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Dr K L Rao Memorial Lecture

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Background of
Dr K L Rao Memorial Lecture

Dr Kanuru Lakshmana Rao was born on July 15, 1902. After passing his Intermediate Examination in Science from the University of Madras, he took the B E Degree in Civil Engineering with Honours from the College of Engineering, Guindy in 1925.

His first appointment was as Assistant Engineer in the Visakhapatnam District Board in 1926. He subsequently worked in the College of Engineering, Rangoon and Guindy, and later in the Cauvery – Mettur project. During this period he also qualified for the M Sc (Eng) Degree of the University of Madras by research, being the first recipient of a research degree in engineering from that University. In 1939, he proceeded to England to specialize in reinforced concrete and obtained his Ph D Degree from the University of Birmingham.

Between 1943 and 1945, he was employed as a Senior Lecturer in Loughborough Engineering College, England. On his return to India in 1946, he was appointed by the Madras Government as Design Engineer in the Ramapadasagar Project and in 1951 joined the Central Water and Power Commission at New Delhi as Director (Dams). In 1954, he became Chief Engineer (Planning and Designs), and then became a Member (Designs and Research) in the same Commission.

During these later years, Dr Rao was closely associated with major dam projects in this country, notably Lower Bhavani, Tungabhadra, Hirakud, Malampuzha, Kosi and Umtru and with flood control on the Brahmaputra River at Dibrugarh. His personal contributions to these projects are acknowledged as outstanding.

Dr Rao is the author of a well known standard work 'Calculation, Designs and Testing of Reinforced Concrete' published by Sir Isaac Pitman and Sons. His contributions to technical journals are numerous. Dr Rao joined the Institution as a member in 1947 and became its President for two sessions (1958-1960). He was also a Minister of Government of India.

Dr K L Rao Memorial Lectures

was delivered during Indian Engineering Congress

Water use Efficiency and Conservation in Industrial Water Use

Mr A B Pandya

Chairman
Central Water Commission

Our country has initiated action for transforming itself into a global manufacturing leader. In order to realize the dream the country has to adopt a multi pronged strategy involving many sectors including water sector.

Water is one of the important resources needed for ensuring industrial growth. The same is required in many processes in an industrial unit, which include cooling, washing, cleaning etc. In some cases, water is also required as one of the raw materials. Some of the industries namely, Textile, Paper and Pulp, Iron & Steel etc. consume large amount of water. Apart from the use or consumption of water, the effluent from industries is one the major causes for increasing water pollution. The occurrence of Minamata disease in Minamata city, Japan in the year 1956 due to continuous release of methylmercury from Chisso Corporation's Chemical factory; Ontario Minamata disease in the Canadian province of Ontario in 1970 due to illegal disposal of industrial chemical waste; environmental disaster resulting in massive mortality of aqua-life in river Rhine caused by a fire and its subsequent extinguishing at Sandoz agrochemical storehouse in Schweizerhalle, Basel-Landschaft, Switzerland in 1986 are few examples of industrial pollution and its harmful effects. As such this aspect is also required to be dealt appropriately.

Further, development of industries is dependent on availability of power in the region. Water plays an important role in power generation. Water is a key component in Thermal Power Plants and is required for multiple processes namely, ash handling, cooling tower, drinking and domestic use and for service uses like, fire fighting, cleaning etc. It is said that the thermal power sector accounts for the highest share of freshwater use in the industrial sector. The other major power source is hydropower, which requires large amount of water for power generation but the use is mostly non-consumptive.

It is mentioned that CWC has conducted a cumulative basin impact study for Siang Sub-basin of Brahmaputra basin and a master plan based strategy on hydro development keeping environmental and habitat concerns has been developed. This has paved the way for substantial development of hydropower in the basin to the tune of 17,800 MW. If the same is implemented then the demand for power for not only the North-Eastern region but many other parts of the country could be met. This will boost industrial development in this region and many other parts in the country.

The total utilizable water available in the country is estimated to be about 1123 BCM. This water is used in various purposes namely, domestic consumption, irrigation, power generation, industries, environment management etc. In various part of the country, the demand for water is already more than the supplies. With increasing population, urbanization and industrialization, the situation is getting worsen day by day. All these uses are competing each other for allocation in the total water available in the region. At national level, it is estimated that at present the industrial water requirement, including that required for energy generation, is about 8% of the total water requirement in our country. However, its share is rising rapidly and by the year 2050, it is expected to increase to about 13% of the total projected water requirement at that time.

Further, the industries require water on regular basis throughout the year. Therefore, ensuring reasonable supply of water for industries even during the lean periods is a challenge. Further, as the priority for water supply for industry is low as compared to other uses, namely, drinking and domestic needs, irrigation, the industry suffers a lot during a drought year. As such, availability of reliable and regular supply of water is an important aspect which may be considered before setting up an industrial plant.

The scenario of increasing demand and dwindling water supplies demands action for its efficient and optimal use. Further keeping in view that the industries are one of the important sources of pollution of water resulting in further decrease in supplies, steps are also required to be taken for arresting further deterioration of sources due to industrial pollution. It is estimated that at present the industrial plants in our countries consume about 2 to 3.5 times more water per unit of production compared to similar plants operating in other countries.

There is an urgent need and scope to make the systems more efficient and operate with reduced quantity of water. The efficiency of water use can be increased by adopting suitable water conservation procedures involving minimizing of water losses, prevention of water wastage, etc. In order to promote above measures, suitable provision for incentives for adopting water conservation or for adopting such technologies using least amount of water may also be necessary, in the time to come. Water management plans must be part of an integrated approach that examines how change in water use will impact all other areas of operation. Water conservation involving both distinct areas i.e. technical and human should be properly addressed.

The case study done by Federation of Indian Chambers of Commerce & Industry (FICCI) regarding water use in Thermal Power Plant (TPP) is worth mentioning. The contribution of coal fired thermal power plant is about 65% of the total power generation in the country. Further, a study by Centre for Science and Environment has estimated the volume of water used in TPPs to the tune of 35,157.4 million cubic metres (MCM) annually, which constitute 87.8% of the total industrial water use. The case study has indicated that the Adani Power Limited has adopted conservation measures in their Plant and were able to save about 7,84,000 KL of water per anum. Similar results have also been achieved in 3 other plants in the country.

While working for solution for ensuring optimal utilization of water, it is necessary to have a realistic estimate of water being used / wasted in the industrial unit. A water audit provides a full understanding of where and how water is used and discharged in any system. Water audit determines the amount of water lost from a system due to leakage and other reasons such as theft, unauthorized or illegal withdrawals from the systems and the cost of such losses to the utility. Comprehensive water audit gives a detailed profile of the water distribution system in the unit and consumption of water in various sub unit / process, thereby facilitating easier and effective management of the resources with improved reliability. It helps in correct diagnosis of the problems faced in order to suggest optimum solutions.

Water audit is an effective tool for realistic understanding and assessment of the present performance level and efficiency of the sub unit / process in an industrial setup. Elements of water audit include a record of the amount of water input to the system, water delivered / water used by sub-unit / processes, water loss and suggested measures to address water loss (through leakages and other unaccounted for water losses).

Central Water Commission (CWC) has formulated "General Guidelines for Water Audit and Water Conservation" in the year 2005. These guidelines have been circulated to all the State Governments and concerned Central Ministries and other Utilities for framing their own specific guidelines. Water audit is to be carried out annually. All industries should introduce Water audit as a regular activity. The water audit exercise includes survey of the plant to identify all points where water is used, including hose connections, and to determine the quantity of water used at each point. The area where water is wasted or where water could be reused is also identified. The above information is evaluated to identify the major water-using operations, to review the water reuse practices currently employed. Evaluate the need and feasibility of installing cooling towers and to assess the potential for screening and disinfecting reclaimed water to increase the number of times it can be re-used.

In addition, the audit study may also explore possibilities of rebates or financial incentives for increasing water use efficiency as available from the government. It may also suggest activities to be taken up by the plant for increasing water awareness in the employee and provision for suitable incentive for the employee. Benchmarking of water use in the various industries is an important tool to judge the performance of a plant with respect to efficient and optimal utilization of water. Each industry has its own benchmark measure for efficient water use. Benchmarking of water use by industry will help in measuring the performance of any plant, comparing the performance against other similar plant, identifying potential inefficiencies, determining realistic operating targets and finalizing better plan for changes in the operations having low performance.

In India, many studies have been conducted by various organisations on water conservation and management. However, specific information on water use patterns & benchmarks in the select water intensive industry sectors is lacking at national level. Due to lack of information, awareness & motivation, very few industries have proactively adopted available best practices. Further, though the scientists constantly innovates the new techniques, there is a gap on the application of the appropriate technologies, which needs to be removed.

The organisations like, FICCI & Confederation of Indian Industry (CII) may get involved in studies for assessment of present level of water consumption for various water intensive industries (including energy, mainly thermal projects). The main aim of these studies will be to identify the companies in the same industry, which are managing with less water, establish bench marks, take up research to identify water efficient technologies that can be adopted by industries without appreciable additional investment, especially in water intensive industries and encourage them to adopt the same.

Further, there is immense scope for recycling and reuse of water in the industrial sector. The concept should be made mandatory to reduce pressure on demand of fresh water. Reusing and recycling the waste water from such water intensive activities and making the reclaimed water available for use in the secondary activities within or outside the industry will save lot of water. Incentives in the form of tax relief, excise exemption, etc. can also be provided for industries and commercial establishments to encourage recycling and reuse by the State Governments / concerned local authorities. The cost of industrial water recycling varies from site to site and depends on comparison of cost of waste treatment prior to disposal with that of treatment of waste water for reuse within the Plants. But in future, the recycling of water is likely to become cheaper as the cost of supply water may increase to a great extent.

As indicated earlier, the water pollution from industries is a major threat to water availability as this is making the source itself unsuitable for water supply. There are various approaches to tackle water pollution. One of the traditional approaches to pollution management is by the method of dilution. In this method, it is assumed that sufficiently diluted pollution is not harmful. It further assumes that the dilutant, water in most of the cases, is in virtually unlimited supply for the application.

Such simple treatment for environmental pollution on a wider scale might have had greater merit in earlier centuries when human population and densities were lower, technologies were simpler and their by products more benign. But these are often no longer the case. In addition, consideration of the environment beyond direct impact on human beings has gained prominence.

Yet in the absence of a superseding approach, this older approach predominates practices throughout the world. One possible superseding approach is elimination of pollutant by providing suitable treatment. However, migration from pollution dilution to elimination in many cases can be confronted by challenging economical and technological barriers. Another important concept which is needed adopted in industries to curb pollution is the “Zero Liquid Discharge (ZLD)”. This process is beneficial to industries as well as the environment because it saves money and no effluent, or discharge, is left over. ZLD systems employ the most advanced wastewater treatment technologies to purify and recycle virtually all of the wastewater produced. Also Zero liquid discharge technologies help plants meet discharge and water reuse requirements, enabling them to treat and recover valuable products from waste streams and use produced water. The recovered products can be economically exploited.

In order to promote water conservation in industrial sector, the existing system of subsidies and tax structure on investment in water conservation, water recycling and pollution control technologies should be reviewed. Particular attention needs to be paid to introduce a significant and punitive variable tax on the act of pollution. Central Pollution Control Board (CPCB) has already issued Standards for discharge of Environmental Pollutants from various Industries. There is need to put suitable mechanism in the country for implementation as well as regulation in this regard. Selection and zoning of industries associated with potential risks especially those releasing toxic waste need a thorough analysis and planning before they are set up in any water basin.

The concerned State Government and other local bodies should have a coordinated approach in selecting and locating industries of a specific nature with respect to their water requirement and facilities for wastewater disposal. A policy for zoning the water basins according to the types of industries, quantity of water consumed/discharged needs to be laid down. Clearance from the concerned Ministry dealing with State Water Resources may be made mandatory for discharging effluents in the drainage system. The tariff rates have to be prescribed such that the industry is motivated for implementing the recycling and look into technological interventions leading to reduced use per unit production. For effecting maximum conservation, production processes have to be modified, to have lesser generation of effluent water. Periodic water auditing should be mandatory and a norm for water budgeting. The research efforts in Industrial & Energy sector are to be given due importance for furthering the efficiency in industrial sector.

To end I would like to mention that there is a need for a paradigm shift in approach from development to efficient management by making concerted efforts to achieve higher standards of efficiency in water use. There is an urgent need and scope to make the systems more efficient and operate with optimal efficiency. Effective legislations need to be brought out and enforced for treatment of industrial effluent discharge and its reuse so as to achieve high level of efficiencies in water use.

Sustainable Development & Faster Construction Technology

Dr. Anoop Kumar Mittal

Chairman-cum-Managing Director, NBCC (India) Limited

Good Morning all distinguished guests!

I really feel honoured that I have been invited by "The Institution of engineers (India)"at its 31st Indian Engineering Congress to deliver Dr. K.LRao memorial lecture. Thank you IEI for extending me this privilege.

Dr. K.L Rao is better known as father of the Indian irrigation system, for his remarkable and invaluable contribution of NagarjunaSagar& Bhakra Dam. At a time, when there was very less area with irrigation facilities, his vision and work has increased the cultivation area that led to an increase in food production and employment to millions of farmers. He is still remembered by many across the country as a saviour from starvation. Because of his eminent contribution in the field of civil engineering, he is revered by the nation even today. Dr. Rao has also been conferred with a number of awards including "Padma Bhushan" for his excellence in his professional field that made real difference to the development of nation at large.

Now moving forward on legacy I would like to take this opportunity to deliver my lecture on "Sustainable Development along with faster construction technology", which I feel shall be a great tribute to Dr. K.L.Rao.

Introduction

India with the vision of Late Dr. A. P. J. Abdul Kalam of becoming a super power by 2020 is emerging swiftly and amazingly at international level in various fields like political, social, economics, industrial, educational, literacy, scientific, engineering and religious. Our Honourable Prime Minister Mr. Narendra Modi's Vision of providing houses for all by 2022 encourages construction industry to adopt the faster construction technologies. At the same time, United Nations resolution of lowering the carbon emission by 2020 has together imparted the responsibility and need of sustainable development for developing countries like ours. Construction Industry being the significant contributor for its share in GDP of India, also carries the responsibility to look upon the methodologies which are faster & construction materials that are less carbon eminent from their sources. With the rapid depletion of non-renewable source of energy, construction industry has the challenge to incorporate the renewable sources in its development plan. All these objective scan be achieved with the concept of Sustainable Development.

What is Sustainable Development?

"Sustainability or Sustainable Development" is one of the worlds most talked about but least understood words. It is often clouded by differing interpretations and by a tendency for the subject to be treated superficially. But for developing country like ours, we should embrace concept of sustainability as preservation of the environment as well as critical development-related issues such as the efficient use of resources, continual social progress, stable economic growth, and the eradication of poverty.

In simple words, sustainable development incites the activities/actions that are taken for meeting human goals with maximum and effective utilization of renewable sources without disturbing the natural flora-fauna of locality and without harming the environment.

Why Sustainable Development?

More than half of the world's population is now living in urban areas. By 2050, that figure will rise to 6.5 billion people – two thirds of all humanity. The rapid growth of cities in the developing world, coupled with increasing migration from rural to urban areas has led to a boom in mega-cities. In 1990, there were ten megacities with 10 million inhabitants or more. In 2014, there are 28 mega-cities, home to a total of 453 million people [3].

Extreme poverty is often concentrated in urban spaces and governments are struggling to accommodate the rising population in these areas. Making cities safe and sustainable means ensuring access to safe and affordable housing,

and upgrading slum settlements. It also involves investment in public transport, creating green public spaces, and improving urban planning and management in a way that is both participatory and inclusive [3].

"Breathless in Smoke House Delhi" Times of India, 06'Nov-2016 Headlines itself is an evidence of Environment degradation happening to our society. "During the period of severe air pollution, all construction, transport of construction material and stone-crushing activities must be stopped. States would also have to shut down power plants, hot-mixers, brick kilns and diesel generator sets whose emissions are above the prescribed limit", the National Green Tribunal said in its interim order. National Green Tribunal guidelines are forcing construction industry to use construction methodologies & building materials that are environmental friendly and at the same time useful for sustainable development.

NBCC being the largest construction CPSE owns the obligation for implementation of concept of sustainable development and also has proven through its recent housing and commercial projects.

How Sustainable Development can be accomplished?

The implementation of sustainable development can be elaborated broadly in five steps:

1) Architectural Design & Layout – Design efficiency
2) Selection of Construction Material – material efficiency
3) Selection of Construction Methodology – construction efficiency
4) Use of Self Sustainable technologies
5) Maintenance of Existing Structures – Operation efficiency

1. Architectural Design & Layout

The design process plays a significant role in creating built environment respecting all principles of sustainable development. The various climatic zones like hot-dry, warm-humid, composite, temperate and cold climates as well as sun path movements and annual wind directions along with rainfall are the vital statistics data which need to be considered while designing a project. Architectural Design includes

1. Effective site planning through the orientation of the building according to sun path, and wind direction.

2. Establishment of the fact that no critical natural resource like floodplains; forest department areas; water bodies such as sea, lakes, rivers, public parks; agricultural land are impacted by the project or dredging operations.

3. Adoption of passive architectural design strategies to create climate sensitive buildings, with higher thermal comfort and lower energy consumption.

Under the Ministry of Urban Development, Government of India, CPWD published the "Guidelines for Sustainable Habitat" in March'2014. NBCC through its consultants in each project, ensure that the Guidelines for Architectural Design & Layout are complied with, positively.

GRIHA rating is an additional tool for evaluating the performance of buildings and its impact on the environment through a predefined set of criteria relating to the design, construction, and operations of buildings. In pursuit of the sustainable habitats, NBCC has constructed various green buildings all over India, but one of the finest example that would stand apart from rest, would be National Institute of Solar Energy in Gurgaon constructed for Ministry of New and renewable energy, inaugurated by Hon'ble Minister of State (IC) for Power, Coal and New and Renewable Energy on May 14, 2015. The building has been designed on principles of GRIHA 5 star rating aiming towards Net Zero electricity centre through use of Solar Photovoltaic Technologies and innovative construction materials, reducing reliance on fossil fuels.

Indian Green Building Council (IGBC) of the Confederation of Indian Industry, is also rating tool which enables the designer to apply green concepts and reduce environmental impacts that are measurable. Implementing these green concepts, NBCC has constructed. The Indian Institute of Corporate Affairs at Manesar for Ministry of Corporate Affairs, which has been conferred with the prestigious LEED Gold rating.

Another such example is GPRA at New Moti Bagh, New Delhi, which has successfully achieved the Green Building Standards required for the IGBC Green Homes Silver Certification under the IGBC Green Homes Rating System in January 2014.

The green concepts and techniques in the building sector can help address national issues like water efficiency, energy efficiency, reduction in fossil fuel use in commuting, handling of consumer waste and conserving natural resources. Most importantly, these concepts can enhance occupant health, happiness and well-being.

We at NBCC are committed to introduce best green features for all its upcoming projects and will strive to make all new/redeveloped buildings as GRIHA/ LEED compliant to give our customers full value for money.

2. Suitable Selection of Construction Material

The second step for moving towards sustainable development is selection of construction material. In 2000, the Urban Development ministry had estimated that India generates about 10 to 12 million tonnes of Construction and Demolition waste annually [4]. The disposal of this huge waste is a herculean task for Municipal & Local bodies. Also disposal of such waste near the rivers disturbs the bio-diversity.

It is to be noted that use of C&D (i.e. Construction & Demolition Waste) Brick Blocks, Paver block, Kerb Stones can significantly reduce the burden of disposal of construction waste. Air voids and Water absorption is high in recycled C&D blocks. Thus the C& D brick blocks can be used in the basements & inner wall partitions of building.

- NBCC has taken an initiative to mitigate C&D Waste generated from the project of Redevelopment at East Kidwai Nagar, Delhi.
- Estimated C&D waste from this project is about 75000 ton.
- With a mandate of ZERO waste, an in situ 150 Ton per Day, C&D waste Recycle Plant has been established in the project.
- Recycle Plant produces the Bricks of modular size $230 \times 110 \times 75$.
- The Plant has produced 15 lacs Class-II bricks (7.5 N/mm^2), which is being consumed in the project.

Due to this initiative of NBCC, advantages achieved are:-

- Less wastes end up in landfills, increasing lifetime and reducing costs.
- Saving on the cost of material. Return of waste materials into the materials cycle.
- Reduction of the dependency on primary materials.
- Saving of transportation and processing fees as Recycle Plant is inside the Redevelopment Campus only.

Fly Ash Bricks, A.A.C blocks (Autoclaved aerated concrete blocks), Rice husk ash are the other example of Lighter Building material. The objective is to promote use of lighter materials thus reducing the overall energy requirements of buildings including lesser transportation effort, lesser lifting effort etc. The lesser weight of the materials results in reduced dead weight of the building which optimises building design and reduces quantity of structural materials as well.

Heat reflective façade, Tiles, Low emission (VOC) Paints, Double Glazing units, Heat reflective coating on external glazing, low heat emissive and recyclable carpets are the new materials available which improve the energy efficiency of building by keeping a lower core temperature inside the building.

One of the most proficient method in achieving material efficiency is through use of locally available materials, recycling the wastes and incorporation of technologies in the mainstream building design. For example, use of municipal waste in construction of roads offloads lot of waste from landfills and reduces the burden on the Municipal Corporations thereby resulting in overall improvement of surrounding environment. Similarly, deployment of Building Management System (BMS) and use of Occupancy sensors, sensors controlled taps/ urinals, low flow fixtures, also results in significant reduction and material efficiency.

3. Selection of Construction Methodology

Construction methodologies play a vital role in the implementation of sustainable habitats and it is fact that pre-construction and construction phase are the most critical stage which defines the overall outcome of the project and its effect on the surrounding environment.

It is desirable and most importantly necessary, to adopt construction methodologies which generate minimum waste and has minimum energy consumption. One way this could be achieved is through use of innovative construction technologies over the conventional methods of construction.

Some of the readily available techniques are use of Aluminium shuttering instead of plywood which is faster, recyclable and reduces the waste up to 10 %. Extension to Aluminium Formworks, other faster shuttering evolved during recent times are MIVAN and Table Formwork, which are best suited for typical structural members of uniform shapes and sizes, bigger spans & grid sizes and uniform floor heights, thereby reducing the overall slab cycles up to 7-10 days.

Plastforms (Plastic Formworks) are other examples of innovative shuttering technologies best suited for complex designs and useful in case of floating shear walls of variable thickness and curved walls.

The other important component in RCC structures is reinforcement bars, wherein there is significant wastage depending on the bar bending schedules. Thus in order to curb such wastages and to achieve higher material and cost efficiency, Automatic Steel bending and cutting Plant may be deployed at mega value projects.

It is also pertinent to mention that there are various other modular Construction techniques available with us, by employing which construction can be fast tracked with very less impact on the environment. Examples of such techniques are - Structural steel design i.e. composite steel structures, Light Gauge Steel (LGS) designs, Prefab structures, Precast structures, modular kitchens/toilets, dry wall panels, etc. These techniques have an edge over the conventional cast-in-situ construction, as pollution (basically dust, air and noice) are reduced significantly since the structural members are fabricated at fabrication yard, and then transported, erected and commissioned at site. There is also an advantage in reducing the overall completion timeline, attaining desired level of quality and faster integration of services with the surrounding.

NBCC has also taken a leap in employing such modular construction techniques in its upcoming projects and plans to designs & construct all upcoming non-residential buildings on composite steel structures.

Other than above-mentioned techniques, I would also like to inform that NBCC's R&D Cell is actively involved in bringing the technologies that are faster, sustainable & low cost together. Recently, the company has also taken an initiative to explore the suitability of 3D printers for low cost housing scheme which if implemented, can be a milestone in construction sector.

Other aspects of Construction activities leading to environmental degradation also needs to be addressed, one such form is emissions and smoke generated through construction machineries. Therefore, in order to curb carbon emissions, use of Diesel generators should be avoided in cities to promote green techniques as the electricity supply in cities is capable enough to take care for operations of major equipment like Batching plant, Tower Cranes, Concrete Pumps etc.

Also, dust and air pollution from construction activities is a major concern and to mitigate such issue National Green Tribunal has issued guidelines, in verdict of Vardhaman Kaushik Vs. Union of India &Ors. And Sanjay Kulshrestha Vs. Union of India & Ors. On 10.04.2015[9], to keep in check dispersion of dust into atmosphere in any form and precautions to be taken care thereof.

Some of the key directions of the verdict are reproduced as under:

- Every builder or owner shall put tarpaulin on scaffolding around the area of construction and the building.
- Restriction on storing of construction material particularly sand on any part of the street, roads in any colony.
- The construction material of any kind that is stored in the site will be fully covered in all respects so that it does not disperse in the Air in any form.
- The construction material and debris shall be carried in the trucks or other vehicles which are fully covered and protected.
- The dust emissions from the construction site should be completely controlled and all precautions taken in that behalf.
- The vehicles carrying construction material and construction debris of any kind should be cleaned before it is permitted to ply on the road after unloading of such material
- Fixing sprinklers, washers for trucks, creations of green air barriers, etc in site to diminish dispersion of dust in air.
- Compulsory use of wet jet in grinding and stone cutting.
- Wind breaking walls around construction site

4. Use of Self Sustainable technologies

I would like to emphasize more on these self-sustainable technologies and recommend them as a back bone of Sustainable Habitats.

A. Waste Water Treatment Plant

Sewage Treatment Plants are designed by NBCC for treating 100 % waste water within the site and ensuring Zero discharge to municipal drains. Effluent Water from the Sewage Treatment Plants are recycled and used for gardening after proper treatment. This has been implemented in a big way in the recently completed General Pool Residential Accommodation at New Moti Bagh, Delhi. Approx. 5.6 lacs litre water is treated per day and is being used for irrigation purpose through irrigation pipe network laid in the whole campus.

Residual sludge cakes are used as manure within the complex. For Monitoring purpose, Laboratory has been set up in the complex and on daily basis, monitoring of BOD, COD and pH of treated water is being done. NBCC is propagating these ideas in the projects undertaken by it for various Ministries and Govt. departments all over India.

B. Solid & Green Waste Management Plant

Generally the waste from cities and towns are moved to Landfills in the conventional method and when it breaks down, the by-product of such disintegration is harmful. Gases like methane and carbon dioxide are these harmful by-products.

If solid & green waste is not managed properly it results in breeding of diseases through flies, mosquitoes, cockroaches, rats and other pests. Contamination of sub-soil water due to leaching of poisonous waste materials is also very much harmful to the mankind.

To mitigate the above mentioned ills, NBCC has implemented quite a number of Solid waste Management plants at 7 Locations in the recent past consisting of a total of 2125 Tonnes/day of waste recycle[8]. This has helped in not only keeping the city clean but also protecting the overall environment and reducing carbon emissions.

C. Solar Heating& Solar Lighting System

We are blessed with Solar Energy in abundance at no cost. The solar radiation incident on the surface of the earth can be conveniently utilized for the benefit of human society. Some of the popular devices that harness the solar energy are solar hot water system (SHWS) &Solar Photovoltaic Street Lighting system. NBCC is implementing these sustainable initiatives in each redevelopment and upcoming project.

As in Solar Heating, Solar Power Generation also reduces the demand of energy from conventional sources. With improvement in technology, SPV modules are available with improved efficiency and elimination of mandatory use of batteries by use of Grid Interactive System has helped in reduction of atmospheric pollution by lead and acids.

An SPV plant of 16 KWP has been installed over the roof top of Kitchen-cum-Canteen at the Corporate Office of NBCC at Lodhi Road, Delhi and commissioned in March 2013. It is fully functional as on date. The average energy generated on daily basis is 65 KW and this has resulted in a yearly saving of conventional energy to a tune of 23890 KWP (Peak).

D. Rain Water Harvesting System

The concept of rain water harvesting is simple i.e. Collect, Store the natural climatic rain& Recharge the ground water table. Currently, many state governments have issued policy directives to encourage this practice. It is mandatory under law to construct the Rain Water Harvesting systems in the new houses and officessans which “No Objection Certification” from respective legal bodies are hard to be obtained. NBCC is committed to the implementation of this concept on every roof top constructed. East Kidwai Nagar, Delhi is the example of such implementation where around 49 Tanks of each 15 cum capacity are constructed to capture the natural rains.

E. Plastic Waste To Fuel Converter

The “Plastic Waste to Fuel Treatment Plant” is the first-of-its-kind technology installed by NBCC in North India at Moti Bagh GPRA Complex. The technology can treat all plastic wastes including laminated plastics, plastic carry-bags, wafers and chips packets, chocolate wraps, thermocol etc. Although plastics are 100% recyclable, however the above mentioned plastics are difficult to

recycle by normal mechanical recycling process. The technology is termed as 'Feedstock Recycling Process' and can recycle all types of plastics waste in mixed condition without proper cleaning. The mixed plastic wastes are heated inside the fuel conversion plant up to a maximum of around 400 degree Celsius in the absence of oxygen. An added catalyst with a supply of filtered water breaks down the molecules of the plastic waste and converts it into Light Diesel Oil (LDO)/ Furnace Oil, Liquefied Petroleum Gas (LPG) and Carbon, without releasing any harmful emissions. The byproducts i.e. LDO or Furnace oil is used as energy in boilers and furnaces, LPG is used for cooking in gas cookers/burners & the carbon residue is also used as solid fuel.

Net Cost Effectiveness by adopting the above mentioned technologies per Annum

At Two Construction Sites for FY 2014-15 is

= INR 9, 00, 15, 164/- (INR Nine Crore Fifteen Thousand One Hundred Sixty Four Only)

13,50,000 USD

5. Maintenance of Existing Structures / Facilities

The objective of maintenance is: -

(i) To preserve machinery, building and services, in good operating condition.
(ii) To restore it back to its original standards, and
(iii) To improve the facilities depending upon the development that is taking place in the building engineering.

Maintenance aims at effective and economic means of keeping the building and services fully utilisable. It involves numerous skills as influenced by occupancy and the performance level expected of a building. Programming of works to be carried out to keep the building in a good condition calls for high skills. Feedback from maintenance should also be a continuous process to improve upon the design and construction stages.

NBCC Services Limited: A wholly owned subsidiary company has been incorporated on 16.10.2014 with main objective to act as Execution and Implementation Agency to undertake maintenance Projects and related activities on behalf of its own or for any other Govt. Undertakings/Semi Govt. Undertakings or any other concern.

It has also been mandated to act as an execution and implementation agency for sustainability projects, heritage building restoration works, etc. and execute maintenance and internal renovation works of major projects completed by NBCC, thereby extending end to end service to its customers.

To conclude, Construction sector is required to adopt all the available innovative measures and construction methodologies which are not only sustainable but are also capable of delivering the structures as fast as possible to fulfil the dreams of “Home to Every One”. The onus lies on awareness and a detailed eye which can call for innovativeness as well.

The real estate companies can contribute much and save on to the pollution to the environment and can sustain the re-development as well as new construction works by affecting a good chunk of savings towards their expenditure which is actually the hard earned money of the exchequer.

All construction companies can take lead from the efforts pitched in by NBCC and can learn much from the efforts undertaken by this Navratna Company of the Govt. of India.

Thank you all guests once again for your patient hearing. I am sure, the vision of the present government backed by its vigorous initiatives that have already rolled in shall be certainly a real game changer in our endeavour for sustainable development.

India in Space

Mr V Ranganathan

Programme Director, Capacity Building, ISRO & Deputy Director, Solid Propellant Plant, SDSC SHAR Sriharikota

Space is always mystery and induced interest in humans. Hard to believe, the earliest known space fiction appeared way back in AD 168. The author was a Greek satirist by name Lucian. In his book tilted 'True History', a powerful whirlwind lifts a ship from sea to moon, where inhabitants, both human and animal were depicted. Much later, the telescope was invented in 17th century. In 19th century it was the collective scientific work of Tycho Brahe, Copernicus, Kepler, Galileo and Newton, which transformed fiction to fact.

In AD 1232, Chinese used Arrows of Fire, arrows attached to rockets propelled by gunpowder to drive away invading Mongols. In 18th century, Hyder Ali and Tippu Sultan of Mysore, India used rockets against British army. In the context of modern rocketry, between 1903-1923 three pioneers stand out — Konstantin Tsiolkovsky (a Russian teacher, known for mathematical equation of fundamental to rocketry), Rabert. H Goddard (an American Physicist, known for, theoretical treatment of rocketry propulsion) and Hermann Oberth (a Austrio-Hungarian mathematics teacher, who published The Rocket into Interplanetary Space).

Modern Space Age and Space Events

- The modern space age dawned on October 4, 1957 with first man made satellite, Sputnik-1 orbited around the earth.
- On 31st January 1958-US"EXPLORER" went into orbit
- 1961 -Yuri Gagarin - First man in space
- 1968 - Lunar Landing
- 1981 -Space shuttle

Space Fairing Nations:

Countries capable of building and launching satellites on their own rockets from the launch centres:

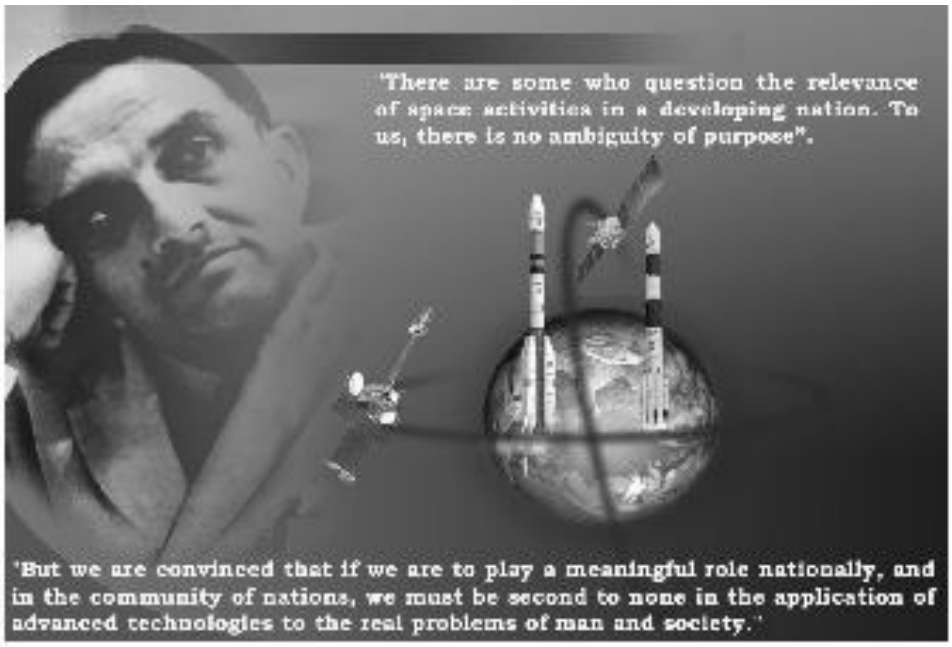
- Europe, European Space Agency (ESA)
- India(ISRO)
- Japan (JAXA)
- China(CNSA)
- Russia & Ukraine
- United States (NASA)

India enters Space

India decided to go to space when Indian National Committee for Space Research (INCOSPAR) was set up by the Government of India in 1962. With the visionary Dr Vikram Sarabhai at its helm, INCOSPAR set up the Thumba Equatorial Rocket Launching Station (TERLS) in Thiruvananthapuram for upper atmospheric research.

Rockets are launched from atleast 15 different launch sites including a sea launch site

Indian Space Research Organisation, formed in 1969, superseded the erstwhile INCOSPAR. Vikram Sarabhai, having identified the role and importance of space technology in a Nation's development, provided ISRO the necessary direction to function as an agent of development. ISRO then embarked on its mission to provide the Nation space based services and to develop the technologies to achieve the same independently.



India started its space endeavour with the launch of its Aryabatta, the first Indian satellite in the year 1975 and followed by Apple satellite in 1981.

Throughout the years, ISRO has upheld its mission of bringing space to the service of the common man, to the service of the Nation. In the process, it has become one of the six largest space agencies in the world. ISRO maintains one of the largest fleet of communication satellites (INSAT) and remote sensing (IRS) satellites, that cater to the ever growing demand for fast and reliable communication and earth observation respectively. ISRO develops and delivers application specific satellite products and tools to the Nation: broadcasts, communications, weather forecasts, disaster management tools, Geographic Information Systems, cartography, navigation, telemedicine, dedicated distance education satellites being some of them.

To achieve complete self reliance in terms of these applications, it was essential to develop cost efficient and reliable launch systems, which took shape in the form of the Polar Satellite Launch Vehicle (PSLV). The famed PSLV went on to become a favoured carrier for satellites of various countries due to its reliability and cost efficiency, promoting

unprecedented international collaboration. The Geosynchronous Satellite Launch Vehicle (GSLV) was developed keeping in mind the heavier and more demanding Geosynchronous communication satellites.

ISRO's own Lunar and interplanetary missions along with other scientific projects encourage and promote science education, apart from providing valuable data to the scientific community which in turn enriches science.

ISRO endeavours to optimize and enhance its technologies as the needs and ambitions of the country evolve. Thus, ISRO is moving forward with the development of heavy lift launchers, human spaceflight projects, reusable launch vehicles, semi-cryogenic engines, single and two stage to orbit (SSTO and TSTO) vehicles, development and use of composite materials for space applications etc.

ISRO's launch vehicles overview

Launch Vehicles are used to carry spacecraft to space. India has two operational launchers: Polar Satellite Launch Vehicle (PSLV) and Geosynchronous Satellite Launch Vehicle (GSLV).

PSLV

Polar Satellite Launch Vehicle was developed to launch Low Earth Orbit satellites into Polar and Sun Synchronous Orbits. It has since proved its versatility by launching Geosynchronous, Lunar and Interplanetary spacecrafts successfully.

GSLV

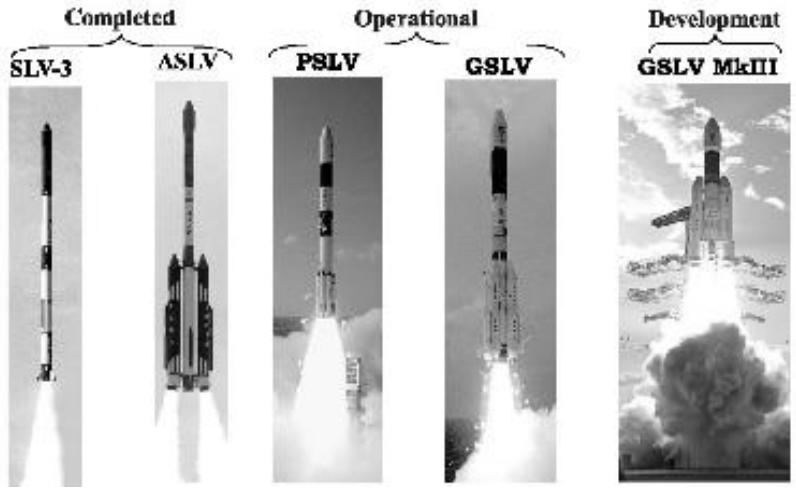
Geosynchronous Satellite Launch Vehicle was developed to launch the heavier INSAT class of Geosynchronous satellites into orbit. In its third and final stage, GSLV uses the indigenously developed Cryogenic Upper Stage.

GSLV MKIII

ISRO's latest launch vehicle GSLV MKIII had two developmental missions, its experimental mission (LVM3 X/ CARE Mission) without C25 stage was launched from Sriharikota, SDSC SHAR, the Spaceport of India on December 18, 2014 and its maiden developmental mission GSLV MKIII D1/GSAT-19 was on 05-06-2017. GSLV MKIII is powered by 2 gigantic S200 solid strap on motors. The core vehicle consists of L110 and C25 stages. The vehicle is capable of putting 4t class satellite into GTO.

Success story:

√ SLV launch - Two
√ ASLV launch - Two
√ PSLV launch - Thirty seven
√ GSLV MK II launch - Seven
√ GSLV MK IU launch - One experimental + one developmental flight



New Launch Vehicles Technology Development

RLV-TD

Reusable Launch Vehicle-Technology Demonstrator (RLV-TD) is one of the most technologically challenging endeavors of ISRO towards developing essential technologies for a fully reusable launch vehicle to enable low cost access. RLV-TD was successfully flight tested on May 23, 2016.

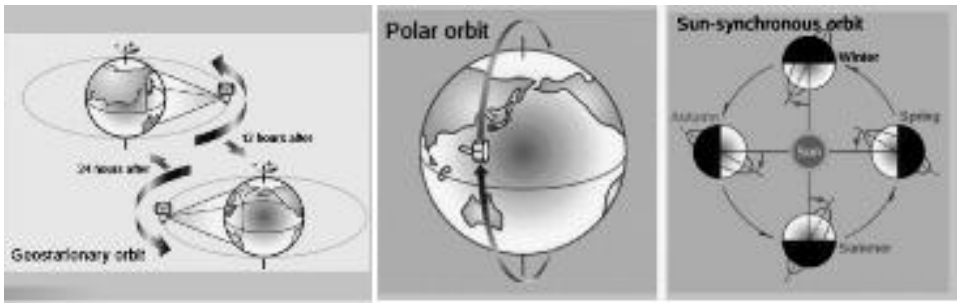
Scramjet Engine—TD

The first experimental mission of ISRO's Scramjet Engine towards the realization of an Air Breathing Propulsion System was successfully conducted on August 28, 2016.

Crew Module Atmospheric Re-entry Experiment (CARE)

Crew Module (CM) is identified as the payload in GSLV MK-IIIX/CARE Mission. CARE is the acronym for Crew Module Atmospheric Re-entry Experiment. The mission was used as a platform for testing the re-entry technologies envisaged for Crew Module including validating the performance of parachute based deceleration system. CARE enhanced the understanding of blunt body re-entry aerothermodynamics and parachute deployment in cluster configuration.

Satellite Application



Earth Observation

With a humble beginning in early 1960s, Indian space program has matured as a symbol of the country's sophisticated technological capabilities and its growing regional and global prestige. Over the last four decades, Indian Space program has made remarkable progress towards building the space infrastructure as the community resource to accelerate various developmental processes and harness the benefits of space applications for socioeconomic development.

The Indian Space programme has the primary objective of developing space technology and application programmes to meet the developmental needs of the country. Towards meeting this objective, two major operational systems have been established — the Indian National Satellite (INSAT) for telecommunication, television

broadcasting, and meteorological services and the Indian Remote Sensing Satellite IRS) for monitoring and management of natural resources and Disaster Management Support.

The Indian Remote sensing programme is driven by the user needs. In fact, the first remote sensing based pilot project was carried out to identify coconut root-wilt disease in Kerala way back in 1970. This pilot project led the development of Indian Remote Sensing (IRS) satellites. These IRS satellites have been the workhorse for several applications - encompassing the various sectors such as agriculture, land and water resources, forestry, environment, natural disasters, urban planning and infrastructure development, rural development, and forecasting of potential fishing zones.

Satellite Communication

The communication satellite series, which started with the APPLE satellite, grew into a very large constellation of satellites in the INSAT and GSAT series. These satellites revolutionized the technological and economic growth of the country. The INSAT satellite system is one of the largest domestic communication satellite systems providing regular services in the areas of telecommunications, business & personal communication, broadcasting, and weather forecasting & meteorological services. Today, newer initiatives have been taken to expand the INSAT applications to newer areas like Tele-education, Tele-medicine, Village Resource Centre (VRC), Disaster Management Support (DMS) etc., have enabled the space technology to reach the common man in India. The INSAT system has extended the outreach to less accessible areas like North- East, other far-flung areas and islands.

Indian Space Research Organisation (ISRO) has made remarkable progress towards building the space infrastructure - as the community resource to leapfrog the developmental processes. The launch of INSAT system has been the major catalyst in the rapid expansion of television coverage in India apart from growing applications like DTH, Satellite News Gathering, VSATs, Internet services etc. Use of INSAT for e-governance and developmental communication applications is also fast expanding.

Disaster Management Support

Disaster management support, in terms of space based critical infrastructure and services, is yet another community centric deliverable. One of the elements on which the space based Disaster Management Support (DMS) systems have been built is emergency communications systems. The DMS programme of ISRO/DOS, a convergence of space communications and remote sensing capabilities, is an effort to have technologically robust and a compatible system, which could strengthen India's resolves towards disaster management.

Satellite Navigation

Satellite Navigation service is an emerging satellite based system with commercial and strategic applications. ISRO is committed to provide the satellite based Navigation services to meet the emerging demands of the Civil Aviation requirements and to meet the user requirements of the positioning, navigation and timing based on the independent satellite navigation system. To meet the Civil Aviation requirements, ISRO is working jointly with Airport Authority of India (AAI) in establishing the GPS Aided Geo Augmented Navigation (GAGAN) system. To meet the user requirements of the positioning, navigation and timing services based on the indigenous system, ISRO is establishing a regional satellite navigation system called Indian Regional Navigation Satellite System (IRNSS).

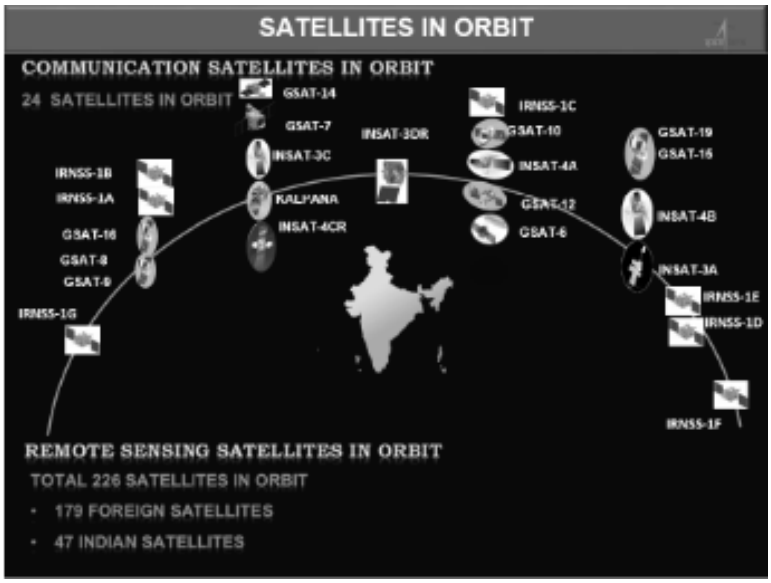
Climate and Environment

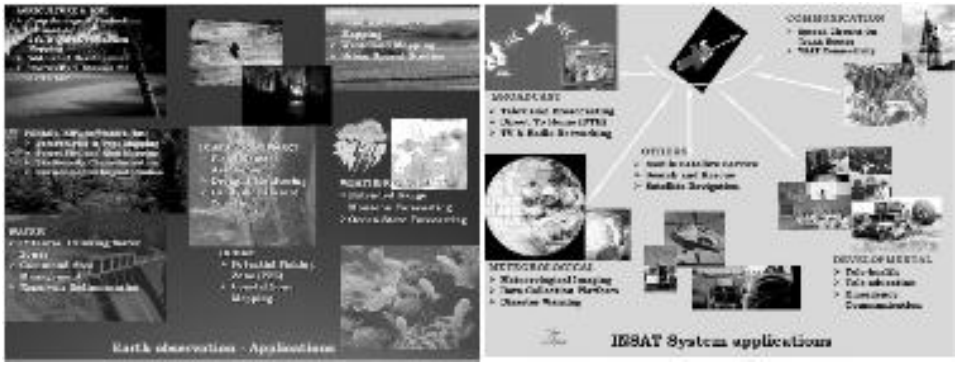
ISRO has designed and developed indigenous systems for ground based observations of weather parameters. It includes (i) Automatic Weather Station (AWS) to providing hourly information on critical weather parameters such as pressure, temperature, humidity, rainfall, wind and radiation from remote and inaccessible areas; (ii) Agro Metrological (AGROMET) Towers to measure soil temperature, soil moisture, soil heat and net radiation, wind speed, wind direction, pressure and humidity; (iii) Flux Tower for multilevel micrometeorological observation as well as subsurface observations on soil temperature and moisture over the vegetative surfaces; (iv) Doppler Weather Radar (DWR) to monitor severe weather events such as cyclone and heavy rainfall; (v) GPS Sonde and Boundary Layer LIDAR (BLL) for observing vertical profiles of atmospheric parameters.

Disaster Management Support System

India has been traditionally vulnerable to natural disasters on account of its geo-climatic conditions. Floods, droughts, cyclones, earthquakes and landslides have been recurrent phenomena. About 60% of the landmass is prone to earthquakes of various intensities; over 40 million hectares is prone to floods; close to 5700 km long coastline out of the 7516 km, is prone to cyclones; about 68% of the cultivable area is susceptible to drought. The Andaman & Nicobar Islands, the East and part of West coast are vulnerable to Tsunami. The deciduous/ dry-deciduous forests in

different parts of the country experience forest fires. The Himalayan region and the Western Ghats are prone to landslides.





Interplanetary Mission:

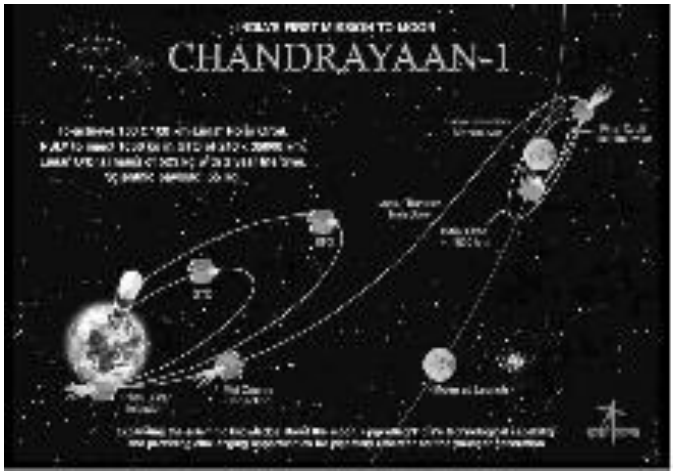
Chandrayaan-1

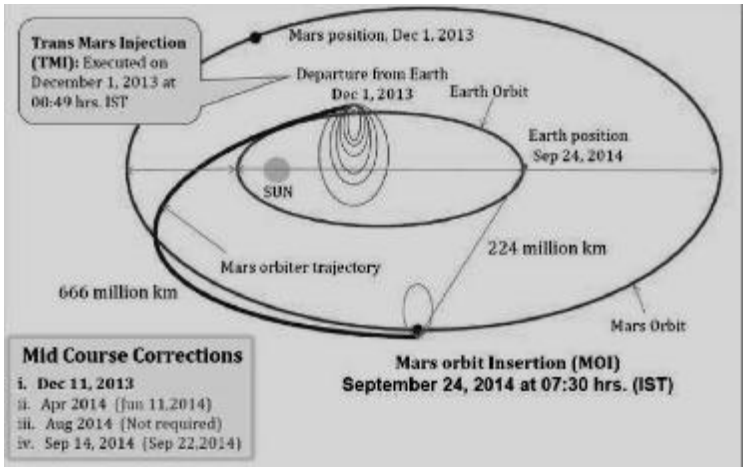
Chandrayaan-1, India's first mission to Moon, was launched successfully on October 22, 2008 by ISRO's workhorse launch vehicle PSLV-C11. The spacecraft was orbiting around the Moon at a height of 100 km from the lunar surface for chemical, mineralogical and photogeologic mapping of the Moon. The spacecraft carried 11 scientific instruments built in India, USA, UK, Germany, Sweden and Bulgaria during May 2009.

After the successful completion of all the major mission objectives, the orbit has been raised to 200 km. The satellite made more than 3400 orbits around the moon and the mission was concluded when the communication with the spacecraft was lost on August 29, 2009. The Chandrayaan- 1 went on to moon detect water on lunar surface.

Mars Orbiter Mission (MOM)

Mars Orbiter Mission is ISRO's first interplanetary mission to planet Mars with an orbiter craft designed to orbit Mars in an elliptical orbit of372 km by 80,000 km. Mars Orbiter mission was a challenging technological mission and a science mission considering the critical mission operations and stringent requirements on propulsion, communications and other bus systems of the spacecraft. The primary driving technological objective of the mission is to design and realize a spacecraft with a capability to perform Earth Bound Manoeuvre (EBM), Martian Transfer Trajectory (MTT) and Mars Orbit Insertion (MOI) phases and the related deep space mission planning and communication management at a distance of nearly 400 million Km. Autonomous fault detection and recovery also becomes vital for the mission. This satellite was launched on 05-11-2013. India’s Mars orbiter spacecraft successfully entered into an orbit around planet Mars on 24-09-2014.





Space Science & Exploration

Indian space programme encompasses research in areas like astronomy, astrophysics, planetary and earth sciences, atmospheric sciences and theoretical physics. Balloons, sounding rockets, space platforms and ground-based facilities support these research efforts. A series of sounding rockets are available for atmospheric experiments. Several scientific instruments have been flown on satellites especially to direct celestial X-ray and gamma- ray bursts.

AstroSat

AstroSat is the first dedicated Indian astronomy mission aimed at studying celestial sources in X-ray, optical and UV spectral bands simultaneously. The payloads cover the energy bands of Ultraviolet (Near and Far), limited optical and X-ray regime (0.3 keV to 100keV). One of the unique features of AstroSat mission is that it enables the simultaneous multi-wavelength observations of various astronomical objects with a single satellite. AstroSat with a lift-off mass of 1515 kg was launched on September 28, 2015 into a 650 km orbit inclined at an angle of 6 deg to the equator by PSLVC30.

Others:

South Asia Satellite (GSAT-9) is a Geostationary Communication satellite realized by India. The primary objective of GSAT-9 is to provide various communication applications in Ku-band with coverage over South Asian countries. GSAT-9 was launched by GSLV-F09 on Friday, May 05, 2017.

Achievements of ISRO:

- 91 Spacecraft Missions including 2 Nano Satellites

- 63 Launch Missions including Scramjet-TD & RLV-TD
- 9Student Satellites
- 2Re-entry Missions
- 209 Foreign satellites of28 countries
- Several scientific missions with national and international participation having conducted using the Rohini sounding rockets.

ISRO's future Missions

Chandrayaan-2

Chandrayaan-2 will be an advanced version of the previous Chandrayaan-1 mission to Moon. Chandrayaan-2 is configured as a two module system comprising of an Orbiter Craft module (OC) and a Lander Craft module (LC) carrying the Rover developed by ISRO.

Aditya—L1 First Indian mission to study the Sun

The Aditya-1 mission was conceived as a 400 kg class satellite carrying one payload, the Visible Emission Coronagraph (VELC) and was planned to launch in a 800 km low earth orbit. A satellite placed in the orbit around the Lagrangian point 1 (L1) of the Sun-Earth system has the major advantage of continue viewing the Sun without any occultation / eclipses. The Aditya-1 will have a halo orbit around the L1, which is 1.5 million km from Earth. The satellite carries additional six payloads with enhanced science scope and objectives.

Space port of India— Satish Dhawan Space Centre SHAR

- SDSC SHAR Provides the launch base infrastructure for Indian space programme.
- The principal launch centre of ISRO/DOS/INDIA.
- Ideal for launches - being on east coast and latitude is favourable for achieving low inclinations.
- Located 80 km north of Chennai and 80 km south of Nellore.
- Covers an area of about 175 sqkm (44000 acres) - with coast line of50 km.
- Pulicat lake surrounding SHAR is a bird sanctuary.

Facilities at SDSC SHAR

- Solid propellant production plants.
- Static test facilities for ground testing of solid propellant motors.
- High altitude and environment test facilities.
- Launch complexes — First launch pad and Second launch pad facilities.
- Liquid propellant storage & stage servicing facilities.
- Weather monitoring & forecast facility.
- Range safety, tracking, real time processing and mission control facilities.

Societal Engineering – Imperatives for Nation Building

Prof S S Chakraborty

Chairman
TransAsia Infrastructure (India) Private Ltd., New Delhi

I am delighted to be here to deliver the 5th K L Rao Memorial Lecture. It gives me immense pleasure to be amongst the eminent Engineers and Technologists from all over the country.

The association of Dr K L Rao with major dams in India and also his book on "India's "*Water Wealth*" was a guide when I started working in this sector, besides I grew up reading his book on "*Reinforced Concrete*". Society recognized his good engineering works by electing him to Parliament. Societal Engineering in today's increasingly connected world of universal internet accessibility & social immediate dominance is the study of what changes the thought patterns and behavior of society holds an ever increasing importance. The modification of nature by engineers take many forms in response to social needs.

Engineers are in forefront in every walks of life and driver of all STEM (Science, Technology, Engineering and Mathematics) activities. They use their specific knowledge they have within a specific industry in order to make things work for the society and solve problems, in agriculture, infrastructures, medicine, or environment and provides most of the artifacts (shelter, energy, communications, manufacturing, water supply, use of resources and disposal of waste.)

Sectors

a. Agriculture: This sector is unorganized (vast geography, cultural and linguistic diversity), cash strapped and ravaged by frequent of natural disasters. With infusion of Artificial Intelligence (AI), improved data collection technique, easier access to cutting-edge research, along with better telecommunication infrastructure and improvement in technology- literacy, the endemic problems are being solved by the engineers. AI-enabled technology provides a unique opportunity for agriculturist to break down the linguistic and literacy barrier. Prediction modeling for future crop pattern with more accurate meteorological data would enable enhanced production.

IoT in Agriculture

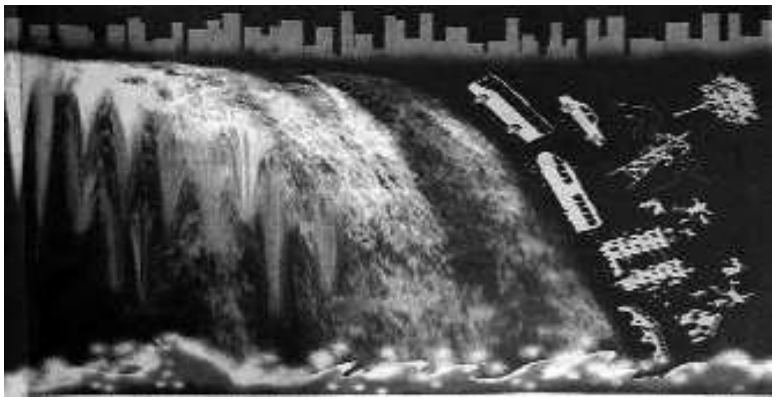
b. Infrastructures: Infrastructures (water, waste, energy, transport) planned, designed, commissioned, operated and maintained by engineers has the ability to impact the society from smallest family unit to the global community. It reduces hardship, poverty and help the society to achieve its potential. With three strands: "*Connect, supply and protect*", engineers link communities, supply (water, gas, electricity etc.) the daily needs and protect from floods reducing poverty and hardships; making the environment (built-in and natural) safe and greener.

(i) Water (crisis), floods and river systems: We cannot afford to leave India dry, as much we cannot treat rivers as static channel. Instead of traditional flood control of dams and dykes, engineers are moving forward with natural measures giving rivers and other water bodies more space, preserving natural landuse-forests, river bank and wetlands, and work with natural systems to augment water resources rather than against them.

India faces worst water crisis

With Technology Indian Engineers cope with natural disasters

Rivers Talk: Need to restore flood plains



Give rivers more space

In August 2019, the Ullhas River on the outskirts of Mumbai burst its banks swamping the land around it including local housing estates, and stranding the passengers of the Mahalaxmi Express.

Dams and embankments in the Ganga-Kosi flood Plains (Dr. K L Rao was associated)

Tungabhadra Dam Hospet (Dr. Rao's debatable project)

Farakka Barrage commissioned in 1975: (Project creating centre of growth as well as centre of pollution-faces a barrage of criticism)

To avoid frequent flooding havoc, Engineers to regulate construction on flood plains by Indian Engineers.

Farakka Barrage Project-Main objective

- To divert adequate quantity of Ganga waters to Bhagirathi.
- Bhagirathi reduces salinity and ensures sweet water supply to Kolkatta and surrounding areas.
- The rail-cum-road bridge built over Farakka Barrage across the river Ganga at Farakka.
- The Bhagirathi, the Feeder Canal and the Navigation Lock at Farakka from part of the Haldia-Allahabad Inland Waterway (National Waterway No.1)

River Ganga Rejuvenation Programme

The vision for Ganga rejuvenation constitutes the wholesomeness of the river defined in terms of ensuring continuous flow, unpolluted flow, Geological and ecological integrity. It has 307 identified projects and engineers are working relentlessly to complete all the projects by 2022.

In Himalayan Mountains

Before Rejuvenation Plan

Ghats at Baranasi

(ii) Transportation, communication and disaster management: From transport infrastructure leading to product and services (roads, railways to urban rapid transport system, electric vehicle, air transport and their contribution in predicting and mitigating the disaster. Physical environment, societal preferences and business motivation have channelled the development of transportation options. Be it personal or public transportation or logistics and freight transport, engineers are creating the mobility of the future, with IoT connectivity, AI etc.

Research indicate surge in artificial intelligence (AI) in transportation sector in last four decades

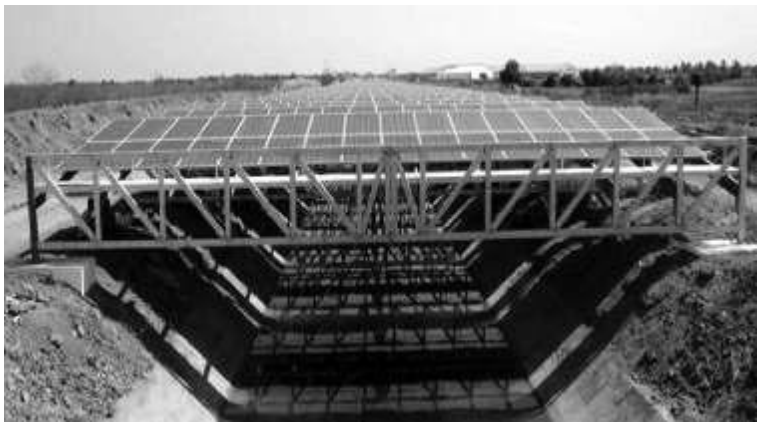
Disaster Management

India has a national vision to build a safe and disasterresilient India by developing a holistic, proactive and multi disaster and Technology- driven strategy for Disaster Management (DM). The entire engineering process will be community centric.

PAMBAN RAMESWARAM BRIDGE (TAMIL NADU, 1914)

(Mandated to restore the bridge in six months for the pilgrimage: restored in six weeks by Indian Engineers) Compared to 1914, nowadays disaster management is technology driven and the entire human, material, economic and environmental impacts of the said disaster is being dealt by the engineers in a different manner even in emergency situation. That is the contribution of the engineers to the society under emergency condition and under severe distress.

c. Energy: Engineers find means of converting fossil fuels, sunlight, falling water, wind, geothermal, biofuel into useable energy resources for agriculture, transportation, waste disposal, IT and communication and increased use since industrial revolution and caused global warning. Engineers are now trying to find how to maximize energy from solar, wind, air into useable energy instead of coal, oil and gas to meet the increased use of energy and simultaneously manage the energy demand technologically.



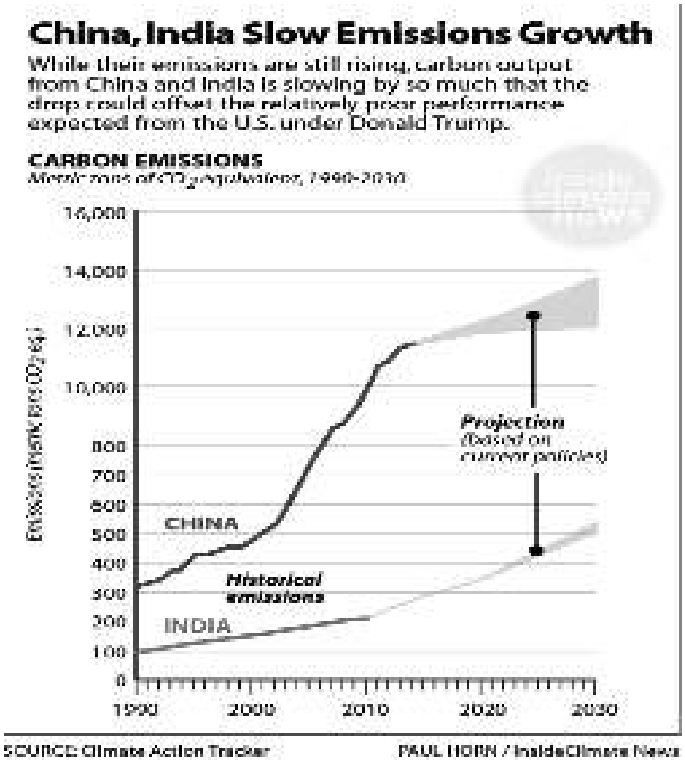
Narmada Canal Solar Project (Mehsana, Gujarat) (Not only developing renewable energy project but also saving thousands of square km of land.)

d. Healthcare, life science and Technology: Healthcare has improved dramatically thanks to advancement in technology, thanks to engineers. Technological advancement induces improvement of medical techniques leading to diagnostic improvements result saving and improving lives of many. It is evident that the exponential technology development have deep impact on pharma and medicine and transforming healthcare systems through location and process visibility.

Digital health is the convergence of technologies with health, healthcare, living and society to enhance the efficiency of healthcare delivering and make medicine more personalized and precise. Treating patients with virtual reality. Digital Health Technology can revolutionalise health care. Indian National Academy of Engineering (INAE) prepared an in depth report with an emphasis on "Technologies" and how technologies can help in improving the healthcare. It further states "*There is a dire need for cost-effective equipment and instruments for screening and diagnosis at the point of care*".

Technology advancement in healthcare information, telemedicine, HIS, electronic health records, remote diagnostic and therapeutic tools have pivoted the first step towards technology enabled healthcare and can be further leveraged to effect new modalities of health care. The integration of IT and network have now become the centre of the "new era" where both, digital and societal aspects are pivotal to the complete patient experience.

e. Societal impact of environment that stem at least in part from engineering and technology themselves.



Challenges are

- Climate Change;
- Nature and bioderversity
- Use of Natural Resources
- Environment and Health

These challenges also could be addressed with an enlightened technology.

However, in case of energy, technological or commercial fixes cannot mask the need to rethink globally the impact of consumerism and the interrelationship of energy, environment and economic development and the society should provide the "*Happiness Index*" for managing the supply- demand.

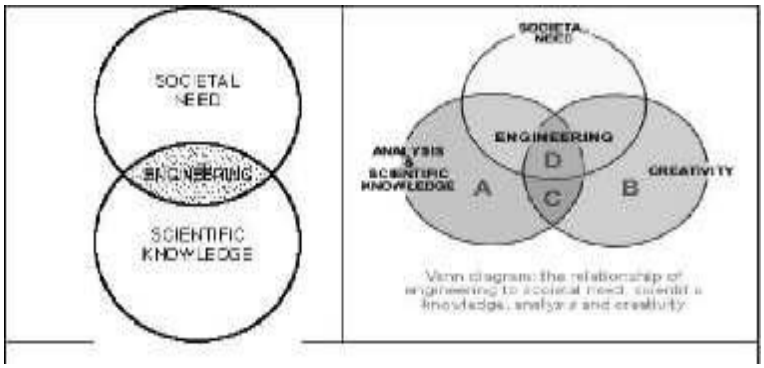
Lessons Learned:

a. When social systems and technology have been able to complement each other, engineering has been immensely effective in improving human life by augmenting agricultural production, building infrastructure producing jobs, improving public health.

b. Engineering can best carry on its social purpose when it is involved in the formulation of the response to a social need, rather than just being called to provide a quick technological fix (Disaster management).

Engineers at Cross roads

Engineering has exerted little purposeful influence in shaping the social systems that have been fostered and enriched by it.



Interrelation ship between society, engineering and science

Today engineering has an unprecedented opportunity to exercise leadership in showing how technology can offer the means for creating a better world.

Fundamental difficulty that engineers encounter in addressing major social problem

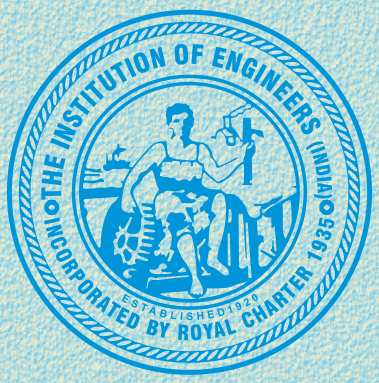
- Limited or simplistic views of the social role of engineering.
- The propensity of engineers to find technological fixes for existing social system rather than develop and use technological innovations.

Actions needed

- Work more closely with leaders of business and government to develop a sense of seamless engineering and technology as one of the essential components of their preparation.
- Increase attention to complex socio-technological problems such as poverty or education.
- Reshape engineering education not only to serve the engineering community but also to serve the society as a whole with an inclusive growth agenda.
- Engineers opportunities cannot be realized if they are not prepared to take the lead in drawing bold plans to address the issues- city by city- road by road. They must be prepared to fight major battles with bureaucracies, unions and so-called environmentalist.
- Make provisions for consequences when technology fails (e.g. air conditioning in Mecca Haj Pilgrimage Hall)
- Avoid dangerous by products or uncontrolled side effects
- Uphold the dignity of man (privacy, dexterity, aesthetics, etc)

In construction business and defense industries society must treat engineers as professionals rather than commodities. If engineers are to drive strategic innovation and change at a societal level, the role of engineer in society expectations is to be transformed to build the nation.

No one knows exactly how engineers would make a difference to society in future but it is guaranteed they will. New engineering jobs are constantly appearing in society. Society's intuition about future is linear but the reality of technology and engineering is exponential, and that makes profound difference. Going forward engineers have the potential to create the next miracle by harnessing the collective intelligence of the engineering community, through seamless engineering.



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