EPC Turnkey Projects (“Silver book”), Second Edition, 2017);
- Client/Consultant Model Services Agreement (“White book”), Fifth Edition 2017;
- Conditions of Contract for Design, Build and Operate Projects (“Gold book”) First Edition 2008; and
- The Short Form of Contract (“Green book”), First Edition 1999.

The contracts mainly include the latest 2017 Second edition FIDIC contracts, which cover a wide range of international construction and infrastructure work, and the IDB’s move represents another major endorsement for the contracts from a major international funding organisation, following a similar agreement signed with The World Bank back in February this year. FIDIC also expects to announce further agreements with other multilateral development banks soon.



(Left to right) FIDIC CEO, Nelson Ogunshakin; Maria Eugenia Roca, Technical Procurement Advisor for the IDB; and FIDIC President-Elect, William Howard

OTHER NEWS, VIEWS & NOTES

CEAI OUTREACH

As part of an ongoing process, CEAI is continuously expanding its outreach by way of providing support to other professional events and promoting its own to reach out to new members. One such event is:

- Municipalika and CAPEX 2019 – 16th International Exhibition & Conference on Smart & Sustainable City Solutions, scheduled from 28 to 30 November 2019 at Bangalore. For more details, please contact Mr. V Suresh, President, Good Governance India Foundation, Mumbai.

Ph: +91 22 45558555, Email: contact@municipalika.in
in Website: www.municipalika.com

OBITUARY

EAI regrets to convey the sad demise of Mr. Wasim Rahman, Life Member of CEAI.



Mr. Rahman graduated in Civil Engineering and did his Masters in Soil Mechanics and Foundation Engineering from the Indian Institute of Science, Bangalore.

Mr. Rahman retired from UP Government as Chief Engineer after serving for 36 years.

We pray to the Almighty for eternal peace of the departed soul.

VIEW POINT

The themes for the next four issues of Viewpoint spread over a year would be:

- Safety & Security in Planning, Design & Construction** (September 2019) {Construction inter alia implies fabrication, erection, testing, commissioning, operation and maintenance.}
- Pollution** (December 2019)
- Building Services** (March 2020)
- New Materials & Systems for Buildings** (June 2020)

Considering the experience of CEAI members and various stakeholders in the subject, CEAI would be happy to receive articles on the above themes.

Authors could share their knowledge and experience by providing case studies of the works executed or in execution, firsthand accounts of the challenges faced, practical issues experienced and the solutions to those, etc. Photographs, charts, diagrams, drawings, etc. would benefit our readers for better appreciation of the issues encountered and addressed.

The articles for an issue need to reach CEAI at least 6 weeks prior to the month of the Viewpoint issue. Articles need to be in Times New Roman 12 with single line spacing with before and after 6 pt and normal margin on A4 size.

Advertisement in View Point

VIEW POINT is circulated to all CEAI Members, FIDIC, Ministries of the Government of India, Public & Private Sector Undertakings, Construction Firms, Contractors, Consultants, Foreign Missions and Funding Institutions in India and other organisations related to or dealing with the engineering profession.

Advertising in the VIEW POINT gives the advertiser wide exposure and visibility.

The rates for advertisements in VIEWPOINT are given below. This is excluding GST @18% or as prescribed, which will be extra:

Item	Rate Per issue* (Rs)	Discounted rate at 20% for 4 consecutive issues* (Rs)
Back Cover **	25,000/-	80,000/-
Inside Front Cover	15,000/-	48,000/-
Inside Back Cover	15,000/-	48,000/-
Full Page	10,000/-	32,000/-

* GST @ 18% or as prescribed will be added to the above rates.

** Back Cover booked till December 2019.

Tech Quiz

1. **When did planned engineering start?**
 - a. 3000 BC
 - b. 4000 years ago
 - c. Prehistoric times
 - d. 8000 years ago
 - e. 5000 BC
2. **When was the first college of engineering started in India?**
 - a. 1850
 - b. 1794
 - c. 1895
 - d. 1920
 - e. 1847
3. **Who was the first civil engineer in world?**
 - a. Captain Alden Partridge
 - b. John Smeaton
 - c. Thomas Telford
 - d. Benjamin Wright
 - e. John Loudon McAdam
4. **Who is considered as the father of engineering in India?**
 - a. K L Rao
 - b. Satish Dhawan
 - c. Sir Mokshagundam Visvesvaraya
 - d. Abdul Kadeer Khan
 - e. E Shreedharan
5. **How old is India's maritime history?**
 - a. Since around 8000 – 4000 BC
 - b. Since around 2000 BC
 - c. Since 2nd Century AD
 - d. Since 12th Century AD
 - e. Since 1st Century BC
6. **When was the first Mechanical Engineering Institution formed?**
 - a. 1847
 - b. 1900
 - c. 1880
 - d. 1927
 - e. 1817
7. **When did the first Indian women engineers graduate?**
 - a. 1943
 - b. 1940
 - c. 1945
 - d. 1944
 - e. 1947
8. **When was the first personal computer released in market?**
 - a. 1971
 - b. 1972
 - c. 1975
 - d. 1978
 - e. 1977
9. **Who invented wireless power flow?**
 - a. Marin Soljačić
 - b. Nikola Tesla
 - c. Hidetsugu Yagi
 - d. Hatem Zeine
 - e. Geoffrey Landis
10. **Who observed conduction and rectification in metal sulfides?**
 - a. Karl Ferdinand Braun
 - b. Edwin Herbert Hall
 - c. Charles Fritts
 - d. Alessandro Volta
 - e. Eduard Riecke

The first person who mails the correct answers to CEAI info@ceai.org.in will get a congratulatory mail and will be acknowledged by publishing his/ her photograph in the next issue.

Contributed by A P Mull



Answers to Tech Quiz March 2019 issue

1(e), 2(a), 3(d), 4(e), 5(d), 6(b), 7(c), 8(d), 9(c), 10(a)

Prof Mainak Ghosal, Consultant is the winner of the Tech Quiz with full/ maximum marks.

FIDIC PUBLICATION

- 1 The Short Form of Contract (First Edition, 1999). Agreement, General Conditions, Rules for Adjudication and Notes for Guidance
- 2 Conditions of Contract for EPC Turnkey Projects (First Edition, 1999). General Conditions; Guidance for the Preparation of Conditions Particular Application; Forms of Tender and Agreement, etc.
- 3 EPC/Turnkey Contract 2nd Ed (2017 Silver Book)
- 4 Conditions of Contract for Construction (First Ed. 1999). For Building and Engineering Works designed by the Employer. General conditions; Guidance for Preparation of Particular Conditions; Forms of Tender, etc. FC-RA-A-AA-09
- 5 Construction Contract 2nd Ed (2017 Red Book). For Building and Engineering Works designed by the Employer.
- 6 Conditions of Contract for Plant & Design-Build (First Ed, 1999). For Electrical & Mech. Plant & For Building & Engineering Works Designed by the Contractor.
- 7 Plant and design-build contract 2nd ed (2017 yellow book)
- 8 Dredgers Contract 2nd Ed (2016 Blue-Green Book). Form of Contract for Dredging and Reclamation Works (Dredgers Contract; Second Edition, 2016). Agreement, General Conditions, Dispute Adjudication and Notes for Guidance
- 9 Client/Consultant Model Services Agreement 5th Ed (2017 White Book)
- 10 Client-Consultant Model Services Agreement (White Book) 3rd Ed, 1998
- 11 Client/Consultant Model Services Agreement (White Book) 4th Ed, 2006.
- 12 GUIDE to Client/Consultant Model Services Agreement (White Book) 2nd Ed 2001
- 13 Conditions of Subcontract for Construction (First Edition, 2011). For building and engineering works designed by the Employer.
- 14 FIDIC Contracts Guide to the Construction, Plant and Design-Build and EPC/Turnkey Contracts (1st Edition, 2000)
- 15 Conditions of Contract for Design, Build and Operate Projects (1st Ed, 2008) GOLD BOOK
- 16 GUIDE to Conditions of Contract for Design, Build and Operate Projects GOLD BOOK
- 17 Conditions of Contract for Construction - MDB (Multilateral Development Bank Harmonised Harmonised Ed. Version 3: June 2010)
- 18 Conditions of Contract for Electrical and Mechanical Works (3rd Edition, 1987; Reprinted 1988).
- 19 Supplement to Third Edition 1987 of Conditions of Contract for Electrical and Mechanical Works First Ed 1997
- 20 GUIDE to Conditions of Contract for Electrical and Mechanical Works 3rd Ed 1998
- 21 Conditions of Contract for Works of Civil Engineering Construction (4th Edit. 1987 reprinted 2011
- 22 Model Joint Venture (Consortium) Agreement 2nd Edition (2017)
- 23 Selection of Consultant 2nd Ed (2013)
- 24 Risk Management - A Short Guide -A short guide to five key areas of risk in consultant's appointments
- 25 Definition Of Services Guidelines (Building Construction) 2009
- 26 Insurance of Large Civil Engineering projects (2004), including the 1997 Progress Report and Update and the 2004 Update
- 27 Conditions of Contract for Design-Build and Turnkey (1st Edition, 1995 Orange Book). Part 1: General Conditions; Part 2: Guidance for the Preparation of Conditions Particular Application. -Reprinted in 2011
- 28 FIDIC Guidelines for Business Integrity Management (BIM) in the consulting industry (Test Edition, 2001)
- 29 ISO 9001:2015 Interpretation And Application Guide 1st Ed (2017)
- 30 Definition Of Services Guidelines (Civil Works) 2016
- 31 Quality Based Selection (QBS) Guidelines (2011)
- 32 Standard Prequalification Form for Contractors (3rd Edition, 2008), including guidance and sample forms
- 33 Professional indemnity insurance and the insurance of project risk, 2004.
- 34 European International Contractors (EIC) Contractors Guide to the FIDIC Conditions of Contract for EPC/Turnkey Projects (The EIC Silver Book Guide), 2nd Edition, 2003
- 35 European International Contractors (EIC) White Book on BOT/PPP, 2003
- 36 European International Contractors (EIC) Contractors Guide to the FIDIC Conditions of Contract for Plant and Design-Build (The New EIC Yellow Book Guide), 2003.
- 37 European International Contractors (EIC) Contractors Guide to the FIDIC Conditions of Contract for Construction (The New EIC Red Book Guide), 2001
- 38 EIC Contractors Guide To The Fidic Design, Build And Operate Contract (2008 Gold Book Guide) 2009
- 39 FIDIC Business Integrity Management System (BIMS) Training Manual (1st Edition, 2002)
- 40 Capacity Building: Building the capacity of the industry (2001) with five inserts
- 41 ISO 9001:2000 quality management interpretive guide 1st ed (2001). A guide to the interpretation and application of the ISO 9001:2001 Standard for the consulting engineering industry (1st Edition, 2001).
- 42 Integrity Management System (Fims) Guidelines 1st Ed (2011)
- 43 DBO (2008 gold book) contract guide 1st edition 2011
- 44 FIDIC Procurement Procedures Guide 1st Ed (2011)
- 45 Conditions of Contract for Electrical and Mechanical Works (3rd Edition, 1987; Reprinted 1988)
- 46 Operation, Maintenance And Training Guidelines (1991 OMT)
- 47 Project Sustainability Management Guidelines (2004)
- 48 Quality Management Training Kit 1st Ed (2001) -Quality management in the consulting engineering industry training kit (1st Edition, 2001)
- 49 EMS Handbook: Environmental Management Systems Handbook Test Ed
- 50 Model Representative Agreement (1st Ed, 2013)
- 51 Sub-Consultancy Agreement 2nd Edition (2017)
- 52 FIDIC Guide To Practice, The Business Of A Professional Services Firm - 2015 Edition

More more information, please contact CEAI Secretariat



STUP, established in 1963, an Indo-French organization of international repute which provides design, construction engineering, technology transfer and project management services for multiple sectors.



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