TCExpression

TATA CONSULTING ENGINEERS LIMITED

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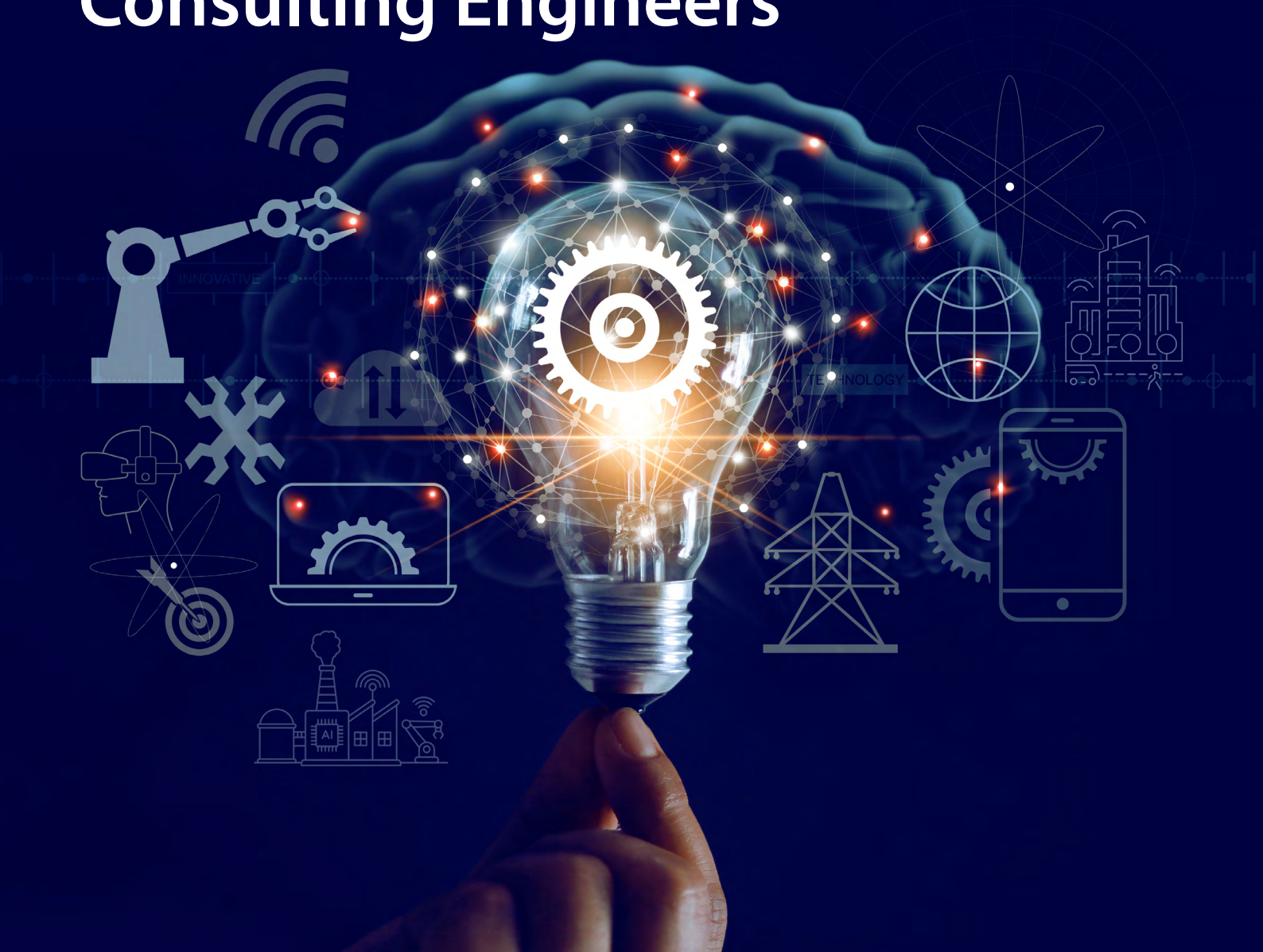
Engineering Innovations and Emerging Technology for Consulting Engineers



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EDITOR'S NOTE

Dear Readers,

This edition of TCExpression, Engineering Innovations and Emerging Technology for Consulting Engineers explores the latest developments in technology and engineering and how TCE leverages these in its ongoing and upcoming projects.

As industries, infrastructure and homes become smarter and sustainable, engineering consultants too need to evolve and deliver customer expectations by continuously learning, unlearning, reimagining, reinventing and innovating. We have tried to capture the latest technology developments worldwide and hope you enjoy reading the perspectives and articles.

I wish to thank Mr Atul Choudhari, CTO – Tata Consulting Engineers and all our authors for helping us put together the content and Ms Shruti Deshpande for the beautiful design.

Please share your thoughts and feedback with us at tceconnect@tce.co.in

Happy Reading!

Alpna Singh

REFLECTIONS

I am pleased to share with you this issue of TCExpressions focusing on Engineering Innovations & Emerging Technology for Engineering Consultants.

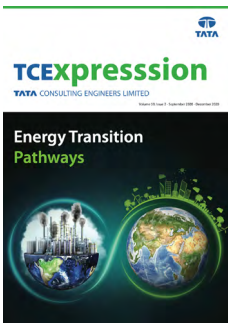
Science and technology are driving innovations in the engineering industry. The consulting sector, too, has witnessed rapid changes like adopting new technologies, construction techniques and digital tools for enhancing the quality and reducing the project schedules.
As leaders in the Engineering Consulting space, TCE takes pride in imparting thought leadership with many firsts to its credit.

TCE embarked on the sustainability journey more than a decade ago and researched and presented Energy Transition solutions and facets of the hydrogen economy to the world. These aspects were covered at length in our previous issue of TCExpressions.

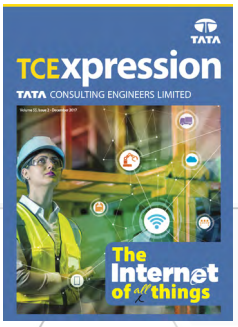
In this issue, you will read more about how during COVID induced oxygen emergency, TCE engineered indigenous solutions to help provide oxygen in a short time.

Amit Sharma
Managing Director

This issue focuses on Industry 4.0,(also featured in 2017), IIoT and Digital Era and how these technologies create Digital solutions and concepts for Engineering Consultants. From making digital designs using 3D, 4D, 5D technologies to smart geo scanning using drones, to Smart Project Management using apps to Digital point solutions for smart plant operations to 3D printing buildings.



As engineering consultants, we always strive to present the latest pathbreaking solutions to ensure the customers benefit from the technology and save essential resources such as time and money. I am excited to see how Industry 5.0, where people work alongside robots and intelligent machines, unfolds in the coming years.

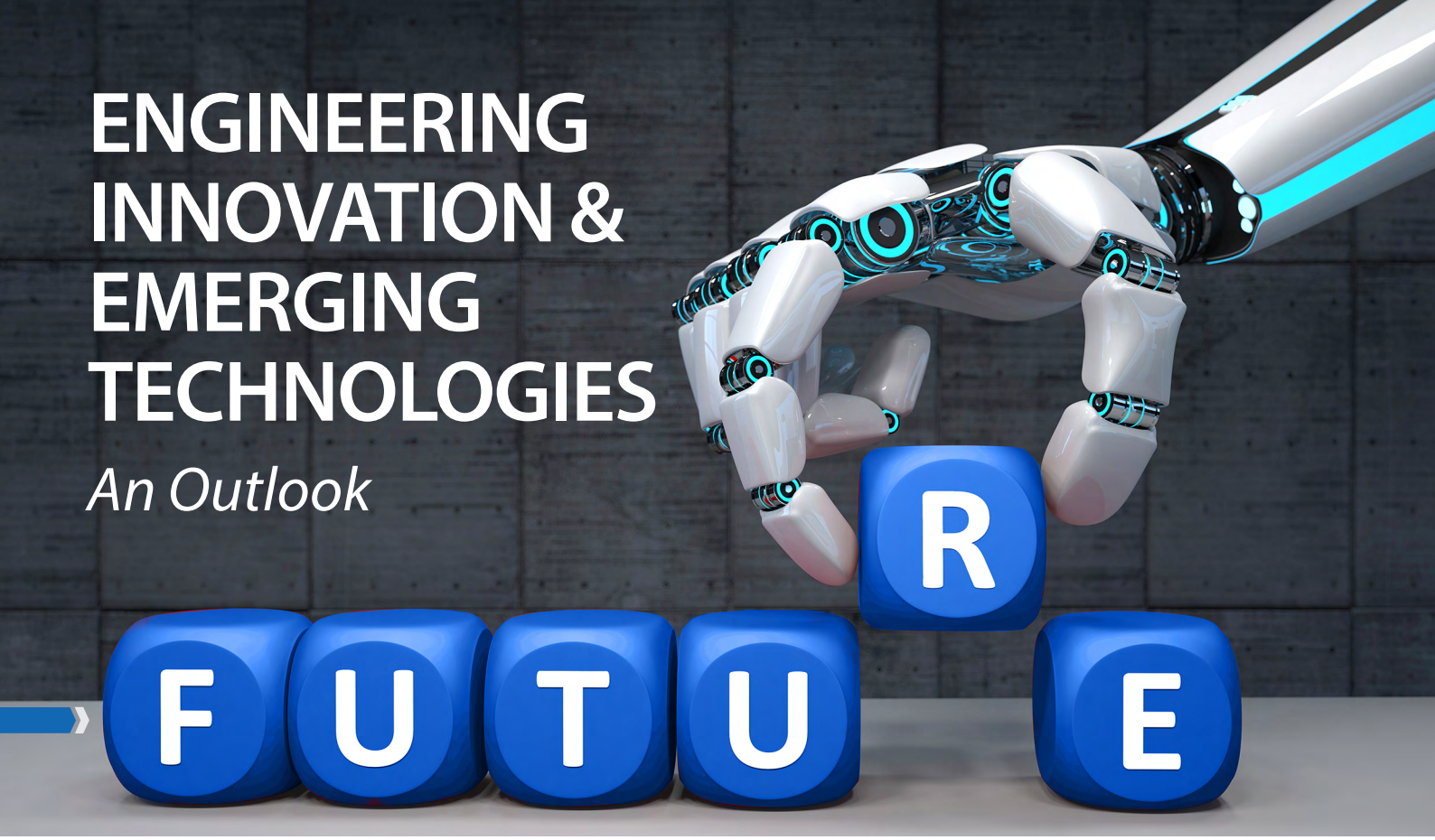


Everyone is eagerly waiting for normalcy to return and for COVID-19 to be behind us. I wish and hope that all our readers and their near and dear ones are safe and are getting vaccinated. I hope you enjoy reading this issue and learn more about the innovations for engineering consultants; we will be glad to connect with you and understand how we can assist you in finding the best-fit engineering solutions for your specific need.

Enjoy the Magazine!

ENGINEERING INNOVATION & EMERGING TECHNOLOGIES

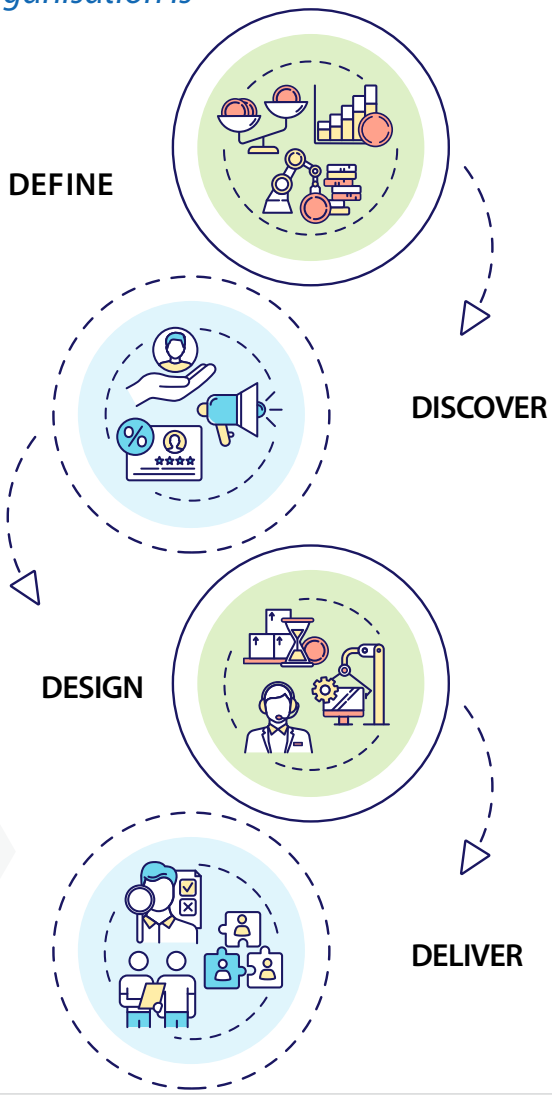
An Outlook



Innovation is a change that unlocks new value. It is defined as "the process of translating an idea into a product or design or service that creates measurable impact". The idea cannot just move linearly from concept to implementation; there are many uncertainties, evaluations & validations, iterative experiments involved for an idea to get the real impact. Thus, Innovation is an outcome of an iterative process through a series of experiments and validations.

Over the years, global competition is driving the need for Engineering companies to reduce cycle time, be cost-competitive, provide a safe operating culture by innovating and implementing modern cutting-edge technologies. Hence, it is imperative to consider 'Innovation in Engineering Design' as a business enabler.

A refined way to define Innovation in an organisation is



Transformation of Industrial Innovation

The industrial value chain is changing all streams - Offering, Value and Execution. The traditional product-centric (PUSH) approach is moving towards to customer-centric (PULL) approach, which is a focal point of Industry 4.0.

The climatic change and emerging technologies are creating a paradigm shift of focus in the Engineering industry. Industry Innovation is shifting from hands to minds. In the late 18th century, Innovation in Industry 1.0 began with the introduction of water and steam-powered machines to help workers in the mass production of goods. The journey of Innovation has undergone a radical change from the Integration of hands and assembly lines to the Integration of minds, machines, sensors, data analytics and real-time decision making aided via multi-grid energy sources.

PUSH

Offering
- Products based on mass appeal
- Limited customer choice
- Drives product features

Value
- Investment based on scale economics
- Maximised fixed asset utilisation

Execution
- Long development cycles
- Collaboration is limited
- Products pushed to match production

PULL

Offering
- Products tailored to customer needs
- Customer choice is a must
- Customer input drives product features

Value
- Investment based on customer needs
- Constantly configure and upgrade asset

Execution
- Short time to market window
- Collaboration is extensive
- Market demand pulls production

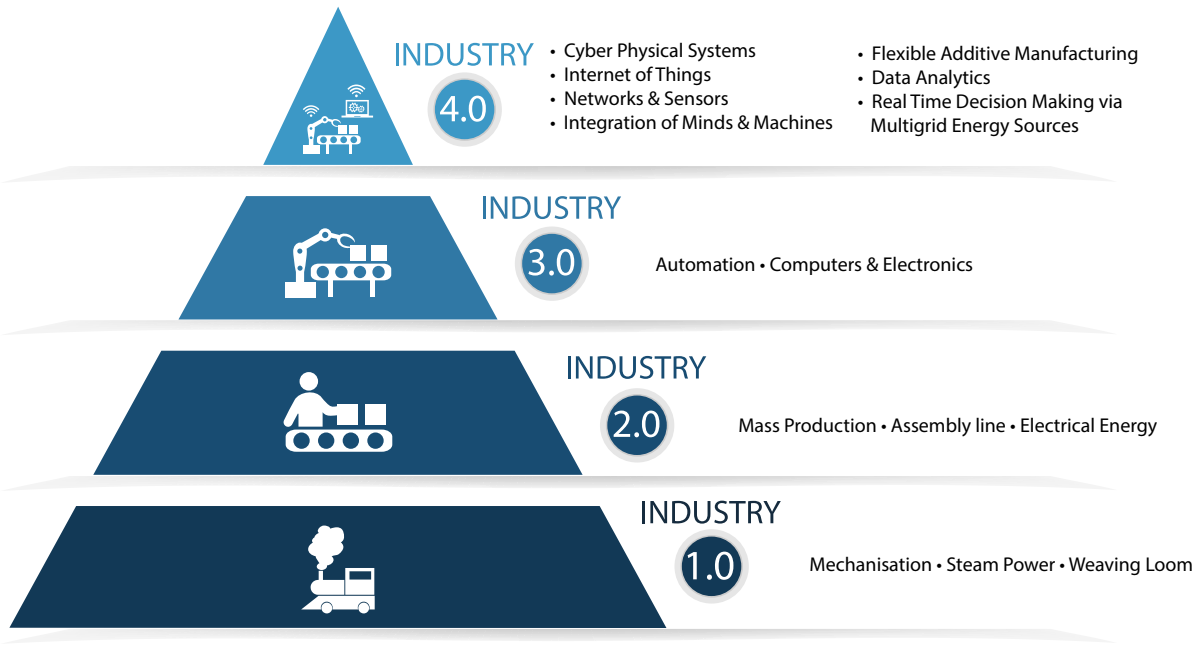
The traditional model of the Corporate R&D department with a concentration of talent to focus on Innovation is less tenable for various reasons and is giving way to more collaborative efforts across the organisation. This is more pronounced for a knowledge-based Consulting Engineering firm like TCE. Thus, consulting organisations need to use business model innovations by inculcating the culture of Innovation and adopting PUSH to PULL strategies, focusing on new technologies for business sustainability and future-readiness.

From the integration of Hands and Assembly lines, Construction workers, siloed workers to single purpose machines and basic energy sources.....

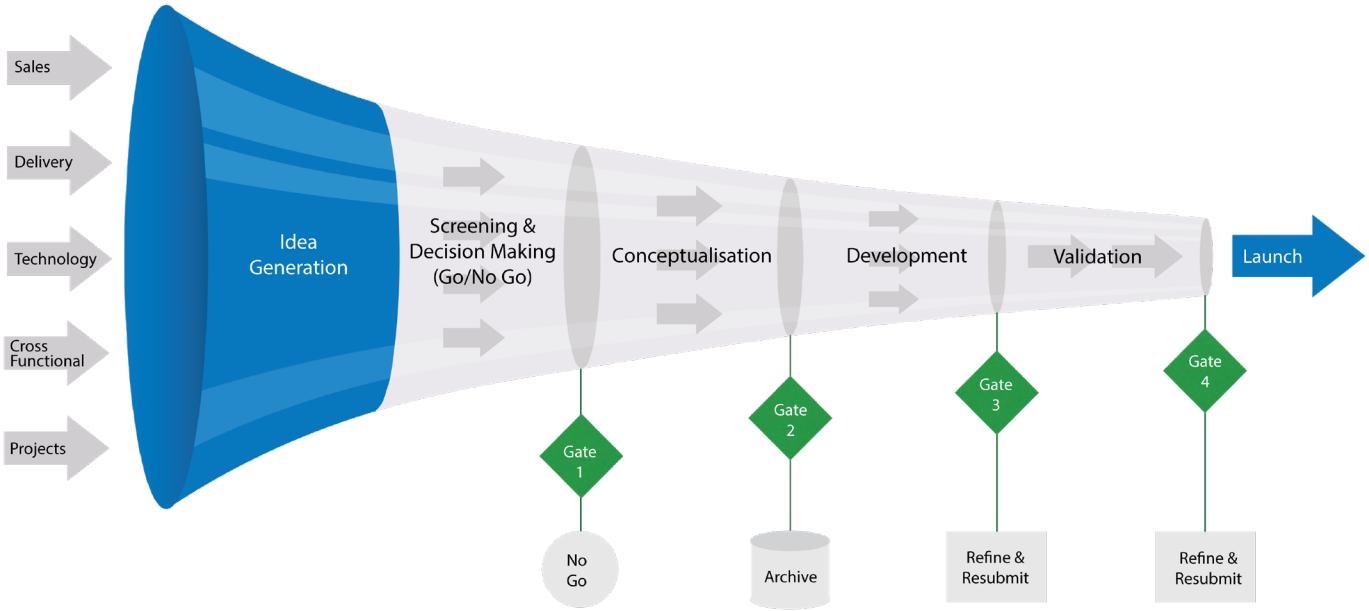
1784 → 1870 → 1969 → TODAY

INDUSTRY 1.0 | INDUSTRY 2.0 | INDUSTRY 3.0 | INDUSTRY 4.0

.....To integration of minds, machines, flexible additive manufacturing, sensors, data analytics and real time decision making aided via multi-grid energy sources.



In TCE, one of the Business Pillar identified is "Technology and Innovation". TCE works in diverse sectors, cultures and markets, resulting in a cross-pollination of ideas. Ideation and further germination of the ideas is possible only through promoting innovation culture in the organisation. TCE follows a systematic stage-gate approach model for Innovation, and it employs agile methods within the stage-gate process of Innovation framework, as shown in the below figure.



Dawn of Emerging Technologies

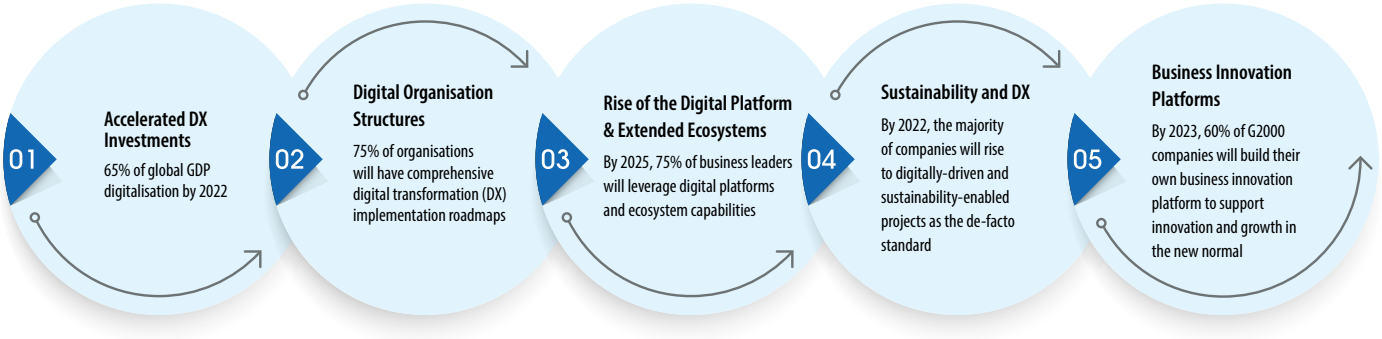
The key emerging technologies in engineering can be classified into digitalisation and digitisation, energy transition technologies, construction technology and the 5th mode of transportation.

Digitalisation and Digitisation

The digital transformation journey is accelerating the industry rapidly and impacting the economy and societies. The recent global pandemic has disrupted the conventional industrial structure and business models. Reframing new business models by combining business process efficiency and digital engineering tools has become the mission of many organisations. Digitally enabled business models and the digital economy has become the new normal post-COVID.

While cloud computing and big data are the BUZZ words for the IT industry, engineering firms align with virtual reality by offering integrated digital engineering solutions.

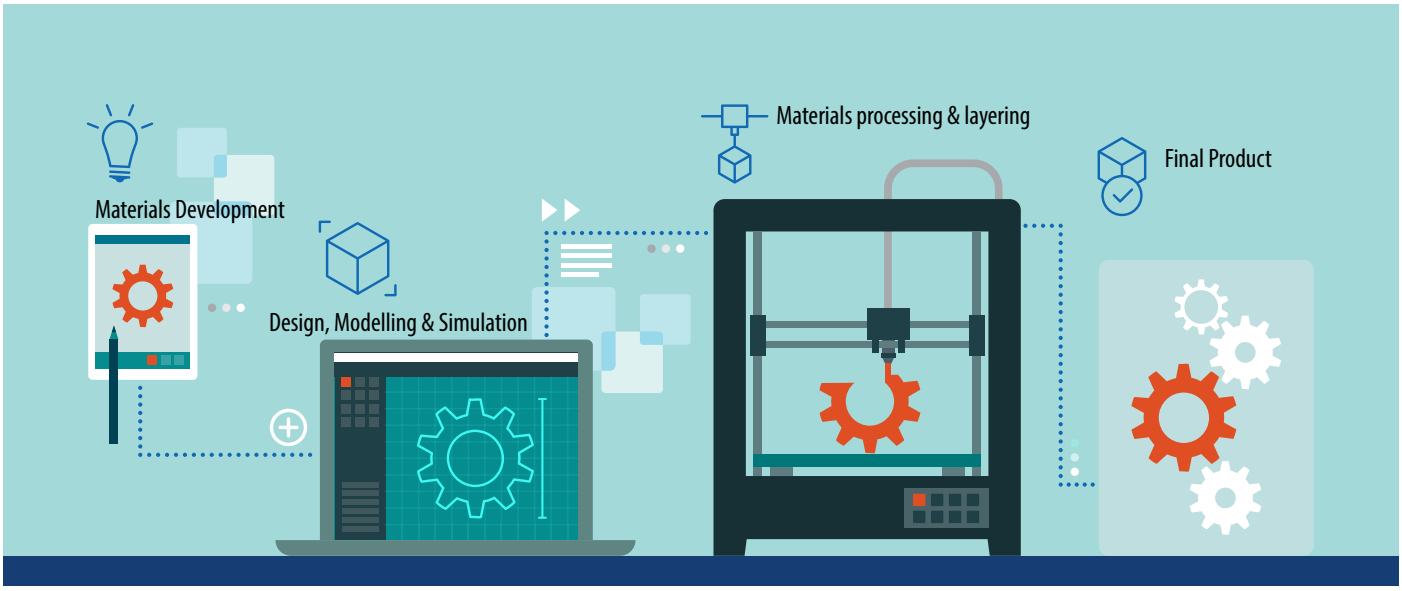
International Data Corporation (IDC), one of the top digital transformation (DX) market research global firms, has reported that despite global pandemic in recent years, the annual growth rate of digital transformation investment growth (CAGR) is around 15.5% and is expected to reach $6.8 trillion in 2023. Some of the interesting predictions by IDC about the digital transformation are depicted in the figure.



The emerging area of digitalisation and digitisation in the engineering field include 3D printing, IIOT, digital twin, 3D laser scanning, Asset integrity management etc.

3D Printing

Aerospace was one of the earliest industries to adopt 3D printing. Now it has gained its popularity in many other industries such as automotive, medical devices, prototyping and manufacturing, construction, arts & jewellery, education, consumer products.



The benefits of 3D printing include faster product development, greater design flexibility to the manufacturing supply chain, create complex geometries with reduced material waste.

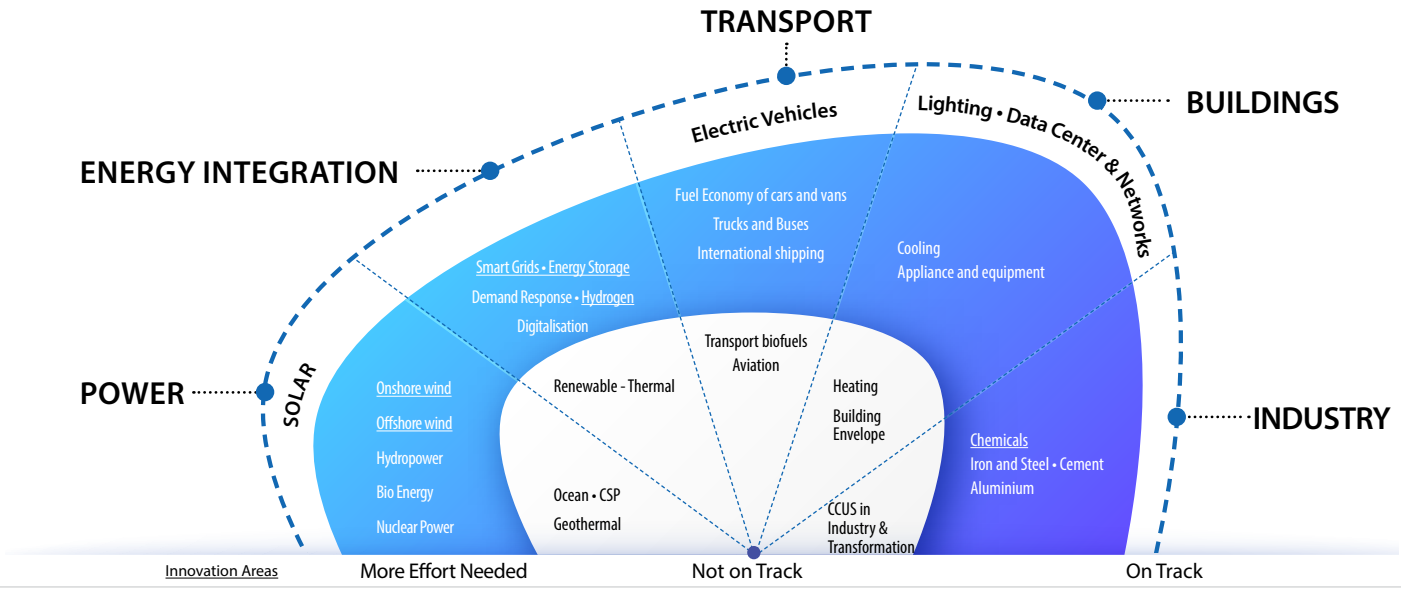
IIoT is mainly driven by the convergence of information technology (IT) and operational technology (OT). With the advancement in technologies such as asset management and Integration, predictive maintenance and digital twin, industries have started realising the potential applications and benefits such as Integration of production management, Business management, Energy optimisation & Energy management. These technologies provide significant improvements in productivity, product quality, product purchasing costs and manufacturing costs.

An innovative concept of Digital Twin (DT) is leading the Industry 4.0 revolution, supported by tremendous growth in IoT connectivity and advanced data analytics in recent years.

Energy Transition Technologies

Many countries focus on developing a low-carbon economy and green industries that align with sustainable economic development and sustainable environment vision. Two common approaches adopted to achieve a low carbon economy are:

- Increasing the share of green energy by reducing fossil fuel dependency
- Improve the energy conservation measures and reduce emissions



The various technologies contributing to energy transition include renewables, energy storage, green hydrogen, electrification of buildings, transport and industries, energy management and conservation.

Solar power, the world's fastest-growing renewable energy, is evolving with advanced technologies such as floating solar, BIPV, solar fabric etc.

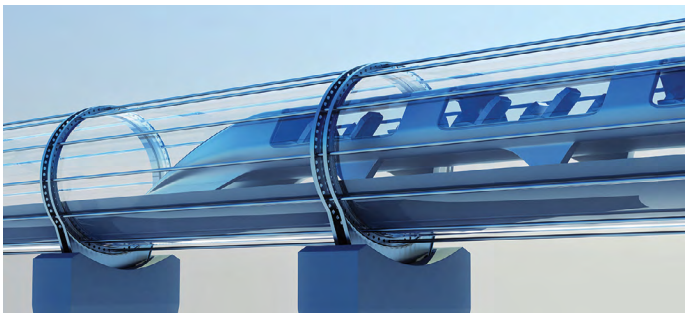
Energy storage plays a crucial role in the energy transition by supporting the large-scale renewable energy penetration into the grid. It benefits the entire power value chain, from generation, transmission and distribution, all the way to users. Recent developments in battery storage technologies and power electronics have expanded the opportunity for electric storage as a cost-effective electric energy resource.

Many industries are adopting and moving towards a low carbon economy, the green hydrogen. Hydrogen has several merits associated with clean-burning and emission-free fuel, high energy density (120 MJ/kg) compared to gasoline (45 MJ/kg), NG (54 MJ/kg, LPG, (50 MJ/kg). Hydrogen has extended many new applications like green mobility, carbon-free steel making, green ammonia etc.

The global electric vehicle (EV) market has witnessed significant growth in the recent past and expected to gain great prominence in the energy transition. Various smart technologies such as Vehicle to Grid Operation (V2G), Vehicle to Home/Building (V2H or V2B), Vehicle to load (V2L) and Vehicle to Vehicle (V2V) are under different phases of development and implementation. These smart charging technologies are expected to play a critical role in supporting grid integration of EVs in future.

Transportation

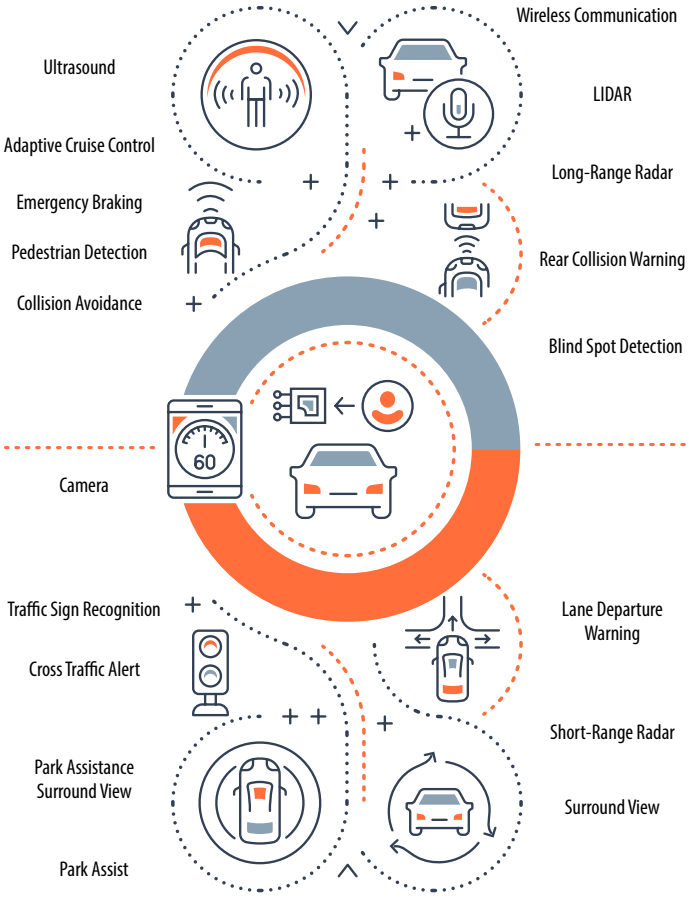
New advanced technologies are transforming the field of transportation. Some emerging technologies poised to create a revolution are hyperloop, autonomous cars with safer autonomous navigation, maglev trains and delivery drones.



Hyperloop is a new form of ground transport currently in development by several companies. It could see passengers travelling at over 700 miles an hour in a floating pod that races along inside a giant low-pressure tube, either above or below ground. The pods carrying passengers travel through tubes or tunnels from which most of the air has been removed to reduce friction. Hyperloop could be cheaper and faster than train or car travel and less polluting than air travel.

Maglev Trains are high-speed trains that run on magnetic levitation wherein the train floats over the guideway due to electromagnetic propulsion. It runs at a speed of 370 mph but produces less noise and vibration. Though six lines are currently in operation worldwide, three in China, two in Korea and one in Japan, advancement in technology such as high-temperature superconducting (HTS) is in place.

Autonomous Vehicle operates without any human intervention by sensing the surroundings and taking appropriate actions. It employs radar, ultrasound, 5G, Vehicle to Vehicle (V2V), Vehicle to infrastructure, etc.



Construction

The adoption of digital technologies in the construction sector is taking place at an increasing pace. Various technologies like big data, artificial intelligence, machine learning, IoT applications, mobile and cloud-based technologies and applications will change the way data is used in construction projects. The acquisition, processing, and management of this large volume of data would be used to make decisions regarding safety, quality, work scheduling, materials management, logistics, resource deployment, and monitoring and controlling the myriad activities in the construction project.

Drones prove effective for surveying work, especially in difficult/ inaccessible terrains, for safety surveillance and material transport. BIM technologies provide the opportunity to design, construct, and manage facilities in multi-disciplinary and multi-dimensional models for effective control over the project's complete life cycle. The complete pre-visualisation in BIM models can be further enhanced through Virtual Reality (VR)/ Augmented Reality (AR) to contextualise the design against physical settings – this helps in better design and site collaboration, real-time feedback, and improved assessment of safety risks.

Construction technologies are also changing – many on-site activities are getting transformed to offsite and shop manufactured items. Technologies like prefabrication, use of precast elements in construction, pre-engineered buildings are gaining increased usage due to better quality control, enhanced mechanised fabrication and erection, reduced safety and health risks for the workforce and enabling faster construction at lesser costs.

Offsite fabrication also allows better control and management of resources and energy consumption for enhanced environmental compliance.

3D printing technologies being developed can completely upend traditional construction practice by incorporating additive fabrication resulting in saving precious resources and improving sustainability in construction. New or altered conventional materials, including waste products, are finding increased usage by developing new technologies; these would also make the construction industry more sustainable and reduce its environmental footprint.

Conclusion

Emerging technologies have an impact on the way of working, business operations and the economy. The adaptability & implementation of emerging technologies is a journey consisting of experiments and improvements which largely depend upon the engineering innovation of the business processes and agility. Hence, it is necessary to develop the culture of Innovation for developing the work processes and technical competencies that are future ready.

Author:

D Geethalakshmi - General Manager

Tata Consulting Engineers Limited (TCE)

EMERGING TECHNOLOGY & THE INNOVATION CULTURE

in Engineering Consultancy

The role of consulting engineers is to perform engineering design and construction management to assist customers in developing projects. Consulting engineering has traditionally been a service sector industry. A consulting engineer is an expert in a specific field or branch of engineering. Various experts work in a connected and coordinated manner to provide solutions to a project's complete needs. The projects can range from setting up infrastructure for public utilities and production facilities to design and manufacture products.

The Role of Engineering Consultant

The role of an engineer in consultancy assignment is multi-dimensional – on the one hand, the requirement of technical expertise in the domain is very high, but then the person is also expected to contribute in other areas to help provide an integrated solution. In the words of Stuart B. Brown, founder and managing principal of consulting firm Veryst Engineering, Needham, MA, "Engineering consultants must be bipolar – be an expert and then do everything else. A client approaches a consultant for assistance in a specific area for lack of resource, expertise or time, but the solution may require other and different skillsets. The consultant should understand the client's problems beyond his expressed requirements and then find holistic solutions." [1]

1 Tips to Succeed as an Engineering Consultant - ASME

The differentiators that characterise services offered by consultants are:

- Offer the highest level of expertise – being better than others offering similar service.
- Use of standardised and validated tools for timely and consistent output.
- Express ideas and opinions strongly.
- Persistence with marketing the services going beyond the explicit requirements of the client and finding new ways to serve the client.
- Offering solutions within the gambit of statutory rules and standards and extending to incorporate new research and set new standards.

The consultancy service has traditionally been highly dependent on human capital. Though the various laws and theorems of science are the foundations of engineering principles, applying these principles to real-life situations allows using unique understanding to produce different outcomes. This variability in the results led to the creation of two schools of thought – one in which similar problems would lead to similar results and the other in which each situation has a different set of solutions. The former lends itself to standard practices, guidelines and templates tending to productise the design. On the other hand, the latter produces a special design that the client identifies as a unique outcome tailor-made to his specific requirements.

The Role of Technology in Consulting

Notwithstanding the above two opposing approaches to engineering consultancy, technology underlies the best practices in both. The role of a consulting engineer is to use the available information of physical reality and the client's desire expressed in terms of the specification and blend the two inputs into a unique outcome.

At the core of the design process is the requirement for handling and use of data. The availability of evolving technologies and tools allows better systems for more effective use of the data during the entire project lifecycle. The next step is of presenting the data in a form that the client easily understands, and the tools offered by new technologies make it possible to generate outputs that can engage the physical senses of the client through a complete walk down of the solution. Thus, the data-driven and tool-driven approach to engineering consultancy has emerged as the forerunning technology disrupting the traditional pen and paper process.

The digital tools allow the engineer to incorporate more updated site-specific information in the design, improving the solution's relevance to the given settings. It also allows the user to review the details of the facility that experts from the early stages are designing through virtual visualisation platforms. This increased participation of all stakeholders leads to a happy customer and good business for the consultant.

Opportunity for Digitalisation

According to research agencies, the engineering and construction industry has been low in adopting digital technologies and ranks only above agriculture. The focus has been on making slight process improvements fuelled by the assumption that each design project is unique with little chance for standardisation. Scaling up new ideas is complex, and imbibing new technologies is not required[2]. Some of the major trends in various stages of development and implementation for the engineering and construction industries are shown in Figure 1. Engineering consultants are realising the importance of these skills and tools in the field of work and use them for better management of data throughout the lifecycle of the project.

High-Definition Survey

New surveying techniques include LiDAR, 3D-laser scans, drone survey for above ground mapping and ground-penetrating radar (GPR), magnetometer survey for subsurface features. This data can be overlaid on geographic information system data to give a comprehensive real-time background against which the new design can be superimposed.

BIM Modelling

Multi-dimensional BIM tools allow a project to be presented digitally with its complete physical and functional traits. Using the multiple levels of BIM, all stakeholders can visualise the entire design on an intelligent platform and study the effect of changes to design, materials, schedule and costs and identify risks that help make better decisions. In further advanced applications, the BIM design can be superimposed on holographic images of reality to create a mixed reality with which users can interact virtually.

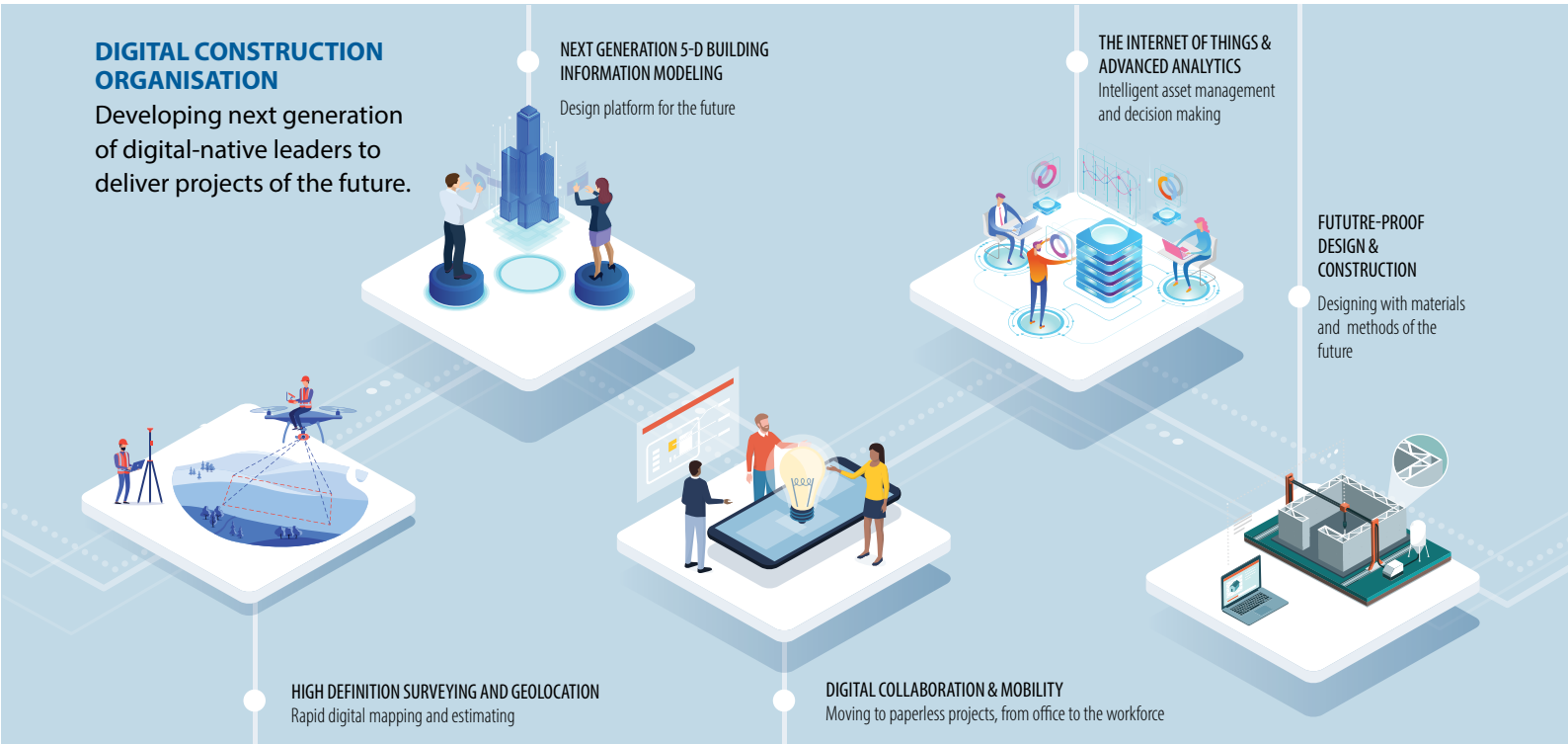


Figure 1: Trends for Engineering & Construction Projects[2]

2 Imagining construction's digital future | McKinsey

Digital Collaboration

The use of digital space for design projects allows better collaboration among the various agencies involved in the process and capturing complete information. It also uses analytical tools to process the current information and modify the design for better outcomes and risk mitigation. The digital collaboration is extended beyond the desktop onto the field implementation through mobile and handheld devices, integrating the site managers with the project for real-time feedback and monitoring.

Internet of Things

The Internet of Things at the construction site can enable the exchange of information between construction equipment, materials, and structures, helping collect critical parameters to ascertain the quality and pace of construction, health of equipment, managing the store and inventory, energy usage and safety of workers.

Futuristic Designs and Materials

Using new materials like self-healing concrete, water-absorbing bitumen road surfacing, nanomaterials, aerogels, and concrete canvas can change many traditional construction methods. The use of demolition waste and other green construction practices using less energy with lower carbon footprints is also current.

The new technologies that are finding applications in the E&C industry are shown in Figure 2.

New Construction Techniques

Innovative construction techniques like 3-D construction, preassembled and modular units, robot assembled construction can improve quality and reduce on-site time. Prefabricated, prefinished volumetric construction (PPVC) is a new concept where complete standard designed units with internal finishes, fittings and fixtures are made in the factory, transported to site and erected as modular units. This technique can be applied to hotels, hostels and apartment blocks.

The benefits include up to 50% reduction in on-time site and workforce, lower pollution and better safety practices. An example from a project in Singapore is shown in Figure 3. Engineers can now exploit the advantages of these mechanised construction techniques through the principles of modular design approaches that also include analysis for transport and lifting of the preassembled units and special splicing connection details to achieve the desired behaviour of the entire unit after complete erection. Crane placement and part lifting are also designed using digital tools overlaid on accurate site data to simulate the actual erection process, which gives better safety and quality control, especially at existing sites.

Photo credit: Singapore Building and Construction Authority

Figure 3: PPVC technique of construction in Singapore[2]

EXHIBIT 1 | Many Digital Technologies Can Be Applied Along the E&C Value Chain

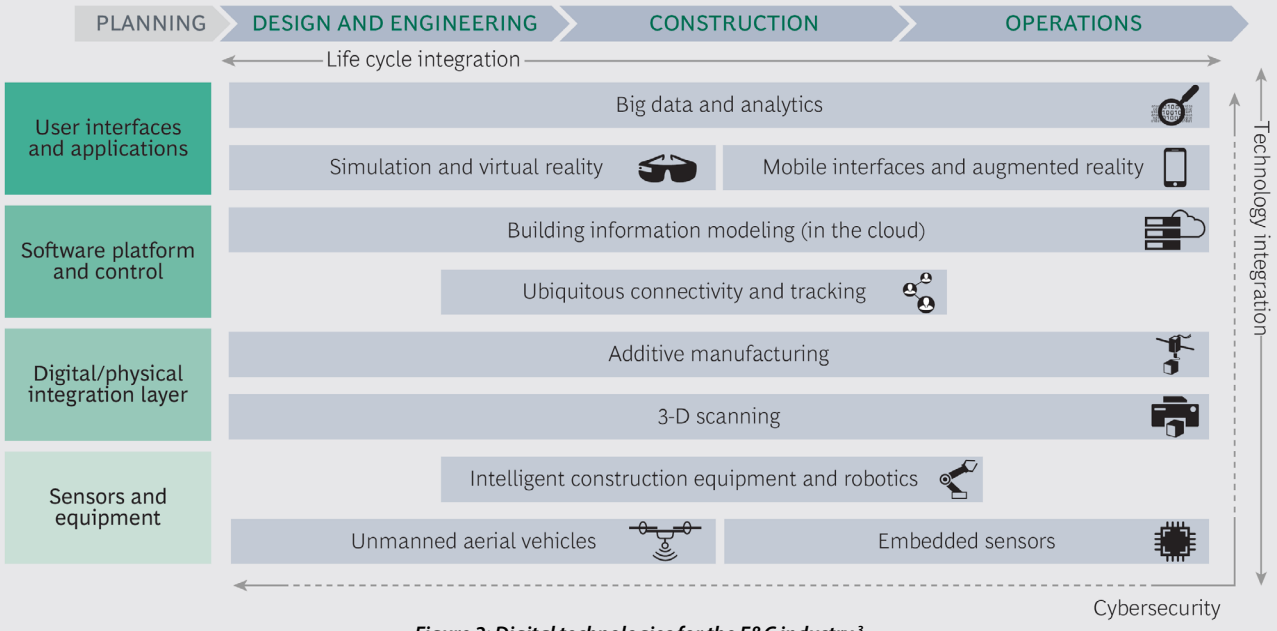


Figure 2: Digital technologies for the E&C industry [3]

Source: BCG analysis.

3 Digital in Engineering and Construction: The Transformative Power of Building Information Modeling (futureofconstruction.org)

Adoption of New Technology

A survey across engineering professionals[4] showed that 3D printing had been the dominant technology adoption at 74% implementation, followed by IoT application at 33%, artificial intelligence at 20% and collaborative robots at 13.5%.

Another research[5] on BIM use by private and public sectors in construction projects through a survey of the Architect Engineering Construction (AEC) industry shows that the adoption across various engineering disciplines varies. The findings are shown in Figure 4.

The use of digital technologies can open the doors to many new opportunities in the Engineering and Consultancy (E&C) industry, as shown in the infographic in Figure 5.

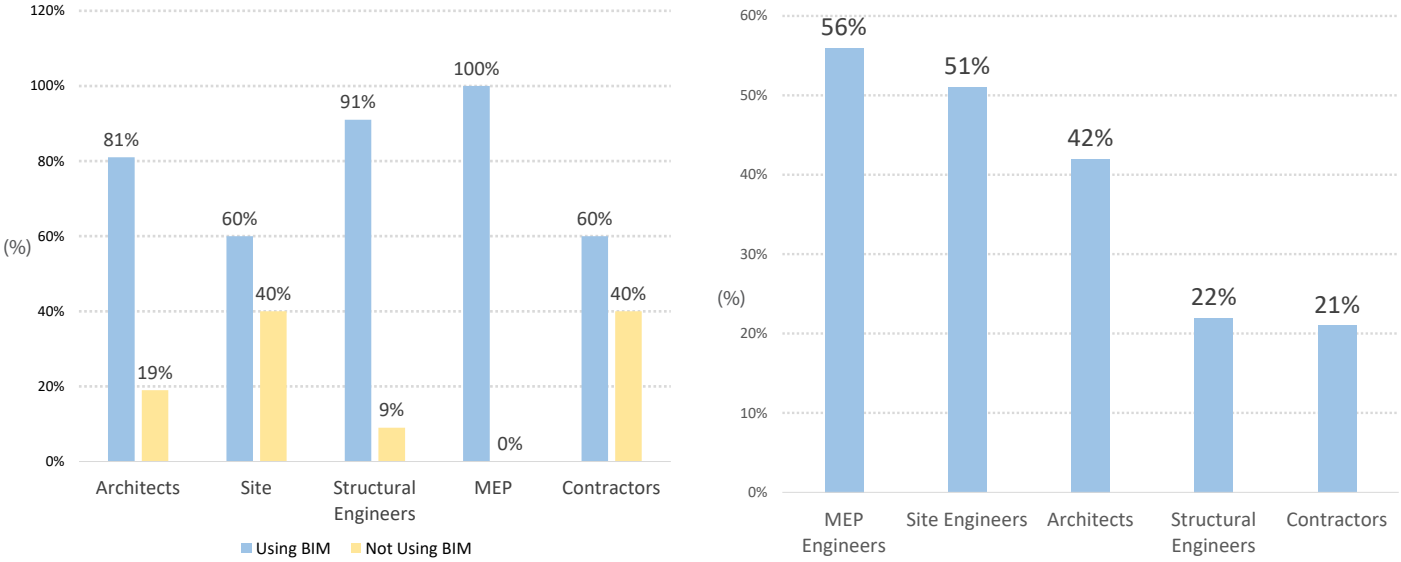


Figure 4: Discipline-wise role and BIM knowledge distribution in Engineering Consultants[4]

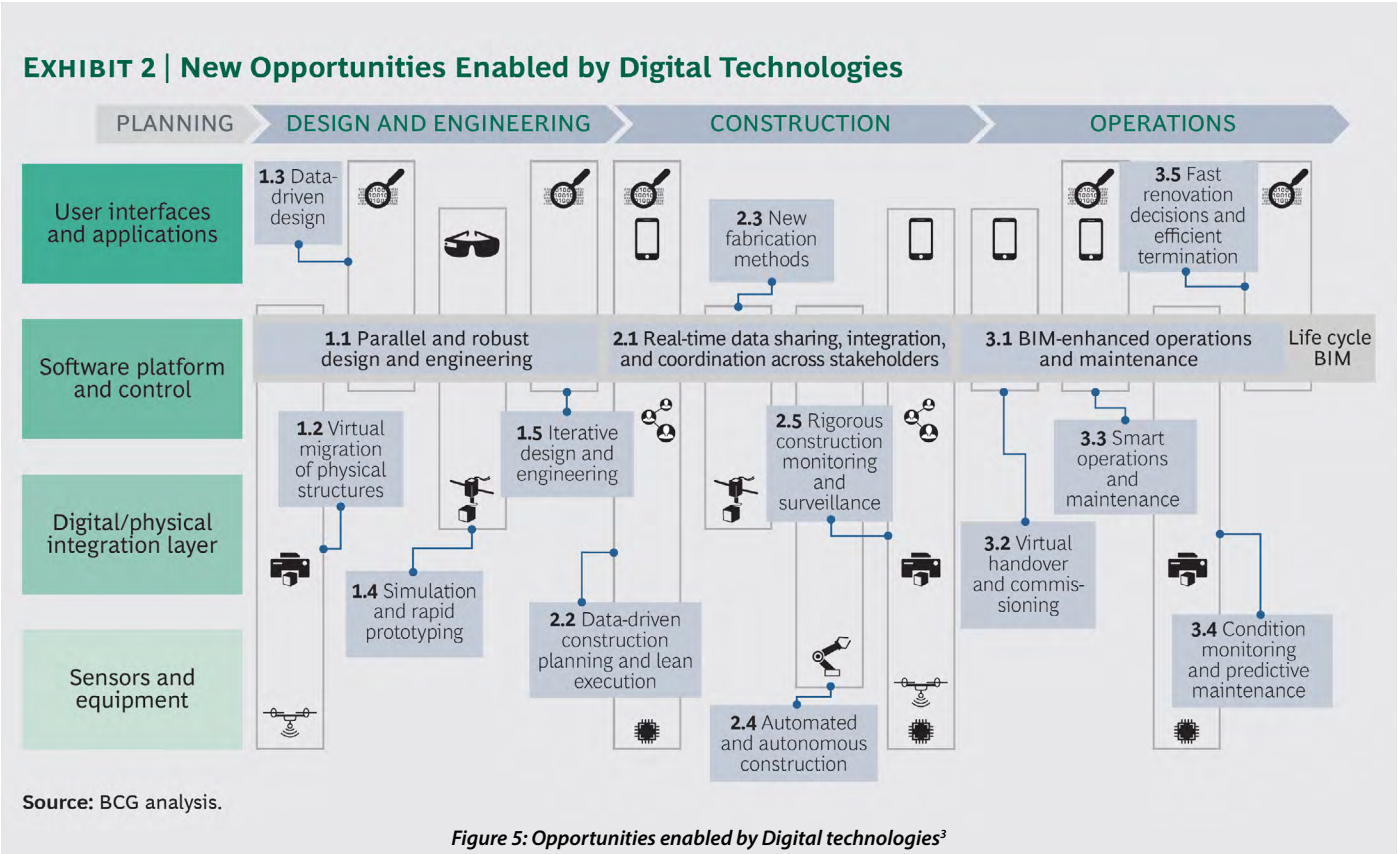


Figure 5: Opportunities enabled by Digital technologies[3]

4 New Technologies Pushing Engineers to Become Better, Stronger, Faster | Machine Design
5 Cristina Moreno, Svetlana Olbina, Raja R. Issa, "BIM Use by Architecture, Engineering, and Construction (AEC) Industry in Educational Facility Projects", Advances in Civil Engineering, vol. 2019, Article ID 1392684, 19 pages, 2019. https://doi.org/10.1155/2019/1392684 | https://www.hindawi.com/journals/ace/2019/1392684/

The Technology Path for E&C Industry[6]

Once the organisation has understood the way forward for adopting digital technologies, a policy must be framed for a focused approach. The usual procedure adopted is creating a technology team that would frame the objectives, data strategy, and budget requirements and present this to the company leadership. This team, led by the technology executive, chalks out plans to improve existing technology in the organisation, analyses the data from reports, and develop a long-term strategy for the business. The digital strategy will include:

a. Improving the hardware set-up including computers, servers, mobile devices, surveying and measuring instruments, IoT devices as per the future business plan

b. Automation of tasks of repetitive nature and work that can be standardised through established methods.

c. Internal development of working engineer teams and work processes can also include creating software packages as long-term goals. This will also need to strategise the procurement of high end and proprietary commercial software tools for special applications.

d. Keep abreast of the latest technologies and lead and support the project teams to incorporate such new technologies in business offerings.

A Culture for Innovation

Engineering innovations are fast becoming standard expectations for their projects, and Engineering Consultants realise this need in their project deliveries. It makes good sense to create a specialised team to oversee this transition to new technologies that can otherwise drain effort and cost. An innovation committee is a common practice to lead this technology change and adoption. The committee led by the technology executive generates the new ideas and approaches that are then discussed and debated. Agreed ideas are further developed by the technical teams in line with the direction and goals set by the committee. The leadership of the Engineering Consultant acts as the prime support to this effort by supporting the innovations with the required budget and time and allow the business to innovate.

Author:

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Tata Consulting Engineers Limited (TCE)

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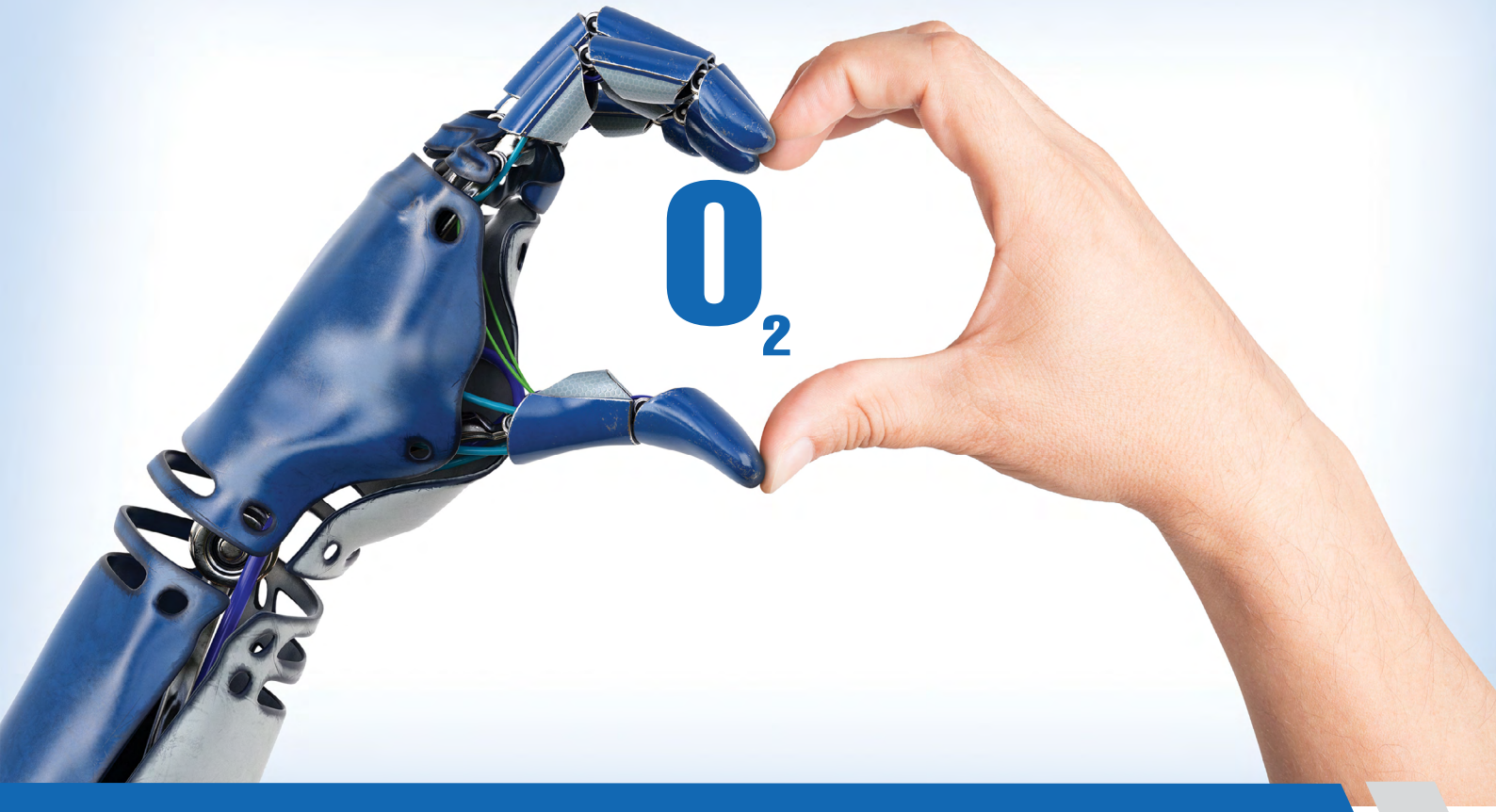
6 Consulting - Specifying Engineer | Does your engineering firm need a tech stack? (csemag.com)



ENGINEERING LIFE:
COVID-19 Specific Engineering Solutions by TCE

As the Pandemic's impact was being felt from March 2020 onwards, and while the teams were working on rewiring TCE operations and taking other prudent measures, there was a deep sense of responsibility towards contributing to the fight against the Pandemic.

TCE's key currency is the intellectual horsepower, thought leadership and innovative mindset of its talent. The company took a firm resolve to use this currency and contribute effectively to the cause. To date, close to 15,000+ consulting person-hours have been devoted to fighting the Pandemic. TCE's efforts focused on ideating, conceptualising, designing, engineering, and enabling various innovative initiatives as a Pro-Bono activity.

The ongoing Pandemic second wave required urgent actions towards enhancing the country's healthcare, medical oxygen generation, and distribution capacity. TCE's teams have made humble efforts towards contributing their bit on this critical requirement, focusing on Agility, Indigenisation aligned to self-reliance, quality and cost competitiveness. The company's actions have leveraged collaboration, teamwork, and partnerships externally to achieve more together in the shortest possible time.

1. **Emergency COVID-19 Infrastructure:**
   A team from TCE and its subsidiary Ecofirst worked on war footing to conceptualise and design both modular units for COVID-19 patients and emergency jumbo COVID-19 hospital structures. The team collaborated with the Group Companies and multiple External Firms to provide these concepts and solutions for implementation and actual rollout.

2. **Oxygen Ventilators:**
   An engineering, feasibility and viability study was conducted on multiple ventilators, and a viable open source ventilator was identified. The learnings were shared with group entities for evaluation, and appropriate next steps were suggested for mass manufacturing related tie-ups.

3. **Oxygen Distribution Supply Chain:**
   To enable last-mile oxygen distribution and supply chain logistics, TCE researched and presented the concept of conversion of cylinders such as Co2, CNG, LPG (for gas) etc. Suitable precautions, colour coding and planning for Gaseous Oxygen distribution across the country leveraging the existing LPG bottling and distribution network was also detailed and shared with PESO.

4. **Oxygen Generation PSA Plant Scale:**
   To leverage the existing infrastructure in the country, the concept of conversion of PSA Nitrogen plant to PSA Oxygen plants was developed by TCE and successfully piloted along with IIT Bombay. Close to 75+ PSA Nitrogen plants (more expected to add up to 100+) are currently being converted for Oxygen generation.

5. **Oxygen Plant Critical Raw Material:**
   Jointly as a team, Tata Consulting Engineers, Tata Chemicals and IIT-Bombay were able to garner GOI support for emergency airlift of Zeolite from Germany with the support from BASF leadership. The implementation of this concept is being done with the help of the Ministry of Environment entity Central Pollution Control Board (CPCB) as assigned by the GOI and project managed by TCE.

6. **Oxygen Generation using O2 Concentrator:**
   TCE prototyped opensource design (oxikit) in less than five (05) working days with benchmark results of 10-20 LPM with 90-94% oxygen concentration. TCE made several necessary design changes and process refinements to ensure benchmark results under Indian conditions. Except for the Zeolite, locally available Indian parts for the prototype were used. The Opensource oxygen concentrator design is actively being explored by startups, entrepreneurs and MSME's across India.

7. **Oxygen Infrastructure within Hospitals:**
   TCE teams are assisting various Central efforts, State Governments, Startups, NGOs and Hospitals on all above topics and are also providing consultancy for new PSA Oxygen plants, hospital oxygen infrastructure, pipelines and related checklists and audits. TCE has responded to more than 3000+ requests for information and support in the last three weeks.

8. **Project O2 for India:**
   TCE is proud to be a part of the 'Project O2 for India' initiated to ensure the supply of critical raw materials such as zeolites, the setting up of small oxygen plants, and manufacturing of compressors. The consortium is not only looking forward to providing immediate to short-term relief but is also working to strengthen the manufacturing ecosystem for long-term preparedness.

Visit https://www.tce.co.in/tce-combating-covid/ to know more

Conversion of PSA Nitrogen Plant to Produce Oxygen

While the liquid oxygen manufactured by cryogenic air separation plants, installed in Indian Refineries and Steel plants, was being diverted for medical use, that was not enough to meet the increasing demand. Therefore, there was a need to look for additional sources through which oxygen could be generated quickly closer to the consumption point.

A task force was set up at Tata Consulting Engineers to study all possible options and work on engineering the fastest and best-suited option in the current circumstances. In addition, alternate and out of box solutions for storage and distribution of oxygen were also investigated and published as the whitepaper (*https://www.tce.co.in/wp-content/uploads/2021/04/Meeting-Oxygen-Demand-Tata-Consulting-Engineers-Response.pdf*), including CO^2 fire extinguishers and LPG cylinders for medical oxygen service.

All these methods involve statutory, legal and other approvals and must be done with the proper involvement of the government authorities. Adequate cleaning and colour coding of the cylinders is required for safety reasons. A governance mechanism involving government officials, PESO, Controller of Explosives, Fire Department, Medical Department (Min. of Health) and administrative authorities are also required for related compliances and approvals.

A new 'Pressure Swing Adsorption (PSA) oxygen generation Plant typically takes about eight months. PSA nitrogen plants were already installed and operational in many industries for industrial purposes.

Conversion of existing PSA nitrogen Plants for oxygen production emerged as the winner and the most practical solution given the current situation. The PSA technology has been in existence since 1970, so workability was not an issue, the only concern was to see it working in front of us, and that too quickly as time was of the essence.

The Technology:

The basic configuration and technology for both Nitrogen and Oxygen PSA units are similar. The significant difference being the adsorbent material. When the adsorbent material (activated carbon molecular sieve - CMS) of the nitrogen generating units is replaced (by Zeolites), the same unit that produced nitrogen will now be suitable for producing oxygen.

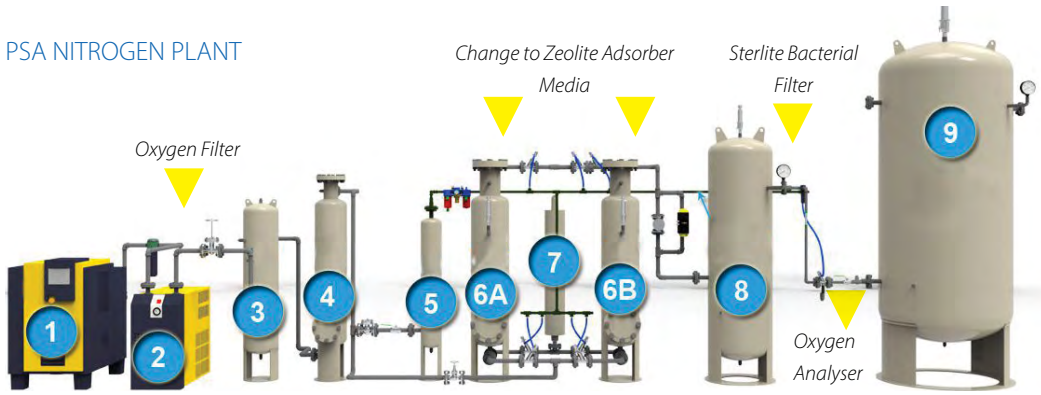
The OEMs also confirmed this point. However, when such conversion is implemented, the nameplate capacity of the converted unit will be reduced roughly to 25% of the original nitrogen generation capacity. Some of the significant steps involved in the conversion are as seen in the image below:

Changes to Existing Nitrogen PSA Units for Conversion to Oxygen Generation Units

PSA OXYGEN PLANT

1. Air Compression
2. Air Filtration
3. Air Drying
4. Air Buffer Tank
5. Trace Oil Particle Filter
6. Air Buffer for Pneumatic Valves
7. A Adsorbing Tower A
   B Adsorbing Tower B
8. Flue Gas Vent Silencer
9. Oxygen Surge/Buffer tank
10. Oxygen Storage Tank

PSA NITROGEN PLANT



1. Air Compression
2. Air Drying
3. Air Buffer Tank
4. Trace Oil Particle Filter
5. Air Buffer for Automatic valve
6. A. Adsorbing Tower
6. B. Adsorbing Tower B
7. Flue Gas Vent Silencer
8. Nitrogen Surge/Buffer tank
9. Nitrogen Storage Tank

The Challenges

Once the feasibility was established, the team started contacting various OEMs to get the desired timelines. Most OEMs estimated three weeks for complete conversion of the units. The time indicated by OEMs is generally on the higher side because of the internal process of procurement of adsorbent beds and other equipment like oxygen filter, oxygen Analyser, some amount of piping changes, valves required, transport to site and then site installation, recommissioning etc. Work also involved flushing/ cleaning/ purging the entire PSA Plant and making it suitable for medical Oxygen production. The estimated time of these activities included the time from order to medical oxygen output.

Approximately 30-45 days are required to build an Oxygen plant from scratch, which was not an option given the emergency caused by the acute shortage of medical oxygen. TCE needed the retrofitting within five days. Various challenges needed to be overcome to achieve a quick turnaround. Some of the significant challenges were:

1. ZMS availability
2. Control panel retrofitting
3. On-Site workforce for removing CMS, completely dedusting the adsorber towers, and filling the ZMS.
4. Commissioning of Oxygen plant
5. Area requirement based on the size of the Nitrogen plant available. A Nitrogen plant of 100 Nm3/h capacity, if converted to oxygen, will produce approx. 25 Nm3/h. This requires a space of approx. 3 m x 5 m and additional space for compressor, dryer and Oxygen tank.

The Turnaround

The team branched out to tackle all the issues simultaneously. Considering, research and development capabilities and availability of laboratories at premier academic institution IIT Bombay and the availability of nitrogen skid from an OEM, the teams of TCE, IIT Bombay and Spantech Engineers signed an MOU for establishing proof of concept of converting the existing nitrogen PSA unit into oxygen generating unit at IITB.

The R&D team of IITB offered the infrastructure available in their Cryogenic Lab. And they arranged for a suitable capacity compressor and dryers to integrate it with the demo unit of the nitrogen PSA unit.

M/s. Spantech engineers carried out the activities for the conversion at their premises, including the supply of the molecular sieve adsorbent.

Prof. M D Atrey (Dean R&D, IIT Bombay *Amit Sharma (CEO &Managing Director)*

A new oxygen analyser was installed to check purity and compliance of medical oxygen requirements on the discharge pipeline from the Oxygen receiver. In addition, a fine filter was installed to filter out carryover of any particulate matter, dust etc., to suit medical oxygen specifications which can be further connected to the pressure regulator to meet the supply pressure requirements of medical oxygen.

The entire conversion took 2-3 days, and on the 3rd day, the skid was transported to the IITB Cryogenic lab and connected with the existing compressor and dryer. On day five, from the MOU signing, the skid was commissioned, and oxygen with 93.5% purity was generated at 25LPM with an input air temperature of 40 degrees. C

When the country was in urgent need of medical oxygen, the partnership of industries and academia demonstrated that the existing nitrogen PSA units can be quickly converted into medical oxygen units.

CLICK HERE TO CHECK THIS YOUTUBE VIDEO

To date 75+ Nitrogen Units have been converted to oxygen producing units and have been attached to COVID-19 hospitals in more than 20 states in India.

This technology is also being implemented in some Asian countries using our pro-bono technology transfer consultancy.

Indigenous Opensource Oxygen Concentrator Design

While the initiative around Conversion of existing PSA nitrogen Plants for oxygen production was underway, India saw a surge in COVID cases in rural India. A need for felt for a portable solution to help local MSME's build concentrators and attach those to patient beds.

The task force started exploring the concept of developing a concentrator with an output flow of more than 20 LPM, keeping in mind the need for such portable oxygen concentrators to provide Oxygen to COVID-19 patients needing between 5-20 LPM with 90% Oxygen concentration, and for interiors parts of India where PSA Industrial Oxygen plants may not be available or feasible. Both the industrial-scale Oxygen plants and Oxygen Concentrators use the same principle, Pressure Swing Adsorption (PSA), a 50-year-old concept.

The aim was to explore concentrator design that can be manufactured in bulk, at a reasonable price point, in the shortest time frame and most importantly, using locally sourced components. Multiple open-source concentrators and other designs were studied, and it was decided to study and prototype the OxiKit opensource concentrator for this initiative.

As time was of the essence, the objective was to develop a concentrator using indigenous parts in the shortest possible time. The prototype leveraging opensource design (www.oxikit.com) was accomplished in less than five (05) working days, with complete local parts as available in India (except Zeolite) and with benchmark results of 10-20 LPM of 90-95% oxygen concentration. In addition, several necessary design changes and process refinements were incorporated to ensure benchmark results under Indian conditions.

The Technology:

Oxikit opensource concentrator is based on proven PSA technology (https://oxikit.com). It utilises a molecular sieve to adsorb gases and operate on the principle of rapid pressure swing adsorption of atmospheric nitrogen onto zeolite minerals at high pressure. PSA technology is a reliable and economical technique for small to mid-scale oxygen generation.

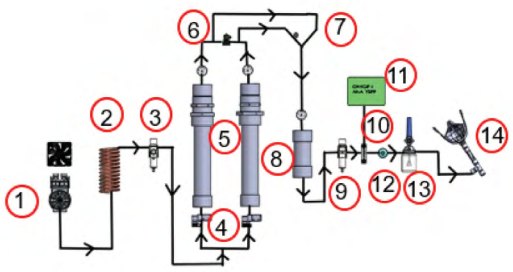
TCE prototype uses 3.2 Kg (7 pounds) Sodium Zeolite (0.4mm) to produce 20+ LPM of 92-95% Oxygen concentration. TCE design uses sodium Zeolite instead of Lithium-Zeolite, keeping in mind the Indian ambient conditions, Zeolite availability, and to ensure a competitive price point advantage.

TCE has calculated (pure material cost approx. INR 35-45k) and a benchmarked competitive price of INR 60k (+/-10%) for the specification designed, which can be further optimised based on mass manufacturing and bulk procurement strategies.

Even though the technology is proven, the device is sensitive to ambient conditions, and the study carefully assessed these aspects in the prototype test trails. This necessitated detailed review and modification in Oxikit design to suit Indian requirements with locally available parts refer the enhancements in the image below:

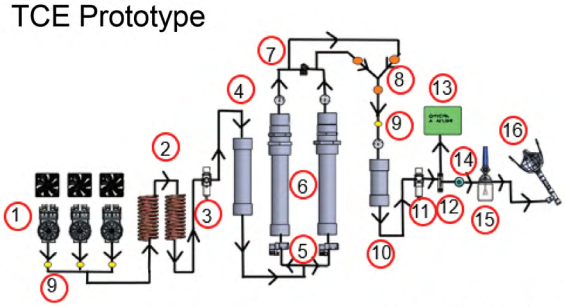
TCE Prototype - Enhancements

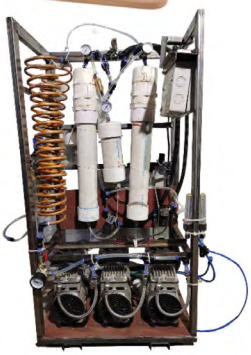
Oxikit oxygen generator



1. Air compression
2. Air cooling coil
3. Air Filtration and Regulation
4. 3/2 Charge/purge valve
5. Adsorbing tower A
   Adsorbing tower B
6. Pressure equivalisation valve
7. Orifice
8. Surge Tank
9. Low pressure regulator
10. Oxygen flow meter
11. Oxygen analyser
12. HEPA Filter
13. Humidifier
14. Oxygen mask

TCE Prototype





1. Air compression
2. Air cooling coil
3. Air Filtration and Regulation
4. Air Drying (Silica gel dryer)
5. 3/2 Charge/purge valve
6. Adsorbing tower A
   Adsorbing tower B
7. Pressure equivalisation valve
8. Orifice
9. Non return valve
10. Surge Tank
11. Low pressure regulator
12. Oxygen flow meter
13. Oxygen analyser
14. HEPA Filter
15. Humidifier
16. Oxygen mask

Non-Return Valve (NRV)

TCE's Value Addition

- Use of Compressor head without tank to reduce overall weight and cost of compressor
- 2 nos. of cooling coils considering ambient temperature in India
- Low-cost Silica Gel Dryer bed to improve O2 Concentration
- Non return valve at input of surge tank to maintain the pressure in surge tank.
- Modification of Absorbing tower assembly to suit locally available parts

The Challenges

The biggest challenge was to achieve the desired purity of oxygen above 90% concentration and at a 20 LPM flow rate. TCE's technology, product design and process experts analysed the technology and process parameters impacting purity, such as humidity, operating temp, pressure, and continuous hours of operation. Considering the variation in relative humidity and ambient temp, required enhancements were done by TCE to the process design to ensure optimal outcomes from the device.

Once these modifications were frozen, the team started contacting various fabricators to get timelines to manufacture the prototype. Most fabricators estimated between 4-6 weeks for manufacturing of prototype. The time indicated by fabricators is generally on the higher side because of the availability of parts in the local market matching with specifications specified by Oxikit, zeolite material, oxygen analysers, electronics circuit etc.

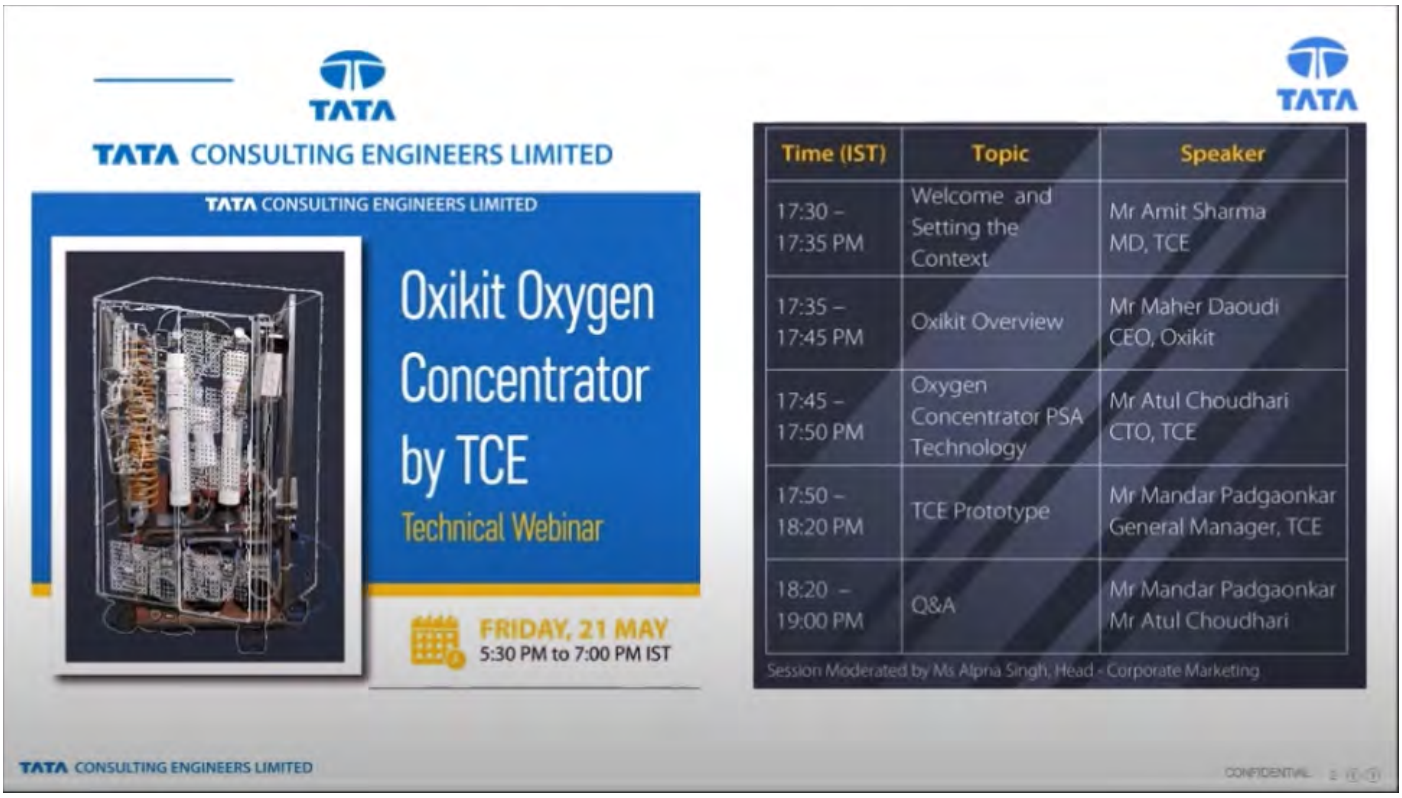
Considering the present acute shortage of oxygen, approximately 4-6 weeks to build a prototype was unacceptable. After carefully studying the requirement and technical challenges, TCE decided to build the prototype itself. The prototype was ready within three days to be open-sourced to MSME and entrepreneurs across India.

Various challenges needed to be overcome to achieve a quick turnaround. Some of the significant challenges were:

1. ZMS availability (Zeolite)
2. Availability of Oil-Free Air compressor of required capacity
3. Availability of HDPE pipes/ Solenoid valves in the local market
4. Availability of electronic circuit and other components
5. Availability of Oxygen Analyser and flowmeter
6. Availability of HEPA filter
7. Availability of Air Dryer unit

The Turnaround

The team planned to tackle all the issues simultaneously. Considering, availability of parts in the local market, necessary design modifications were carried out. The team discussed with various suppliers to arrange suitable capacity compressors, valves, electronic components, and ZMS. A local fabrication partner was identified to work under TCE's program management to develop the prototype, and as a team, they jointly put in efforts to procure the required components. Another partner was identified to create the outer casing of the concentrator.



CLICK HERE TO CHECK THIS YOUTUBE VIDEO

The entire prototype was completed within three days. On the 3rd day, the prototype achieved an oxygen purity of 70-80%. TCE change the Zeolite specification and incorporate additional design refinements, and on the 5th day, 11th May 2021, the TCE prototype achieved the 94% oxygen concentration at 20 LPM. Thus, the team could make a prototype in 5 days despite lockdown. TCE experts worked from home leveraging MS-TEAM and WhatsApp Video calls and delivered the prototype even with market restrictions impacting the sourcing of components.

Oxikit teams informed us that TCE is the first team in India to achieve this milestone since the release of the Oxikit opensource concept in July 2020 by the Oxikit team. The feedback truly humbles the TCE team. A few weeks ago, a team from Oxikit visited our office and studied the prototype first hand.

However, true success will be when TCE enables and ensures that 1000 more accomplish this milestone in INDIA at the earliest – with actual products coming out of manufacturing facilities in lacs soon. With that vision, TCE shared everything online and conducted an online Webinar which received an overwhelming response.

The prototype is built using 100% indigenous parts, except Zeolite and is ready for mass production. TCE will provide technical guidance to all interested or to MSME having regulatory approvals to make this.

When the country needed medical oxygen, this initiative demonstrated that the manufacturing of Oxygen concentrator with locally sourced components from within India is possible and must be explored by MSME, state bodies and entrepreneurs together.

Without ambiguity, it has been made clear that any and all regulatory, standards related, safety, validated final designs for mass manufacturing, supplier validation and after-sales service is the responsibility of the manufacturing unit and entrepreneurs or state bodies who wish to bulk manufacture the device.

A private entrepreneur in UP is taking up to 50,000 units of these Oxygen Concentrators working with Oxikit teams. Close to 200 teams across India are also working on the opensource Oxikit initiative and ready to roll out their devices in the coming days. TCE is happy to be part of this movement and help accelerate its adoption.

For technical details and FAQs, refer:
https://www.tce.co.in/tce-combating-covid/

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Tata Consulting Engineers Limited (TCE)

DIGITAL POINT SOLUTIONS

A Smart Approach to Digitalisation of Plants

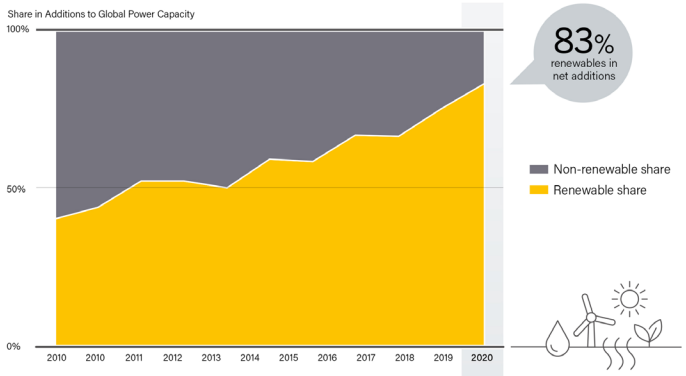
Digital technologies and digitalisation have touched every bit of life and have enhanced human comfort significantly over time. Large volumes of digital data generation and acquisition, a quantum leap in computation power, reliable high-speed internet, young digital-savvy workforce, industry 4.0 technologies etc., are accelerating the digitalisation in the plants. Digitalisation is making its presence felt in plant engineering and operation too. It benefits the operators in optimised energy and utility consumption, preservation of the operational know-how and practices, improvement in safety, remote monitoring, maintenance optimisation, emission control and compliance and satisfaction of operation and maintenance (O&M) staff.

Digital Transformation is a challenge and an opportunity for the engineering community to become the leading partner in this technology led transition by offering reliable digital solutions that can better plant operation and maintenance. This article reviews the requirement and application of digital technology in power and process plants. It explores different options available in the market and explains an optimal approach for plant digitalisation.

Digitalisation- A must for Power Sector

The power industry is undergoing rapid digitalisation among the different sectors due to the ongoing clean energy drive. Decarbonisation has become necessary to offset global climate change, and digitalisation complements the transition by technologically enabling it. The curtailment of fossil fuel-based power generation, efficiency improvement of fossil fuel-based plants and rapid shifting to renewable power sources are happening in the industry to meet the climate targets.

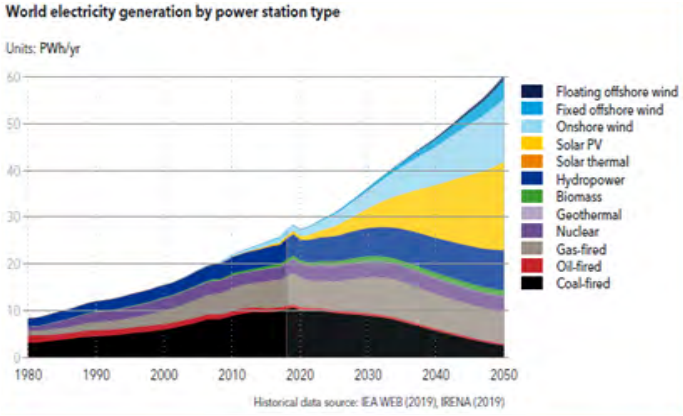
About 83% of the new power generation capacity added in 2020 globally is renewable energy (RE) as per the Renewable 2020 Global Status Report. (Ref: Fig-1). The global power generation from coal-fired plants would decline steeply in future as per Energy Transition Outlook 2020 (Ref: Fig-2).



Source : Renewable 2020 Global Status Report – Annual Report by REN21 Renewable Energy Policy Network for the 21st Century, June 2021

Figure 1

The variability introduced in the power system by the higher share of weather dependent RE sources poses a challenge to grid operators. Decentralisation of RE power, Mini/microgrids, flexibilisation of the thermal power plants, smart grids, pumped hydro plants are being implemented as countermeasures to manage the variability from RE sources.



Source : Energy Transition Outlook 2020 – A Global and Regional Forecast to 2050 – DNV GL

Figure 2

Further, reducing the RE power tariff leads to lower plant load factor (PLFs) and diminishing profit margins for the coal-fired powers under the existing regulatory framework. Hence improving the efficiency and flexibility of these plants are non-negotiable requirements for their existence. Digitalisation is essential for managing this complexity of fast-paced energy transition in the power sector. It offers benefits in efficiency and cost too.

The digitalised process optimisation in power plants can lead to about a 5% increase in the electricity output per unit of fuel input for all subcritical and supercritical coal-fired power plants. It can also result in a 5% reduction in the O&M cost of the plants.

Digitalisation in Process Plants- Aid in Real-Time Process Optimisation

There is a focused drive in the process plants of every sector to improve yield and minimise the energy & utility consumption to run the plant optimally. Digital tools are proven to be reliable means for Real-Time Analysis and Optimisation.

Most industrial plants are instrumented adequately and generate a large amount of digital data related to complex processes. Considering the complexity of the process, continuous attention is required from the operator to run the plant optimally. The advanced digital tools can continuously monitor and provide insights into the conditions of critical equipment/processes. They can detect anomalies and provide timely alerts to the operators. The digital tools analyse the data quickly and provide the operator with valuable insights and actionable information into the processes/equipment condition, which otherwise would not be available to the operator in the plant leading to increased efficiency of the plant.

Approach for Plant Digitalisation - Platform/Point Solutions?

Most of the operators in power and other sectors are aware of the need and benefits of plant digitalisation. However, they face a dilemma while deciding the approach for implementation due to various factors like options available in the market, their costs, benefits, impact on plant operation, timelines for adoption, operational ease, operator acceptance, frequent technology changes etc.

There are two major approaches; Platform-based and Point Solutions (PoS). The enterprise-level digitalisation solutions are mostly platform-based. The digital twins of the equipment and systems are developed or hosted on the platform, integrating seamlessly with instruments/sensors, plant historians, and ERP/SAP systems. Asset performance monitoring, maintenance optimisation, work schedules etc., are possible at the enterprise level using this integrated approach. The plant data would be appropriately archived and utilised by the intelligent systems to make near autonomous decisions to run the plants efficiently and smartly. Usually, these platforms are generic and require significant effort and time to develop the plant digital twin for deployment with all these capabilities.

The digital PoS run on open architecture and focus on issues of specific process or equipment which are of priority. Such point solutions can be implemented quickly and independently as per requirement in a plant to take advantage of time and cost.

Depending on the requirement, these point solutions adopt data processing tools like SQL, NoSQL, Kafka, Apache Spark, etc., high-level languages like C#, Python, R, etc., machine learning, deep learning applications like TensorFlow, Pytorch, Keras, etc. in their solution architecture. Most of such point solutions are cloud or edge deployable and are offered in the Software as a Service (SaaS) model. Such PoS can be integrated into full-scale digital platforms in future with minimal modifications.

An example of a digital point solution related to condenser performance monitoring and diagnostics is given below (Fig-03). This digital PoS can assist the operator in monitoring the steam condenser performance and analyse multiple influencing

Figure 3

parameters in near real-time to ensure optimal performance levels throughout plant operation.

Few of the capabilities of this digital PoS are listed below.

Real-Time Monitoring of condenser Key Performance Indicators (KPIs)

i. *Anomaly detection based on historical behaviour*

ii. *Recognise deviated parameters and provide early warning alerts*

iii. *Predict the condenser performance for different load conditions*

iv. *Provide insights into factors influencing condenser performance*

v. *Help to plan the maintenance actions.*

The success of digital PoS depends on the accuracy of the digital twin, which maps the equipment and process that exist. Plant operation involves complex scenarios, and plant engineering involves analysing many such operation scenarios to assess the impact on equipment and function in different operational contexts. Typically, it would take years to occur all possible scenarios during the operation of a plant. The digital twin shall capture all such scenarios so that its predictions/ actions/ recommendations would be comprehensive in such conditions and ensure that the plant's efficiency, emission levels, and safety are not compromised. Domain players can build accurate hybrid digital twin models taking advantage of their collective domain knowledge, historical operation data and incorporating all critical plant scenarios to the operator's benefit.

Digital Point Solutions - A Smart Approach

These PoS are tailored for the domain/plant/equipment and considering the operator's priority & criticality concerning plant operation. The digital PoS focuses on complex equipment or system which is difficult to operate manually in an optimal manner. Hence the deployment would be rewarding and take less time. The PoS can adopt the best-proven technology available to solve the problem, and it is easy to accommodate technological changes compared to a monolithic sizeable digital platform.

Complete digitalisation of plants through an enterprise-level digital platform is a giant leap that involves disrupting conventional workflows, method changes, changes in interactions, etc., leading to a cultural transformation in plant operation. However, this journey can be made simple by adopting a step-by-step approach and adopting digital point solutions and reaping early benefits from the low hanging fruits in the process. It helps the operators become familiar with the process involved in digitalisation and the operational benefits from such deployments. It is a state of 'digital readiness' for the plant.

An asset criticality assessment along with cost-benefit analysis will help the operator to identify the assets/areas where they shall attempt to deploy PoS and where they shall depend on the platform while digitalising the plant O&M. The digitalisation can be initiated with the implementation of identified digital PoS and a comprehensive digital platform shall be deployed once the plant becomes 'digital ready'. The PoS would then be integrated into the platform with minimal modification to the digital twin. The futuristic digital platforms shall have well defined standard interfaces (APIs) for smooth & secure integration of digital PoS. Hence, a combination of digital PoS and Platform would be preferred to take the best advantages of time, cost, comprehensiveness, and technology in plant digitalisation to ensure optimum O&M of the plant.

Author:

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Tata Consulting Engineers Limited (TCE)

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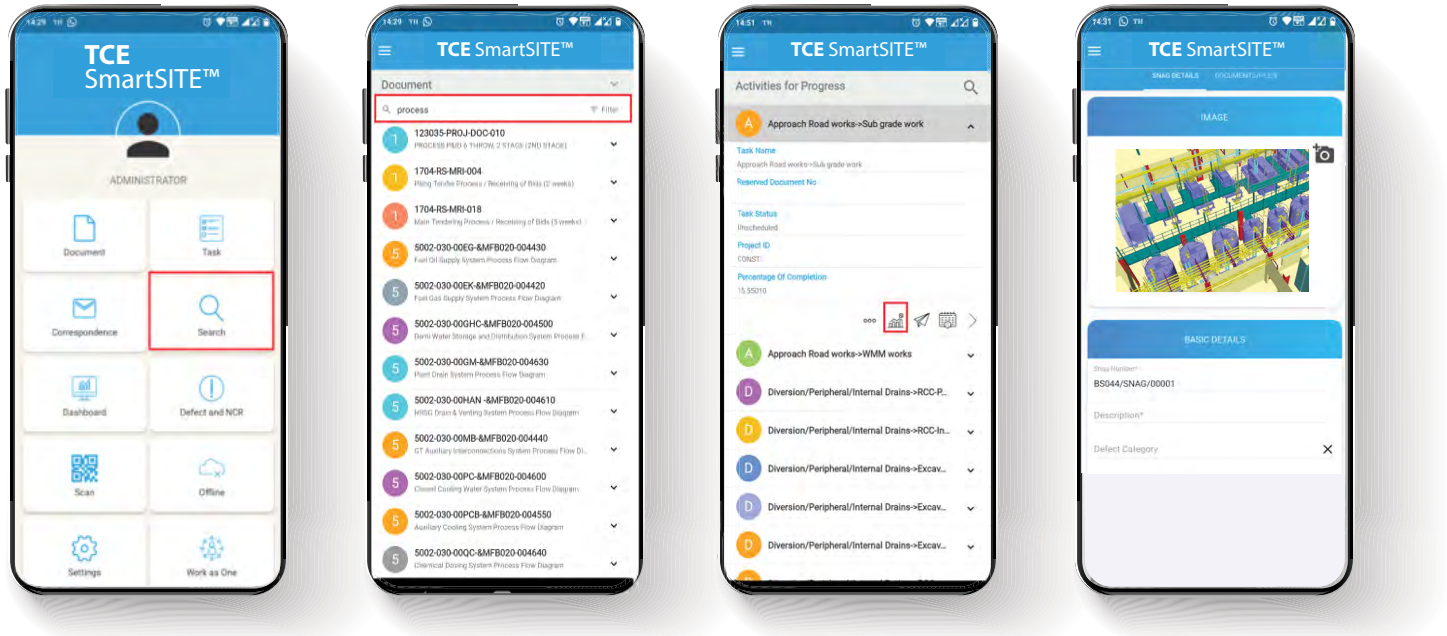
SMART APPLICATIONS:
Go Paperless

At Tata Consulting Engineers (TCE) we have promoted the use of smart project management applications that help reduce the exchange of paper and stop the spread of infection in COVID19 times. With the help of the following apps, we have managed to go paperless to a large extent:

1. Suraksha App for daily tracking of site safety indicators.
2. Increased use of drones and fixed point photography to reduce the need for manual inspection
3. TCE SmartSite™ App supports Digital Collaboration and Mobility. The app is the unison of 60 years of experience in TCE and agility brought by real-time information sharing. The app users have easy access to all the standard processes, checklists and way of working developed by TCE with the experience gained while working across various sectors and geographies, right on their mobile phone.
    - Use of mobile based TCE SmartSITE™ App to
        - Manage and track engineering drawings and documents across their lifecycles.
        - Bring all stakeholders together on the same platform, having built-in quality management processes.
        - Ensure that everyone works on the most up-to-date information with complete traceability.
        - Collaborate digitally through electronic reviews, comments, approvals, RFI's, correspondences and transmittals
        - Work as a team and make sure everyone is held accountable for their responsibilities and action items.
        - Ensure better visibility through real-time dashboard and reports.
        - The accessibility to past data on the SmartSite™ App helps in analysis and data-driven decision making. The inputs like activity progress, project risks, quality, safety issues and snags are summarised in dashboards used to monitor key metrics like open/close status of issues, planned v/s actual completion of milestones, look-ahead plans, mitigation plans, etc. to depict the project health accurately.



CONSTRUCTION & DEMOLITION WASTE

Sustainable Management and Innovation by Emerging Technologies

Construction and Demolition (C&D) waste is defined as "the waste comprising of building materials, debris and rubble resulting from construction, re-modelling, repair and demolition of any civil structure"[1].

It is estimated that the construction industry in India generates about 10-12 million tons of waste annually. Technology Information, Forecasting and Assessment Council (TIFAC) in 2001 had estimated that new construction generates about 40–60 kg of C&D waste per sq. m of built-up area in India. As for demolition, the estimate is 300–500 kg per sq. m of built-up area.

Globally, cities generate about 2.01 billion tonnes of solid waste per year. Nearly half of the solid waste generated can be characterised as C&D waste, according to a 2018 report on

Figure 1 (Construction and Demolition waste)

solid waste by the World Bank. The 9th and 10th Five Year Plans accounted for 50% of the Capital Outlay to the Construction Sector. As the growth of the construction sector has got a direct relation to urbanisation, a study by extrapolation of data of urban population growth (2011 census) estimated urban C&D waste as 716 million tonnes in 2015, which would increase to 2.7 billion tonnes per annum in 2041[3] (Figure 2).

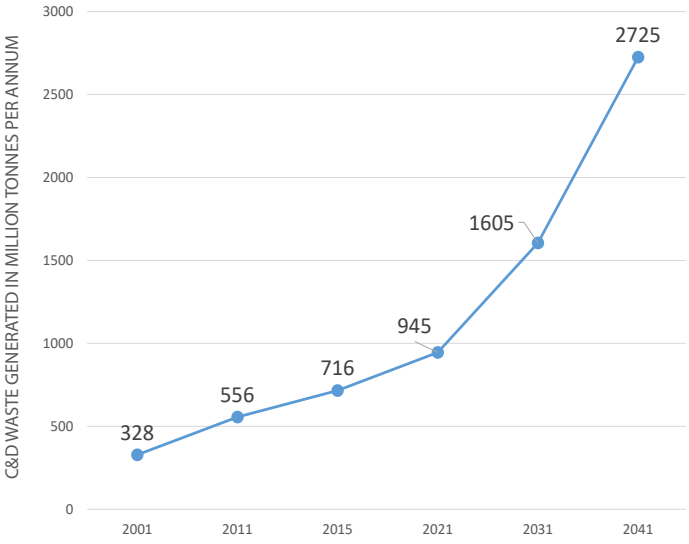


Figure 2[3] (C&D Waste generation projection in urban India)

The C&D waste had been very ill-managed in India for long. The practice had been to get rid of the waste somehow. Consequently, a big chunk of the C&D debris gets dumped uncontrollably in an unauthorised manner at various sites such as lands, roadsides, streams and nullahs (Figure 3). This is a big concern and a significant threat to the ecological system.

Given the massive generation of C&D waste, its ever-increasing trend and absence of specific regulations concerning management, MoEFCC, GoI reviewed the then-existing Municipal Solid Waste (Management and Handling) Rules, 2000. They felt the need to revise the existing rules, emphasising the roles and accountability of waste generators and various stakeholders. Therefore, it was decided to stress upon segregation, recovery, reuse, recycle at source, and address the management of C&D waste. Thus, MoEFCC promulgated the Construction and Demolition Waste Management Rules, 2016, in supersession of the Municipal Solid Waste (Management and Handling) Rules, 2000.

Characterisation

A wide range of materials is available from C&D waste like soil, sand, bricks, concrete, steel (structural & rebars), ceramics, glasses, metals, plastics etc. The content, of course, varies depending on the type of structure being constructed or demolished. Traditionally, the availability of data in India regarding quantum and distribution of various materials in the waste is minimal. This is because the same had not been separately collected, and the usual practice was to mix up with Municipal Solid Waste (MSW). However, the study done by TIFAC in 2001 though pretty old, may be seen as an indicator (Figure 4)[3].

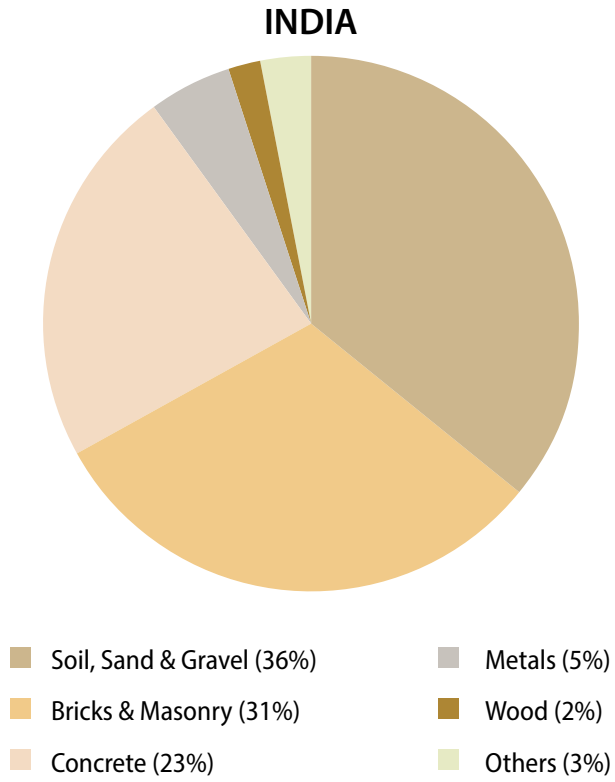


Figure 4[3] (Sample characterisation of C&D waste in India- 2001)

Figure 3 (Haphazard disposal of C&D waste)

The study shows that bulky materials like soil, sand and gravel(fines), bricks & masonry, and concrete constitute about 90% of the C&D waste. Few more findings of survey data are presented in Table 1. These data cover a time horizon from 2001 to 2015 and indicate a similar distribution with 90 to 98% contribution from the said bulk materials. Concrete is the primary construction material contributing to 23 to 35% of C&D waste and has been ranked third by all the surveys.

Need of Sustainability

It is notable that while there is an ever-increasing demand for construction materials like cement, steel, sand, brick on one side, there is a projection of massive generation of C&D waste on the other side. This is because the production of construction materials harms the ecology by increased mining of natural resources like iron, limestones, sand etc. and at the same time is highly energy-intensive. While cement and steel in a typical building constitute only about 8% and 3% respectively of the total mass of construction materials, but the embodied energy for the same accounts for nearly 63% and 18% respectively (Figure 5). For India, it is estimated that about 80 per cent of the construction sector's GHG emissions come from materials likes cement, bricks, steel and lime[5].

Under the circumstances, a sustainable approach towards the management of C&D waste is essential. A significant part of C&D waste can be processed and brought back to substitute the original material. It has been observed globally that 80 to 90% of the C&D waste can be processed and reused in various applications[4]. The processing technology concerning cementitious materials mainly comprises crushing, cleaning, washing and recovering recycled aggregates (RA)/ recycled concrete aggregate (RCA). BIS and IRC have updated the Standards to allow RA/ RCA with certain limitations.

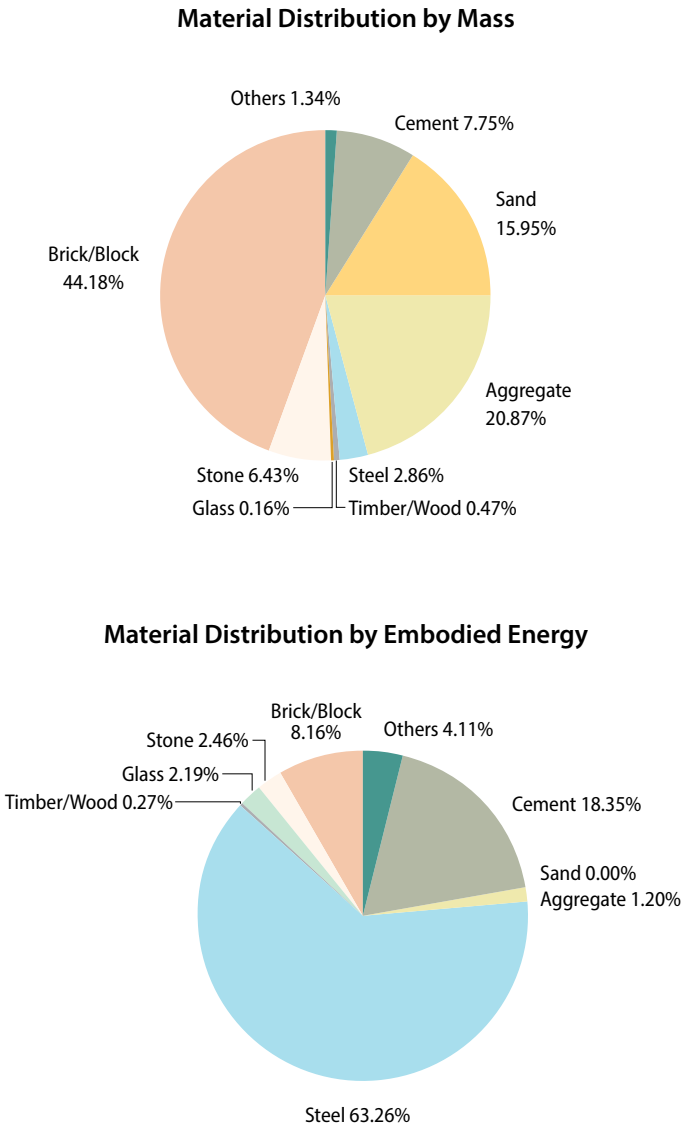


Figure 5[5] (Mass distribution and embodied energy of typical construction materials)

Waste sub-streams	As per Technology Information Forecasting and Assessment Council (TIFAC), 2001 (India)	As per MCD survey, 2004 (Delhi)	As per survey by Infrastructure Leasing & Financial Services (IL&FS) Ecosmart, 2005 (Delhi)	As per study by University of Florida, 2009 (India)	As per Coimbatore City Municipal Corporation survey, 2015 (Coimbatore)
Soil/sand, gravel	36	43	31	35	49
Bitumen	2	0	0	2	0
Metals	5	0	0.4	5	4
Mansonry/brick	31	15	59	30	19
Concrete	23	35	0	25	23
Wood	2	0	1.5	2	2
Others	1	7	7.6	1	3

Table 1[5] (Characterisation of C&D waste in India snapshots)

Conventional Sustainable Solutions

Global status reveals that the rate of reusing and recycling the C&D waste in the EU and USA are 79% and 70%, respectively. Some EU members and Singapore have reported over 90% of reuse and recycling[5]. India has also taken an organised initiative for recycling as early as 2009 and made a pilot plant operational in Delhi. A list of C&D waste recycling plant in India is given in Table 2.

Apart from recycling for reusing in concrete making, C&D waste is being used to make various precast products like paver blocks and kerbstones. Multiple uses of C&D waste, converting it from waste to resource, is shown in Figure 7.

Thought for sustainable management of C&D waste remained focused on the conventional concept of landfilling, landscaping, making aggregates for concrete, roads, etc. However, the time has come to think about the innovative use of C&D wastes using modern cutting-edge technologies in the present context when the world is embedding increased automation and advanced technologies in the construction sector. While Building Information Modelling (BIM) on a digital platform is gradually making inroads, Virtual reality, Digital twins, 3D printing

City	Place	Capacity (TDP)	Operation Status
Delhi	Burari	2,000	Operational
	Mundka	150	Operational
	Shastri Park	500	Operational
Noida	Sector 80	150	Operational
Gurugram	Basai	300	Operational
Ghaziabad	Ghaziabad	150	Operational
Thane	Daighar	300	Operational
Indore	Devguradia	100	Operational
Hyderabad	Jeetimedia	300	Operational
Bengaluru	Chikkajala*	1,000	Operational
	Kannur	750	Operational
Ahmedabad	Gyaspur Pirana	1,000	Operational
Tirupati	Thukivakam village	150	Operational
Vijayawada	Vijayawada	200	Operational
Chandigarh	Industrial Area Phase 1	150	Operational
Surat	Surat	300	Operational

Table 2[5] (C&D Recycling plants in India)

Figure 6 (C&D waste Recycling)

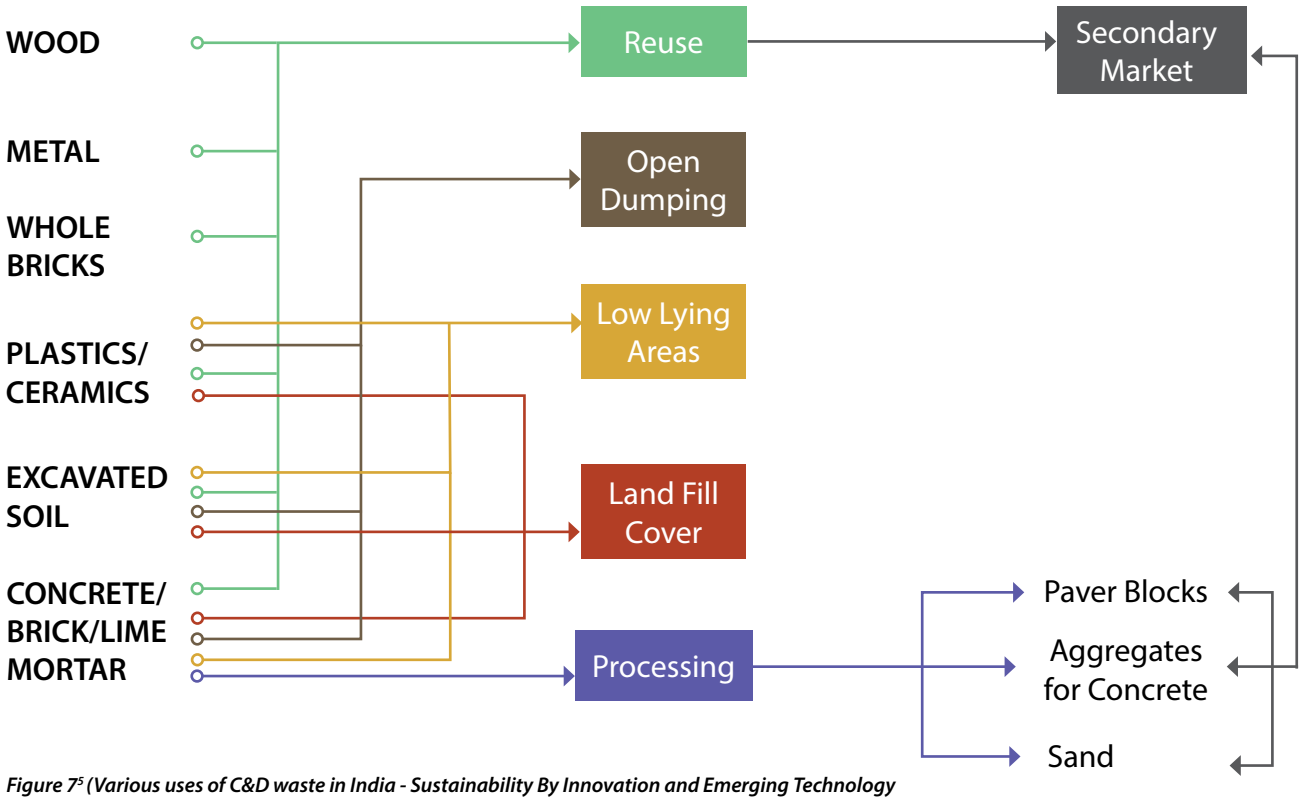


Figure 7[5] (Various uses of C&D waste in India - Sustainability By Innovation and Emerging Technology

(3DP), Robotics are being increasingly researched to apply in the construction industry. While 3DP had been increasingly used in manufacturing industries like automobile, aerospace, medical; - attempt has been initiated to apply it in the construction sector. According to a study by BCG[6], the digitalisation in Engineering and Construction industry would save $1.0 to $1.72 trillion by 2025 during the life cycle.

3DP, also known as additive manufacturing, is making forms by depositing successive layers one upon another. It has significant advantages of good & uniform quality, reduced cost, less wastage and increased safety. In addition, it reduces construction time, environmental pollution, workforce requirement and eliminates requirements of formwork.

A lot of research and development work for developing the material (binder mix) suitable for 3DP was undertaken in leading Universities, mainly in Europe and the USA. The popular way of 3DP is by extruding the binder mix through the nozzle of the printers and forming the shape by adding layers one upon the other (Figure 8). The significant properties of the binder mix shall have pumpability, extrudability, buildability and open time. The rheology of the binder plays an essential role in extrudability. While research across the globe so far have given attention to developing the printer material from sand, cement, aggregates, polypropylene by admixing with superplasticizers, filler materials etc.[7] there had been little progress in converting the C&D waste to the binder suitable for reuse in the 3DP for house construction. The binder mix has to be tested for acceptance during the fresh state, the hardened state, in addition to durability and strength. Absence of standards, knowledge materials, industry-academia collaboration, target frameworks etc., are the primary bottlenecks to the research and development in this sphere.

Several small projects for making buildings, pedestrian bridges have been piloted globally, and in India, IIT- Madras has also succeeded in creating a Concrete 3D printed single bedroom house recently.

3D printed large structures will take some time to become a reality, but tiny modular homes, sanitation blocks, bus stops, disaster shelters etc., can be made by 3DP. Various Government schemes like Pradhan Mantri Awaas Yojana Gramin (PMAYG), Swachh Bharat Mission and FM's announcement in the budget speech that Government priority would be affordable "Housing for all" set the ideal context for the innovative solutions. Technology is currently focused on using the concrete mix as a 3DP material. Still, there is enough scope of research for the use of C&D wastes as the feed material to 3DP. Additionally engineering and design of the modules made of C&D waste by 3DP are the creative challenges to the consultants. Making the buildable and optimised layouts considering the architectural

Figure 8 (3D Printing by extrusion and additive layers)

details and finishes, analysing and creating the design concepts and methods, ensuring stability, durability and scalability are the core challenges to be resolved by the consulting engineers by adopting innovation and good practices.

Conclusions

India will be having a boom in the infrastructure and construction sector during the forthcoming years. This is predicted to generate substantial urban C&D waste of about 2.7 billion tonnes per annum in 2041. The situation is critical as the demand for construction materials (cement, steel, bricks, etc.) will increase manifold, but we have to deal with a massive quantum of C&D waste as well. Construction materials are huge energy-intensive and a significant contributor to greenhouse gas (GHG) emissions. Under the circumstances, there has to be a sustainable solution leading to a circular economy that would cater to the demand of construction materials by recycling the C&D waste and plough it back to the reuse for construction and offset the requirement of parent construction material. Though the framework is in place, the effort needs to be scaled up.

Additionally, other innovative solutions using cutting edge technologies have to be explored to convert the C&D waste to resources. In this context, developing the material mix out of C&D waste to use in 3DP for building tiny modular houses, shelters, sanitation blocks, bus shelters, safe homes, etc., would immensely contribute to society through sustainable and innovative solutions. Engineers, Consultants, Academia can collaborate to make it happen. Government of India target of 4 crore rural houses by 2022 and a recent announcement during budget speech that affordable housing would be the priority areas provide the opportunity to contribute to society through sustainable and innovative solutions.

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Figure 9 (India's first 3D Printed house). Image Courtesy: thebetterindia.com

DIGITAL TRANSFORMATION IN INDUSTRIES

Digital transformation (DX) is essential for organisations that want to remain relevant in a constantly evolving and competitive landscape. DX should not just be a technological advancement or trend. It should be the main focus of organisation strategies across all industries. Organisations that proactively prioritised DX have demonstrated that they could react and respond more efficiently to the recent pandemic.

DX comprises Digitisation and Digitalisation. Digitisation is the conversion of data and processes; digitalisation is a transformation. With the application of digital technology, the existing data is sorted, analysed, and trends established to make better business decisions by leveraging Industry 4.0 concepts in line with the Digital India Initiative.

The significant challenges that the industries are facing with regards to digital transformation or adopting industry 4.0 concepts are:

- Where to start
- How much to do and phasing out the implementation
- Standardisation of data
- Integration of data
- Analysis of data
- Generating business insights and informed actions

Digital transformation has both immediate and long-term effects. One needs to identify the right platform to utilise the data and provide relevant, informed action to get maximum benefit for the organisation.

From the above challenges the industries face, it is evident that "Data" is the primary factor for digital transformation. The complete digital transformation or industry 4.0 concepts

are all hovering around the data. Gathering the correct data, communicating the data to the right location, integrating the data and analysing the data to generate intelligent actions together makes the digital transformation.

Below is a case study for the digital transformation (data collection, communication and integration).

Technical Document Management System (TDMS) – A Case Study:

TDMS was developed to facilitate day-to-day information accessibility to the users via a Web-based interface, which would be the focal point for future engineering modifications, upgrades, and plant operation. The scope comprised of supply and commissioning of software and hardware at nine refineries and the headquarters. Figure 1 shows the architecture for the document digitisation at the nine refineries. Tree structure type browser was formulated and finalised for all refineries. Around 8 lakh documents were uploaded at only two refinery locations. The data was stored in a secure digital place. Metadata or important attributes were updated for all the documents, including scanned documents and drawings. Any person located at any refinery can view the documents from any location at any given time. The Document digitisation system provided digitised documents, pictures and information with the facility to view any information from any site at any given time. Now the data/information available at a centralised location can then be utilised in many ways, such as

- Plant expansion
- Debottlenecking
- Preventive maintenance
- Performance enhancement
- Optimisation of resources
- Productivity improvement
- Training and development
- Sharing best practices across the organisation
- Generating meaningful insights by integrating and analysing the data from various refineries located across the country.

Implementing the document digitisation system involved a well-structured workflow for handing a massive quantity of documents/drawings / 3D models.

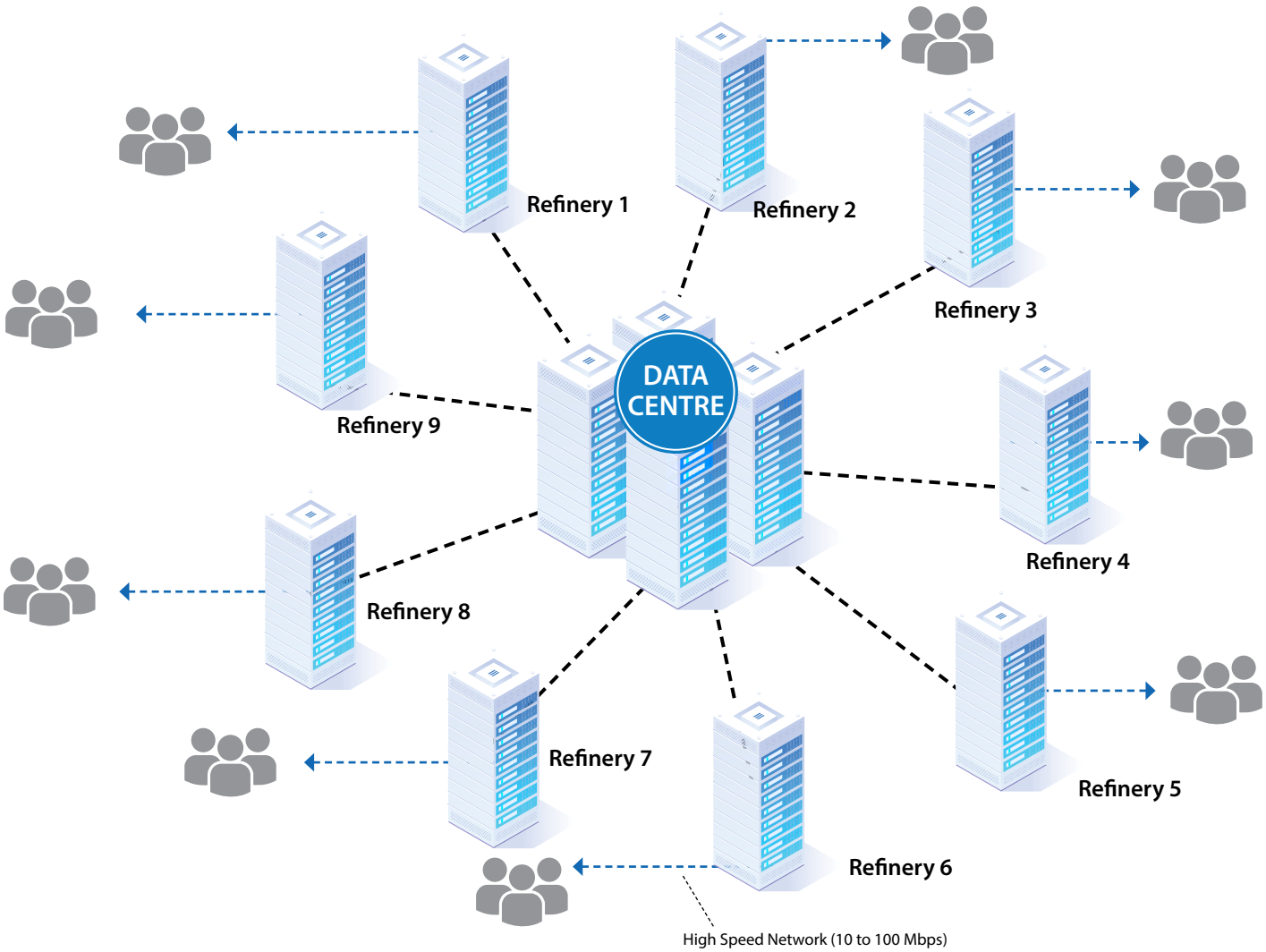

Figure 1: Architecture for Document digitisation across the geographical locations

Figure 2 shows the workflow followed for the implementation of document digitisation in refineries across geographical locations.

The digital data thus obtained can be sorted based on time period, type, severity and can be used across the organisation for various types of analysis and reports.

There are many use cases of digital transformation applicable across industries which include:

- Performance forecasting
- Production forecasts
- Enhanced production
- Analytics across unconventional assets
- Predictive maintenance
- Automation of work
- Remote operations
- Location-based wireless technologies allow remote monitoring of any potential hazards/ accidents, theft or any untoward incidents. It can also monitor contractors in potentially dangerous situations at construction sites.
- Enhanced asset security
- Logistics analytics
- Remote sensors and drones are now utilised for monitoring equipment.
- Remotely monitored & controlled trucks are being developed to transport goods.
- Predictive analytics / Predictive maintenance

Digitalisation

Examples of digitalisation include:

1. Laser Scanning and Virtual Reality in Plant Design
2. Automation and Robotics
3. Cybersecurity and blockchain
4. Machine-to-Machine (M2M) communication
5. Immersive technologies [XR]

From all the above examples, laser scanning as a digitisation approach is discussed in detail.

Laser scanning projects for Industrial plants involve scanning the plant in total or in sections to generate digital data known as a point cloud. Data in the form of the point cloud is used to create 3D models, perform clash checks, reverse engineering and virtual reality applications.

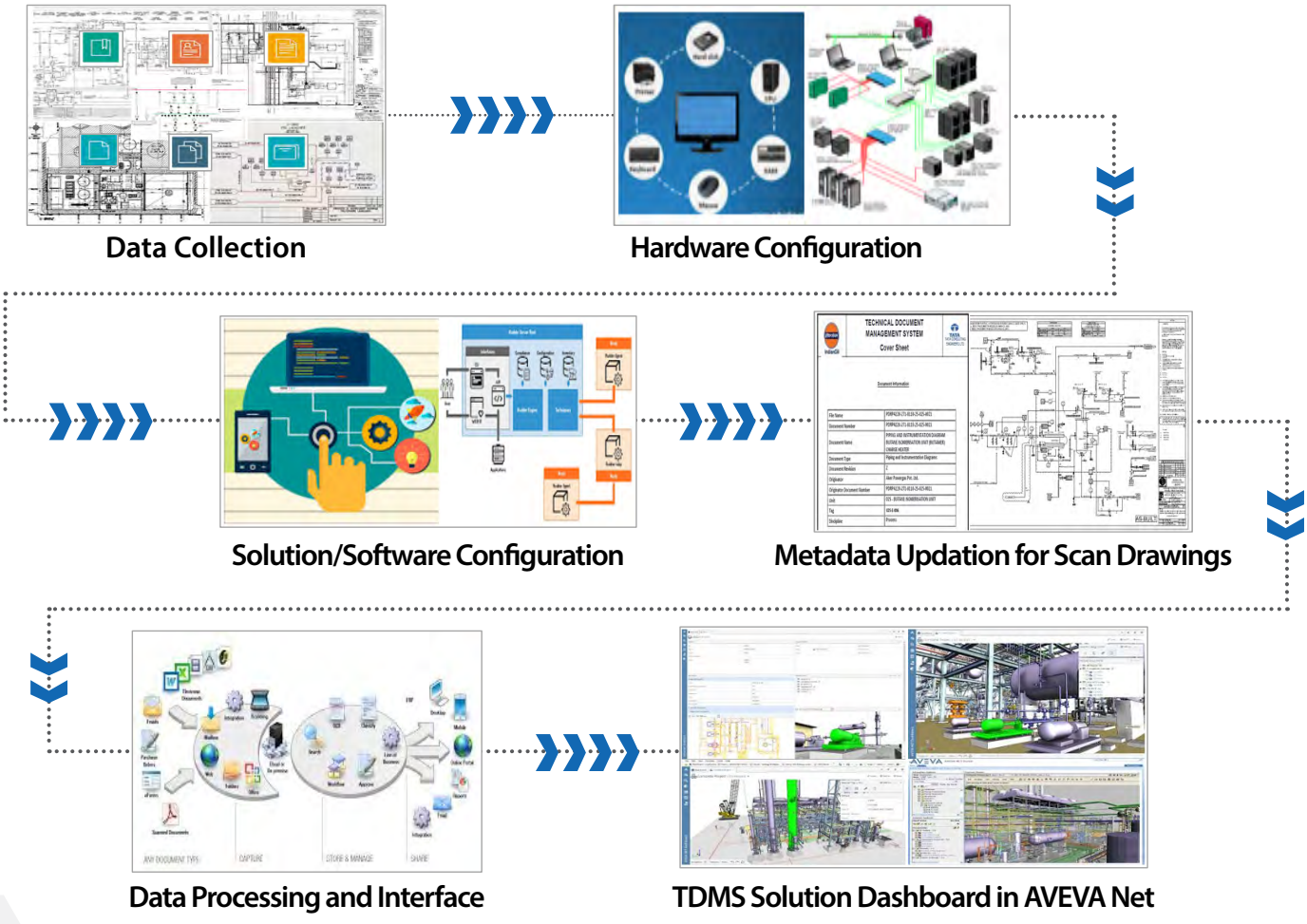

Figure 2: Workflow for implementation of document digitisation

Once the objective of laser scanning is set, it facilitates both the compilation of appropriate As-built documentation and meets the clients demand for high-quality data. In addition, this technology is cost-effective, highly precise and quick to implement. As a result, projects are completed faster, resulting in considerable cost savings.

The steps involved in the 3D Laser scanning technique are indicated in Figure 3 below.

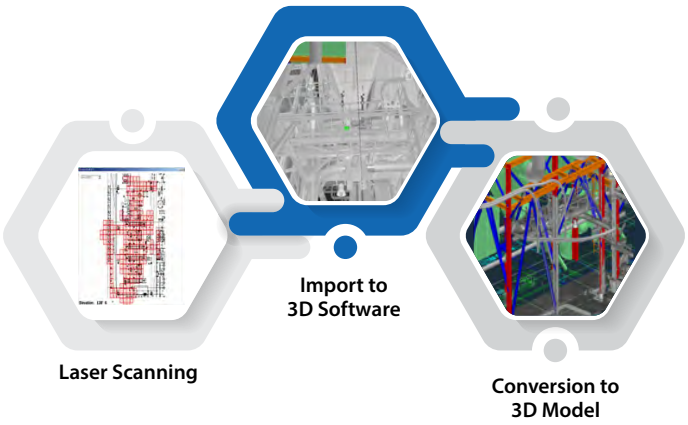

Figure 3: Steps involved in Laser scanning

The benefits of 3D laser scanning are depicted below in Figure 4.

Asset Information Modelling Approach

Asset information modelling involves complete scanning of a Brownfield plant comprising an enormous number of lines and equipment. From the data obtained, 2D P&ID's and 3D model are developed. The shutdown activities are to be managed as per the project schedule. If no data is available with the client, validation of the data for the new process will be a challenge.

An Asset Information Model is a model based on the information available for the operation of an asset, thus enabling Asset Management. The data can be in the form of tables, graphical or non-graphical, metadata, and documents. Such information should be available for each asset in the project. The 3D laser scanning involved the creation of point cloud data using laser cameras, as shown in Figure 5.

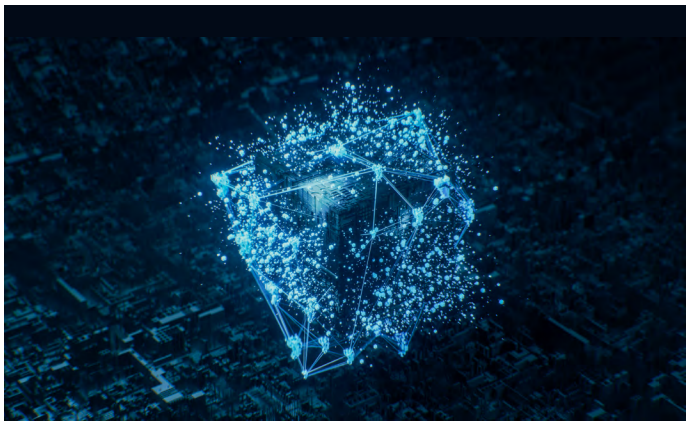

Figure 5 Point Cloud Data

The point cloud data is then fed to software to convert the point cloud data into a 3D model, as shown in Figure 6.

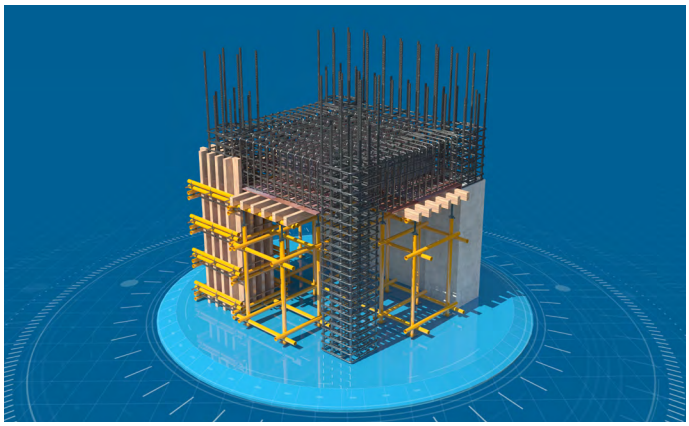

Figure 6: 3D Model

Figure 4: Benefits of 3D Laser scanning

The block architecture for the asset information modelling is as shown in figure no. 7 below. It involves collecting all data available in 2D, 3D, digital or hard copies. This information may be in a different format and different locations. Using a suitable gateway, all data is communicated to a central location. This data is then integrated, analysed, and the relevant information for each asset mapped. For example, suppose somebody wants to know about some particular pump. In that case, he has to just click on that pump on the screen, all the relevant documents like pump P&ID, pump operating manual, datasheet, 3D Model, maintenance record etc., related to that pump pop up on the screen. With one single click, all the information related to any asset can be accessed. The benefit of having all asset data in AIM enables one to view the data in 3D, thereby enabling quicker decision making across disciplines. It also reduces errors and delays in execution by making even complex assets simple to understand.

Lower oil price is the new regular, and profit margins are squeezed. Oil & Gas companies must take this opportunity to invest in innovative technologies rather than carrying out small knee jerk cost-cutting measures. Digital transformation is not only rapidly changing work practice, but it is also reshaping the very nature of the workforce and work experience. From the above, it is clear that data collection, data communication, data integration and data analytics are the essential steps towards Digital transformation.

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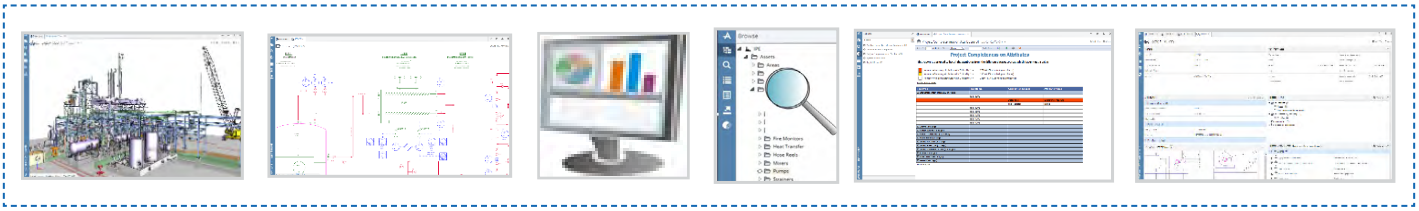
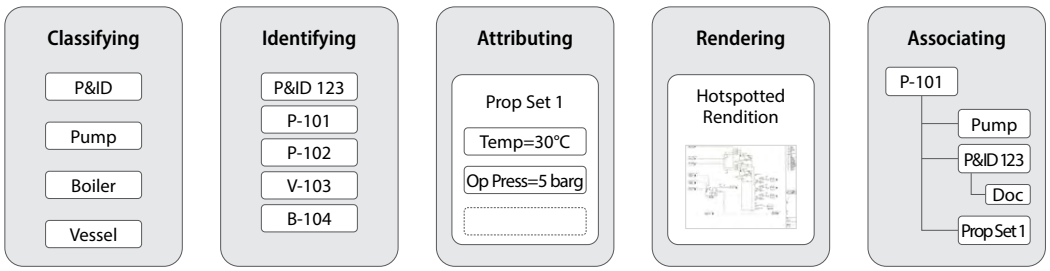


AVEVA NET Workhub

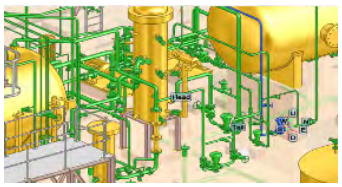
Repository | Association & Validation | Collaboration

Access & Visualisation | Reporting | Integration Hub

AVEVA NET Gateways

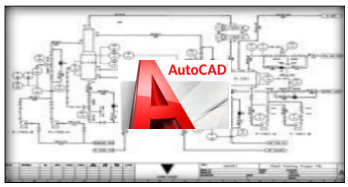


Laser Scanning



3D Models (AVEVA E3D)

Documents



Drawings

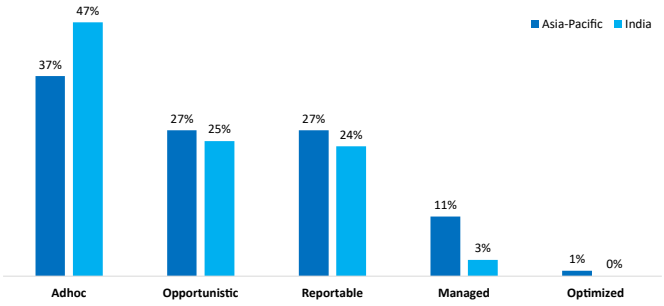
Figure 7: Block Architecture for Asset Information Modelling

CONSTRUCTION AT THE CROSSROADS:
Digital Transformation (DX)

The Construction industry faced several challenges in 2020, some of them unencountered either by academia or professionals in the industry. However, there have been many positive outcomes while facing the challenges of the COVID-19 pandemic, the most significant being the intensification of deployment of digital philosophy across all industries, including Construction. The good news is that along with increasing operation dynamics of the construction business in India and improvement in innovation levels, there has been a visible acceleration in digital transformation, further pushed by the increasing internet penetration. The growth observed an exponential rise in just five to ten years, impacted by digital pressures on stakeholders ranging from Promoters to Suppliers, leading to new modalities that help scale productivity and improve business decision-making.

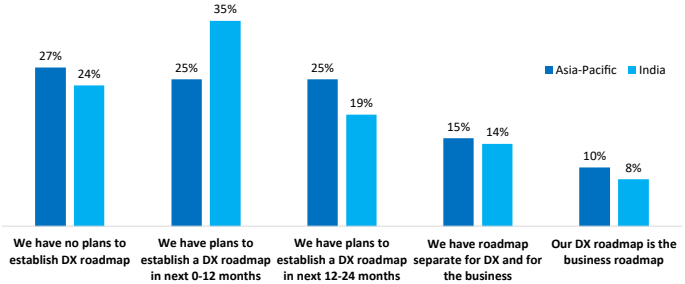
Many companies quickly learned best practices from their peers who attained maturity to respond to the local demand and digital pressures, including standard tools for Design, Project controls and Project Management Information Systems (PMIS). The Digital Transformation (DX) includes web-based applications that offer Project Managers and project personnel technological solutions that address unique project challenges. The web-based applications are primarily used for design integration, construction simulation, managing and monitoring progress and mitigate risks in Construction.

Over 70% of Construction companies in India are in the starting phase of their DX journey



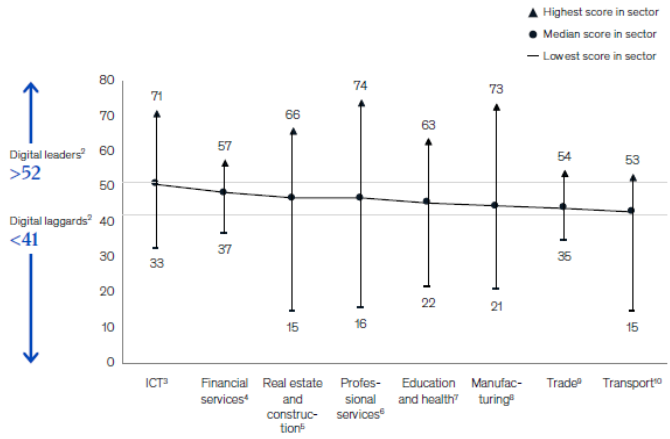
Source: Article published in Livemint in July 2020

In India, 35% construction companies are planning to establish the DX roadmap in the next 12 months. 19% are planning the same in the next 12-24 months. 8% have established their DX roadmap as a business map. These figures highlight the priority of DX for Indian companies, which is above region's average.



Source: Article published in Livemint in July 2020

Interestingly, the construction industry is no more a laggard in adopting and leveraging the competitive drive offered by digitalisation through enhancement of productivity and a data-driven decision-making. This exponential adoption in digital transformation is undeterred by the complex chain of multiple stakeholders and labour intensiveness, which are characterised as inhibitors for a rate of change in innovation and productivity.



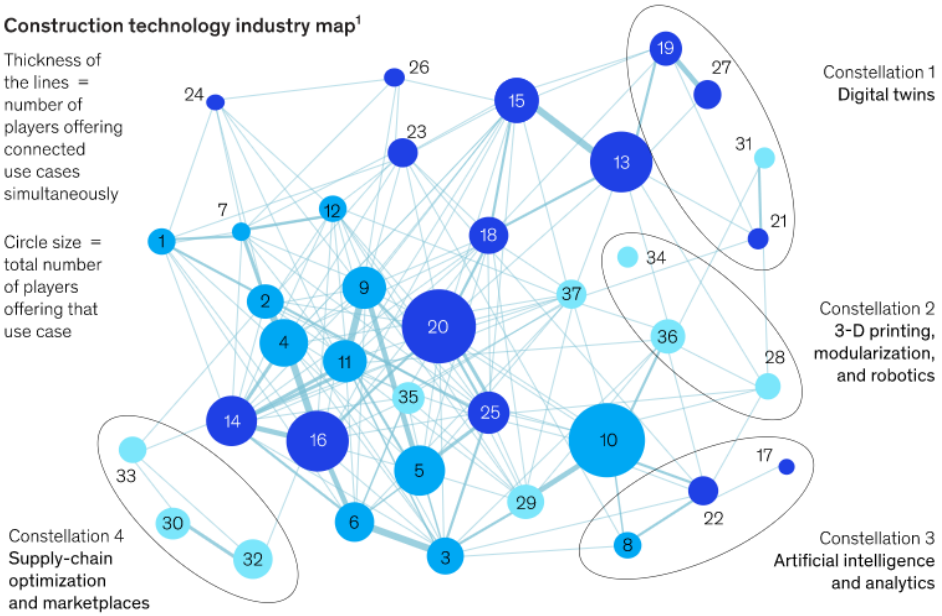
	ICT[3]	Financial services[4]	Real estate and construction[5]	Professional services[6]	Education and health[7]	Manufacturing[8]	Trade[9]	Transport[10]
Sector median digitisation score	**50**	**48**	**47**	**47**	**46**	**45**	**44**	**43**
Leaders % of firms in sector	41	28	40	36	24	21	5	10
Laggards % of firms in sector	26	17	15	20	29	27	45	19

Source: Digital India Report by McKinsey Global Institute published in March 2019

Furthermore, the environment under new normal prompted the companies to revisit the DX strategies and establish an industry-paced DX roadmap, unlike the self-paced strategies earlier.

In 2016, TCE envisioned the model of establishing a separate business unit, viz. Digital and Advanced Technologies Business Unit (DATBU) to act as a catalyst in adopting digital initiatives across the company. Alike models of many digital leaders in the industry, the business unit was responsible for managing and coordinating digital enterprises for the entire company. The Engineering & Construction (E&C) companies, like TCE, attempt to collect data from multiple and complex sources and are responsible for driving the projects based on data-driven decision-making and consulting, face their own set of challenges in developing digital tools and processes. Of the many challenges identified, major ones are collecting data from siloed sources and ensuring minimal duplication, enhanced data accuracy, integration between design and construction interfaces, minimal re-work and error-free deliverables, adhering to time-tested processes and systems gained over the years, and controlled and secured accessibility across the organisation including remote locations. Hence, E&C firms rely on custom-built applications for various processes and integrating them at the backend rather than procuring readily available products in the digital market.

A recent report by McKinsey Global Institute (below) reveals that maximum process digitalisation is being implemented in back-offices for Document Management (20), Contract Management (16), Bidding Process (14) and Design Management (18). The bright side in the industry is that a comprehensive relationship can be observed between 3D modelling (13), BIM (15), Design Simulation (19), and Progress tracking and Performance dashboards (27), as companies are using multiple offerings simultaneously through a connected use case. This intelligible trend will have an over-arching impact in integrating complex design processes with in-situ planning and execution. Other prospective developments are a pull relationship between Customer Relationship Management (2), Estimating (4) and Contract Management, and companies offering 3D modelling (13) and BIM (15) as a connected case. The four constellations, viz. Digital twins (Constellation 1), 3D printing, modularisation, and robotics (Constellation 2), Artificial intelligence and analytics (Constellation 3), and Supply-chain optimisation and marketplaces (Constellation 4) are the ultimate objectives towards which the construction industry's DX strategies are focused.



Digital Collaboration
1 Capital financing
2 Customer relationship management
3 Equipment management
4 Estimating
5 Manpower optimisation
6 Materials management
7 Portfolio planning and management
8 Predictive assessment performance
9 Project Scheduling
10 Real-time monitoring and control
11 Resource planning
12 Risk management

Back Office
13 3-D modelling
14 Bidding process
15 Building-information modelling
16 Contract management
17 Deep learning
18 Design management
19 Design simulation
20 Document management
21 Laser scanning
22 Machine learning
23 Process simulation
24 Productivity management
25 Progress tracking and performance dashboards
26 Value engineering
27 Virtual learning

On-site execution
28 3-D printing
29 Compliance
30 Construction materials marketplace
31 Drone-enabled yard inspection
32 Equipment marketplace
33 Labor and professional marketplace
34 Off-site fabrication
35 Quality control
36 Robotics/automation
37 Testing and training

Source: Rise of Platform Era Report by McKinsey Global Institute published in October 2020

Building Digital Strategies

With the complex chain of stakeholders, transformation in Construction is not limited to introducing new technologies and applications only. It needs additional assurance that the platform being implemented is functional and handy for most stakeholders, if not all. The implementation must have a ripple effect across multiple end-users and enhance interrelated processes. This fundamental shift can be achieved by developing strategies around three key areas of transformation. The below table shows the status of TCE against the key areas of change.

A robust digital strategy has enabled the adequate flow of information from the job site, ranging from delivery centres and remote construction sites across the globe to regional offices to Corporate, thus facilitating efficient business communication and digital delivery. However, an exhaustive and all-embraced utilisation of digital tools and systems are yet to be achieved. Therefore, despite TCE creating and owning a great digital strategy, we are yet to reap all the potential benefits.

Digital Business (Growth)

Developing digitalisation as a service as a key differentiator and generate both revenue and value.

TCE's Status

A separate business unit (DATBU) identified driving business growth in the digital economy and aligning other units towards the common goal. Developed a few market differentiation products, including SmartSITE for on-site digital collaboration.

Digital Process (Profitability)

Optimise performance and efficiency through digitalising end-to-end business processes.

TCE's Status

Rhythm intranet services ensure that entire TCE business processes are digitalised and brought to a single platform. Though there are standalone applications for various functions, the same has been captured on a single web portal to ensure improved performance and efficiency.

Digital Backbone (Security)

Support for all digital initiatives, addressing and debugging all IT complexities, risks, and impediments to innovation to meet agile business demands.

TCE's Status

All digital developments are backed by a strong in-house IT team, ensuring a secured cloud server-based controlled access to employees. The in-house team also helps reduce the barrier for innovation and application development compared to outsourcing services to IT companies, as it is driven by the common objective and timelines of the company.

Scaling Opportunities: Building Information Modeling (BIM)

Architecture has always been at the centre of the digital transformation journey of the construction industry. BIM platform comprises a single asset model at the pivot and integration of other vital components such as project planning, construction simulation, operations, maintenance, and project documentation. This holistic approach allows for a real-time view of project design, cost, and schedule. In addition, visual information provided by BIM enables Stakeholders and Project Managers to identify risks early in a project and better administration of Contract with improved decision-making.

To get the most out of BIM, resources should be set aside for implementation, and skill-building should start early in the design process. In addition, data-reporting systems that are compliant with BIM should be used. Finally, at TCE, we should aim to achieve full-scale BIM implementation across business units and scale up business growth by leveraging the platform for data-driven decision-making and consulting.

Enhance Smart Decision-Making: Way Forward

The new norm is for project data to be digitalised and visualised to help the project team make informed decisions. An effective PMIS and digital transformation facilitate quick and strategic decision-making crucial for successful E&C project management.

For improving decision-making, there must be an integration between PMIS and analytics. PMIS provides streamlined data collection using accurate Client data, staff usage, and current conditions created by multi-facility environments that operate simultaneously, thus supporting the identification of project metrics to optimise business processes. Complimentarily, analysis and implementation of these systems are set up using Power BI, Tableau, SAP VI, Navisworks, etc.

By combining Power BI with existing best practices, job products, and program controls, analytics that support an organisation's operational strategy are produced. Power BI links data sources (such as Excel and SharePoint) and compiles them into drill-down data sets. Data can then be monitored, and outcomes precisely projected, and dashboards can be shared that provide a real-time view of the data.

Business Intelligence (BI) systems, such as Power BI, provide owners, project managers, construction managers, and other key stakeholders with a complete picture of the current situation during complex construction projects.

Opinion

TCE has successfully augmented its capabilities by building the essentials of the DX journey and has achieved this stage entirely driven by cultural shifts that have transcended beyond isolated tests. Similar to many digital leaders, evolving mindsets and top management have fully supported the culture. However, categorically, to leverage the available resources and scale further, we need to achieve digital congruence across the organisation and align all our projects with global industry standards and benchmarks in digital delivery.

Author:

Abhishek Gaurav - Manager

Tata Consulting Engineers Limited (TCE)

"Digitisation adoption was ticking up. Demand for data integration across systems was increasing. Then, with almost no warning, the COVID-19 pandemic struck."

- ENR article on "The Importance of Digitisation in Construction Project Management"

DIGITAL TRANSFORMATION IN STEEL INDUSTRY

Complex manufacturing process like steel production has a high probability of quality deviation due to the energy, material and asset-intensive nature. Therefore, the primary objective of digital transformation is to achieve the "zero-defect" quality goal by identifying the defect, tracing the root cause and adjusting the production processes according to the feedback.

The two essential aspects, which have dominant importance for the steel industry are as follows:

- Customer satisfaction through Quality Product and Product Service System
- Optimised production

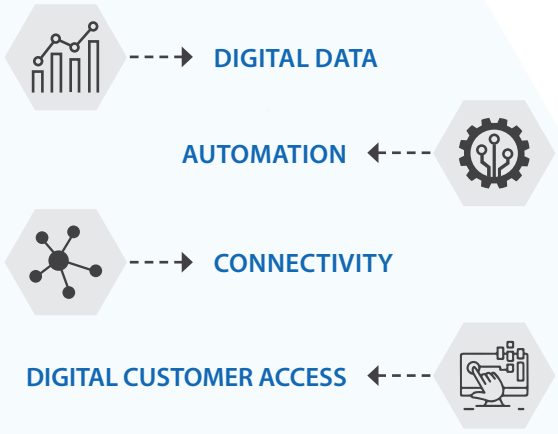
With the concept of Metal Orchestra, the digital transformation should focus on seamless integration of the above two aspects to yield maximum business benefit. For example, in an orchestra, all the players need to play their instruments in perfect harmony with each other.

Also, all the players in a good orchestra need to be trained and need to possess properly maintained good musical instruments with the correct music sheet. Similarly, the focus of digital transformation in the steel industry is to bring perfect harmony among all aspects of the steel business ***(Herzog, et al., 2018)***.

By efficiently capturing, storing, processing and communicating data at every business level, smart steelworks should ensure a faster and effective decision-making process by creating predictive models (SMS Group, 2017).

Verticals for Implementation

In the steel industry, digital technologies can be implemented in four verticals as Digital Data, Automation, Connectivity and Digital Customer Access. More details about these verticals are provided in the following paragraphs (Branca, et al., 2020).

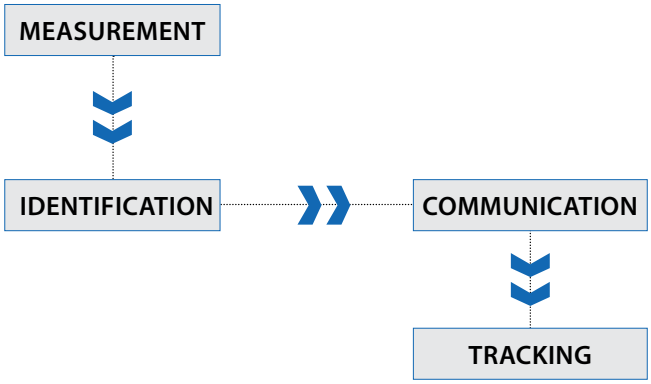


Digital Data

Capturing, processing and analysing data will enable the steel producers to forecast process behaviour. At the same time, it will help to make a quicker and smarter process of decision-making. Application of sensors, cameras and instruments, application software, wireless connection, enhanced data collection & storage capacity will help implement IoT-enabled systems. The system will enable collect data from all the sources, processed and analysed through advanced analytical technologies. The advantage of this integration is the faster tracking of errors and defects with root cause analysis.

Furthermore, it will help in the necessary process or equipment corrections with a feedback mechanism in place to eliminate error. This eventually will lead to enhanced product quality.

Four significant aspects of digital data are measurement, identification, communication and tracking (Branca, et al., 2020).



Example of digital data capturing, including the application of smart sensors, are as follows (Herzog, 2017):

- Camera-based slag detection and free-board measurement for converter tapping,
- Advanced tracking system for scrap chute, ladles, pots, baskets and vessels
- Model predictive control along with the camera for strip steering in a finishing mill
- Continuous casting model suite for product quality enhancement
- Rolling mill cooling model for microstructure control & new steel grades by integration of material, process and water management

Another example of digital data is an accurate prediction of surface defect of steel slabs and necessary correction of the process to reduce the occurrence (Branca, et al., 2020).

The use of visual sensors to monitor the bubbles in steel production is one more example of digital application. The quality of steel affects if air bubbles are present in liquid steel. Visual sensors and heat sensors can scan the surface of the molten metal and assess the quality. If there is a deviation from a set quality, the analytical system analyses the gap and automatically prompts the necessary adjustment in the steel making process (World Economic Forum, 2017).

Also, using the collected data and the application of Machine Learning (ML), predictive and condition-based maintenance can be implemented. The equipment's reliability, availability, and life cycle can be enhanced (Branca, et al., 2020). For example, there are numerous plant assets in a steel plant. Many of the assets have embedded tools for collecting and storing asset data. Using these data, advanced condition monitoring and predictive maintenance can be implemented as part of Asset Management (ABB, 2019).

One of the upcoming maintenance supports through IoT based digital application is automatic detection of equipment malfunction by using microphones. This is more applicable for areas where access inside the plant is not possible. Another example of the usage of digital technology for condition-based monitoring (CBM) is Basic oxygen furnace (converter) tilting-drive monitoring and railway condition monitoring (Herzog, 2017).

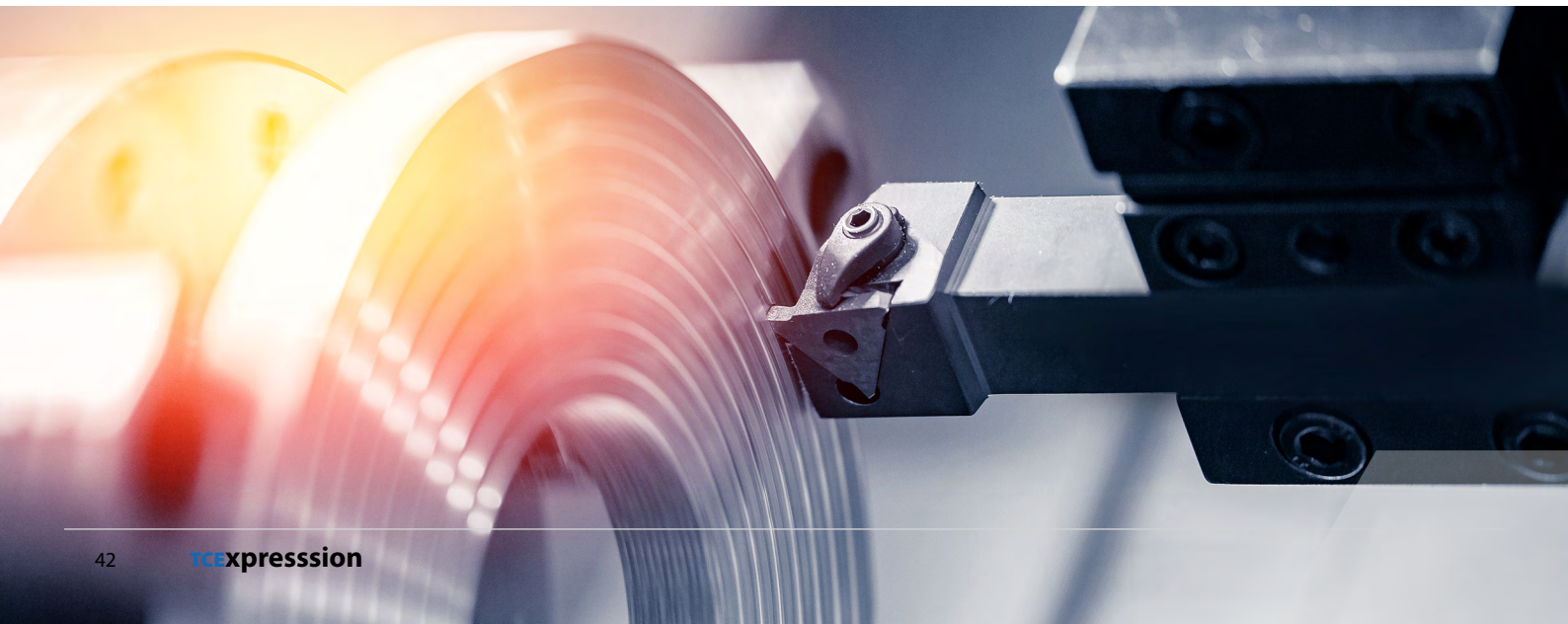
Automation

Artificial Intelligence (AI) and Machine Learning (ML) based approaches will be implemented for production automation. It will reduce error factors, increase the speed of operation and reduce operational expenditure.

An example of implementing automation for a specific application is as follows:

- Automated converter tapping incl. the positioning of the ladle transfer car and alloy charging (Herzog, 2017)

Various applications for augmented operation in the steel industry are under development. One of the examples is optimised logistic control in a high-bay coil store. 3D mapping of the entire warehouse, including associated dynamic activities, is generated, which enable the warehouse operator to track the movements in reality and the virtual set-up. It even provides detailed information like the real-time temperature of the coil. Moreover, the operator can work in sync with the autonomous crane and the forklift trucks. This augmented system will maximise logistic planning transparency (SMS Group, 2017).



Connectivity

Interconnection of the entire value chain using mobile or fixed-line broadband telecom will help in enhanced communication and transparency. Also, Machine to Machine (M2M) communication will improve process efficiency (Branca, et al., 2020).

Examples of digital connectivity are as follows (Herzog, 2017):

- Wireless data transmission from the ladle transfer car
- KPI dashboards for mobile devices

Connectivity will help to improve the widespread supply chain. Steel producers can explore API (Application Programming Interface) led connectivity approaches to establish application network. API-led connectivity may be implemented while maintaining legacy B2B (Business to Business)/ EDI (Electronic Data Interchange) technologies. It is an example of two speed IT. (MuleSoft, LLC, 2020).

Digital Customer Access

Customer's behaviour and expectations are changing with increasing options in life due to the advent of digital platforms. In this context, creating a digital platform for customer access is not a mere adoption of various digital technologies. Instead, while designing a customer access platform, the focus shall be on creating an omnichannel service operation experience to suit changing customer behaviour (Deloitte, 2013). Through the Digital Customer Access model, customers are getting directly connected with the business. This enhanced customer interface will provide more transparency and direct feedback (Branca, et al., 2020).

Aashiyana, Tata Steel's e-commerce platform, is an example of leveraging the digital platform for customer access. Tata Steel created this digital portal to expand the retail footmark and increase revenue from the B2C segment in India. Construction of a home is a challenging task for individual home builders in India due to a lack of relevant guidance, information and ideas. The online portal of Tata Steel provides the necessary information, pictures and authentic contacts to the individual home builders, which is a unique concept to connect customers (The Economic Times, 2018).

Way Forward

The steel industry across the globe is implementing digital technologies to transform the operational model. The steel industry needs to set a value-added digital strategy to enhance the transformation experience by creating an agile culture. One of the approaches can be initiating two speed IT concepts with quick, agile pilot projects using operational technology to generate results in a short duration, instead of transforming full legacy information technology (IT) system (Zhou & Hu, 2019).

However, as the digital transformation matures, both ITs (operational technology and legacy/ traditional information technology) need to be converted.

It is a fact that, compared to industries like retail and media, the adaptation of digital technologies is slower in the steel and metal industry. However, companies who have identified the opportunities of digital applications and implement the same by creating a business ecosystem will inevitably gain competitive advantages.

Engineering consultants have an enormous role in identifying opportunities in all the verticals to empower steel producers for adopting digital technologies. Due to vast engineering and operational experience, engineering consultants can create a data bank for any particular operation of an existing steel plant. This data bank can be used as a baseline parameter that can be correlated with the real-time data to identify the problem areas and potential hazards. Using this data pool, a predictive model can be generated for a specific operation that can help forecast operational stability and condition-based monitoring. For creating the predictive model, data sources need to be digitally connected for all the related aspects of operation, maintenance, environmental impact, health and safety.

To enhance the digital experience of a steel plant, engineering consultants can create a dynamic model for logistic movement inside the existing plant premises, including shop areas such as steel melt shop. It can enable steel plants to take an effective decision for future augmentation and implementation of automation. Also, it will help to identify the actual location for fixing sensors and devices for implementing automation. One potential area where an engineering consultant can empower the steel plant is to prepare control logic for wireless communication for a potential application. Engineering consultants can also capture and analyse data from the customer access platform. The analysed data can be assessed to identify the potential areas of improvement in process and operation to enhance customer experience.

Authors:

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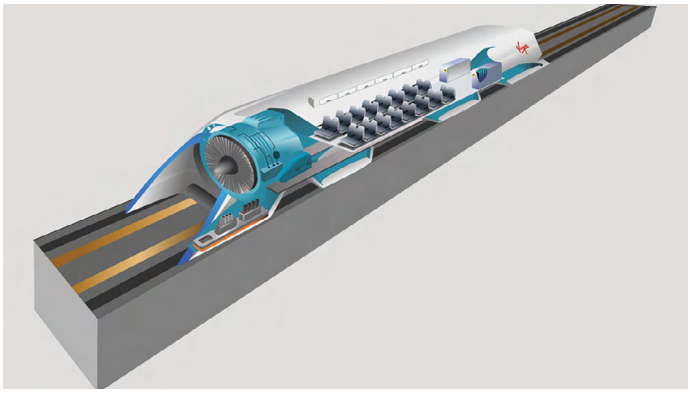
HYPERLOOP
A Revolutionary 5th Mode of Transport

What is Hyperloop?

Hyperloop is the fifth mode of transport, after - Road, Rail, Water and Air. The concept was envisioned by the billionaire Elon Musk – founder CEO of SpaceX and co-founder CEO, Tesla Inc. It is conceptualised as a rapid mode of transport faster than Air and claimed to be eco-friendly compared to the other transport systems. Capsules/ Pods with onboard passenger/cargo/ passenger + cargo is conceptualised to run at ultra-high speed max 0.99 Mach (1220 kmph) inside a low pressure (vacuum-like) tube. Each pod is planned to carry twenty-eight passengers.



The pods are planned to levitate using air bearings/ magnetic levitation. Vacuum condition coupled with levitation shall eliminate the drag and friction respectively and allow the pods to move inside the tube practically with no resistance. Thus, the pods glide at ultra-high speed with minimal consumption of energy. The number of pods one after the other at close intervals shall move between the start and destination stations, forming a loop and thus, the name - Hyperloop.

Stations are located at terminals. Intermediate stations can also be made.

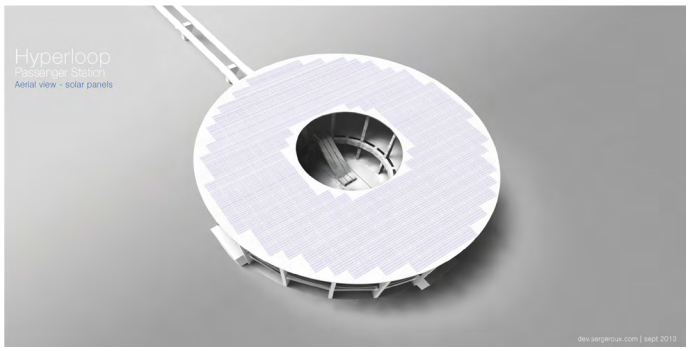


Figure 1[1](Station aerial view – Looped Track)

The Hyperloop shall be primarily on an elevated track to make it independent of any on-grade obstructions and be in underground tunnels to reach the downtown.

Why Hyperloop?

The Hyperloop concept germinated primarily because of a mode of transport that would take on the challenges due to urbanisation, socio-economic developments, and increasing environmental pollution. Global scenario demands faster movement of passengers and freights at an affordable cost between the cities medium distances apart.

1 http://dev.sergeroux.com/portfolio/hyperloop-passenger-station/

With Hyperloop in place, it will take 35 mins to travel 640 km in-between San Francisco to Los Angeles, 12 mins from Abu Dhabi to Dubai (140 km), and 25 mins from Mumbai to Pune (148 km).

With the increasing risk to the global environment, it is pertinent to think of energy-efficient and sustainable modes of transport. Since the Hyperloop glides almost without any resistance, - the power required to drive is intermittent. It is envisaged that much of the requirement would be augmented by the solar panels planned to be installed on the tube top all along the route. It is estimated to be saving 1,50,000 tonnes of CO2 annually, catering perfectly to the need of the current global environment framework.

Hyperloop vs High-Speed Rail (HSR), Air Passenger Transport (APT)

To assess the potential of Hyperloop, it is essential to benchmark the Hyperloop with other modes of transport like HSR and Air Passenger Transport APT.

The study reveals significant time saving for Hyperloop, but the transport capacity is lower than other modes. The physical restrictions related to size/maximum number of passengers per pod and minimum time distance between two subsequent pods imply that capacity will remain a fundamental issue for Hyperloop. Frequency has been estimated to be relatively high compared to other modes of transport, which indicates significantly less wait time. Reliability is assured as it will run under a protected environment independent of storms, rains, snowfall etc. Regarding energy consumption and greenhouse gas emissions, Hyperloop is on a better footing compared to other modes. So far as cost is concerned, though it is estimated to be about one-third compared to Air, it is still a grey area because of various factors like Technology maturity, Topography, Supply chain, etc.

Some preliminary estimates have suggested that the Hyperloop system can be about 2–3 times more energy-efficient than the HSR depending on transport distances, about 3–6 times more energy-efficient than Air Travel.

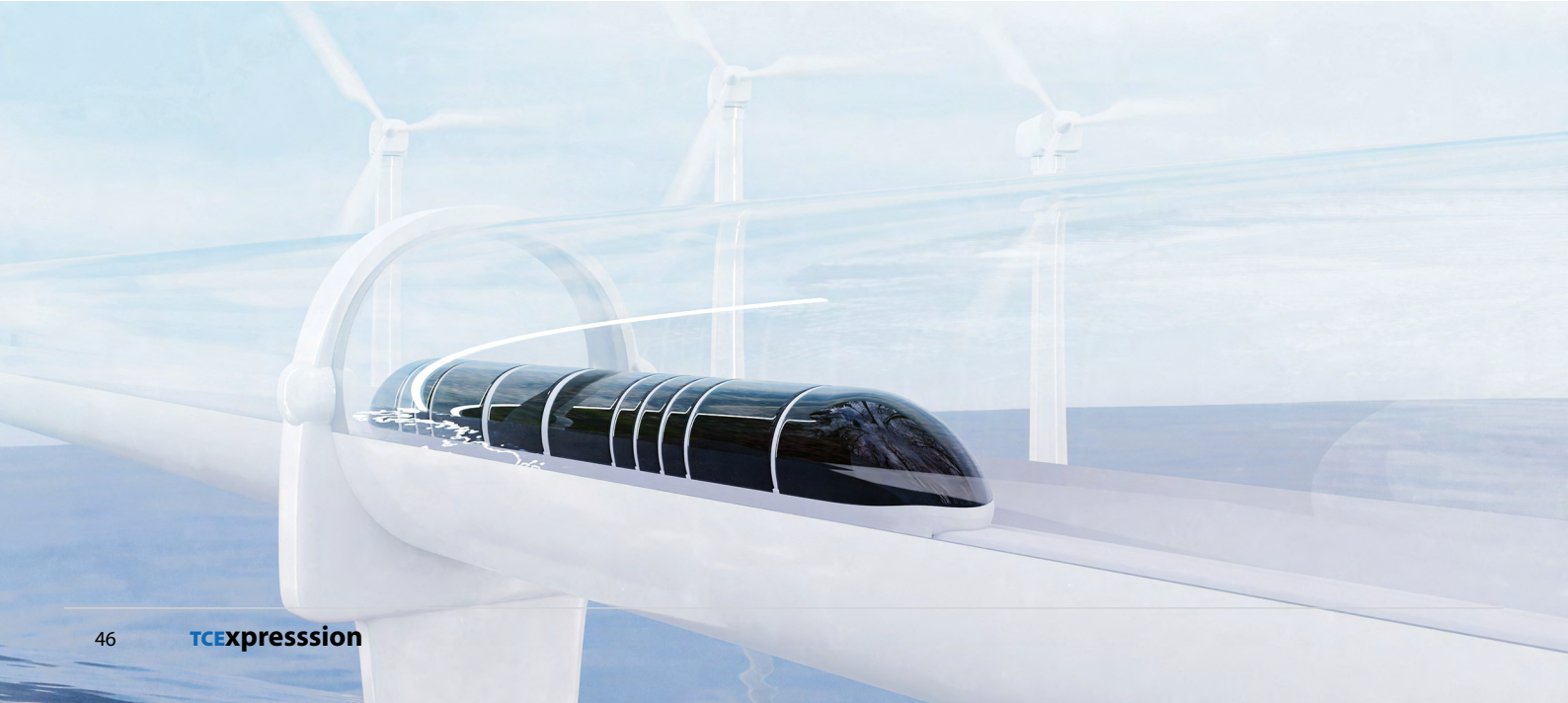
Technology Update

Hyperloop technology is at the primary stage, and many companies across the US and Europe are working on developing and testing the technology. Progress made by few leaders are described below.

In 2016 "Hyperloop One" (presently Virgin Hyperloop One) had invited proposals for the construction of Hyperloop as a part of a global challenge. There were 11 winners out of 2600 teams of companies, engineers and urban planners who had submitted proposals for constructing hyperloop networks connecting cities worldwide. Ten routes have been shortlisted, which includes the US, Canada, Mexico, UK and India.

A 500M test track has been set up in the deserts of Nevada in the US to test individual components and systems as a whole. A full-scale system test was conducted in May 2017. The functions of propulsion, braking, levitation, control systems and vacuum were found satisfactory. A top speed of 385 kmph was achieved. In 2018 the firm presented its first passenger pod design for the Dubai-Abu-Dhabi route, wherein the journey time is expected to reduce from 2 hrs to 12 min. The pod is made up of carbon fibre and aluminium aeroshell.

Hyperloop Transportation Technologies (HTT) is completing a full-scale test track of 320 m in Toulouse, France. It will start a series of tests for its hyperloop passenger pod called Quintero 1, unveiled in October 2018. They are installing a proprietary vacuum pump system on the track. They have developed the technology of passive magnetic levitation. They have also used a new material for the pod called Vibranium. Using carbon fibre and embedded sensors, the new smart material is eight times stronger than aluminium and ten times stronger than steel. It can transmit critical information regarding temperature,

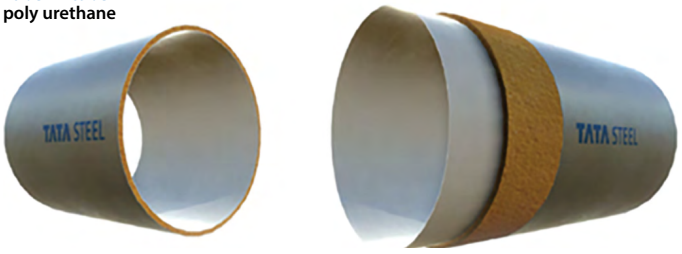


stability, integrity wirelessly and instantly. It is much lighter in weight @ five times than steel and 1.5 times than aluminium. This will reduce the energy required to propel the pod.

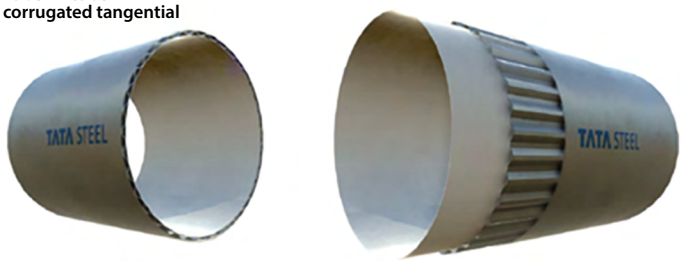
In 2019 Hardt Global Mobility, a start-up in Europe, constructed a 3 km test track in the Netherlands to test speeds up to 700kmph and lane switching. They have plans to connect all major European cities within ten years. What distinguishes Hardt from other key players is the "Lane switching technology". With this technology, several routes can be planned in a single tube. It will also be possible to divert a pod to a city in between.

Tata Steel (TSL) has undertaken various University Projects and progressed in evolving multiple configurations of the tube geometry with the primary objective of cost optimisation.

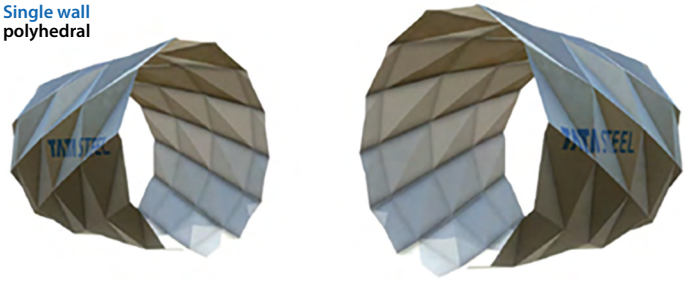
Tube-in-tube
poly urethane



Tube-in-tube
corrugated tangential



Single wall
polyhedral



Challenges

While much work is going on and many futuristic projects are being planned globally, like every new concept, Hyperloop has also got many challenges. Researchers, developers, authors are focusing on the various challenges, not to discourage but to make a collaborative effort and focused approach. Significant challenges pertain to Technology development, Safety, Cost optimisation, Enterprise Business Models, Governance and Regulations. While most of the work is concentrated on pod technologies and safety, others must be geared up at par.

Master Planning - Global Scenario

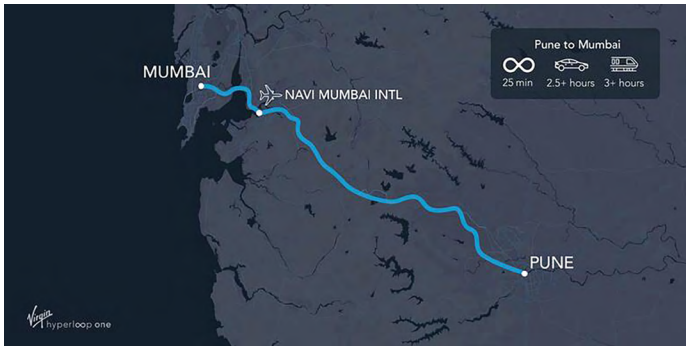
Several routes are being planned across the world, considering the distance range and market potential. Some routes are company speculations while some are business cases, and few have been transformed into signed agreements.

Some of the routes are Los Angeles – San Francisco (614 km), Chicago – Cleveland (594 km), Helsinki – Stockholm (500 km), Abu Dhabi – Dubai (140 km), Bratislava – Brno – Prague (338 km), Seoul – Busan (330 km). Several other routes have also been identified in Canada, the US, Poland, China, Netherlands.

Indian Perspective

A few planned routes in India are Mumbai – Pune (140 km), Amravati – Vijaywada (42 km), Bengaluru – Chennai (334 km), Mumbai – Chennai (1102 km).

In Feb 2018, Virgin Hyperloop One and Pune Metropolitan Region Development Authority (PMRDA) signed a framework agreement to implement Hyperloop between Pune and Mumbai. The route is from Wakad to Mumbai (BKC), touching the Navi Mumbai international airport.



In Aug 2018, a detailed feasibility study was submitted to PMRDA. In Nov 2018, the Govt of Maharashtra declared it as a public infrastructure project. A consortium between DP World and Virgin Hyperloop One was formed. DP World is planning to invest $500 million for Phase 1 of the project. This pilot project of an 11.8 kms demo track is expected to be completed in 3 years. The total project of 140 kms will become operational in 6-7 years. It will reduce the travel time between Mumbai to Pune from 3 hrs to < 30 min. If approved, this project will be the largest infrastructure project in India.

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ROLE OF EMERGING TECHNOLOGIES

at Construction Projects concerning Consulting Engineers

Adopting emerging technology is a necessity for today's consulting engineers. The Indian construction industry is worst affected by time and cost overruns. In India, it is estimated that complete construction projects suffer from 20 to 25 per cent time and cost overruns. The primary source of time and cost overruns have been identified as the inefficiency of the resource. In today's competitive world, it isn't easy to survive by implementing traditional construction methods. The emerging technology and consulting engineers coalition can satisfy the needs and add value to the construction project.

Each construction has its definite function, which has to be accomplished within a given time and cost. The use of 3-D printing, drones, and mobile applications is transforming the construction industry. A consulting engineer can use these emerging technologies to optimise costs and time, helping the project execution become more efficient and sustainable.

Growth of Construction Industry

Today, the Indian construction industry is the engine of the Indian economy, with an average growth rate of 9 to 11 per cent a year. India is set to become the world's third-largest market in construction by 2050.

The last two decades have brought lots of revolutionary changes in the construction industry. Two decades ago, the construction drawings were in the blueprint; now, they have shifted to colour print and digital 2D and 3D drawings. Technologies that began the new era of construction include Building Information Modeling (BIM), 3D Printing, 4D Scheduling and 5D cost modelling. These technologies are highly efficient and minimise the time and cost overruns very effectively. The latest 4D project management software implemented at a construction site for progress monitoring tracks and efficiently validates the construction work of the site much ahead of time.

The recent economic growth of India has placed tremendous pressure on its limited infrastructure. The smart cities project initiative of the Indian government is one such initiative to meet these demands like the mission of "housing for all" implemented in all rural areas. The "housing for all" mission aims to construct 20 million houses across India. New technologies play a vital role in these types of scattered project locations. Collecting all the data of each project quickly and efficiently, makes monitoring easy at a higher level.

Recently India has concentrated on its development agenda for infrastructure establishment. It's one of the indicators that construction activities in the country will emerge very effectively. Some of the significant infrastructure projects that the government has initiated are as follows:

- Air-Taxi Project
- CIDCO- Residential Tower Project
- Delhi Metro Rail Project
- High Speed Bullet Train Project
- Highway Projects
- River Inter-Linking Project
- Sea-Ports Project

Emerging technologies include 3D printing, Artificial Intelligence, Augmented Reality, Mixed Reality, Building Information Modelling, Drones, Mobile Technology, Robotics, and Virtual Prototyping. These technologies help to execute and monitor mega construction projects at all levels. These emerging technologies increase efficiency and the value of construction projects.

Project Execution with New Technology

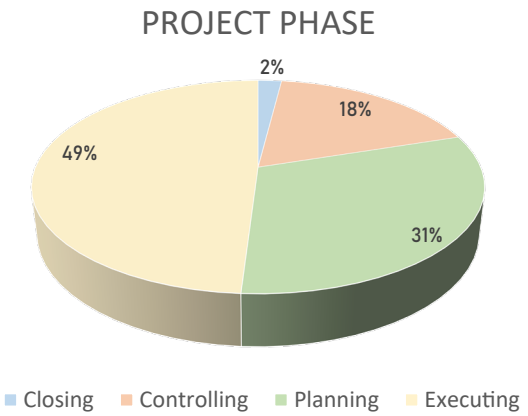
Some of the significant causes of time and cost overrun include poor planning and engineering design, discrepancies in geological data, poor execution and control, the traditional method of working, slow and centralised pre-tendering approval process, problems in land acquisition, weak dispute resolution practices, weak performance management, non-availability of skilled and semi-skilled workers, inadequate monitoring and rework, weak risk management skills etc.

Technological evolutions have transformed the field of project management. A famous phrase, ***"Change is the only constant."*** seems very true for the project management and construction industry. The project management area is changing rapidly with new technologies, tools, and the latest trends, and, the change doesn't seem to slow down.

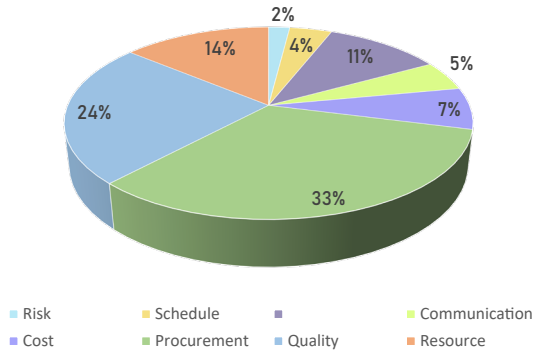
Uses of new technologies in different phases of project management are as follows:

Sl	Project Phase	Emerging Technology						
		3D Printing	Building Information Modeling (BIM)	Artificial Intelligence (AI)	Augmented Reality (AR)	Mixed Reality (MR)	Mobile Technology (MT)	Virtual Prototyping (VT)
1	Project Initiating Phase							
2	Project Planning Phase							
2.1	Project Scope Mgt.		•		•			•
2.2	Project Schedule Mgt.	•						
2.3	Project Cost Mgt.	•	•	•				
2.4	Project Risk Mgt.		•	•				•
2.5	Project Quality Mgt.			•				•
2.6	Project Resource Mgt.		•		•			
2.7	Project Procurement Mgt.		•					
3	Project Executing Phase							
3.1	Project Quality Mgt.				•		•	
3.2	Project Resource Mgt.			•	•		•	•
3.3	Project Communications Mgt.						•	•
3.4	Project Procurement Mgt.	•		•			•	
4	Project Controlling Phase							
4.1	Project Schedule Mgt.				•			
4.2	Project Quality Mgt.				•	•		
4.3	Project Communications Mgt.				•		•	
5	Project Closing Phase							
5.1	Project Communications Mgt.		•					•

Use of new technology at different Project Phases



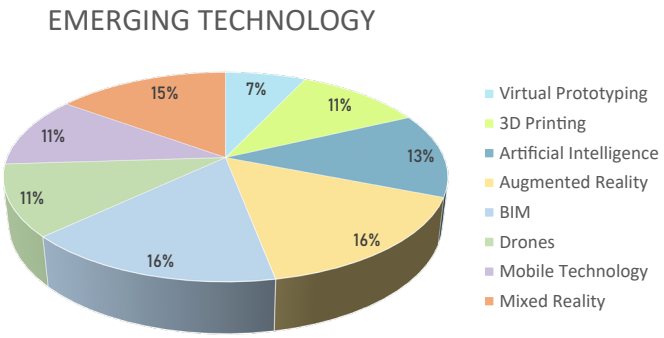
Use of emerging technology at different Project Knowledge Area



Time and money are the most critical aspects of construction projects. Emerging technology helps the stakeholders – engineers, architects and builders-work in tandem and derive an accurate estimation for both. Emerging Technology helps very much in controlling project costs and facilitate efficient project management.

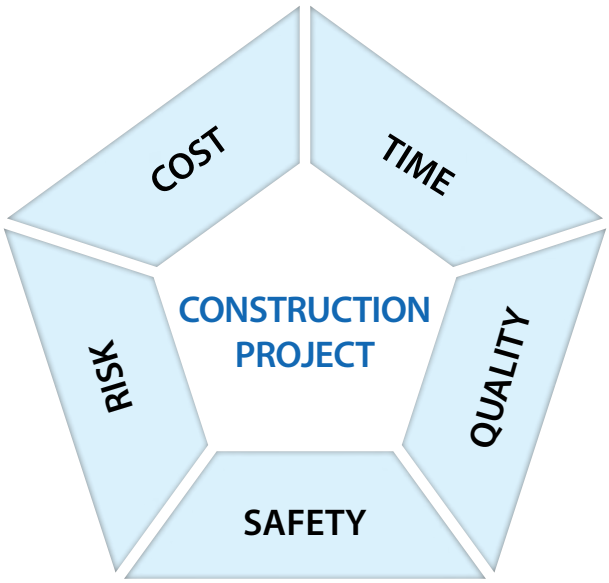
Today's new technologies can provide the status of site information, monitor project sites in parallel and feed data back to the predictive analytics systems. Comprehensive knowledge of site progress and real-time status reporting can be shared with the help of smart devices, mobile applications, sensors and on-site cameras, drones. Construction management software links with advanced GPS easily and effectively.

Type of emerging technology use at Construction Project



Project Pentagon

A project is considered successful when it fulfils all five fronts, i.e. Time, Cost, Risk, Quality, Safety. These five parameters of construction projects are needed to be stringently evaluated. These are the five pillars of the project pentagon.



New technologies are beneficial in planning, controlling, monitoring and executing construction projects. Cost, Time, Quality, Safety and Risk are the parameters that reflect the project's outcome. A consulting engineer can make an enduring contribution in these areas depending on their skill, experience, and expertise.

1. **Cost:** It is the topmost concern for any project. New technologies play a vital role to reduce the total cost of the project. AI is beneficial to predict any cost overruns, realistic timelines and can also help site engineers to access information.
2. **Time:** It is another area of concentration in the construction phase. Planning software like 4D project management software and BIM can easily eliminate time-consuming tasks.
3. **Quality:** Rework is one of the significant causes of time and cost overruns. Using BIM, AI, and mobile applications can significantly increase quality at the construction site.
4. **Safety:** It is paramount at the construction site. With the use of AI, construction sites can be monitored for safety hazards; by using the latest technology such as geo-location to identify dangerous areas, we can readily make a safety plan to minimise the risk in that area.
5. **Risk:** Since the last decade, risk assessment is another area of focus. All types of risks at the construction sites can be mitigated with the help of technological tools, sensors & AI.

Engineers with Technological Solutions

A consulting engineer with specialised background, familiarity with emerging technology, and vast experience can supervise, execute, monitor, and help the management as per project requirements. As the construction industry becomes more tech-enabled, the need for consulting engineers with digital skills is also growing.

Emerging technology help working from a remote location in many ways. For example, a cloud-based system like SharePoint can store all the documents, as can collaboration tools such as Teams, Zoom etc., but the communications and files for this data have to be maintained independently, which requires much manual effort.

One of the significant reasons construction projects are time and cost overrun is the discrepancies in geological data. Actual ground conditions are not matched with the early survey estimates. To counter this issue, consulting engineers use emerging technologies like high-definition photography, 3-D laser scanning, and geographic information systems enabled by recent drone and Unmanned Aerial Vehicle (UAV) technology, which dramatically improve accuracy and speed. All the information received can be uploaded to other analytical and visualisation systems for project planning and construction execution. Emerging technologies are often used together to save time and money. Ultimately, a more proactive consulting engineer approach supports spot decision making by equipping project sites with the knowledge they need to ***build it right the first time.***

Emerging technology helps the consulting engineer to address the following issue:

- Detail work assignment of resources and real-time monitoring of work.
- All the stakeholders are connected on a digital platform to ensure that work is executed as defined in the scope.
- Digital collaboration between all the stakeholders results in less rework.
- Availability of all the documents in the cloud creates a digital audit trail.
- Access all project related information from anywhere, anytime.

So building it right the first time is crucial to project success. Consulting engineers' proactive roles eliminate the time and cost overrun, increase the site's productivity, and effectively monitor project management. These technologies save up to 20% on construction project costs and time overruns by eliminating the rework on site, inaccuracies, and decision delays.

Conclusion

At this time Indian construction industry is also ready to take challenges of megaprojects. It is often considered that the construction industry is away from innovations & not adopting new technologies readily. However, that same construction industry efficiently and effectively builds megaprojects worldwide. By adopting new technologies Indian construction industry can easily reach new levels of success and higher standards.

Author:

Mukesh Rawal - Senior Manager

Tata Consulting Engineers Limited (TCE)

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ENGINEERING CONSULTANCY TRENDS

Engineering Consultants lay the foundation of planning and executing a project with the most efficient solution possible. Engineering is constantly evolving, and consultants are no exception to this. Change, being inevitable and the only constant, has been exponential in the past few years. The availability of a vast magnitude of information/data and the uncertainty due to the ongoing pandemic contributed to this extraordinary time.

While consultancy organisations cope with the more insistent contest from new competitors, they are further burdened by the demanding challenges from the customer and emerging trends.

This article is an overview of some of the emerging trends which will propel engineering consultancy soon.

The Emerging Technologies:

- ### Laser Building Scanner Technology

  Many old buildings or plants may not have the plan and layout available. Newer plants and facilities may also have only the physical layouts available. Carrying out a manual survey and generating a digital/ soft copy of the layout consumes massive person-hours and resources, driving up design and consulting costs.

  However, now there are laser scanners to survey the surroundings and create models in just a small fraction of time. Of course, the models lack physical property information. But adding these properties to a digital model is much faster compared to creating the complete model manually.

As Engineering consultants, there can be new offerings based on this technology:

- PMC offerings can be more detailed and accurate with the availability of the laser building scanner.
- Consultants can provide more accurate and faster troubleshooting for any structural defects or other design corrections.
- Design can be developed on real-time data availability in record time.

• Virtual Reality

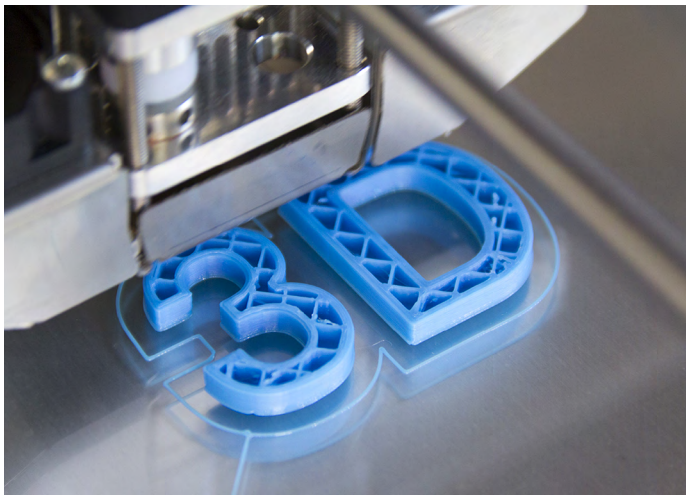
Though virtual reality is mainly associated with entertainment, the same can be a great tool in engineering and consultancy, providing the visuals of the plant and machines to the consultants at their location without a physical visit.

- The consultants can provide valuable insight and solutions to the problems at the site sitting right at their desktop in the office at some other location.
- The consultant's knowledge can be utilised in a real-time environment to provide the required troubleshooting solution.
- The consultant and experts' suggestions can be fed and stored into the gadgets for future reference and use.

• 3D Printing

3D printing consultancy is a new field. 3D printing or additive manufacturing can spark the revolution of a complete industry. The consultants can approach the potential customers with the following offerings:

- Creating organisational awareness to recognise the potential of 3DP along with customer asset assessment.
- To recognise the possible areas of application of 3DP and demonstrate high investment returns (ROI).
- Developing a transformational road map for three to five years.
- Supporting the implementation phase.



• Building Design with Prefabricated Components

Prefabricated components are futuristic and revolutionary because they can accelerate the design and construction.

- Without creating a building model from zero, the engineers can choose from the available prefabricated components and create a model using the available component libraries.
- The prefabricated components can also be directly ordered at the site and assembled in much lesser time.

Using the prefabricated components requires the technical know-how needed to use these components at the optimal design conditions and environment.

Experts will be required to formulate the standards for these components, which is expected to be different from the conventional construction standards.

Also, the role of expert consultants in designing the safety guidelines for these comparatively newer technologies is the key to the success and further sustenance of these technologies.

- ## Big Data & Analytics

Data is the new age gold and is available in abundance all around. The analysis of this data to derive meaningful insight is the growth path ahead. Consultants are the medium to provide intellectual understanding to the analysed big data.

Conventional consultancy requires focusing on this expanding arena.

Consultants can have the following offerings in their basket:

- Data collection
- Data processing
- Data analysis

- ## The Internet of Things

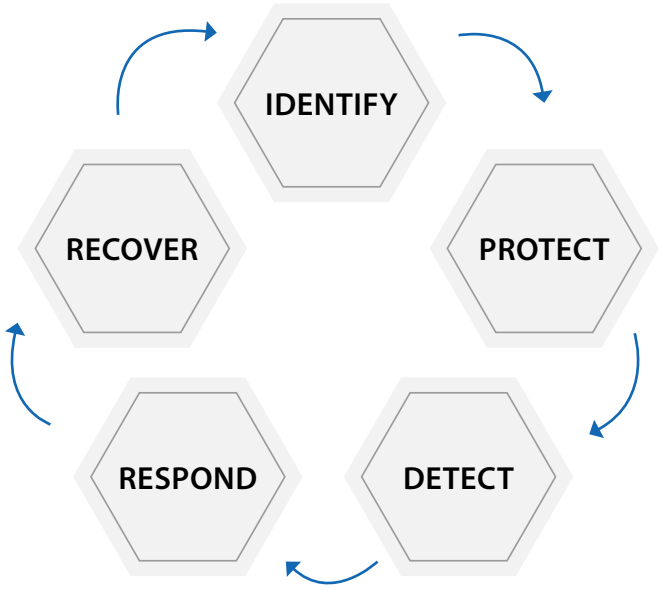
The IoT is no longer restricted to mobiles and computers. It is everywhere. Sensors are connected for HVAC, lighting, air conditioners etc. Any issues during construction can also be recorded, and notification sent on mobile to the consultant and engineer.

The power to know the future lies within this technology. With the availability of information and collected data, the ability to forecast and foresee is immense. However, with the combination of emerging technologies and the consultants' expert human minds, the results of the engineering innovations will be far-fetched.

In a connected world, data and information can flow from anywhere and everywhere. Using this information to provide the appropriate and desired acumen will prove a game-changer for the future of the consultancy industry.

The availability of data pertaining to past designs and their analysis will provide in-depth foresight for future designs and help overcome the previous shortcomings and defects.

With the advent of Industry 4.0, another sector that comes into focus is Cybersecurity. The construction industry represents low hanging fruit for cybercriminals. The consultant's role becomes significant in making the customers aware of the potential threat and help build Cybersecurity which is the following framework.



With the scale of the cyber threat set to continue to rise, the International Data Corporation predicts that worldwide spending on cyber-security solutions will reach a massive $133.7 billion by 2022.

A cybersecurity consultancy is another diversification that can yield disruptive results in the consultancy industry.

- ## Emerging Business and Operation Models

There is a phase shift in the technology, and the operational and functional aspects of the consultancy have undergone a paradigm shift. As a result, the following functional trends will be the future of the consultancy operation.

Quantifiable Results:

Firms employing consultants in future will expect a quantifiable return from their investments. In addition, clients will expect consultants to provide cost-effective, reliable & realistic solutions in line with the customer's financial goals rather than expensive diagnoses.

• Strategic Partnerships

The uncertainty of the business environment will reinforce the requirement of partnerships for consultants. Customers will look for partners who will share the risk. Consultancy firms need to transform their business model from the conventional/traditional billable model to a scalable model. The consultancies would require collaborating with expert firms.

Regardless of the partnership's goals, the procedure of finding the most feasible partners is as follows:

- Make a list of the prospective partner companies.
- Determine the evaluation criteria for the partnership.
- Shortlist the potential partners.
- Establish relations with the companies and perform discussions to work out the details of a contract.

• Evolving Billing and Pricing Models

New and unconventional billing and pricing business models are in demand currently. For example, earlier consultancy fee was charged periodically or on completion of the project. Now clients are requesting milestone-based billing plans.

Clients also request financial transparency – like ballpark cost and discount on fee or delivery time.

• Remote Consulting

Given the current situation due to the pandemic and the development of IoT and digital platforms, remote consultancy services will be the trending factor for consultancy firms.

All enabling departments in the firms will also be required to take the remote and virtual platform route like recruitment and training.

Conclusion

The disruption of the consulting industry is here, and consultants are required to acclimate to the client sensitivity of pricing, timeline, and knowledge. In this competitive market, adaptability is the only way out if consultants want to thrive.

Collaboration, flexibility and agility may hold the key for the future. The environment may be volatile, but this is also a time for ever-increasing opportunity and growth for those striving to make a difference.

Author:

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Tata Consulting Engineers Limited (TCE)

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EMERGING TECHNOLOGY, INNOVATION & RISK MANAGEMENT

In a highly competitive and often challenging business scenario, change and agility are no longer desirable attributes but absolute requirements for survival and growth. For most organisations, especially for knowledge-driven ones like TCE, transformation and agility need to be driven by innovation and emerging technologies.

The term risk is defined as the effect of uncertainty on objectives. The Risk Management Function works towards identifying, assessing, and prioritising risks, followed by steps for mitigation of risks and enhancement of opportunities, with the ultimate aim of ensuring that the organisation achieves its objectives.

Change in most of its forms brings uncertainties, and hence emerging technologies and innovation are inextricably linked with risk. This article seeks to explore the essential aspects of this relationship.

Risks to an Organisation due to Innovation and New Technology Adoption by the Competition

In their pursuit of differentiation and price competitiveness, organisations seek to bring innovative solutions and adopt new technologies. If an organisation is not abreast with the latest advancements in the industry, it risks either losing its customers or its profitability or both.

There are numerous instances where new technology has enabled paradigm shifts in business models and disrupted the industry. As a result, many existing players in the sector have been caught off-guard, and many closed shop. Examples like Uber and Ola in the taxi industry, Apple in the media industry, Airbnb in the hospitality segment, etc., are the few which readily come to mind.

Organisations need to embrace innovation, nurture culture change, and adopt new technologies to remain relevant. The key mitigation measure would be continual scanning of the external business environment to identify technological

advancements and keep track of the competition. It is also necessary to build up the capability of an organisation to work on and swiftly respond to potentially disruptive technology in the market.

Addressing the Risks Arising from Innovation and Emerging Technologies

Technologies once considered "emerging" like connected devices, artificial intelligence, blockchain, cloud computing, etc., are being adopted as a necessity for a company's survival and growth.

However, new technologies bring new and often complex risks that, if managed poorly, could lead to undesirable consequences. Another crucial area of risk that has become apparent is the third-party risk that arises when companies depend on external providers for these new technologies.

When managing technology risk, an organisation should foresee changes before they happen and determine the associated risks. The goal is to make sure you adopt innovations and technology smartly and effectively manage any emerging threats.

One significant set of risks in this domain is those associated with information technology systems. While IT systems have become the backbone of engineering companies like TCE, it is all the more critical, particularly in the current Work from Home scenario, to ensure cybersecurity to protect networks, computers, programs and data from malicious attacks, damage or unauthorised access.

Risks to Innovation and Adoption of Technology

Everyone is familiar with risk management as a part of the project management function. Let's consider an innovation exercise as a project. It is easy to visualise that there could be several uncertainties during the course of an innovation that could threaten the achievement of the objectives. Time duration of the innovation project would also be an important factor here. The more time passes between the initial ideation, its development, and the final launch; the more risks are likely to emerge.

Naturally, companies would like to see their innovation processes succeed and benefit their business. So the first important step would be to ensure that the innovation chosen for implementation aligns with the strategic business vision. Then the company should treat this as a project and ensure that a structured risk management exercise is undertaken to identify, address and monitor the risks till the completion of the project.

Adverse Effects of Technological Advances on Employee Health and Well-being

One often overlooked facet of new technologies that a risk manager is concerned about are the latest technologies that organisations are forced to adopt. These have several adverse effects on the health and well-being of the employees. An article on the website www.businessinsider.in lists the following adverse effects of new technology:

- Technology is Addictive
- Technology is leading to sedentary lifestyles
- Social media and screen time can be bad for mental health
- Insomnia can be another side effect of digital devices
- Relationships can be harmed by too much tech use
- Young people are losing the ability to interact face-to-face

Of course, the above list cannot be said to be comprehensive. The first requirement in addressing such risks is to spread awareness across the organisation. Companies should understand and acknowledge their existence and take adequate measures to minimise or preferably avoid these ill effects.

Innovations and Technological Advancements in Risk Management

While the risk management function addresses the various facets of emerging technology and innovation to ensure mitigation of risks and maximise opportunities, it cannot remain insulated from the latest technologies. It is well known that good risk management depends on high-quality data and compelling analysis of the same to produce relevant information to aid the internal customers and the management to make informed calls in the various operations or strategic matters.

Multiple technologies aid risk managers with better abilities for enhancing risk management effectiveness. Some examples are:

- Data Mining, Integration and Analytics
- Automation
- Risk Dashboards
- Risk Tools for Analysis
- Mobile applications

Adopting new technologies in the risk management process could result in benefits like:

- Better and sharper data analysis
- Access to real-time information on risk dashboards
- Better monitoring of risks
- Better sharing of relevant risk data across the organisation to ensure enterprise risk management.
- Faster and assured escalation of risks.

However, it is important to know that each of the technologies proposed for risk management could have its risks and associated costs.

In Summary

Innovation and emerging technologies herald a host of opportunities. An effective technology risk management approach will ensure that the company can enhance these opportunities to the maximum while protecting the organisations against the downside risks. Good risk management will enable business leaders to reduce their apprehensions regarding innovation and technology. Indeed, the innovation-technology-risk triumvirate makes a strong case for a special technology risk arm in the risk management function.

Author:

Rajeev Dhanvantray Tanna - Chief Risk Officer

Tata Consulting Engineers Limited (TCE)

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CUSTOMER TESTIMONIAL

I would like to congratulate you on successfully completing the Training Assignment of the Feasibility Study of Power Plant for the team.

Really appreciate the efforts and hard work that you all had put in to conduct this Online Training Program, especially amid the Covid-19 crisis in India. You contributed with a very good mix of practical aspects, experience, and theoretical aspects into your training program.

The team also appreciated your efforts on the last day, which is commendable.

Thank you, team, for being a part of this assignment. I am extremely pleased to be associated with you on this assignment.

We would like to congratulate the team for their contribution along with project execution team and as a support member of the Winner team for simplification of foundation design in distributed ground mount plant of capacity of 300kW to 10MW.

The initiative focuses on strategic or cost-related improvements through people involvement under our Convention 2021, which was held between 15-Mar-21 to 19-Mar-21

We appreciate the efforts and recommend the work for rewards and appreciation as per your company policy.

I take this opportunity to appreciate and recognise your sincere efforts towards "100 Tons of material identified from the available stock of Structural Material". I am aware of the hard work and dedication you have delivered and proved to make the event a successful one.

Once again, I appreciate your contributions. The business is poised for significant growth in the coming days. To achieve our growth plans, we are looking forward to an even higher level of dedication and contribution in future projects.

I would like to acknowledge your excellent work.

We have taken up different development & Infrastructural Development projects for a qualitative change in the life of the people of the city. Among others, the Smart City has initiated the work of 60 projects, and Tata Consulting Engineers Ltd (PgMC) is an integral part of the team. During the last year, despite the COVID-19 Pandemic, we could utilise more than 200 Crs, rising from 13% to 62% of available funds with significant physical progress. This substantial progress is a teamwork that could not have been possible without your active support. The Supervision and Monitoring with proper quality management of your team is praiseworthy, and the billing management with the scrutiny process is systematic for which timely payment is made, resulting in the progress of work.

Further, it is not out of place to mention your sincere initiatives in arranging medical cylinders during the COVID-19 Pandemic and uninterrupted work during the period. While appreciating your sincere work, I hope you will continue to work in the same spirit and ensure the completion of all projects in time.

We engaged Tata Consulting Engineers Limited as the Project Management Consultant for various projects under the Smart City Mission, including some projects funded by the Asian Development Bank, and the efforts of the Team has been commendable for their noteworthy contributions towards realising the goals and objectives of the Projects, due to their consistent and diligent performance, for the past two years of their consultancy service tenure, with us.

Owing to the extension of the project period under Smart City Mission, Tata Consulting Engineers Limited has been provided with an extension of the tenure of their consultancy services for another two years to continue their diligence towards the projects for enhanced achievements under the Mission.

QUALITY MANAGEMENT SYSTEMS IN TIMES OF COVID

Tata Consulting Engineers Limited was first certified to conform to the requirements of ISO 9001 in Jan 1995. It was the first engineering consulting company in India to do so. Subsequently, the company has been successfully recertified every three years and has graduated from the 1994 edition to the 2015 edition, through the 2000 and 2008 editions of ISO 9001.

The certificate applies to TCE's consultancy and construction supervision services for projects related to:

1. Power generation, transmission and distribution
2. Nuclear civilian facilities
3. Urban and rural water supply and wastewater treatment
4. Irrigation, urban and rural development
5. Health care
6. Chemical, petroleum and petrochemical industries
7. Environmental and safety systems
8. Tourism
9. Port, harbour and offshore structures
10. Transportation systems, telecommunications, IT infrastructure
11. Mining minerals, metallurgy, other industries and
12. Special applications to meet customers' requirements

While complying with applicable statutory and regulatory requirements quarterly reviews and audits at the Business Unit (BU) level ensure that the standards are maintained in both letter and spirit. Business Excellence (BE) team schedules and initiates the quarterly activities. Quality Management System (QMS) Coordinators and Internal Auditors at the BUs are the silent workers ensuring the same in coordination with the BE team.

As the ISO 9001 - 2015 criteria evolved and became more business-oriented, incorporating a process approach and risk-based thinking, so have our systems, processes, checklists and templates for audits and reviews. Business Units are encouraged to maximise the number of projects audited, which also helps more Internal Auditors gain experience.

At TCE, we look at every challenge as an opportunity. So, when the present pandemic situation came, we used the situation to strengthen the Quality System.

Armed with various IT platforms, audits and reviews have gone online using the MS Teams platform ensuring employee safety while achieving our QMS targets. Remote audits have given QMS Coordinators the flexibility to nominate internal auditors to audit projects of distant locations. Similarly, remote Management Reviews have permitted more members of the BU Leadership team to participate and enrich the same.

The last external surveillance audit was successfully conducted remotely in Dec 2020, and we are now in the midst of the next re-certification audit.

TATA CONSULTING ENGINEERS LIMITED

TATA

Quality Policy

- To grow as an internationally respected professional engineering consultant offering comprehensive solutions by consistently
  - Meeting and exceeding customers' expectations
  - Protecting and furthering the interests of our stakeholders
  - Meeting and where possible exceeding statutory and regulatory requirements
  - Providing technically excellent and innovative solutions and to become a trusted advisor to strategic clients & partners
- In order to achieve this, we are committed to
  - Successful adoption & deployment of Quality Management System in accordance with the requirements of ISO 9001 by providing adequate resources
  - Provide adequate training to all the employees for effective implementation of the Quality Management System
  - Pursue Business Excellence by adopting the Tata Business Excellence Model (TBEM)
  - Periodic review of Quality Objectives and Quality Management System for continuing suitability, efficiency and effectiveness

Amit Sharma
Managing Director

Lloyd's Register

Certificate of Approval

This is to certify that the Management System of:

TATA Consulting Engineers Ltd

ISO 9001:2015

Author:

Sandhya Mukherjee - Senior Manager

Tata Consulting Engineers Limited (TCE)

INFRASTRUCTURE CLUSTER

CLUSTER VISION
2021-22

In FY 21, the Infrastructure cluster of TCE contributed around 50% in revenue and 63% in the order book. The cluster intends to ride the wave in FY 22 buoyed by the previous year success. Last year, the cluster faced its own set of challenges posed by the once in a century Pandemic but was determined to keep the impact to the minimum by remaining agile and adopting change in the laid-out strategy.

The first strategy was to go after big deals instead of chasing long tail but small deals. The demand for TCE services is majorly driven by CAPEX budgeted by Governments and Private organisations. The economic downturn and instability highly impacted the budgets during FY 21. However, showing resilience, the cluster successfully explored the opportunity to diversify the business into sunrise sectors, develop new key accounts and enter new areas through partnerships.

KEY ACHIEVEMENTS IN FY'21

- **12** Key Initiatives Identified
- **03** New Service Areas
- **26** New Logos Added
- **02** MOUs
- **05** Strategic Accounts Added
- **06** Key Partnerships Forged

K Ramesh
President - Infrastructure,Sustainability and PMC Services

Sectoral Outlook

With a focus on innovation and sustained transformation, the cluster continues its leadership position in most sectors. During FY 21, our business canvas hued into a rainbow with the successful association for developing nation-building projects like Mumbai-Ahmedabad High-Speed Rail (MAHSR), Central Vista, Ayodhya Temple and CIDCO PMAY Affordable Housing. The cluster now aspires to establish its identity in Metro Rail, High-Speed Rail, Defence, Integrated Developments, Industrial and Mixed-Use Townships, Up-gradation of Existing Infrastructure in Metro cities, new Industries, Logistic Parks, Desalination and Water Reuse/Recycling and Digitisation. The aspiration for growth is equally balanced, focusing on Clean Energy & Sustainable Infrastructure like FGDs, Regasification Terminals, Climate Change, Energy Modelling, Flood Modelling, and Green concept in Redevelopment projects.

A considerable impetus shall also be made in the Healthcare sector, developing under the focus of both Government and Private organisations to build integrated public health labs, critical care blocks, and hospitals units. The ball has already been set rolling in FY 21 through our association with Biocon Biologics Ltd. and Andhra Pradesh Medical Services & Infrastructure Development Corporation (APMSIDC).

Key Trends Shaping the Industry

1. Ever-increasing focus from the Government on the need for Infrastructure nationwide and National Infrastructure Pipeline (NIP) has been formulated for different industry domains.
2. An upward trend in Urbanisation and the need for Sustainable Infrastructure is being observed. Several medium to large-sized greenfield townships/affordable housing schemes is planned in Tier-II and Tier-III cities. The up-gradation of existing Infrastructure in Metro cities is also likely to be started. As a result, higher growth is also observed in the affordable housing sector @ 11% p.a.
3. *'Make in India'* and *'Production Linked Incentive (PLI)'* schemes will push for new industries, logistic parks and warehouses across India. Strong growth in the warehousing market will continue at 15% over the next ten years (the warehousing market has increased by 44% CAGR in the last three years)
4. Strong growth in urban Infra segment (from 20 bn USD to 40 bn USD): Investment in HSR, Semi HSR and Metro as Metro coverage expands to 34 cities from 19 cities in 2020, Growth in Ports & Airports – 32 new Airports & 6 new Ports.
5. Expansion in Urban Transportation such as High-Speed and Semi High-Speed Rail projects, Metro Rail projects, Ports, Dam Rehabilitation and River Interlinkages.
6. There is a growing demand for identifying alternate water sources due to extreme weather conditions and high water stress levels, leading to the need for designing efficient distribution of good quality water in towns and cities. The role of private players in the water industry is expanding, panning out a wide range of opportunities for smart water management, alternative water sources - desalinisation and water reuse/recycling.

Power

- 175 GW of renewable energy in 2022 including Hydro. Thermal power will move from 223 GW to 440 GW by 2040.
- Thermal plants to be shut down in case not meeting emission norms - opportunities in FGDs

Healthcare

- PM Atmanirbhar Swasth Bharat Yojana with an outlay ~64,180 Cr over 6 years to improve primary, secondary and tertiary healthcare.
- Plans to set-up integrated public health labs in each district.
- Health outlay to be used to establish critical care units and hospital blocks

Natural Resources

- Increasing urbanisation and expectation of cleaner fuel demand to drive growth of gas-related infrastructure (e.g. Regasification terminals, Gas pipelines)
- National gas grid system proposes an expansion of 51% from present.

Sustain-ability & Climate

- Possible expansion in integrated service & project delivery capabilities in sustainability projects, leverage Tata brand and expand share (e.g. TCE, Tata Housing, TCS, TPL collaborating for smart buildings.)
- Business opportunities in Modelling (energy, light, transport, CFM, Hydraulic, Flood, Carbon, Social, Environment modellings.)

7. Rising focus on sustainability to drive new opportunities in Infrastructure (e.g. Solar power, water treatment, water provision) leads to demand for players with advanced engineering/ technology capabilities & sustainable practices.
8. A shift in value pool - Companies are adopting technologies across the value chain (e.g. 5D BIM, IoT, Drones etc.)

Customer Outlook

The cluster has unique capabilities of working with multiple stakeholders. We plan to work more closely with the Government for developing nationwide Infrastructure, including providing clean and reliable drinking Water Supply, Transportation (Metro, High-Speed Rail, Ports & Harbours and Aviation), Industrial Corridors, Smart Infrastructure and Sustainable Master Plans for Cities, Educational & Medical Infrastructures, Science Museums and Defence Infrastructure. Our proven experience with multilateral funding agencies like EXIM, ADB, World Bank, and JICA encourages us to strengthen our association with them further.

We have planned an equal thrust for our key initiatives such as engagement with the large EPCs in India and abroad (especially Japanese & Korean), strategic Partnerships to strengthen market share in Ports, Transportation (Metro/HSR) and ISBL Refinery sectors, enhancing digital offerings in BIM, Mass Housing projects and Healthcare sector.

In FY 21, the cluster added four accounts: CIDCO, Sumitomo, Reliance, and NHSRCL, which will sustain for the next 4 to 5 years. The infrastructure cluster is pursuing to add more sizeable long term accounts in the Ports, Oil & Gas and Transportation sectors.

Ecofirst, the Sustainability arm of ISC, opened avenues with International Finance Corporation, Union Territory of Ladakh, Adani Enterprises, Welspun and ESR Logistics. The impact of these avenues is not limited to our business sustenance only but reinforces the concept of sustainability in the Infrastructure sector.

Resource Outlook

With around 250 Project Managers and 1600 employees, the cluster manages the largest share of resources under its umbrella, including employees spread across 175 site locations in India and abroad. (In fig., PMCBU employees spread across domestic and abroad locations).

The presence of TCE Project Management Teams at the site during the pandemic time and digital interventions ensured the physical progress of projects. Our valued customers highly appreciated the team for maintaining the progress while following appropriate COVID-19 Safety measures.

The Infrastructure Cluster has multi-disciplinary architecture and engineering talent with capabilities to manage complex projects worldwide.

Appropriate opportunities for reskilling and training are provided to the teams in the technical domain to ensure their maximum utilisation. However, with the present situation of the second wave of COVID-19 and the chances of the third wave, our key focus will remain on remote employee engagement, safety, and employee well-being.

Brand Outlook

Infrastructure Cluster has played a vital role in promoting brand image and visibility for the company with involvement in projects of national importance like MAHSR, Central Vista, Ram Janmabhoomi Temple, Program Management for Puri City, CIDCO Mass Housing, BWSSB, 400 MLD Seawater RO Desalination Plant at Chennai. We are also revolutionising redevelopment projects in Mumbai Metropolitan Region (MMR) and Climate Change Services leading to increased visibility amongst the Financial Institutions requiring Project appraisal, Feasibility assessment and Sectoral Landscape Development for Affordable housing and Climate Change. Our continued focus on customer satisfaction, delivery excellence, and innovative solutions help in delivering these projects with quality, on-schedule, and cost-effective.

We shall continue our efforts and engagement with more such landmark projects. Also, as responsible members of the society, the infra cluster is working for Infrastructure development in model villages in Uttar Pradesh and as a design and supervision consultant for setting up plants for pressure swing adsorption (PSA) and liquid medical oxygen (LMO) across hospitals in Odisha.

As a team of experts, we ensure a positive impact on the environment through environmentally friendly and sustainable design services.

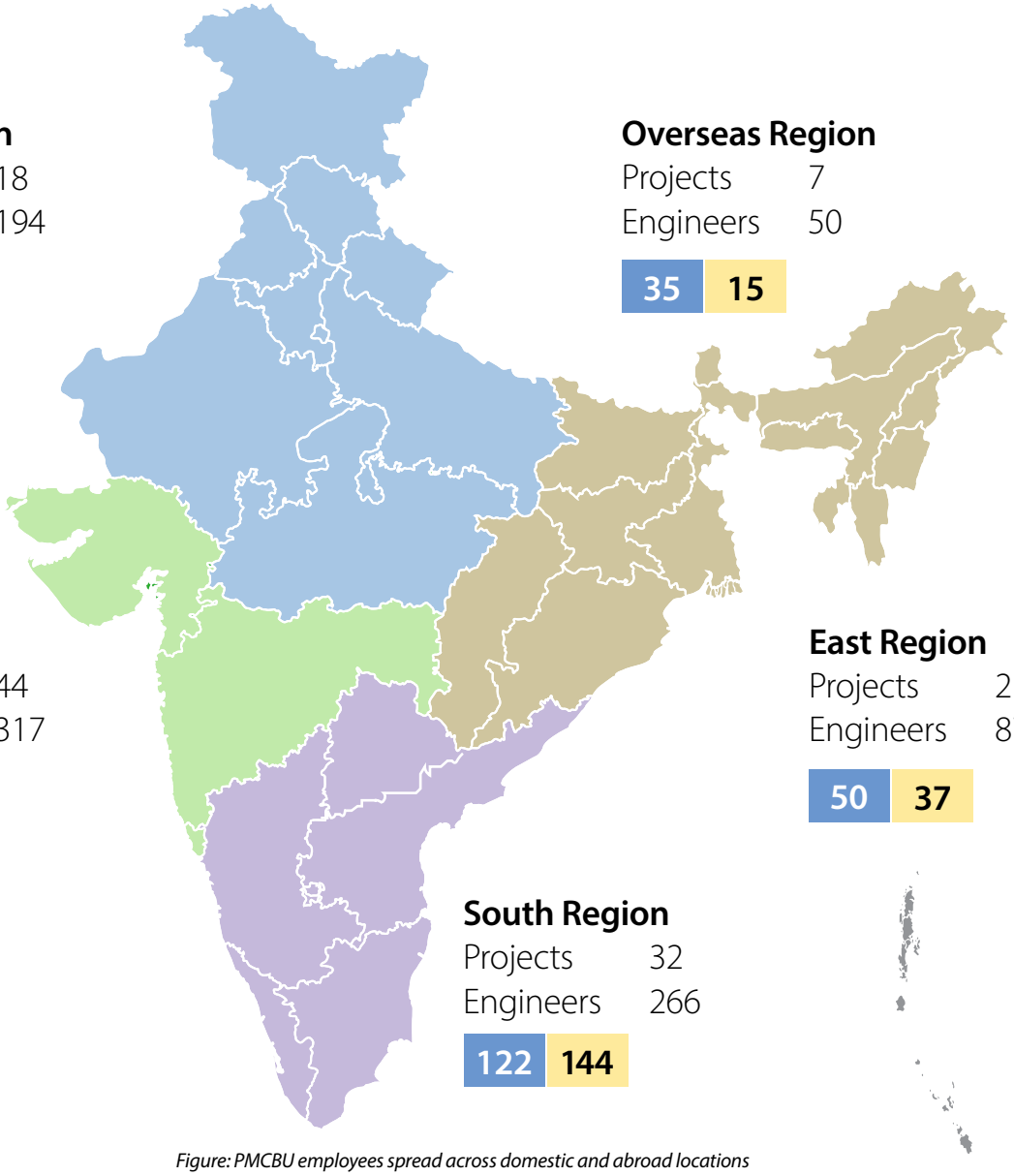


Figure: PMCBU employees spread across domestic and abroad locations

HEALTH AND WELL-BEING

A Metric of Building Performance:

A case study of Godrej One, Mumbai

Ecofirst Services Limited, a 100% subsidiary of TCE, facilitated CII-IGBC (Indian Green Building Council) Health and Wellbeing assessment and certification for Godrej One, the Mumbai headquarters building of Godrej. This is one of the first buildings of this scale/footprint to be platinum-certified.

Ecofirst was tasked to assess and analyse Occupant wellness parameters of the spaces across the project area for facilitating CII-IGBC (Indian Green Building Council) Health and Wellbeing Certification.

The way people 'feel' and 'function' within personal and social circles is correlated to the environment and surroundings. Therefore, the health and well-being of an occupant becomes one of the primary dimensions of the built environment and should be knitted with people-centric design.

In the current perspective, health is a complete mental, physical, and social well-being package and not just the absence of disease or impairment. While wellness imbibes and supports occupant engagement, productivity, creativity, enhanced prowess.

Project Objective

The client was keen to undergo post-occupancy occupant health and well-being assessment and approached Ecofirst as a speciality sustainability consultant to undertake green building certification under CII- IGBC health and Well-being rating system.

Ecofirst, as a part of the assignment, conducted an assessment of indoor environment quality (air quality, water quality, thermal comfort, visual comfort, olfactory and acoustic comfort). Basis the findings, Ecofirst formulated hygiene protocols, Indoor air pollutant control and monitoring processes, Physical and mental fitness-oriented protocols and programs, and Occupant health and well-being initiatives and policies and enhancement measures across the 10,00,000 sq. ft campus.

Methodology

A systematic methodology was adopted to assess and ensure effective integration of health and well-being components across the project area, as shown below.

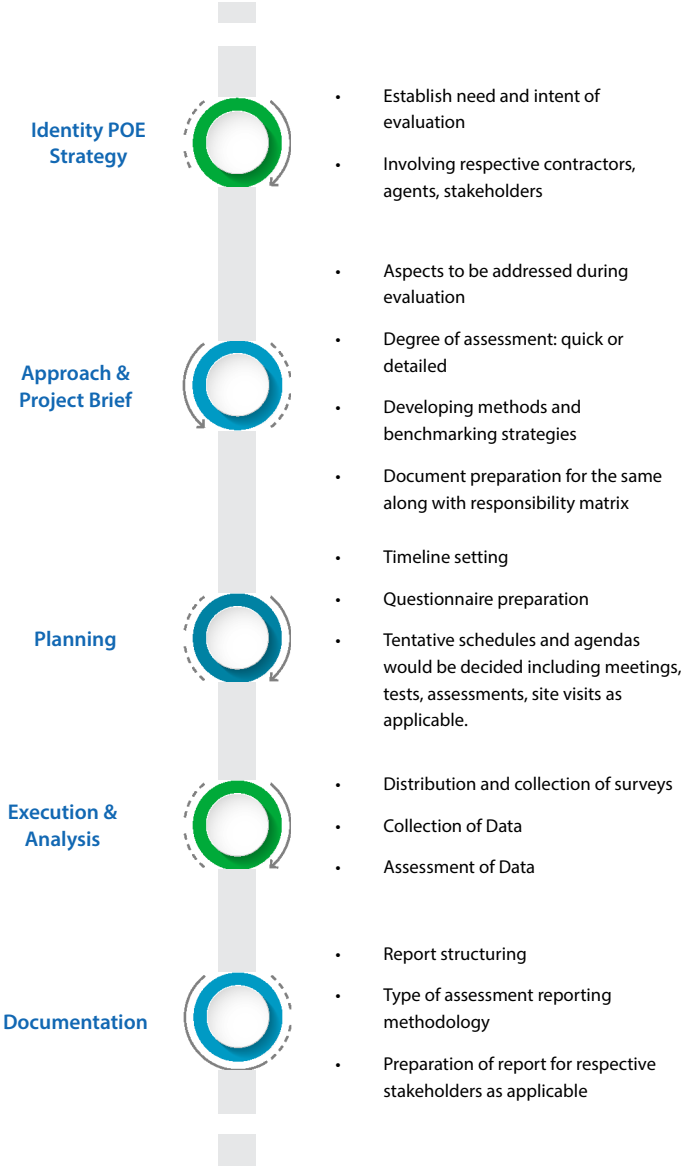


Figure 2: The above outlines approach followed to assess the Wellness aspect of the project, which was defined as a scope for our Post Occupancy evaluation.

Ecofirst played a key role in guiding and coordinating with the facility management team and other project stakeholders of Godrej One concerning the execution of the occupant survey, on-site IEQ assessment and alignment of occupant health and well-being features across the project area to achieve the IGBC Health and well-being certification.

The components for ensuring the health and well-being of occupants can be elaborated as in Figure 3.

- **Indoor Air Quality:** Ensuring good air quality through pollutant control and indoor emission control. The parameters were benchmarked via ISHRAE Standard 10001: 2016 – Indoor Environmental Quality Standard.
- **Water Quality:** Maintenance of drinking water Quality and treated water quality.
- **Occupant Comfort:** Addresses parameters correlated to the project's design, spatial planning elements and building Services like HVAC and a fresh air system. Occupant comfort is a dynamic parameter that takes into account constant occupant feedback.
- **Health and Sanitisation:** High touch surface cleaning and disinfection, use of safe and environmentally friendly chemicals, the safety of housekeeping staff, hygienic and safe use of cleaning equipment's and strict adherence to safety protocols are some of the aspects of this parameter.
- **Fitness and Nutrition:** The project's design is expected to facilitate occupants' outdoor and indoor fitness areas. Organisation policies are expected to promote and encourage physical and mental fitness activities. Access to nutritious and healthy food also becomes an essential aspect of the parameters
- **Emotional and Intellectual Well-being:** A built environment needs to be combined with appropriate policies and measures at an organisation level. An amalgamation of design that brings in nature within the space and policies that support occupants contributes to their emotional and intellectual well-being
- **Social Well-being:** encapsulates a positive feeling of belonging and inclusiveness, socially enabling occupants to connect and function in society. Some of the factors include initiatives towards improving community engagement, safety and awareness on well-being.
- **COVID precaution and Preventive measures:** Considering the various possibilities of the spread of COVID-19 within the building premises, there is a need for significantly enhanced hygiene measures beyond regular practices. Additional measures like improved housekeeping, social distancing, building service maintenance, contact Air purification and filtration measures to be executed.

Figure 3: Aspects of Health and well-being

Results and Findings

IAQ Monitoring and enhancement Measures:

- IAQ sensors had been installed in all AHU's and across regularly occupied spaces and integrated with BMS.
- Parameters monitored – Temperature, Humidity, CO2, PM 2.5, PM 10, within thresholds of ISHRAE 2016:10001 on all floors (G+11).
- Fresh air quality indoors was as per ASHRAE 62.1-2007. MERV 13 filters had been installed to purify the air of airborne particles .
- Entire Premise converted to a no-smoking zone.
- Strict protocols followed to disinfect the entire premises, including cleaning high touch surfaces every 2 hours.

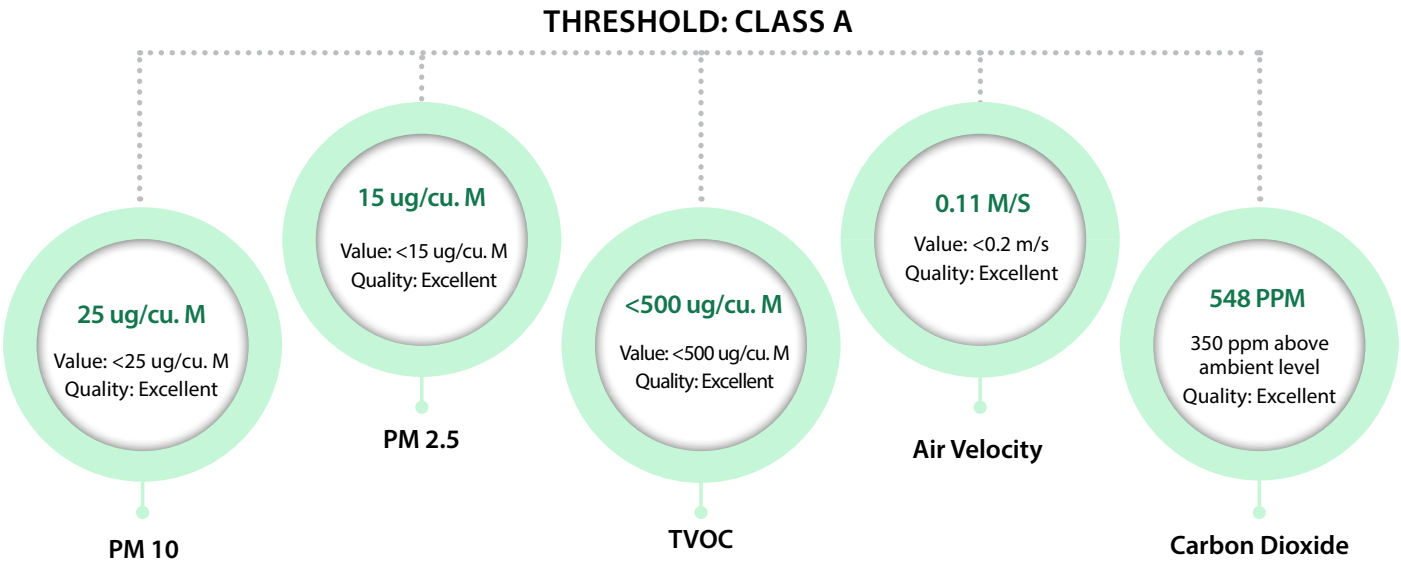


Figure 4: IAQ assessment results with average values observed across the project area have been benchmarked against ISHRAE IEQ standards.

Comfort

Daylighting and Illumination (Visual comfort)
Spaces were designed to optimise daylight and maintain comfortable illumination of 215 lux for more than 95% of regularly occupied spaces.

Thermal Comfort
Building services and systems maintain optimal temperatures, humidity, air velocity within the spaces, suitable for Occupant thermal comfort in about 85% of regularly occupied spaces. The measurements were benchmarked against thermal comfort standards as per ISHRAE.

Emotional Intellectual well-being Spiritual wellness spaces are accessible to occupants. The design is optimised so that 85% of regularly occupied spaces have connectivity to the external environment. The design elements consist of intermittent terrace areas, central atrium, Green landscape areas surrounding the project.

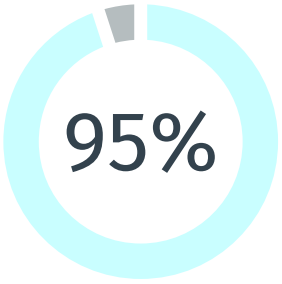


Figure 5: Percentage of regularly occupied spaces with comfortable illuminance levels

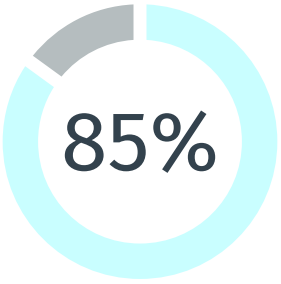


Figure 6: Percentage regularly occupied spaces achieving thermal comfort

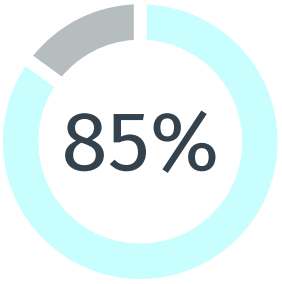


Figure 8: Percentage of regularly occupied spaces with external connectivity

Ergonomics
Anthropometrically suitable furniture has been provided based on the type of function of different spaces to offer optimum body poster comfort.

Olfactory Comfort
The facility maintains efficient exhaust rates in service areas and holds odourless workspaces throughout the year

Universal Design
Dedicated parking space for differently-abled, hindrance free floor level imparting freedom of movement, dedicated restrooms, Braille and Audio assistance in the lift was provided, making areas accessible for all.

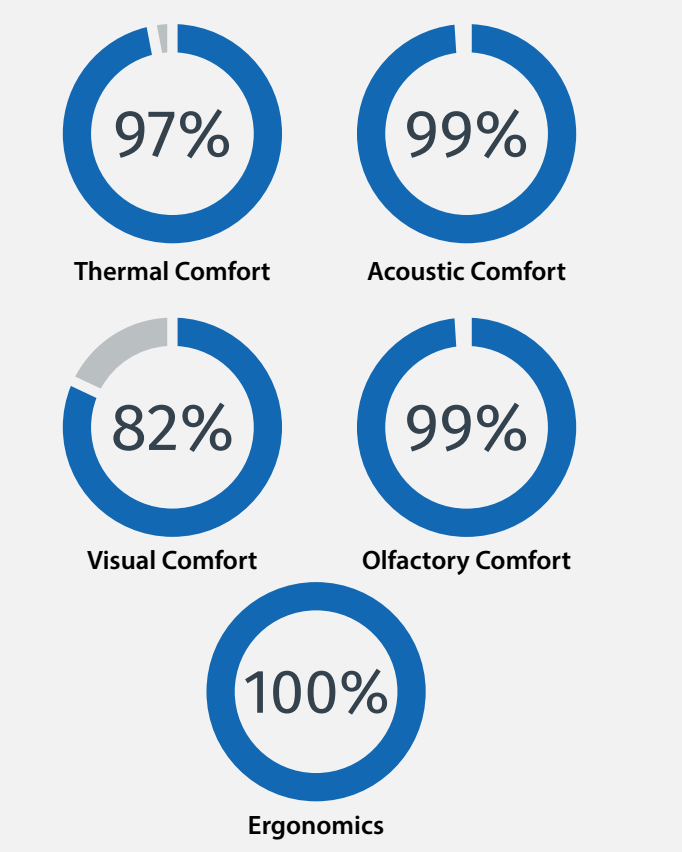


Figure 7: Occupant Satisfaction Percentage concerning each comfort parameters

Water Quality
Drinking water and treated water quality parameters were found to be within threshold limits. The project facilitates access to clean and hygienic drinking water. The parameters have been assessed based on thresholds as per IS 10500- 2012' Drinking Water- Specification Standard'.

Health and Sanitisation
Strict hygiene protocols have been adopted, including cleaning high touch surfaces every two hours. Ecofriendly housekeeping chemicals are being used, ensuring the safety of staff as well as occupants.

Fitness and Nutrition
Physical fitness facilities like Gymnasium, play courts etc., are available and accessible to occupants. The organisation hosts various awareness and encouragement programs for physical and mental well-being for all the occupants

Social Well-being
The organisation encourages recreation and cultural activities for the social wellness of occupants. Utmost care has been taken for employee safety protocols. Godrej as an organisation also commits to community well-being initiatives.

COVID -19 Precautionary Measures
Hygiene has been enhanced, and every precaution taken to minimise contact and ensure social distancing. Regular sanitisation of vehicles, office spaces, water and plumbing fixtures, HVAC and related equipment are executed to ensure occupant safety.

Thus, through this analysis, Ecofirst's Project team assessed and showcased the measures that can be taken for integrating Health and wellness in the sustainability concepts of a green building. Godrej One achieved the highest level of certification, i.e., Platinum under the IGBC Health and well-being certification rating system. Being one of the firsts, the measures and approach adopted in this project will act as a case study towards adding a health and well-being layer and other sustainability measures for similar commercial building designs.

Author:

Rakesh Bhatia - Senior Vice President

Rupali Thakur - Senior Manager

Sonika Kumta - Consultant

Tata Consulting Engineers Limited (TCE)

A Project

ROURKELA SMART CITY

Building on its steel foundation, natural setting and cosmopolitan character, Rourkela will be an inclusive, sustainable and self-reliant city propelling regional economic development with best-class infrastructure. There are 23 projects taken under Rourkela Smart City, including Smart Road, Citizen Friendly Parks, Football Stadium, Indoor Stadium, Auditorium, Museum, Command Control Centre, Pond Beautification, River Side Beautification, Smart Vending Zones, Smart Parking, Market Complexes etc.

Challenges

All significant projects like Birsa Munda Football Stadium, Smart Road, Biju Patnaik Indoor Stadium, Rourkela One started after the lockdown period in April 2020. The projects continue their progress with all due diligence as per plan with no impact on the original completion date. The project team has adopted the latest technologies like Post Stressed Concrete, Lean Technology, Slip Form type Form work for Precast work to expedite the work progress. As the city is ancient, retrofitting all the roads is very challenging. Due to the existing utilities in the ROW and densely populated area, the project team overcame all challenges to execute as planned and ensure proper traffic management. Other challenges include Encroachments, Multi-level approvals, Rehabilitation, High traffic, Low traffic management, Multiple players on the same site, Unorganised existing services and Variable Soil Strata, which we overcame with some strategic planning and sound engineering solutions.

Technologies

Technologies and effective way of working were the reason. We could achieve our targets. In Birsa Munda Stadium, using Post Stressed Technology, we reduced our concrete work and de-shuttering time considerably. Also, taking benefit of Lean Processes, we reduced logistic time for material movement.

We saved considerable time in precast concrete work as we used slip form shuttering at the precast yard. In continuation to above, we also took necessary care to avoid Kota finishing in sitting areas of the stadium by replacing the same with an excellent precast finish, thus saving cost and time.

The project team has taken due diligence to achieve targets by adopting such equipment that was not considered earlier, like the Pile Rig machine for piling work and saved considerable time lost due to COVID-19.

PLANT ENGINEERING CLUSTER

CLUSTER VISION
2021-22

RESILIENCE & SUSTAINABILITY -
Reimagine, Reinvent, Grow

A once in a century pandemic is challenging the world; variant after variant, the virus outbreak continues to surprise and evade preparedness. There is a pressing need for global stakeholders to come together and cooperate to navigate through these choppy waters to make sure humanity will triumph."

The social, economic and cultural ramifications of COVID-19 may not be fully understood for years to come, but the repercussions of the pandemic have caused rapid change across the design sector. Leaders today are grappling with managing short-term pressures against medium and long-term uncertainties.

On a positive note, according to the results of the 2021 Top 500 Design Firms ranking, the predicted revenue shortfall for design firms is not to the extent feared.

Plant design involves Process & Technology, Engineering with an economic outlook, and enablers for Asset Lifecycle performance. Traditionally, these three areas were looked at in silos with specific expertise developed in individual fields. However, with the industry going through a transformation, it was imperative to break the silos and combine the knowledge in design, to add more value to the stakeholders.

Tapan Choudhury
President - Power & Resources

The Plant Engineering and Design (PED)

Cluster of Tata Consulting Engineers Limited (TCE) engineers power generation & distribution, oil & gas refineries and distribution, chemical and petrochemicals manufacturing, fertiliser manufacturing, and processing metals used from mine to market. In many ways, TCE touches human life and supports humanity prosper or in times of crisis fight back and prevail.

Toward Seamless Exchange of Knowledge and Expertise

Plant design involves Process & Technology, Engineering with an economic outlook, and enablers for Asset Lifecycle performance. Traditionally, these three areas were looked at in silos with specific expertise developed in individual fields. However, with the industry going through a transformation, it was imperative to break the silos and combine the knowledge in design, to add more value to the stakeholders.

Any project implementation across the industry goes through the phases of Design, Construction and Operation. If handed over in stages through traditional documentation, knowledge often leads to gaps in information requiring rework of plans or designs, leading to delays and extended resource engagement. Engineering to implement a holistic approach and use of Smart tools addresses the seamless transfer of knowledge with built-in flexibility to enable fit-for-purpose installations and integrated performance throughout the Asset lifecycle.

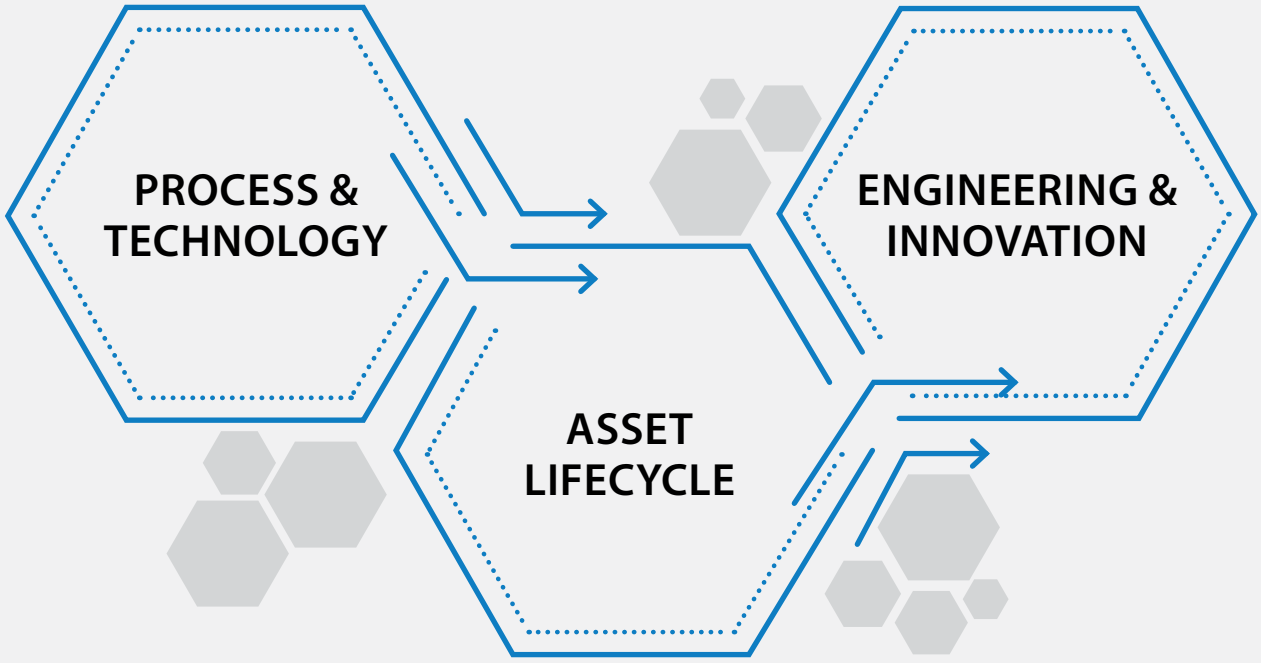
Climate Change, Changing Industry Landscape and Digitalisation

With the rise in global temperature, it is essential to focus on plant sustainability, net-zero initiatives, energy transition, decarbonisation, green metal exploration, carbon abatement, process optimisation and Industry 4.0 applications. TCE has proven expertise in all these aspects.

Solar, wind, hydel and nuclear power show phenomenon growth perspectives in both national and international geographies. The advent of renewables has made the generation of electricity – more and more distributed and the grids more complex. Hydrogen is also evolving as the next generation fuel with natural gas as an interim solution involving long-distance transmission for at least the coming decade.

Processes like 'carbon capture' will enable sustainable manufacturing of chemicals and fertilisers and make green energy a possibility. All initiatives in renewable power, long length pipe transmission, carbon capture, and usage schemes need increased steel and green metals usage.

COVID-19 forced companies to find ways to make information and tools readily available to people, irrespective of their locations. Design virtual collaboration platforms infused adaptability, business continuity and built low-touch / no-touch or remote operating mechanisms enabling remote monitoring and automation to ensure human safety. An evolving 'next normal' will have concern for humanity at its core and will



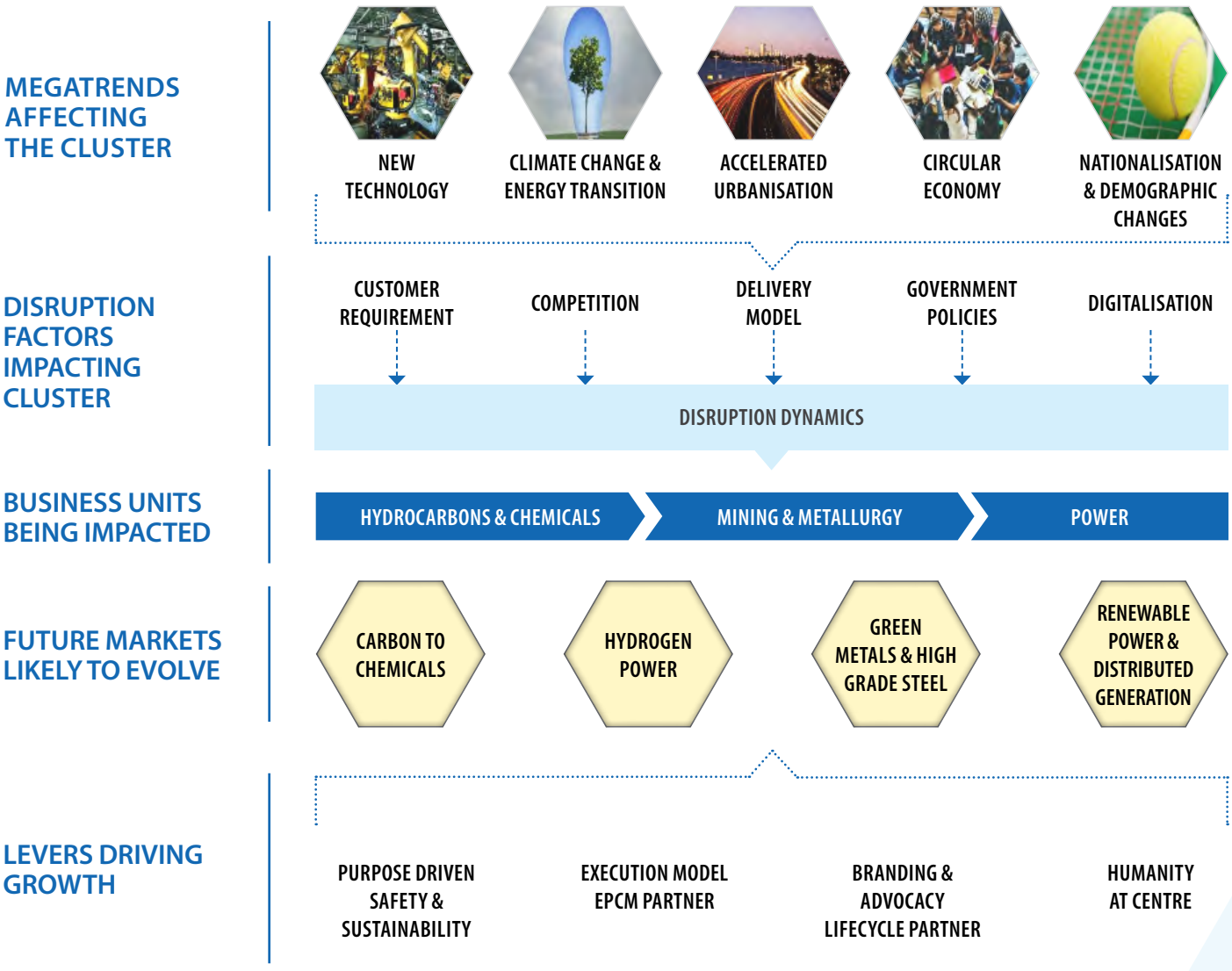
emphasise the speed in technology adoption and innovation at scale. Therefore, digital solutions must be implemented for the overall lifecycle management of existing operating plants. Businesses need to reinvent and revitalise themselves to be relevant in this era of energy transition and Digitalisation.

The Cluster enjoys domain expertise in thermal, renewable (hydro, solar PV & CSP, floating and rooftop solar, onshore wind, energy storage, biomass and waste to energy) and nuclear power, transmission and distribution, petroleum refineries, chemicals and petrochemicals, gas processing, Liquefied Natural Gas (LNG), pipelines, fertilisers, steel & green metals – mining to processing.

Five Levers that will Drive the PED Cluster

The Cluster has identified the following five levers to address the opportunity and challenges:

- Group Synergy
- Branding and Advocacy
- Collaboration and Partnership
- Innovation & Technology Adoption
- Workforce Readiness



NUCLEAR
Enabling the Net Zero Goal

After the ratification of the Paris Agreement in 2015, all countries that are signatories to the United Nations (UN) Framework on Climate Change have taken bold steps to reduce greenhouse gas emissions and restrict the temperature rise to less than 2°C compared to the pre-industrial level. Subsequently, considering the enormity of impending problems, Governments have stepped up their commitments to limit temperature rise to 1.5°C by 2050.

To achieve this ambitious goal, carbon dioxide (CO_2) emissions from electricity generation should drop closer to zero by the middle of this century, even though the global electricity demand would continue to surge and expand in several other sectors such as transportation and more industries as we electrify the industrial processes.

Global Perspectives

As the "clock is ticking" on climate change, we need to embrace all viable, clean technologies to decarbonise the electricity sector. As governments and policymakers across the globe are committed to phasing out unabated coal-based power generation, there is a need to replace coal-based power generation with a low-carbon, cost-effective and round-the-clock energy source, and Nuclear fits the bill.

Nuclear Power supports global socio-economic benefits and is wholly aligned to the UN's Sustainable Development Goals. The lifetime CO_2 emissions of nuclear relative to the energy it provides, or 'carbon intensity', are meagre, similar to wind and hydropower.

Nuclear power will allow expansion of generating capacity with a minimal environmental footprint. Nuclear reactors could also produce green hydrogen, decarbonise heavy industries and desalinate seawater to address the scarcity of clean drinking water.

Nuclear power is the largest source of clean electricity generation in developed economies and the second largest globally, thus providing a solid foundation for energy transition pathways. For more than six decades, Nuclear has offered reliable and low-carbon power generation. As more and more industrial sectors electrify, demand for clean power will surge.

With about 440 reactors in operation across 30 countries, Nuclear power generation contributes to about 10% of electricity generated globally. It must retain its share for decades to achieve the net zero-emission (NZE) target as per estimates of global energy analysts.

The current installed capacity of Nuclear power generation is about **415 GW** globally. For achieving net-zero carbon emission by 2050, the Nuclear power generation capacity must at least be doubled, i.e. the installed capacity of Nuclear power generation should cross **800 GW by 2050.**

The doubling of Nuclear power generation would be challenged by decommissioning of operating nuclear plants. By 2040, about 100 GW of nuclear power plants capacity are due to retire - the most extensive capacity loss of clean power generation in world history so far. There is an urgent need to plan to ensure carbon-free power generation to compensate for this considerable capacity loss and calls for a rapid and substantial increase in nuclear new builds at the rate of about 20 GW per year during 2021-2030 and about 25 GW per year during the period 2031-2050.

The following are the three critical aspects that must be addressed to enhance Nuclear power plant capacity addition:

1. Life extension of existing nuclear plants and related facilities
2. Implementation pace of new power plant construction
3. Fostering R&D and advances in nuclear energy technology.

In developed countries, there is a need to maximise the life extension of existing nuclear power plants and accelerate the new builds. Without plant life extensions and new Nuclear builds beyond those already under construction, nuclear power output in developed countries will drop by two-thirds over the next 20 years. In developing countries, the focus should be to increase the pace of new plant implementation.

There must be a global thrust for advanced nuclear technologies, like small modular reactors (SMRs) and high-temperature gas reactors, as both can expand applications for nuclear power beyond electricity. SMRs and other advanced reactor designs are nearing full-scale demonstration that can be deployed in flexible power situations or in countries that would require small capacity power plants in a cost-effective manner.

New advanced nuclear reactors that are being developed with higher operating temperatures can offer clean alternatives to other non-electric, energy-intensive applications like polymer and plastics manufacturing, blast furnaces for steel making, fertiliser production and efficient hydrogen generation from high-temperature electrolysis or thermochemical methods.

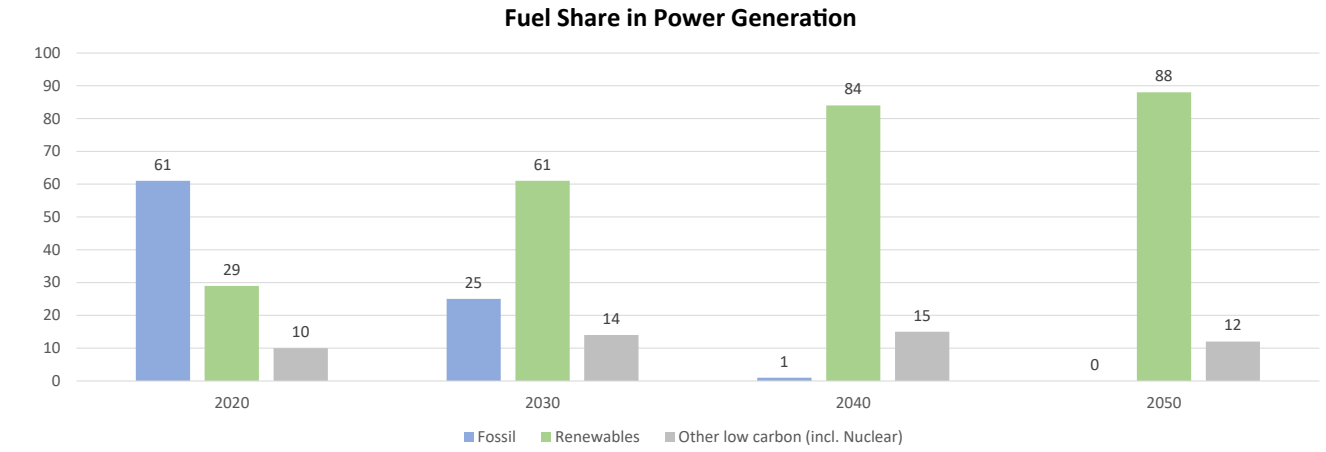


Fig-1: Changing Fuel Mix Scenario in Global Electricity Generation

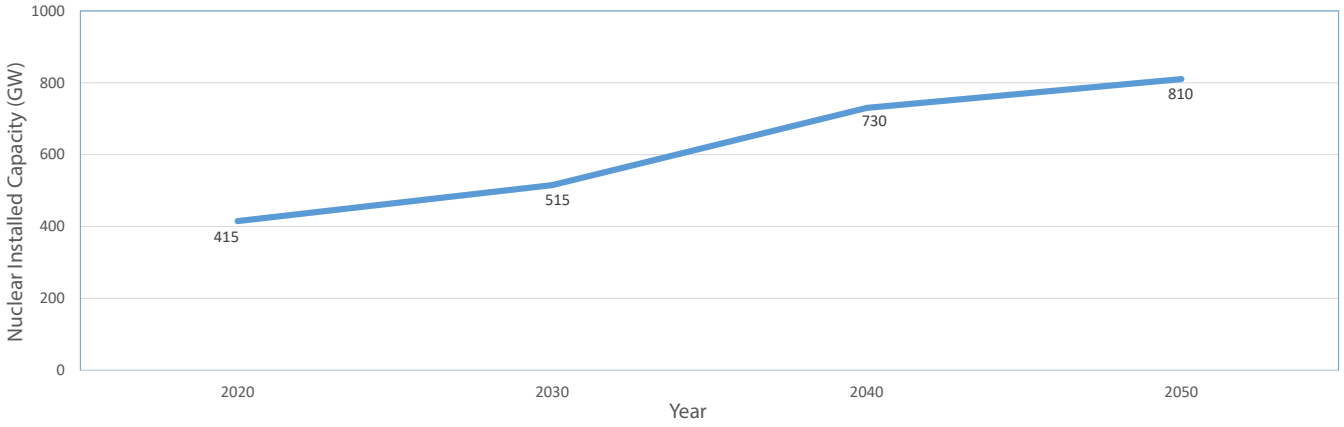


Fig-2: Estimated Global Nuclear Power Plant Capacity Addition

Indian Perspectives

Our country's total installed Nuclear power generation capacity stands at **7 GW** as of 2020, which is only about 2% of the total installed capacity.

The government of India is having an ambitious plan of tripling the installed nuclear power generation capacity in the next ten years. Twenty-two nuclear power reactors are currently operating in India, and many units are under various stages of implementation. It is expected that nuclear power generation capacity will reach about **25 GW by 2030.**

India's nuclear program (three-stage approach) is a long-term approach to meet our country's energy needs for several centuries.

To achieve net-zero aspirations, India needs to consider the following:

1. Accelerate the pace of implementation of currently planned nuclear power projects (Stage-1).
2. Quickly deploy Fast breeder reactors and augment power generation capacity through Stage-2 and Stage – 3 modes.
3. Plan for reaching **50 GW** of Nuclear power generation capacity **by 2050.**

From global and Indian perspectives, Nuclear power would play a key role in achieving energy transition objectives and energy security to advance economic growth and make our planet sustainable for future generations.

Author:

Ramadurai Raghavan - Associate Vice President

Tata Consulting Engineers Limited (TCE)

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CYCLONE RESILIENT DISTRIBUTION NETWORK

Background

The geographic location makes Odisha's coastal zone vulnerable to frequent cyclonic disturbances. Over the last decade, Odisha state has faced many significant cyclones like 'Amphan', 'Phailin', 'Hudhud', 'Fani', 'Bulbul' and recently 'Yaas'. The high wind, torrential rain and storm surge associated with the cyclone cause severe damage to the power distribution assets and results in massive downtime.

Power reliability and customer satisfaction are key elements of TPCODL vision, and aligned to its vision, TPCODL appointed Tata Consulting Engineers (TCE) to technically review the existing distribution network assets with respect to cyclone resilience and provide independent recommendation for making the network cyclone resilient.

Objective of Study

1. Study the climate data, mainly cyclones, to understand the wind's speed experienced in the past, the most vulnerable zones and the extent of the damage.
2. Study the past cyclone data and check the adequacy of the present distribution infrastructure, adequacy of existing codes for tackling the wind loads due to cyclones and various international regulations.
3. Provide Wind zone recommendations for future designs and retrofitting designs for existing infrastructure.
4. Analyse the failures & differentiate the failure, for example, design fault, cascading failure due to Wind-over loads, executions gaps, end of design life etc.
5. Evaluate alternate solutions for pole structures like NBLS tower, UG cables, Monopoles etc.
6. Provide recommendation based on the overall study and suggest a way forward.

Design Adequacy

Rolled Steel Joist (RSJ) sections are widely used tangent poles under the TPCODL distribution network and are most frequent in failure. These existing tangent pole sections are checked for design adequacy under various wind spans, design wind speeds and conductor types. The recent inclusion of cyclonic factor K4 in IS 875 part 3 2015 increases the design wind speed up to 30% for coastal areas. Therefore the existing pole structures do not qualify as per design.

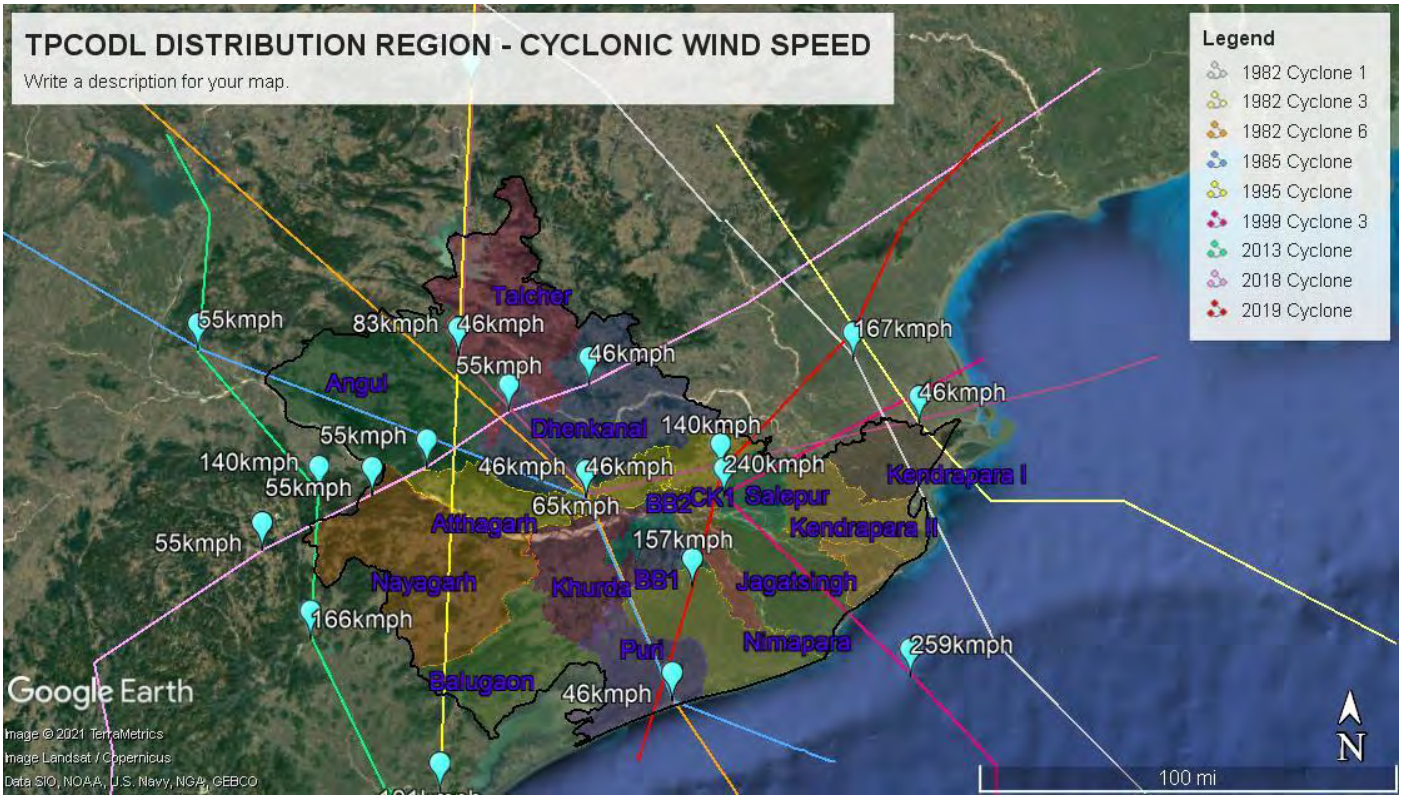
Further, for non-coastal areas also it is found that these poles are grossly under-designed and theoretically unsafe for the height and conductor span presently deployed.

RSJ tangent poles have a lower radius of gyration and are laterally un-restrained for 9-meters, and therefore the pole sections of WPB150 and WPB160 undergo lateral torsional buckling under higher wind loads.

Wind Zoning Approach

International standards and technical papers were referred to identify the key differences in approach to the design of regions susceptible to cyclones. Many International codes have special provisions and/or extra loading considered for high-intensity winds. In contrast, some codes do not have such provisions, but they recognise the need for special metrological studies. Many international codes recommend special studies like simulation/ wind tunnel test for cyclone prone areas. Some of the codes have recommendation of higher reliability levels for an overhead transmission line in areas susceptible to tornados.

We have also analysed the Indian Metrological Department (IMD) data for significant cyclones in the state of Odisha, plotted its path, along with wind speed through the path, analysed the decent in wind speed as a function of distance from the coastline. We have compared these wind speeds with design wind speeds as per various prevailing IS codes and tried to capture the upper limits between the two approaches for various distribution zones. In addition to this, we have taken cognisance of various recommendations made by various Government agencies and provided our recommendations on wind zoning.



Failure Modes

- **Transverse Cascades:**
  Transverse cascades of overhead lines are almost exclusively initiated by cyclones and large synoptic windstorms. When support falls in the transverse direction, its adjacent effective spans become longer and large conductor tensions are induced at the adjacent structures, creating significant transverse and longitudinal load imbalances. If these supports also fail, the collapse may progress, forming a transverse cascade.
- **Wind speed exceeds design wind speed:**
  Many recent cyclonic wind speeds have shown that the actual wind speed exceeds the design wind speed used in the past by almost 30%.
- **Residual Strength Available:**
  Many pole structures due to lack of maintenance (rusting/ heavy corrosion etc.) have much lower residual strength than designed strength. Also, few poles have got partially damaged during past cyclones and are still operational. All these poles are weakest within the network and are maximum prone to collapse.
- **Soil Scouring around foundation:**
  Due to heavy rains and floods, scouring of soil happens. This results in a decrease of foundation strength and leads to tilting of pole structure, resulting in additional moments due to eccentricity and ultimately will cause further tiling and collapse of the pole structure.
- **Topographic Effects:**
  The basic wind speed recommended considers the general level above sea level; however, localised topographic features consists of hills, valleys, cliffs, or ridges. These features can accelerate the wind speed significantly. This is not accounted for in the code of practice for overhead lines (IS 802).
- **Execution & Maintenance Defects:**
  Material quality defects, improper site assessment, lack of quality inspections are few reasons for execution quality defects. Similarly, rusting of structures, scouring of soil around the foundation, missing bolts are few examples of maintenance defects.
- **Design Defects:**
  Improper design of pole structures can be because of improper loading assumption or improper load combinations or design approach. Ignoring the slenderness effect of poles is an example of a design defect. Similarly, for foundation design erroneous load & moment calculation, wrong assumptions on soil parameters can lead to design defects and ultimately failure of the structure.

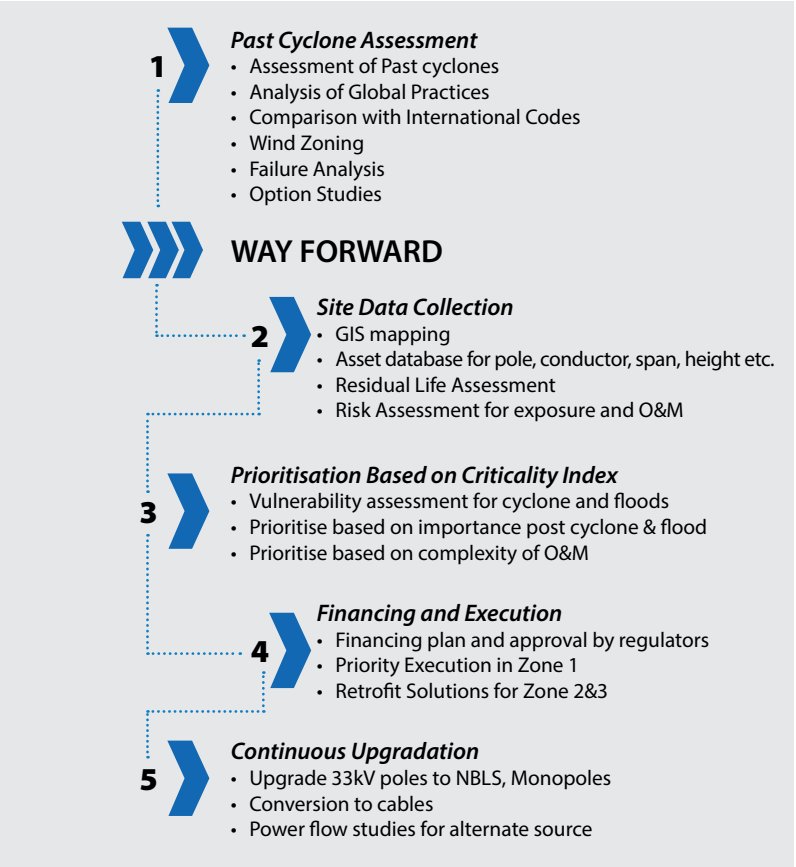
Alternate Material

Monopoles: One of the major advantages over lattice tower is its smaller base, short erection time and lesser maintenance effort. In terms of technical comparison with RSJ poles, monopoles will provide much better performance per ton of steel used because of the hollow section, which has a much higher moment of inertia on both axes and near circular shape, which reduces the wind drag force by almost 40%. Another advantage is that the number of monopoles required per kilo-meter is lesser, which reduces foundation cost and land footprint.

Narrow Based Lattice Towers: Narrow based Lattice towers (NBLS) have much better performance than RSJ poles. For important 33kV lines, river crossing towers, railway crossing, or road/highway crossing, it is a preferred solution because of its higher reliability and ability to withstand higher spans.

Under-ground (UG) Cables: The vulnerable lines and important lines in the network are the 33kV lines that emanate from the Grid Stations and connect to 33/11kV Substations. These are the backbone of the distribution network and, based on RoW constraints, can be considered for UG cabling. UG cable shall also prove effective in places where resiliency could not be achieved through overhead structures.

FRP poles: FRP/GRP poles are preferable in locations susceptible to high corrosion, such as areas near the coastline. FRP/GRP solutions are better than RSJ poles in terms of maintenance requirement, ease of handling, non-conductive, and overall aesthetics look. The FRP poles can be alternative for 415 V and 11 kV lines for urban areas.



Key Recommendations

1. The zone of the first 20 km from the coastline should be prioritised for upgradation. While using IS 802 (Code of Practice for Overhead lines), this zone should be designed for cyclone zone wind factor K4 and an additional percentage increase in basic wind speed to cater for future changes in basic wind speed as per climatology changes.
2. The gap between the present design strength of the distribution network poles vs required strength is maximum for the first zone. Therefore, retrofitting solutions will either not be feasible or not be cost-effective. Moreover, the remaining design life of this infrastructure, considering its exposure to saline conditions and past cyclones, is also doubtful. Therefore, a new replacement design should be adapted for this zone.
3. For the second zone, i.e., 20-70 km from the coastline, we may consider both retrofit/strengthening and new design solutions based on residual life assessment.
4. Special considerations should be made in the design for transverse cascade failure arising during cyclones.
5. Detailed climate and simulation studies in collaboration with government agencies as a long-term risk analysis strategy will help fine-tune the zones.

Authors:

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Tata Consulting Engineers Limited (TCE)

A Case Study

TECHNO-COMMERCIAL FEASIBILITY REPORT FOR WASTE TO ENERGY PROJECT

Introduction

Calik Enerji (CE) is among the leading energy companies globally and has executed many projects successfully to create a better and sustainable future in vast geographies covering the Middle East, Central Asia, Africa, and the Balkans since its foundation in 1998.

CE is playing a vital role in the energy sector of Uzbekistan and has executed 478 MW Navoi Combined Cycle Power Plant (CCPP), the first and the largest CCPP in Uzbekistan in 2012. As a part of this initiative to enter new business areas, CE proposes a Waste to Energy (WtE) plant in Uzbekistan.

CE appointed Tata Consulting Engineers Limited (TCE) as a consultant to provide technical consultancy services for studying the feasibility to set up a Waste to Energy (WtE) plant based on Municipal Solid Waste (MSW) at Turakurgan in Uzbekistan.

Objectives

The prime objectives of the proposed WtE project were:

- Develop an engineering solution that is suitable and sustainable for Uzbekistan.
- Implement an environmentally friendly WtE project in compliance with environmental norms
- Reduce the burden on landfill
- Abatement of fugitive emissions of greenhouse gases
- Reduce surface and groundwater contamination
- Improve health, overall environmental and social conditions in and around the dumping ground.
- Embark on the concept of "zero landfills."

Fig.1 : ULBs of Cluster

Fig.2: Location of WtE Plant near Turukurgan land fill

Sources of Waste

It was proposed to form a cluster comprising various Urban Local Bodies (ULBs) and set up a waste to energy plant near the existing Turakurgan landfill area in Turakurgan. The relative location of ULBs participating in the cluster and the proposed site of the WtE plant is given in Fig.1 and Fig.2 below.

Techno-Commercial Feasibility Report for WtE

Incineration is the most popular waste treatment method that transforms waste materials into usable energy. Incinerators reduce the solid mass of the original waste by 80–85% and the volume by 90-95%, depending on composition and degree of recovery of metals from the ash for recycling. This results in a significant reduction in the amount of waste dumped in the landfill.

Segregation of Waste at Source:
As with most developing countries, the waste generated is not segregated at the source, resulting in mixed MSW generation. The report considered the processing of mixed MSW.

Pre-processing of MSW:
Mixed MSW received at the WtE facility is heterogeneous in terms of content and size. MSW would contain a mix of biodegradable, recyclable and non-biodegradable matter with high moisture content.

Fig.3: Process of Incineration

MSW would be unloaded on to RCC reception platform. The recyclable materials would be manually removed. Large materials would be fed to shredders using a grab crane, and shredded material is provided to the trucks using front end loaders.

MSW to Power Generation:
The trucks carrying the sized MSW (<250mm) would unload the MSW in the MSW pit. The MSW is fed to bunkers which in turn feeds the travelling grate incinerator.

The incineration process occurs in the presence of sufficient air to oxidise the feedstock (fuel). Waste is combusted at the temperature of 850ºC, and in this stage, waste is combusted, and hot flue gases containing oxides of carbon, nitrogen, sulphur are generated. The non-combustible materials with a solid residue state called incinerator bottom ash (IBA) are collected at the incinerator's bottom. The IBA would also contain a small amount of residual unburnt carbon.

The steam generated in the incinerator/steam generator would be fed to the steam turbine for power generation.

Emission Control Measures
The flue gas cleaning system removes the pollutants such as oxides of sulphur, oxides of nitrogen, Hydrochloric acid, organic compounds like Polychlorinated Dibenzodioxins (PCDD), Polychlorinated Dibenzofurans (PCDF), Dioxins and furans.

A selective Non-Catalytic Reduction (SNCR) system is provided to inject the ammonia in the boiler's first pass to capture the NOx emissions.

The boiler's flue gases are led to the scrubber where lime or hydrated lime is to capture SOx and HCl in the flue gases.

Activated carbon powder is pneumatically conveyed from the storage silo to the scrubber and injected in the scrubber to adsorb heavy metals like Mercury and organic pollutants such as volatile organic carbon (VOC), dioxins and furans.

Layout of Project

The layout of the project essentially comprises the following major components:

1. MSW pre-processing area
2. MSW tippling floor and pit
3. Incinerators (2 Nos)
4. Flue gas treatment system
5. Steam turbine building
6. Water-cooled condenser
7. Raw water/Firewater storage and DM water generation system
8. Transformer yard
9. Switchyard
10. Admin and other ancillary buildings.

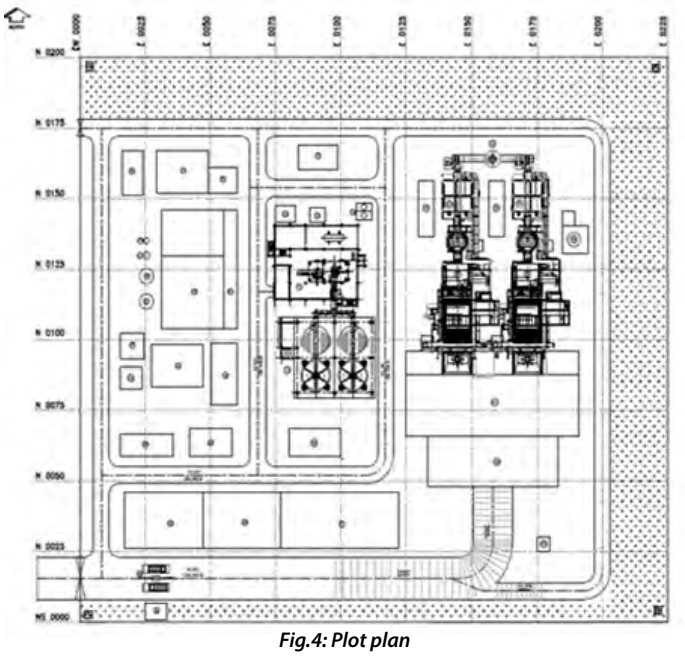


Fig.4: Plot plan

Salient Features of the Project

- Two(2) incinerator/steam generators, each capacity 600 TPD with steam parameters at the steam generator outlet, is considered 46 bar (a) and 4100C.
- One(1) non-reheat, condensing cum extraction type steam turbine generator of capacity 33 MW with water-cooled condensers (WCC)
- Other associated systems & equipment

Value Additions

As WtE is a relatively new technology for Uzbekistan, the client's project team was informed about the significance of calorific value and the moisture content in MSW through numerous telephonic/ teams meeting and requested them to carry out the sampling analysis for the MSW to enhance the accuracy of prediction of power generation from the waste.

TCE provided the list of agencies that can undertake the MSW sampling and analysis at Uzbekistan to obtain the MSW composition and estimate the calorific value of the waste.

Budgetary cost estimates were obtained from a few OEMs and EPC contractors to provide a realistic assessment of the overall project cost.

A Project

GUAM SOLAR POWER PLANT

TCE was involved in the 60MW Grid Connected Solar PV Power Plant + 32MWhr BESS Mangilao Solar farm project of GUAM Power Authority. The project is located on the east coast of Guam, approximately 7 km from Guam International Airport. TCE's scope was to provide the basic engineering and owner's engineering support to the EPC contractor - Samsung Construction and Trading Company, Seoul, South Korea.

GUAM being an island country with a fragile power grid, the grid regulation was stringent and doesn't allow more than 1% variation on power generation from the Solar PV plant. To comply with this regulation and balancing the variable solar PV power production, Battery Energy Storage System (BESS) is used to maintain the required ramping rate. The charging and discharging of BESS are based on the solar ramp up and down conditions.

TCE overall scope included technical concept development, grid code compliance assessment, design of optimum BESS capacity, performance guarantees calculation and penalty cost estimation along with a complete selection of components of BESS and PV system.

KEY CHALLENGES:

1. **Performance guarantee on PV ramp rate control scaled in second & minutes**

   The requirement to maintain the ramping for which 1-second data was required for Ramp Rate Control Function.

   Mitigation concept: TCE developed a Ramp Rate Control Algorithm wherein 1-second data is generated to calculate.

2. **Low Load Curtailment**

   To meet stable electric grid system operation during the low load demand, grid authority initiated the low load curtailment request to the PV plant

   Mitigation Concept: Energy shifting is done with the help of BESS based on battery SOC condition to avoid active power loss in PV plant during low load curtailment requests.

3. **Reactive power support to GUAM Grid from PV Plant**

   The rated power factor at the point of interconnection shall be maintained between 0.95 Leading to 0.95, lagging as per GPA regulations.

   Mitigation concept: The sizing and selection of PV Inverters and the BESS system are made, taking care of this requirement for seamless operation of the plant.

4. **BESS layout optimisation**

   The BESS equipment line-ups were to be accommodated in the available space in the control building.

   Mitigation concept: The PCS and BESS quantity has been optimised based on thorough analysis and & optimisation studies. One line-up was reduced, which helped adjust the required components in the available space.

DIGITAL & TECHNOLOGY CLUSTER

CLUSTER VISION
2021-22

Recognising the rapid technological changes and digital transformation happening across the industries, the Digital, Technology and Innovation Cluster was formalised in FY 21.

While experience and strong domain expertise paid handsome dividends to the sustainability and growth of TCE in the era of traditional engineering, the future would heavily depend on agility and the adoption of Digital to introduce new innovative solutions, services and business models.

Following are the key trends in our view that will impact the engineering & construction sector as we advance

1. **Shifting focus from Capex to Opex**
   Shorter economic cycles and capital flight to non-core sectors have reduced capital availability for large industrial and infrastructure projects. Owners are looking at ways to generate better productivity from existing plants while trying to ensure that they last longer at the same time. Engineering firms need to adopt a lifecycle approach to assets to adapt to the new paradigm.

2. **Modularisation of Engineering**
   Increasing modularisation in engineering will continue to put pressure on the resource-based business model of engineering firms. The evolution of new low-cost engineering bases in SEA and other parts of the world will impact the bottom-line of companies like TCE. Looking at the productisation of domain expertise and monetisation of the same is one way TCE can address the above problem.

3. **Digital Penetration**
   Digital is finally catching up with the industrial and infrastructure sectors; especially post COVID, owners are seriously looking at digital adoption for many use cases ranging from asset digitisation to digital project management to asset optimisation and asset performance management. The digital twin is becoming a reality.

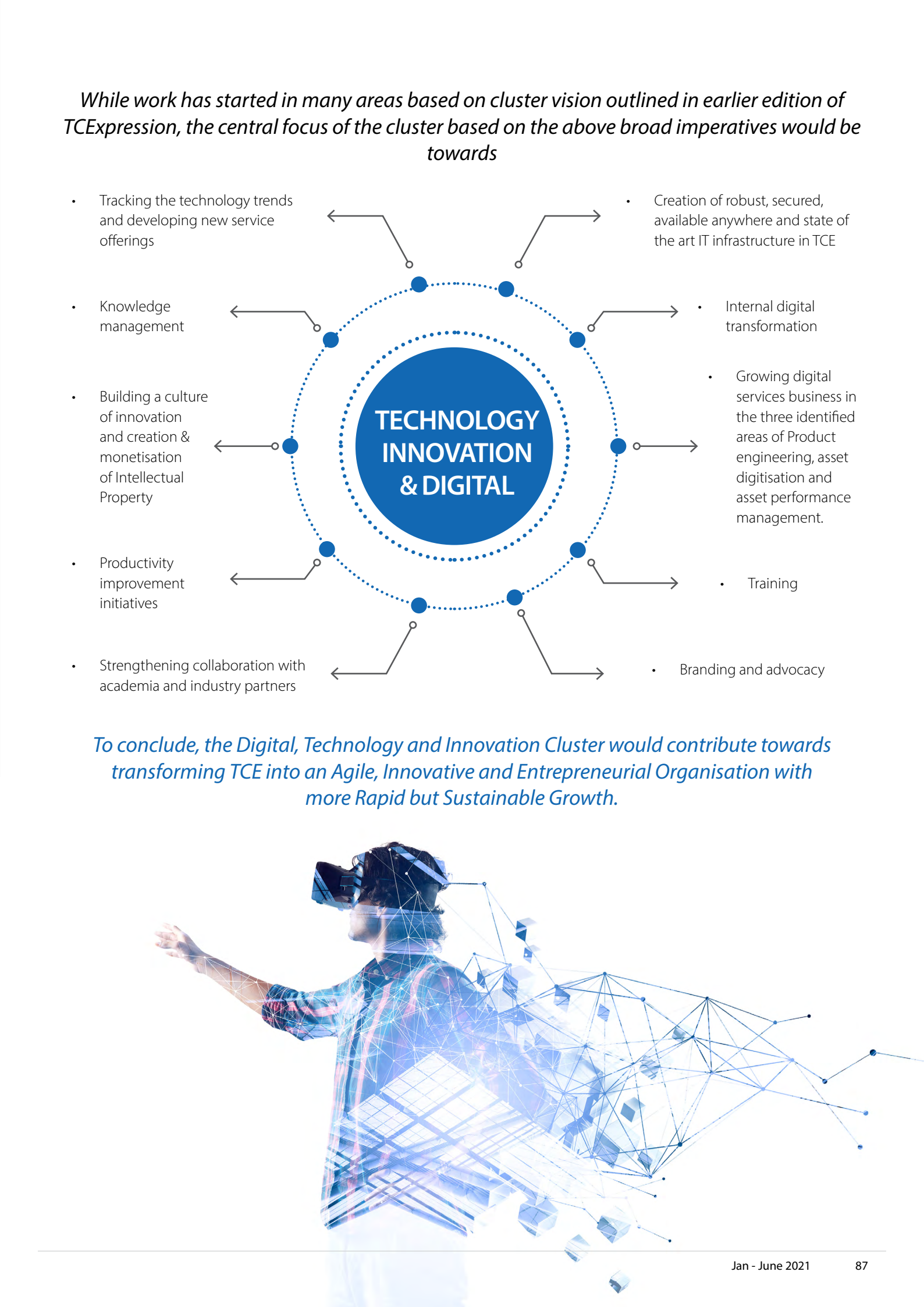
4. **Systemic shift to a more sustainable economy that works for both people and the planet**
   The apparent need to address climate change and decarbonise all aspects of the economy is driving several emerging technologies, one clear example being 'green hydrogen'. The exponential pace at which such technologies are evolving implies that engineering firms need to move much faster than earlier to develop the necessary capabilities to continue serving customers.

5. **Collaborative mindset**
   There is a clear shift in customers expectations which requires a solution mindset and the ability to understand the requirements and expected outcomes and provide optimal solutions leveraging the best of the technologies. This would need highly collaborative effort with customers and partners.

S Vidyanand
President - Technology, Process, Digital & IT

While work has started in many areas based on cluster vision outlined in earlier edition of TCExpression, the central focus of the cluster based on the above broad imperatives would be towards

- Tracking the technology trends and developing new service offerings
- Creation of robust, secured, available anywhere and state of the art IT infrastructure in TCE
- Knowledge management
- Internal digital transformation
- Building a culture of innovation and creation & monetisation of Intellectual Property
- Growing digital services business in the three identified areas of Product engineering, asset digitisation and asset performance management.
- Productivity improvement initiatives
- Training
- Strengthening collaboration with academia and industry partners
- Branding and advocacy



To conclude, the Digital, Technology and Innovation Cluster would contribute towards transforming TCE into an Agile, Innovative and Entrepreneurial Organisation with more Rapid but Sustainable Growth.

DIGITALISATION

A Perspective through 5W 1H, RBV and KBV

Digitisation, Digitalisation and Digital Transformation are part of the modern business lexicon. In today's global and competitive business landscape, the race to achieve competitive advantage is ever accelerating. Digitalisation is at the core of the fourth industrial revolution, aka Industry 4.0. This paper explains the core concepts through the classical 5W 1H approach and then takes a Resource Based View (RBV) and Knowledge Based View (KBV) to provide a theoretical foundation to articulate the strategic importance of Digitalisation.

Introduction

Pick up any business article of repute, and the odds of not finding a mention of something related to Digital, Digitalisation or Digital transformation are very low. As these terminologies are used interchangeably, it is essential first to understand what these terms mean.

A classical investigative approach of 5W 1H of asking questions comprises, What, Why, Who, When, Where and How, to simplify the jargon. The second part of the paper links Digitalisation to proven management theories like Resource-Based View (RBV) and Knowledge-Based View (KBV).

What is Digitalisation?

The common wording of Digitisation, Digitalisation and Digital Transformation creates much confusion.

The terminologies, although used interchangeably, are far from being synonymous. One should have a clear understanding of these terms before proceeding further. An activity of conversion of attributes of physical entities in the machine recognisable data form is Digitisation. LASER Scanning of plant floor to generate "As-Built" drawings that are machine storable and readable is an example of Digitisation. Another example is converting engineering design specifications written on paper into machine storable and readable format. An example on the shop floor is data generated through simple temperature, pressure and velocity sensors and other devices to store into the memory of electronic devices. In a way, Digitisation is a very basic foundation of the interface between a physical world and software.

Digitalisation is more about digitising underlying processes as against digitising mere physical attributes. It is about making sense of such data and taking some actions, either transactional or strategic. Once armed with capabilities to measure a parameter, say, bearing temperature of a motor, one can build the logic in Programmable Logic Controllers (PLC) to observe the trends and apply statistical tools to estimate Mean Time Between Failures (MTBF) for the bearing.

Data related to several such motors can be monitored from one plant or several plants. Such data can be further analysed to identify root causes. Analysis may show either equipment

related deficiencies such as shaft misalignment, soft footing or underpinning plant process deviation responsible for bearing overheating. These are examples of Digitalisation.

The next step to Digitisation and Digitalisation is that of Digital Transformation – in which Information Technology (IT) and Operations Technology (OT) overlap significantly and positively affect both equipment performance and business performance. Digital Transformation is about a larger goal – what is to be done with Digitisation and Digitalisation to transform the business to ensure sustainable competitive advantage.

An example of Digital Transformation from a motor manufacturer's perspective is gathering and analysing bearing temperature monitoring data from its vast end users to make sense of the same, give inputs to its procurement team, and alert the bearing manufacturer. Bearing temperature is just one kind of data. The motor manufacturer can define their own set of parameters to monitor to derive competitive advantage. It could give rise to entering into yearly maintenance contracts with large users and using big data analysis. Such actions help connect both supply and demand sides of motor manufacturers' business to stay responsive and competitive.

Why Digitalisation?

After clearly understanding what Digitalisation means, the focus should shift to WHY it is needed. The Why question is always a profound one as it provides a sense of purpose to undertake the journey. The industrial revolution has seen four distinctive phases. The first phase was about mechanisation, steam power and water power. The second phase was about electricity and mass production. The third phase consisted of leveraging automation advancements in electronics and IT Systems. The fourth phase that is being experienced today is about cyber-physical systems. Every organisation has choices to make about its existence and future. Digitalisation is relevant in answering both questions. Hence adaptation of Digitalisation is no longer optional as it is already a business essential. With increasing attention to cost and quality, the real-time measurement and visibility give opportunities to Managers to ensure timely interventions for continuous improvements. Digitalisation makes it happen. ***Thus, the simplest answer to why Digitalisation – it is to stay relevant.***

Where to Implement Digitalisation?

Every organisation operates in a competitive landscape with its unique ways of working with internal and external linkages. The internal operations of various functions such as Engineering, Sales, Procurement, Production, HR, Finance, Admin and others need to establish Digitalisation within own functions and with all other functions. On similar lines, Digitalisation is necessary in ensuring interfaces with the outside world of Suppliers, customers, and society. The answer to this question is also simple - Digitalisation needs to be implemented in each facet of a business, both core and non-core, both strategic and operational. It needs to be implemented within the organisation and also in the larger ecosystem.

When to Begin Digitalisation?

Organisations must move all their paper-based and manual processes onto a digital platform to create a digitalisation base. Inter and Intra stakeholder processes must be well defined and operational to start using and generating data in a digital form. Thus, the first step towards the Digitalisation journey is about achieving proficiency in Digitisation. It also means, Information Technology function moving from the role of support to that of the business core. Data is fast becoming the bloodline for an organisation. Digitisation needs to reach a certain stage of maturity before real Digitalisation kicks in. Digitisation and Digitalisation stages are closely interlinked and keep overlapping continuously. The phase of asking the question of when to begin Digitalisation is over. As they say, the time is now.

Who Should be Part of Digitalisation?

Everyone who is part of the organisational ecosystem must be a part of Digitalisation. It includes all stakeholders, both internal and external. Organisations need to invest in educating various stakeholders on the essentials of Digitisation and Digitalisation. Every activity from strategy to operation must be part of Digitalisation to reap the real benefits. Unless the Top Management embraces Digitalisation earnestly and wholeheartedly, Digitalisation stays patchy, showing syndromes of "start-stop-start-stop". Digitalisation is all about inclusivity and not at all about exclusivity. Everyone must be on the bandwagon.

How Should we go About Digitalisation?

As is true with every significant change, Digitalisation needs a good framework and proper planning. It begins with Top Management's commitment and unrelenting support. The Apex layer of management needs to define the charter from the perspective of its strategy thoughtfully. The team responsible for operationalising should consist of top functional experts having intimate knowledge about their core functions. The members need demonstrable behavioural attributes related to cooperation, collaboration and teamwork. The exercise is never about oneself but is all about everyone. There are many examples of failures of Digitalisation as the existing manual processes were just digitalised or the team responsible for implementation lacked ownership and cooperation. If one fails to critically review each process before deciding on Digitalisation, it will replicate (and, in some cases worsen) the existing inefficiencies in a digital way. Digitalisation is a big Change Management exercise. It is time to look at all activities in the context of relevance, efficiency and quality. Communication forms the basis of any change management. Effective, timely and purposeful communication helps binding resources together to make the journey purposeful and smooth.

After understanding Digitalisation, the next step is to discuss how it fits into the leading organisational management theories. As management theories are an outcome of research carried out by collaborative minds in industry and academia, understanding the theories provides confidence and support throughout the implementation process. It helps to learn from somebody else's experiences without a need to over-experiment. As an example, two of the profound theories viz. Resource Based View (RBV) and Knowledge Based View (KBV) are discussed briefly.

Resource Based View (RBV)

In a landmark study, Barney, J (1991) tried to find an answer to a simple yet critical question as to why some organisations perform better than others while operating in a similar business environment. The landmark paper continues to act as a leading light for management studies over the last three decades. The research looked at a firm's competitive advantages through two perspectives - one was through analysis of the internal environment and the second one was through analysis of the external competitive environment. The study follows a five-step approach as shown in Figure 1.

The proposed model gained prominence as the VRIN model since it proposes resources as Valuable, Rare, Inimitable and Non-Substitutable. The resources could be either Tangible or Intangible, Heterogeneous and Immobile. Such resources help provide a sustained competitive advantage to the organisation. Thus, if resources cannot be easily imitated by competition (Inimitable), if resources cannot get substituted by some other means or the resources are rare and valuable, the competition finds it challenging to imitate success.

Digitalisation is not a mere technical exercise. It is driven through strategic intent, and it helps organisations critically look at both the internal and external landscape. Thus, Digitalisation helps to unearth, create, enhance and leverage resource capabilities satisfying VRIN conditions. Therefore, well thought through and implemented Digitalisation exercise can help provide a sustained competitive advantage.

This is an era of standardisation. Increasing Industrial bodies are making it almost mandatory to adopt a host of standards while some are recommendations, some are mandatory. The government agencies adopt measures that are primarily regulatory in nature. Thus, adherence to relevant standards becomes necessary to ensure ease of procurement,

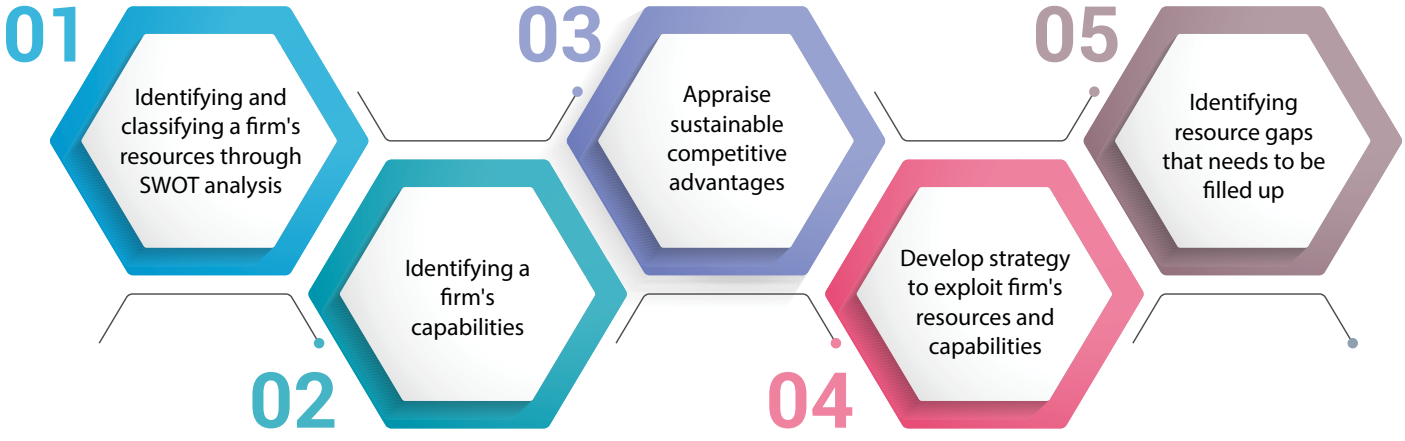


Figure 1: Five Step Approach

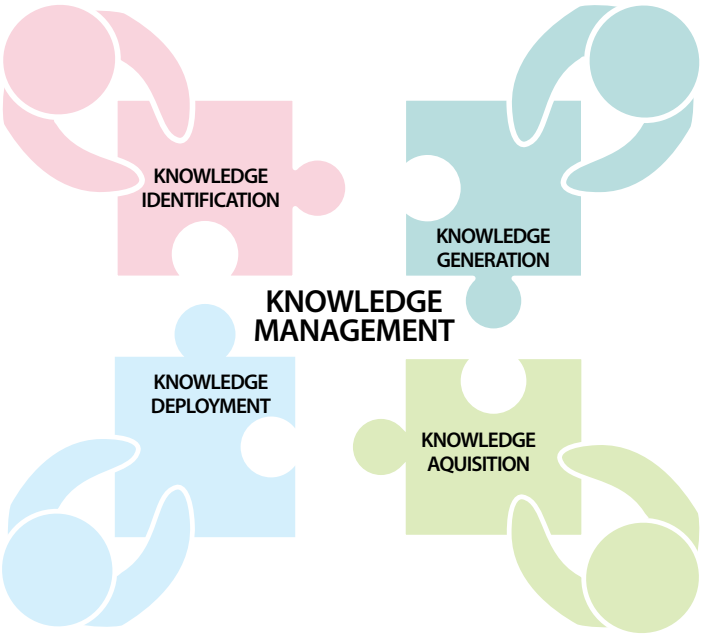
integration, substitution, operation and maintenance. While such standardisation is good for the user, it creates too much similarity amongst the competition, forcing them to compete on price points increasingly. The market keeps demanding differentiation too. It means there are two forces with equal measure, driving businesses to achieve diverse goals that appear to be mutually exclusive and hence challenging to achieve.

How can one develop the standard product or service like a competitor's and yet provide a differentiating experience? The resource-based view can answer the question. Digitalisation can provide data and analysis, enabling Managers to eliminate waste and improve efficiencies to stay relevant on price. It also throws open possibilities to take a Resource-Based View through hard data to keep working on resource acquisition and competency building to fuel development that can provide differentiation. Thus, Digitalisation coupled with RBV can help achieve both standardisation and differentiation by providing all the necessary real view visibility to Managers to keep taking necessary actions.

Organisations need to pay attention to their resources and relentlessly keep tracking VRIN characteristics to ensure the differentiated resources keep driving differentiated products or services while adhering to standards.

Knowledge Based View (KBV)

Knowledge-Based view treats knowledge as an organisational resource and positions it from an organisation's differentiation strategies. The four aspects of Knowledge Management are shown below.



Once they get combined and managed, they can provide a unique competitive advantage to an organisation.

As per Grant, R. M. (1996), organisational knowledge is classified under two categories viz. tacit and explicit. The tacit knowledge is held by individuals and cannot be entirely codified and communicated. Although some portion of tacit knowledge can be codified and converted into explicit knowledge through Digitalisation. Nikolaos, Aggelidis, V., & Georgios. (2009) argue

that the organisation has unique interplays of tacit and explicit knowledge. The RBV and KBV provide a framework for an organisation's differentiating strategy.

As Digitalisation helps unearth and channel such explicit knowledge, firms can reap benefits from their vast knowledge repository. It helps drive down costs, reduce efforts and cut downtime through reuse and automation. The enhanced collaboration and cooperation as a result of Digitalisation gives rise to leveraging tacit knowledge too. The IT security and data management policies need to be in place to ensure such knowledge does not find its way out of the organisation but instead stays within.

Digitalisation not only helps in making a process-driven approach possible, but it interlinks various functions of an organisation. Enhanced Digitisation and Digitalisation ensure knowledge generation and absorption can happen at an increasing pace and across an organisation. The Knowledge-Based View coupled with Digitalisation can thus make organisations reap the benefits of Knowledge Management to stay relevant through standardisation and differentiate on products and services.

Summary

Digitisation, Digitalisation and Digital Transformation mean entirely different things, although they are used interchangeably. Digitisation is the preparation phase, linking the physical world to software. Digitalisation is a process-driven approach linking strategy and operations. Digital Transformation is about achieving strategic differentiation through Digitisation and Digitalisation.

Digitalisation needs as much attention as any large-scale change management activity with careful preparation, planning and implementation. RBV and KBV provide theoretical frameworks to justify investment in Digitalization. Such frameworks help organisations to learn through collective experiences and to aim for industry-leading performance. Both RBV and KBV perspectives can help the organisation to achieve both standardisation and differentiation.

Whichever name one may call it either Digital Transformation, Industry 4.0 or Cyber-Physical Interface, at the core of all these lie carefully planned and implemented Digitalization.

Author:

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Tata Consulting Engineers Limited (TCE)

This article has also been published in ViewPoint magazine of CEAI

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TECHNOLOGY GROUP UPDATE

Global competition is driving the need for Engineering companies to reduce cycle time, increase cost competitiveness, provide a safe operating culture by innovating several work processes and implementing modern cutting-edge technologies.

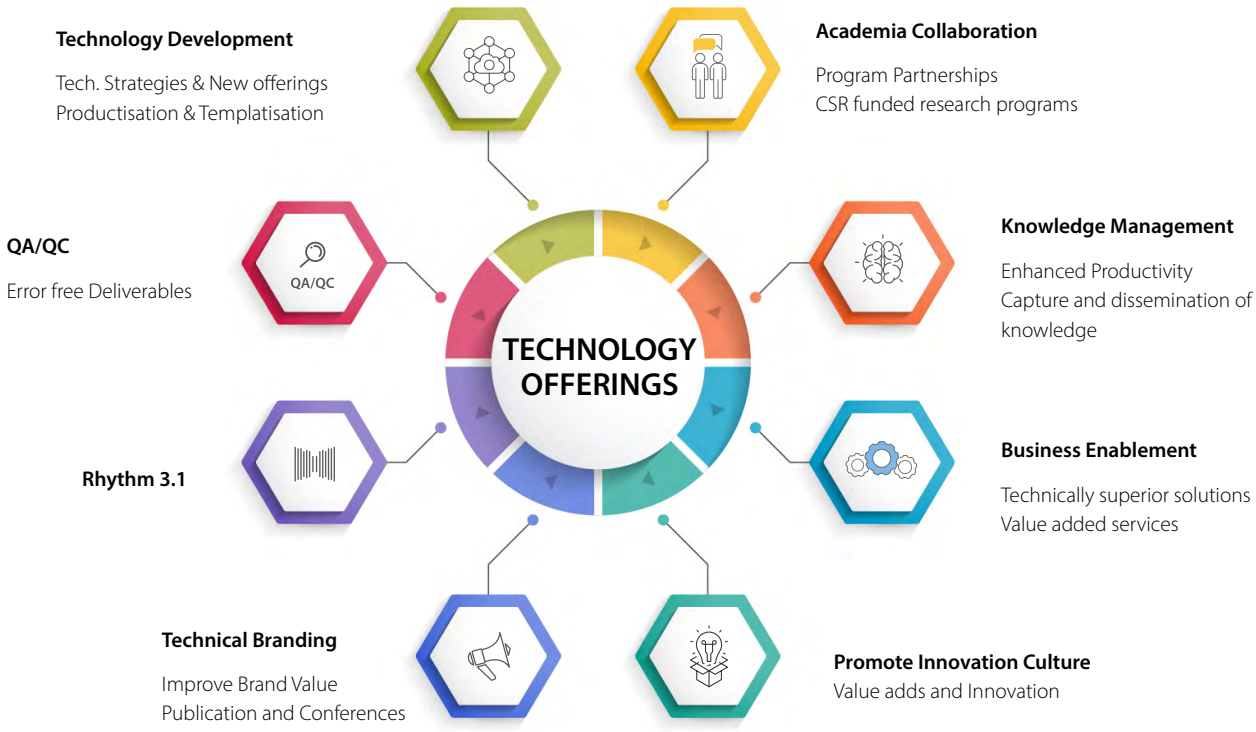
'Innovation in Engineering Design' is gaining momentum, and innovation practices are newly seen as a business enabler. The engineering design of the past facilities did not occupy a large part of the innovation value proposition. However, this trend is being reversed thanks to the competitive market and ever-increasing industrial process complexity.

The technology group also takes the leading role in promoting innovation culture in the organisation. The new initiatives of creating an innovation framework and promoting value engineering practice in projects are aimed to bring a difference in service to the customer. These initiatives are integrated with the business plans of the Business Units (BU's). The significant contributions from technology group in the journey to Innovate include:

TCE Branding

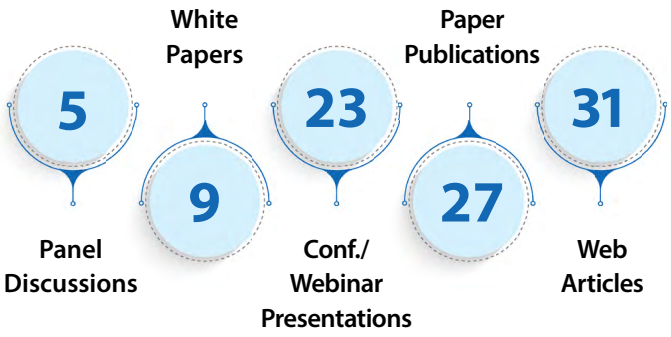
The technology group and subject matter experts authored and facilitated such branding work at the national and international level, TCE's insight on technology trends, showcasing unique designs, and various services.

TCE is actively involved in the development of design standards and is associated with the BIS committee. Fifty-two subject



matter experts from TCE currently represent various BIS committees for revising existing codes/developing new codes. 22 new members are awaiting confirmation.

TCE collaborates with Industries/Industry Bodies such as TERI and IOCL and renowned institutions like IIT-Bombay and IISc Bangalore to research and develop new and emerging technology areas for future commercialisation. To further enhance the connection with current and prospective customers, videos on trending technologies, biodiversity studies and complex and critical project solutions were created and uploaded on the company YouTube channel.



YouTube

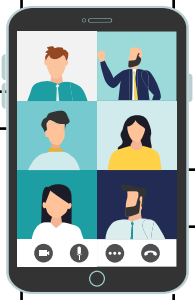
WEBINARS

Indian industry has made significant progress on energy and emissions reduction in the past, primarily by improving the energy efficiency of key industrial processes helping them maintain competitiveness and reduce emissions. However, if long term sustainable growth is to be achieved in combination with global ambition to address climate change, more fundamental changes will be required to reduce emissions by 2050 and beyond.

TCE co-hosted a webinar on energy transition with TERI, focusing on Technologies that define energy transition pathways for Industrial sectors covering Power, Hydrocarbons, Metals, and Transportation sectors. TCE, MD Mr Amit Sharma also presented on the Energy Transition in Indian Industries.

One of the key smart grid solutions that power utilities have been widely using for several years is the Supervisory Control And Data Acquisition (SCADA), designed to prevent significant system failures and enable monitoring and control of critical functions in power generation and transmission & distribution systems.

India Infrastructure Publishing conducted a one-day conference to showcase the promising trends and developments in SCADA technologies, discuss the new and emerging utility requirements and understand the benefits, capabilities and features of new and advanced SCADA enhancements. Mr Sunil Agrawal and Mr K Jayaprakash from TCE presented SCADA for Power utilities and SCADA for Oil & Gas.



Energy efficiency, the first fuel of sustainable global energy, plays an essential role in accelerating clean energy transitions and achieving global climate and sustainability goals. CII organised the 5th edition of the CII National Energy Efficiency Circle Competition in June 2021 through Virtual Platform.

The theme for the 5th edition was "Learn, Compete, Sustain and Scale-up". The competition brings together best in class energy managers of the country to compete and share best practices from their respective organisations.

More than 200 Businesses, Industries, Technology providers and Institutions, including DCs, competed to share their success stories on Energy efficiency. TCE's subject matter expert Mr Bharat Yadav was on the Jury Panels for the fifth time in a row.

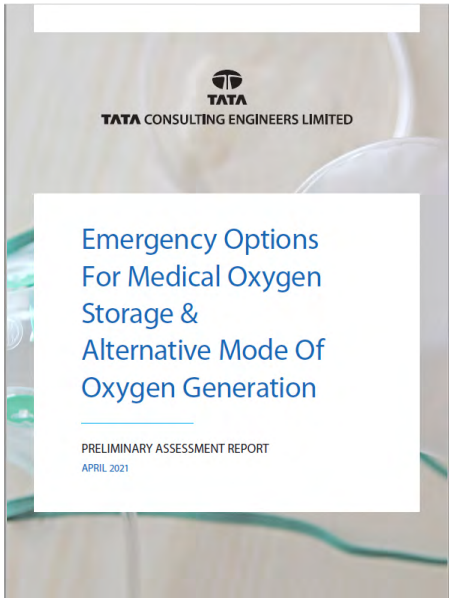
Coal gasification is converting Coal into synthesis gas and carbon dioxide, which can be used in various applications such as in the production of electricity and making chemical products, such as fertiliser.

The Coal Preparation Society of India organised a webinar on Coal Gasification. TCE MD Mr Amit Sharma was a panellist, and TCE CTO, Mr Atul Chaudhuri gave a technical presentation on Coal to liquid – New horizons.

During the lockdown, there have been a large number of fires, blasts and malfunctions. The accidents and instances resulted from transgressions relating to safety in designs, operations and maintenance in chemical Industries.

Consulting Engineers Association of India organised a webinar on Safety in Chemical Industries. TCE, CTO, Mr Atul Choudhari presented on the Design and Operational aspects for safety in Chemical Plants.

WHITE PAPERS

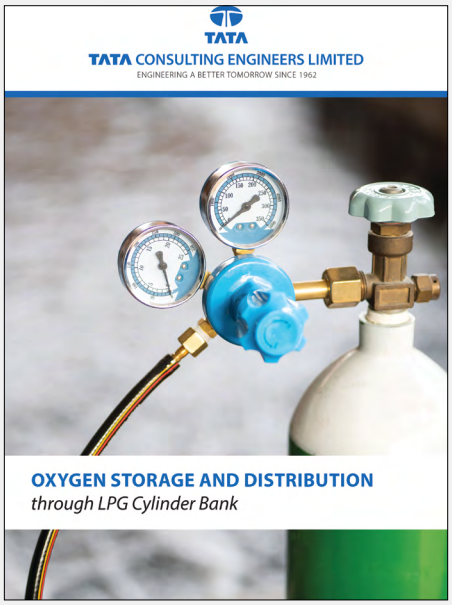


Emergency Options for Medical Oxygen Storage & Alternative Mode of Oxygen Generation

The recent second wave spread of COVID-19 in India is witnessing a shortage of medical oxygen in hospitals. While the oxygen is being made available from various industrial sources, the distribution of the same till patient bed remains a task as recently amended makeshift hospital facilities are not entirely covered through the central permanent piping infrastructure of oxygen till the patient bed. Even if the oxygen is made available, there is still a shortage of oxygen cylinders that can be refilled and used as a dedicated supply source for patients. The motivation of this note is to look for alternative ways of localised oxygen generation and oxygen bottling.

This report covers the following topics:

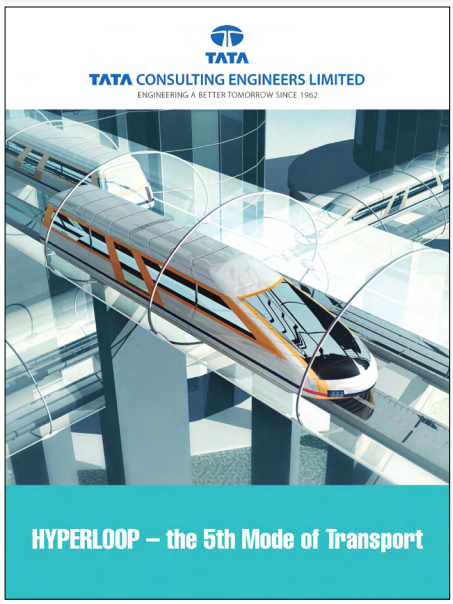
- Suitability of fire extinguishers for storage of medical oxygen
- Suitability of LPG cylinders for storage of medical oxygen
- Conversion of existing PSA nitrogen Plants for the production of oxygen



Oxygen Storage and Distribution through LPG Cylinder Bank

The cylinders are the last mile connectivity between oxygen production facilities and the hospitals' patient beds. Various alternative means for storing medical oxygen are being explored. One such alternative way of overcoming oxygen cylinder shortage, particularly in rural India, is converting domestic LPG cylinders to store medical oxygen and supply to the patient bed and minimise the dependency on the oxygen cylinders.

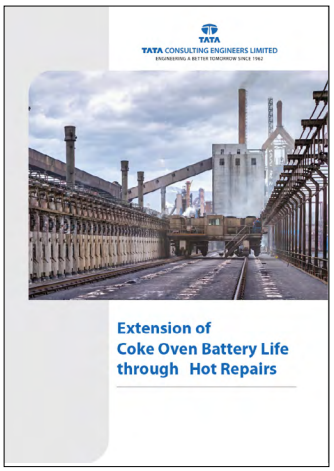
The suitability of domestic LPG cylinders for storing medical oxygen is discussed in "Preliminary Assessment Report on Emergency Options for Medical Oxygen Storage & Alternative Mode of Oxygen Generation", published by Tata Consulting Engineers in April 2021.



Hyperloop – the 5th Mode of Transport

Hyperloop is a rapid mode of transport faster than air and is eco-friendly compared to the other transport systems envisioned by Elon Musk. Hyperloop transport system envisages pods moving in the ultra-low-pressure tube (100 Pascal) using magnetic levitation/ air bearings. Vacuum like conditions coupled with levitation shall eliminate the drag and friction and allow the pods to move inside the tube practically with no resistance. The pods glide within the tube at an average speed of 800 – 900 kmph, the maximum being 1220 kmph.

This white paper discusses the various technical aspects of Hyperloop, the status of technology development by multiple companies, projects currently being pursued, review of safety aspects, benefits of this mode of travel and comparison with other rapid transport modes, challenges to the design and implementation of this Technology and status of Hyperloop projects in India. It will also identify the sectors of the Hyperloop project where TCE can leverage its experience, especially about the Indianisation of the design of principal components and design of the auxiliary systems.

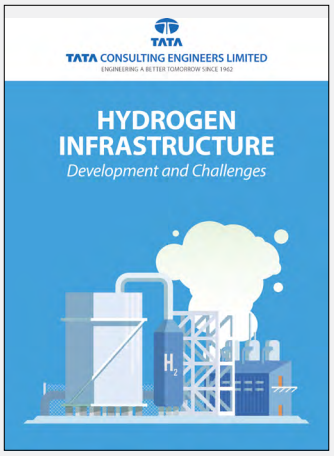


Extension of Battery Life through Hot Repairs

Coke oven batteries play a pivotal role in an integrated steel plant for uninterrupted supply of metallurgical coke to Blast Furnace and coke oven gas to the other user apart from its consumption.

During the operational life cycle, they are subjected to continuous thermal, mechanical, static and dynamic shocks during charging of cold and moist coal/coal cake, the opening and closing of oven doors and opening of charging holes for top charged ovens.

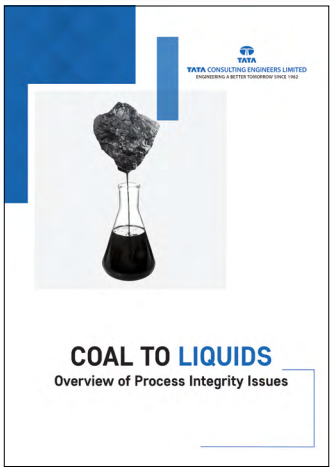
The paper deals with the causes for damage of refractories in coke oven batteries and its remedial measures. An attempt has been made to highlight the issues of understanding coke oven battery health, reasons for health deterioration and life extension strategies through repairs.



Hydrogen Infrastructure

Satisfying energy demands forms an integral part of the development of the world. Growing concerns over climate change, especially finding an alternate means of energy sources to the present fossil fuels, has increased hydrogen interest. Hydrogen is a flexible and alternative energy carrier with potential applications across all energy sectors, significantly impacting economic and social development in the low-carbon economy, especially infrastructure. The availability of suitable and sustainable infrastructure plays a critical role in promoting hydrogen for several industrial sectors.

This paper is intended to offer a brief overview of the infrastructure of hydrogen value chain development which includes production, storage and distribution and their challenges.



Coal to Liquid fuel

CTL (Coal to liquid) technology can be considered an alternate crude oil or natural gas source in producing liquid fuels. Coal is primarily used as fuel in power generation. However, Coal can be used as an alternate source for making liquid fuels. Recent advancements in Technology have successfully demonstrated converting coal into liquid fuels and many other valuable chemicals.

The fuels made from Coal are cleaner than the fuels made using crude oil due to the process schemes.

This paper is intended to provide a brief overview of some of the process related aspects while integrating various units in a CTL complex.

Plant Relocation

When Chemical plants are relocated to some other place, their performance can be adversely impacted. Several location-based parameters can affect the performance of the facility. It is necessary to evaluate existing assets suitability to ensure that it performs satisfactorily in a new environment and under new design conditions. Suitable amendments to the existing facilities may be required after the relocation.

This paper discusses the evaluation of major influencing factors, overcoming challenges, and mitigating risks associated with the relocation of chemical plants.


Digitalization of Healthcare Facilities

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Abstract

Today digitalization is being adopted at a great pace in all aspects of life. This article is focussing on the digitalization techniques as applicable to the healthcare facilities right from scheduling appointments, integrating clinical, financial and operational information to diagnosis of critical diseases in a very efficient way with IoT applications. The areas in the hospitalization sector where the techniques can be applied are discussed and a Case Study presented.

Keywords: Digitalization, Hospital, Management, Physician, Healthcare, ICU, Artificial, Intelligence, Telemedicine, diagnostics, IoT

Healthcare systems today are being challenged on account of the growth in aging population, increase in chronic diseases and co-morbidities which have an impact on the healthcare workforce. To improve patient care and clinical experience at a cost that is affordable by all, the health care industry needs to embrace digitalisation.

Healthcare comprises of nursing homes, home care, critical care centres, medications, hospital care, patient management, clinical services, research and development. To implement digitalization in all sectors of healthcare, advanced software and server security are critical. The use of advanced technology in the healthcare industry improves the efficiency, safety and quality of service, placing the patient at the centre of the healthcare system.

Digital health refers to applying the IT principles to medical knowledge with the aim of improving the patient medical care, diagnosis and supervision. Integration of healthcare system with IT enables not only monitoring of vital parameters of the patient such as pulse rate, blood pressure, oxygen saturation etc. but also to verify as to whether the patient has taken the prescribed medicines. Digital technology can also be interfaced with Hospital Information System (HIS) for real time storage of health records thereby making the entire administration process paperless. Hospital Management software uses the information from the HIS and enhances the performance of the hospital. It also helps to reduce the errors inadvertently committed by the staff. It greatly facilitates any individual to retrieve and examine the past reports of the patients from anywhere.

The advantages that digitalization of healthcare facilities bring in are:

a) Better Doctor-Patient Coordination

Patient's medical history is available in digital form for doctor's review from anywhere before commencement of the treatment. Quick access to correct data at the right time greatly enhances patient care.

Digitalisation for Health care Facilities

C Sailaja & Sunil Agarwal, View Point, Dec 2020

https://drive.google.com/drive/folders/1cRQmyfk2tRy0BGAEi1HRMct0z_NDcBO7

Today digitisation is being adopted at an incredible pace in all industries. Digital Technology can also be interfaced with the Hospital Information system (HIS) for real-time storage of health records, making the entire administration process paperless.

This article focuses on the digitisation techniques as applicable to the healthcare facilities, right from scheduling appointments, integrating clinical, financial and operational information to the diagnosis of critical diseases in a very efficient way with IoT applications. The areas in the hospitalisation sector where the techniques can be applied are discussed.


Dawn of Digital Twin – Leading a New Engineering Landscape

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ABSTRACT

Most of the industries are preparing themselves for the fast-embracing digital future, guided by more encompassing business strategies. Adoption of digital technologies would bring new business models, opportunities for value-creation and new source of revenue, in aligning to the customer demands. Digital Twin (DT) is emerging as a technology tool that enables digital transformation in many industries. This article focuses on the state-of-art of the digital twin technology and its role on product life cycle and various other applications.

Key words: Industry 4.0; Digital Twin, Applications; Implementation stage; Life cycle.

1. Introduction

Digital Transformation is shaping conversation across Industry 4.0, with new emerging technologies such as Artificial Intelligence (AI), Internet of Things (IoT) and Edge Computing and making promises on their ability to optimize processes and create value. Industry 4.0 comprises three main key technological components such as the IoT, Cloud and a Data analytics engine. IoT provides interconnectivity of different smart devices and systems which allows sharing of the information through data transfer. The Industry 4.0 helps in developing the digital economy of any organisation through enhanced transparency, visibility, predictability and adaptability. An innovative concept of Digital twin (DT) is leading the Industry 4.0 revolution, supported by tremendous growth in IoT connectivity and advanced data analytics.

2. Digital Twin

Digital Twin is the next big thing in the fourth Industrial Revolution for the development of new products and processes. It is a comprehensive digital depiction of an individual product or entire process plant that plays an integral role in a fully digitalized product life cycle. Currently, digital twin is mostly adopted in manufacturing, automobile, oil and gas industries, healthcare and smart cities. Industry typically follows 'first build and then tweak' concept. However, the digital twin concept will introduce a new virtual system-based design approach. The digital twin concept links the physical and digital world. Its concept can drive innovation and enhance performance of the entire plant or process. This technology helps companies in better understanding of their customer needs, development of existing products, operations and services.

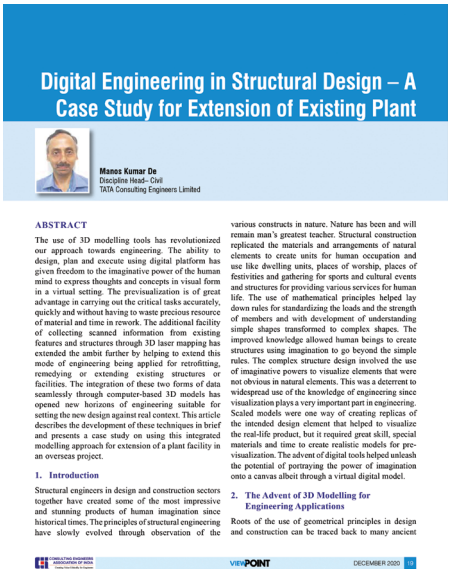
Dawn of Digital Twin – Leading a New Engineering Landscape

Dr Sakthivel and V Lakshmana Rao, View Point, Dec 2020

https://drive.google.com/drive/folders/1cRQmyfk2tRy0BGAEi1HRMct0z_NDcBO7

Digital Twin is emerging as a technology tool that enables digital transformation in various industries. Industrial leaders are introducing digital twin into their offerings, which focuses on all the areas of the Product Life Cycle and demonstrates its superiority over the traditional solutions. Enabling Technology like 5G network with high bandwidth will enhance the growth potential of Digital Twin sooner than expected.

The article focused on the state-of-art of digital twin technology and its role in the product life cycle and various other applications. The figure depicts the application of the digital twin for various sectors and the benefits associated with it.


Digital Engineering in Structural Design – A Case Study for Extension of Existing Plant

Manos Kumar De
Discipline Head– Civil
TATA Consulting Engineers Limited

ABSTRACT

The use of 3D modelling tools has revolutionized our approach towards engineering. The ability to design, plan and execute using digital platform has given freedom to the imaginative power of the human mind to express thoughts and concepts in visual form in a virtual setting. The previsualization is of great advantage in carrying out the critical tasks accurately, quickly and without having to waste precious resource of material and time in rework. The additional facility of collecting scanned information from existing features and structures through 3D laser mapping has extended the ambit further by helping to extend this mode of engineering being applied for retrofitting, remedying or extending existing structures or facilities. The integration of these two forms of data seamlessly through computer-based 3D models has opened new horizons of engineering suitable for setting the new design against real context. This article describes the development of these techniques in brief and presents a case study on using this integrated modelling approach for extension of a plant facility in an overseas project.

1. Introduction

Structural engineers in design and construction sectors together have created some of the most impressive and stunning products of human imagination since historical times. The principles of structural engineering have slowly evolved through observation of the various constructs in nature. Nature has been and will remain man's greatest teacher. Structural construction replicated the materials and arrangements of natural elements to create units for human occupation and use like dwelling units, places of worship, places of festivities and gathering for sports and cultural events and structures for providing various services for human life. The use of mathematical principles helped lay down rules for standardizing the loads and the strength of members and with development of understanding simple shapes transformed to complex shapes. The improved knowledge allowed human beings to create structures using imagination to go beyond the simple rules. The complex structure design involved the use of imaginative powers to visualize elements that were not obvious in natural elements. This was a deterrent to widespread use of the knowledge of engineering since visualization plays a very important part in engineering. Scaled models were one way of creating replicas of the intended design element that helped to visualize the real-life product, but it required great skill, special materials and time to create realistic models for pre-visualization. The advent of digital tools helped unleash the potential of portraying the power of imagination onto a canvas albeit through a virtual digital model.

2. The Advent of 3D Modelling for Engineering Applications

Roots of the use of geometrical principles in design and construction can be traced back to many ancient

Digital Engineering in Structural Design – A Case Study for Extension of Existing Plant

Manos De, View Point, Dec 2020

https://drive.google.com/drive/folders/1cRQmyfk2tRy0BGAEi1HRMct0z_NDcBO7

The use of 3D modelling tools has revolutionised our approach towards engineering. The previsualisation is an advantage in carrying out critical tasks accurately without wasting precious material and time in rework. The additional facility of collecting scanned information from existing features and structures through 3D laser mapping has extended the ambit further for retrofitting, remedying or extending existing structures or facilities. Integrating these two forms of data seamlessly through computer-based 3D models has opened new engineering horizons suitable for setting the new design against real context.

This article describes the development of these techniques in brief. It presents a case study using this integrated modelling approach to extend a plant facility in an overseas project.

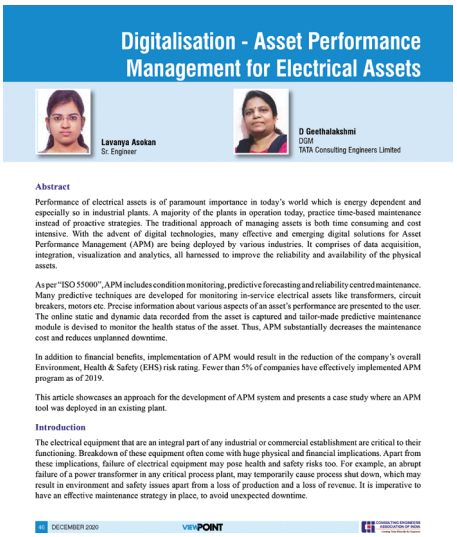
Digitalisation - Asset Performance management for Electrical assets

D Geethalakshmi & Lavanya Ashok

https://drive.google.com/drive/folders/1cRQmyfk2tRy0BGAEi1HRMct0z_NDcBO7

Performance of electrical assets is paramount in today's world, energy-dependent and especially so in industrial plants. The traditional approach of managing assets is both time-consuming and cost-intensive. A majority of the plants in operation today practice time-based maintenance instead of proactive strategies. With the advent of digital technologies, many effective and emerging digital solutions for Asset Performance Management (APM) are being deployed by various industries. It comprises data acquisition, integration, visualisation and analytics, all harnessed to improve the reliability and availability of the physical assets.

This article showcases an approach for developing the APM system and presents a case study where an APM tool was deployed in an existing plant.



Digitalisation - Asset Performance Management for Electrical Assets

Lavanya Asokan
Sr. Engineer

D Geethalakshmi
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TATA Consulting Engineers Limited

Abstract

Performance of electrical assets is of paramount importance in today's world which is energy dependent and especially so in industrial plants. A majority of the plants in operation today, practice time-based maintenance instead of proactive strategies. The traditional approach of managing assets is both time consuming and cost intensive. With the advent of digital technologies, many effective and emerging digital solutions for Asset Performance Management (APM) are being deployed by various industries. It comprises of data acquisition, integration, visualization and analytics, all harnessed to improve the reliability and availability of the physical assets.

As per "ISO 55000", APM includes condition monitoring, predictive forecasting and reliability centred maintenance. Many predictive techniques are developed for monitoring in-service electrical assets like transformers, circuit breakers, motors etc. Precise information about various aspects of an asset's performance are presented to the user. The online static and dynamic data recorded from the asset is captured and tailor-made predictive maintenance module is devised to monitor the health status of the asset. Thus, APM substantially decreases the maintenance cost and reduces unplanned downtime.

In addition to financial benefits, implementation of APM would result in the reduction of the company's overall Environment, Health & Safety (EHS) risk rating. Fewer than 5% of companies have effectively implemented APM program as of 2019.

This article showcases an approach for the development of APM system and presents a case study where an APM tool was deployed in an existing plant.

Introduction

The electrical equipment that are an integral part of any industrial or commercial establishment are critical to their functioning. Breakdown of these equipment often come with huge physical and financial implications. Apart from these implications, failure of electrical equipment may pose health and safety risks too. For example, an abrupt failure of a power transformer in any critical process plant, may temporarily cause process shut down, which may result in environment and safety issues apart from a loss of production and a loss of revenue. It is imperative to have an effective maintenance strategy in place, to avoid unexpected downtime.

60 DECEMBER 2020 VIEWPOINT

Digital transformation in the Engineering sector – challenges and trending perspective

K Jayaprakash & Latha DS

https://drive.google.com/drive/folders/1cRQmyfk2tRy0BGAEi1HRMct0z_NDcBO7

The challenging period during digital transformation is to get over the initial hurdle of the establishment of vision, ensued by a progressive realisation of associated triumph, which creates an optimistic impression among comparable organisations or lagging peers. With the pandemic stretching over months and the end not in sight, there is utmost urgency to meet digital transformation.

Digital transformation would vary with an enterprise's challenges and requirements. However, certain basic elements are a must, i.e., client experience, operational agility, culture and Leadership, Workforce enabling and empowerment, and Digital Platform Integration.

Digital Transformation in Engineering Sector – Challenges and Trending Perspective

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D S Latha
Deputy General Manager – C & I
TATA Consulting Engineers Limited

INTRODUCTION

The art of creating, capturing, integrating and transforming data into useful information which could be utilized effectively for the intended application by means of digital skills and tools is deliberated as digital engineering. Using advanced technology, designers capture and design data in digitalized environment and develop innovative solutions in virtual environment. Some of the simplest and widely used examples in engineering industry are extraction of engineering deliverables like AutoCAD drawings, simulated spread sheets derived from digitized environment of already developed 3D models, 5D models, simulation software, etc. Digital transformation is largely an integration of relevant digital technologies of corresponding business area initiating changes enabling enhanced value deliverables to clients.

Digital transformation varies for each company and needs to be defined considering respective organizational requirements. Further, this requires a major cultural change in the organization coupled with challenge(s) and incessant, reformative updation(s) until the desired result of "improving client experience, increasing productivity and profitability" is achieved. The advent and progression of digital technology in human lives and enterprise on a daily basis has brought in digital acceleration process impacting 3 major area - Labor and Social Relation, Marketing & Sales, and Technology.

Further, the pandemic has had its impact on world economy, business and human life. However, digitalization has supported many an enterprise(s) to adapt, utilize and overcome the adverse circumstances and reduce the complete collapse of well-established systems. This makes it more pertinent to encourage the emergence of new digital products, services and digital talent.

1. Need – Digital Transformation

With the rise in tide of Digital Transformation as an enterprise, considering the management level issues today - technology is enormously integrated with business in such way that it is impossible to name at least one industry which does not utilize digital framework in one form or the other. Industries need to adapt to digital technology in the process to address changing business needs and gain profit to stay in competition.

Time and again, digitization is assumed to focus on fixing pain points and not on installing IT solutions. Few enterprises are just upgrading and replacing legacy systems with new software with the intention of increasing engineering and field productivity. This can lead to digital organ rejection wherein the installed systems fail to deliver visible benefit and the workforce notices it and rejects the system. Hence, process centric digital transformation approach promotes focus on "use case" as real business needs delivery benefits by promoting identification and conviction of working

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TCE Legacy

ANTENNA & TELESCOPE SYSTEMS

Today's Digital Advanced Innovation and Technology Group started as the Special Projects Group (SPG) of Tata Consulting Engineers way back in 1968. The prime objective of this group is to cater to innovative pathbreaking unique client requirements for their one of its kind equipment/ projects. The SPG staffed mechanical engineers specialising in Machine Design at the postgraduate level or graduate engineers with good experience in the relevant fields. Other expertise such as electrical/control systems, civil/structural, and inspection as and when required was engaged from different departments within TCE.

SPG successfully executed several unique and technologically challenging projects in India for various Scientific establishments, Space and Nuclear Applications, Research organisations and many other institutions of national importance. The first assignment of this group was designing the Fuelling Machine Head for 220 MWe Nuclear reactors in collaboration with a Canadian Firm as Tata-DSMA.

Since 1965, TCE has had the privilege of designing and developing many antenna and telescope systems for different applications. In those days, antenna design was done to research and develop small antenna systems by Defence Laboratories. No organised technical consultancy worked on the design and development of antenna & telescope systems in India. TCE ventured into this new field and successfully executed many such assignments over the years for many prestigious clients like DAE, ISRO, TIFR, NCRA, DOT, VSNL, IIA, to name a few.

TCE designed and engineered the following antenna systems and Telescopes spread across India, including providing the Project Management Services as required.

- **9.5 m Antenna at Delhi and Madras Earth Stations (1975)**
  In 1975, ISRO with NASA and the P&T department of Govt of India organised the Satellite Instructional Television Experiment (SITE) and the Satellite Telecommunications Experiments Project (STEP) programs. Under these programs, two 9.5 m parabolic dish antennas were installed, one each at Delhi and Madras. These stations were used to set up communications through ATS-6 (USA) and SYMPHONIE (FRANCO-GERMAN) Satellites and later on through APPLE Satellite.
- **10.7 m Antenna at Delhi and Madras Earth Stations (1977)**
  Later in 1976, TCE was also involved in retrofitting the 9.5 m dish to 10.7 m dishes to make them suitable for communication through APPLE Satellite.
- **6.1 m Transportable Earth Station (TRACT) for SAC, Ahmedabad (1977)**
  The First Transportable Earth Station in India for Satellite Communication was also design engineered by TCE. It consisted of a 6.1 m steerable dish mounted on a Telco truck chassis.
- **3M Emergency Communication Terminal (1977)**
  TCE was instrumental in designing a mini earth station with a 3 m diameter parabolic dish with an X-Y mount that was easy to dismantle and pack into a box to be dropped from a helicopter to set up emergency communication. This antenna did not need a foundation as it stands on its legs supported on a structural hexagonal angle frame during its operation. The total weight of the unit was about 350 kg. This mini earth station was used for ISRO's SITE program and was also used in the Krishna District of Andhra Pradesh during a cyclone in 1977. This mini station was also used with the Apple Satellite in 1981.
- **6.1 M Antenna Systems for Car Nicobar, Vikram Sarabhai Space Centre (VSSC) and Sriharikota (SHAR) Earth stations (1978)**
  A 6.1 M diameter solid parabolic dish antenna with an X-Y mount fixed on a Concrete foundation was used for remote control and telemetry for Apple and SLV-3 (Rohini) Satellites.
- **136/240 MHZ Telemetry Antenna at SAC and SHAR for ISRO (1979)**
  A Yagi type antenna consisting of a 12 m x 12 m flat wire mesh reflector with sixteen dipoles and an EL-AZ mount was first used for tracking BHASKAR Satellite launched by ISRO in 1979 and later for SLV-3 flight in 1980 and with Apple Satellite in 1981.
- **9.5 m S-Band Antenna for SHAR, ISRO (1979)**
  A 9.5 m diameter wire mesh parabolic dish antenna with EL-AZ mount was used to track SLV-3 and ASLV flights by ISRO.
- **Mobile Radar Antenna for IIT, Kanpur**
  This twin dish with a 1-meter diameter radar antenna rising to a height of 6.1 m above the ground with its Telescopic Tower Mount and Electronic equipment housed in an air-conditioned body built on Tata Bus Chassis was used for data collection in forests and hilly areas.
- **14 M Master Control Facility (MCF) at Hasan for ISRO (1981)**
  A 14 m diameter solid dish consisting of 112 aluminium reflector panels antenna with EL-AZ mount was designed with a dual-drive system using two pinions to eliminate backlash in the drive trains. The Reflector was designed and manufactured for RMS error within +/- 1.0 mm and pointing accuracy of 0.08 deg. This facility was used for controlling the launch trajectory of INSAT 1A in 1982 from Kennedy and later for INSAT 1B. Later, this facility was also used for telecommunications, meteorology and television purposes.

Transportable Earth Station (TRACT) for SAC

3 M ECT for ISRO (1977)

137/240 MHZ Telemetry Antenna for ISRO (1979)

Master Control Facility (MCF) at Hasan (1981)

- **4.6 m BEL (Bharat Electronics Limited) Radar Antenna Mount (1984)**
  The radar antenna mount of EL-AZ type for supporting antenna dish of 4.6 m diameter was designed. TCE provided supervision services during the manufacture. The mount was tested for its acceptance with weight equivalent to the dish weight as provided by BEL.
- **11 M Braced Dome Dish for NCRA/TIFR, Pune (2006)**
  This 11 M diameter steerable dish with an EL-AZ mount was designed by TCE and manufactured at Comsat Systems, Hyderabad. This dish is installed in the NCRA/TIFR campus, Pune, for training Astronomy students.
- **18.3 M Antenna systems to VSNL (1990) and DOT (1992)**
  TCE executed these two antennas on a turnkey basis for establishing the Earth stations for Satellite Communications – one at Hathikanda, near Kolkata for (DOT) and another one at Kankot, near Rajkot for (VSNL). The antennae were used for satellite communication in the CB and frequencies with INTELSAT Satellites conforming to INTELSAT Modified Standard A Specification.

The 18.3 m diameter dish comprised a mild steel backup structure comprising 24 radial trusses and supporting 112 aluminium panels forming the Reflector. The dish was supported on an El-AZ mount. Each axis drive was able to rotate the antenna dish in tracking (step-tracking) and slewing mode. The Cassegrain feed system was procured from GTE Inc, USA and the Antenna Control systems from Electro Space Inc, USA.

- **45 Meter Antenna for GMRT for NCRA/TIFR (1992)**
  GMRT consists of 30 antennas of 45-meter diameter, each with its own reflector surface made of wire mesh (0.5 mm diameter SS wires). The dish is supported on Yoke structure arms with Spherical Roller Bearing (forming Elevation Axis). The Yoke is supported on the Concrete tower top through a Slewing Ring Bearing (forming Azimuth Axis). The required axes speeds are obtained through Epicyclic gearboxes driven through Servo motors. The feed systems, the control systems etc., as required for the Astronomical studies, were provided and installed by NCRA/TIFR.

TCE carried out the detailed design engineering, prepared manufacturing drawings, and provided supervision during the manufacture and installation of the antenna systems as PMC services.

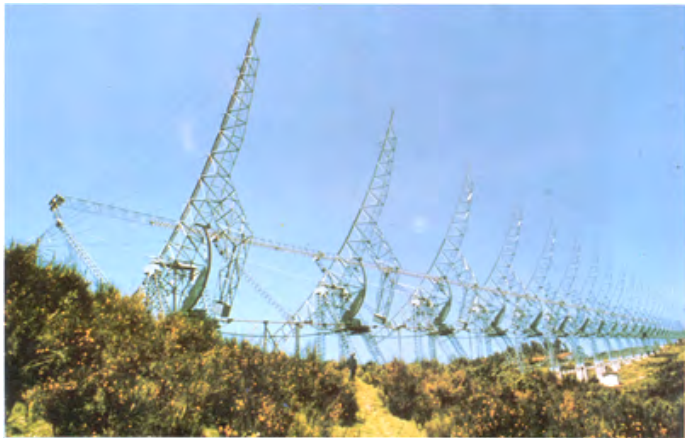
- **2.3 M Optical Telescope at Kavalur for IIA, Bangalore (1986)**
  This optical telescope has a primary mirror of 2360 mm in diameter and is on an Equatorial mount. It consists of a Horseshoe mount rotating on a set of hydrostatic bearings forming the Polar axis and a Tube assembly on trunnions forming the Declination axis. The tube assembly, which

houses the Primary mirror and secondary mirror, rotates about the Declination axis on trunnions. The telescope is rotated through each axis (Polar and Declination axis) with two DC servo motors driving the gear trains.

- **2.3 M Optical Telescope at Kavalur for IIA (1986)**
  The Dome provides the Canopy to the telescope observatory, which shields the telescope from stray light, wind and other climatic disturbances. The shutters and windscreens supplied in the dome form a Window of 4.5 m x 4.5 m size to permit light incidence on the primary mirror. The Dome weighing about 250 tons is supported on 40 Nos. of Spring-loaded wheel assemblies rolling on the rail (22 m diameter) anchored on the top of the observatory.

TCE provided Conceptual Design of Mount, Dome, Drives and related subsystems, Detailed design and manufacturing drawings, Supervision during manufacturing and shop testing, Inspection and expediting services, Design of Mirror Grinding Machine including its manufacturing drawings and supervision during manufacturing/assembly and Assistance during installation

- **Ooty Radio Telescope for TIFR (1971)**
  The Ooty Radio telescope (ORT) consists of 24 equispaced 30 M wide parabolic frames forming a cylindrical reflector of the length of 530 m. The reflector surface was porous and was made of 1100 nos. of equispaced 0.5 m dia SS wires stretched from one end to the other. The total collecting area was 15870 sq. m. The axis of rotation of the cylindrical Reflector is positioned on a hill with a North-South slope of about 11 deg and pivoted at the height of 13 M from the ground.

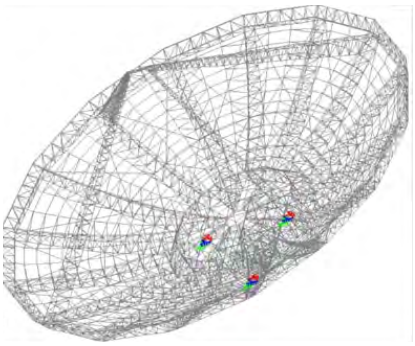


- **Ooty Radio Telescope (ORT) for NCRA / TIFR (1971)**
  The telescope is rotated at different speeds through a common 530 m long shaft (coupled segments), turning all the parabolic frames in unison. The shaft drives cycloidal pinions each at every edge, which drives a 10 M dia pin type bull gear (circular track with hardened pins) attached to each parabolic frame.

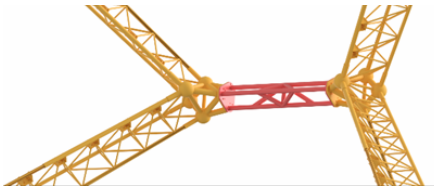
  Electromagnetic radiation from the outer space falling on the Reflector is focused on a set of electronic equipment placed at the focal line all along the length of the telescope.

  Commissioned in 1971, TCE carried out the concept design, detail engineering, prepared manufactured drawings and provided the supervision during manufacture and installation of this telescope as PMC services.

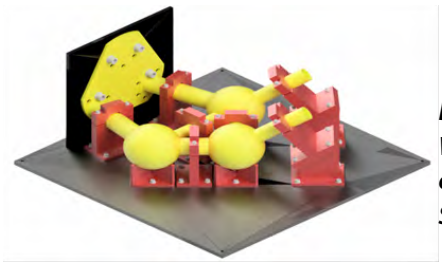
- **Engagement with NCRA-TIFR (2014 to Till Date)**
  Considering TCE's long association with NCRA-TIFR and its expertise in designing and developing complex Antenna / Telescope systems, NCRA-TIFR has continued to avail TCE's engineering services for design validation, modifications and design optimisation of a complex structures like Antenna and Quadripod structures. TCE has also successfully designed Special Fixtures required to maintain and weld these complex structures, enabling easier assembly and maintenance of various structures.



Design Validation of Antenna Structure



Design Modification of Quadripod Structure



Design of Fixture for Welding & Assembly of Quadripod Structure

CONCLUSION / WAY FORWARD

Most of the projects discussed were attempted for the first time in the country. The problems concerning these projects were complex and encountered for the first time, and hence, TCE engineers had to look for novel ways and techniques for their resolution.

While this scenario provided many challenges, it also offered opportunities for indigenisation of the design of mechanical and structural systems, including drive elements/control systems. TCE engineers interacted with and learned from renowned scientists and technologists working in different research institutions during these projects, a matter of great pride and satisfaction for TCE engineers.

Over the period, TCE built on this legacy of executing challenging scientific projects of national importance and is always looking forward to contributing its expertise to many such projects.

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HUMAN RESOURCE & ETHICS

DIVERSITY & INCLUSION AND RISK MANAGEMENT

Risk management (RM) refers to a coordinated set of activities and methods involving identifying, assessing, and prioritising risks followed by implementing appropriate response and monitoring measures to minimise the effects of undesirable events and maximise the realisation of opportunities.

The term risk management is also sometimes used to refer to the programme used to manage risk. This programme includes Risk Management Principles, a Risk Management Framework, and a Risk Management Process.

Diversity & Inclusion (D&I) are essential in the people management strategy. ***Diversity*** ensures a mix of people with differences, including but not limited to race, ethnicity, gender, age, social class, physical ability or attributes, religious beliefs, etc. ***Inclusion*** establishes behaviour and norms that ensure that people feel welcome, where everyone's inherent worth and dignity are recognised and given equal opportunity to contribute to business success.

A survey report published by Lloyds identified the top three global business risks as:

a. Loss of Customers

b. Talent and Skills Shortages

c. Reputational Risk

It is recognised that each of these risks is affected by the company's overall ability to secure and retain the best workforce. Comprehensive, effective diversity and Inclusion ("D&I") programs can significantly reduce these risks and turn these into opportunities.

Bringing a more diverse range of people into your organisation and winning the trust of different communities is an opportunity to get closer to customers. Besides, an increasing number of prospective clients are now demanding that their partners show their commitment to Diversity and Inclusion.

According to Laura Omero, Director, Europe Customer Risk Management at Mastercard: ***"There are several studies where a diverse workforce is proven to enrich the working environment by providing different solutions to the same problem and by opening up constructive debate, ultimately resulting in a better outcome. Companies that do not diversify lose out on competitiveness and talent."***

Diversity and Inclusion can help you to bridge the skills gaps by broadening your talent pool and making your business more attractive to a wide range of prospective talented employees.

Organisations must also recognise D&I as a Reputational Risk. Downsides of poor reputation on Diversity and Inclusion include:

1. **Deterring Talent:** The talent you need to attract may be encouraged to look elsewhere if they believe your organisation's diversity and inclusion approach would make it harder for them to fulfil their potential. Existing employees may also become disillusioned with their prospects and leave.
2. **Putting off Customers:** If you don't have a good reputation for Diversity and Inclusion, there is a risk that customers will switch to a competitor that does. There is even a risk that certain groups could boycott your business.
3. **Challenging Questions from Investors:** Shareholders want assurance on anything that affects your organisation's reputation, and hence the value of their investment. As a result, they're asking more and more questions about Diversity and Inclusion.

According to Amal Merzouk, Senior Subject Matter Expert (EMEA) at Fiserv: *"In Risk Management, we can have many different specialisations; strategic, operational, quantitative, compliance, cybersecurity, IT, etc. Some of these zones have precise and complex requirements, but they all rely on individuals being able to 'see' in 360 degrees. It is these comprehensive perspectives and the tendency to ask questions that are essential in Risk Management. This is where diversity in thinking is important. No diversity means no diversity in thinking which is essential for Risk Management."*

The iceberg principle of Risk Identification (see figure below) highlights the importance of having multi-perspective viewpoints while identifying risks.

We should strive to form a diverse team that can overcome groupthink, balance multiple perspectives and consider a broader array of opportunities and outcomes.

Hence, it is the need of the hour to recognise the importance of D&I and to build it into business planning and to manage it with the same strategic focus, systematic monitoring and, where necessary, active intervention as other risks and business issues. We can turn a company's diversity status from a potentially serious liability to a dramatic competitive advantage and ultimately enhance the bottom line.

Author

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- *https://informaconnect.com/the-true-value-of-diversity-in-risk-management/*
- *https://www.jacksonlewis.com/media/pnc/9/media.2229.pdf*
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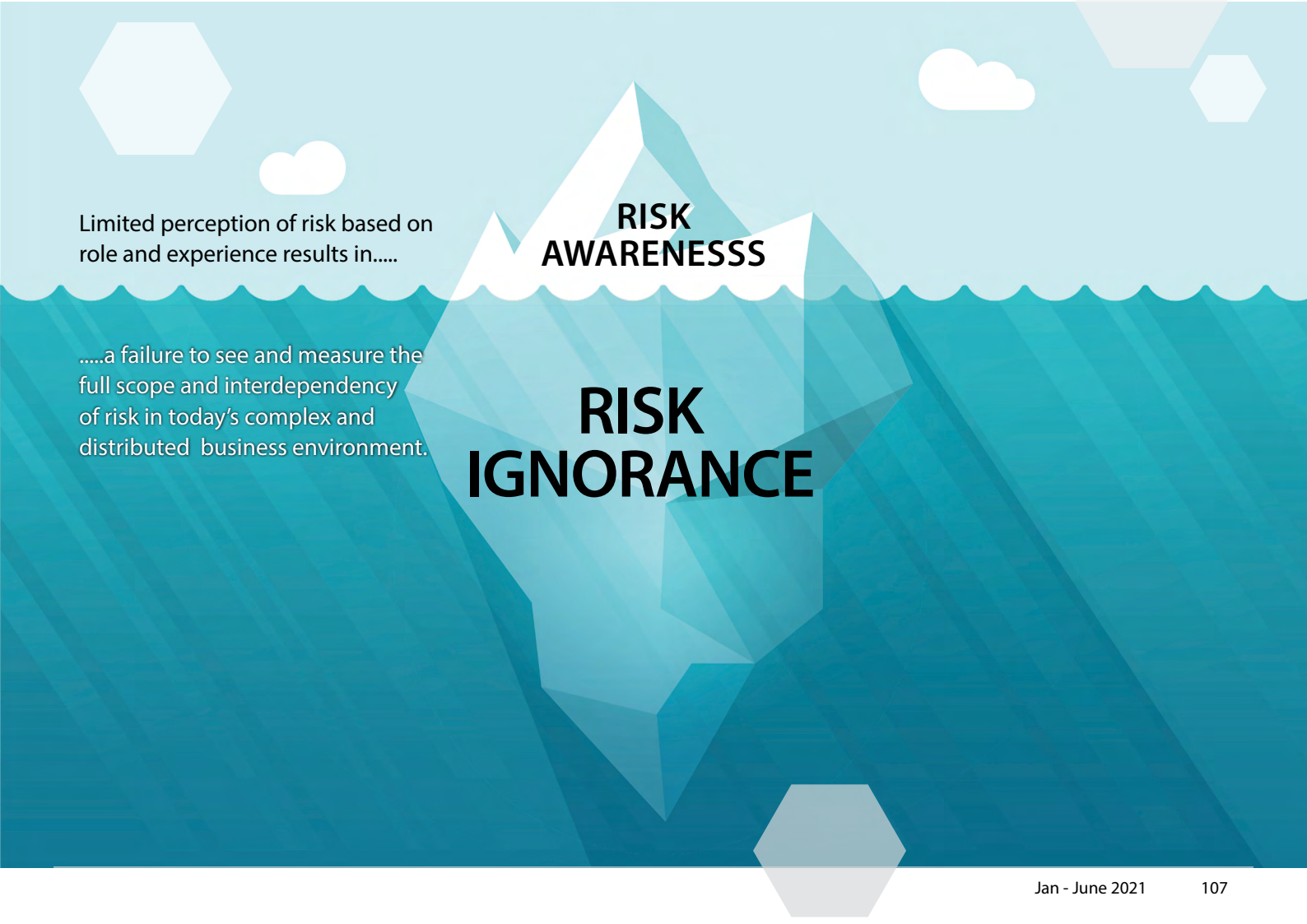
It is not just enough to stop at diversity – we should consciously manage people's inherent biases to promote and ensure all-round Inclusion!



RESOURCE MANAGEMENT:

Rethinking Resource Utilisation

It was March 2020, companies across India were concluding actuals vs targets of FY'20 and preparing budgets for FY'21. At this time, not many were aware that an invisible and fast-spreading microscopic virus had announced its arrival and will be the most significant disruptor of lives across all geographies. As the days passed, the virus started spreading to different locations and what began as a trickle became a torrent leaving nations and economies gasping. Resources earmarked for regular business conduct had to be cautioned, guided to confine indoors but with much less clarity on how to handle the infectious spread of the new COVID-19 virus.

Presently, it is more than a year since the first pandemic declaration by WHO. Professionals are still confined to their homes and adapted to the "new normal" scenario of remote working and increased coordination over digital platforms. The uncertainty of duration and severity of the crisis made it difficult in forecasting the impact on Engineering & Construction activities, more so on the construction industry, which is labour intensive and demands exhaustive coordination among various Stakeholders. Several projects were stalled, and a few cancelled, which compounded E&C companies grappling with business uncertainties.

Companies being hit on numerous fronts were at risk of negative margins amidst the crisis due to idling or under-utilisation of resources. While many companies across the industry were planning for a prolonged reduction in capacity and cost structure, we at TCE focused and attempted to optimise resources across the organisation through an initiative termed START (Strategies to Transform and Align Rapidly Together). To accomplish the endeavour with regards to resource optimisation, an existing vertical viz. Talent Pool Retraining and Deployment (TPRD) was strengthened in a new format and structure viz. Resource Management under the aegis of TEAM (Together Everyone Achieves More) and utilisation rate was made a metric for evaluating the financials and performance of each business unit. The talent pool was developed as a rich pool of shared resources whose utilisation was ensured across the organisation, including support functions, thus helping the organisation safeguard better economic health during uncertain times.

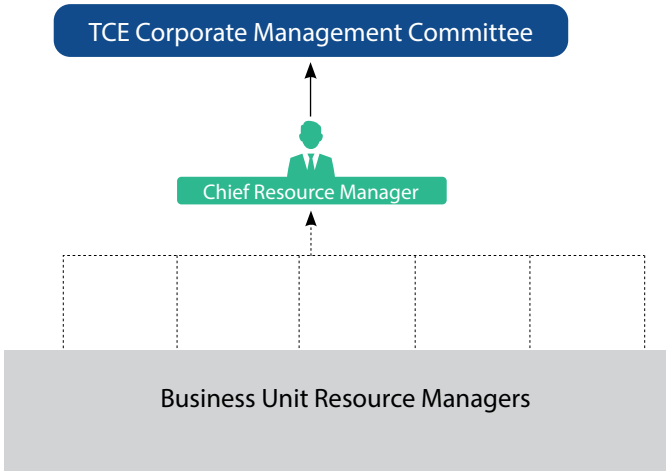


Figure 1: Structure of Resource Management [CMC: Corporate Management Committee; HOD: Head of Delivery; BU RM: Business Unit Resource Manager]

Utilisation is King!

Utilisation is a crucial metric in the consulting services industry. It helps the management understand human resources and the ratio of time spent on billable tasks versus non-billable tasks. The analysis of billable utilisation and average hourly rate is mission-critical for the financial health of a consulting company. On the other hand, it also helps to understand the level of employee engagement across the organisation and may prove to be an aid in optimising attrition rates through enhancing skillsets of resources required for productive utilisation of their available hours. It is the process of strategically measuring the effectiveness of resources.

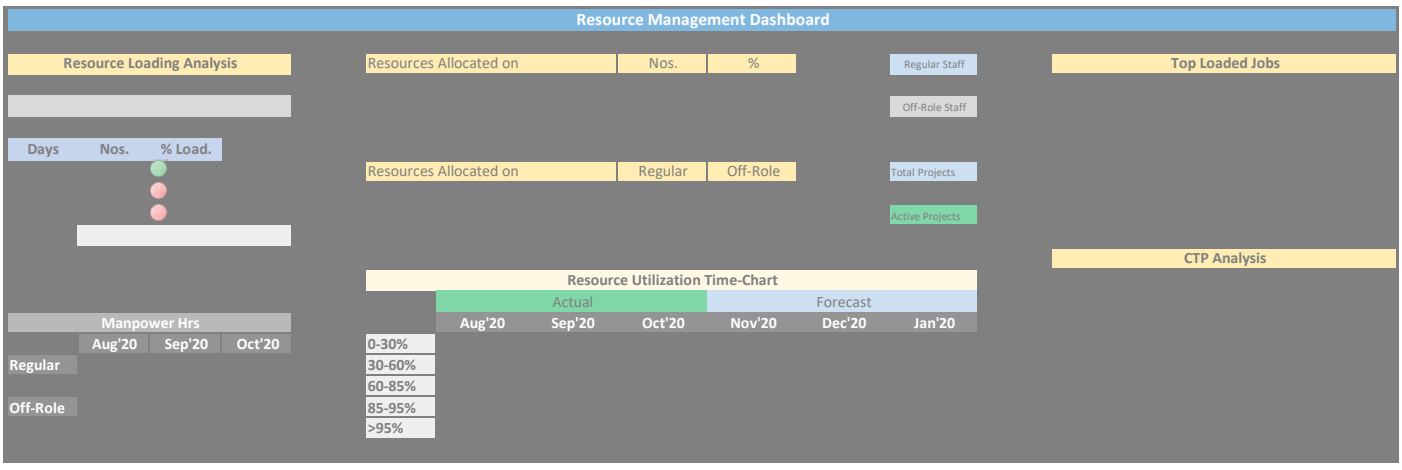
Though utilisation is a key metric, it must be read in conjunction with total revenue and profit per person to drive overall profitability and productivity in the organisation.

"Allocation organises a Project, but it is Utilisation that makes it successful."

Any consulting firm, including engineering & construction consultancy, need to have transparency on their resource profile and project demands, to evaluate the demand-supply relationship. Forecasting of resources provides data-driven foresight into various metrics like resource availability, capacity-demand gap, etc. The business unit or company can implement optimum measures for resource scheduling, recruitment, improving productivity, and developing a pull approach towards future business opportunities.

Towards Growth Mindset

One of the most effective ways to boost profitability in a consulting operation is to maximise utilisation, thus establishing the criticality of the resource management function. Billable utilisation is one of the three critical components (the other two being Delivery and Profitability) for comprehensive and sustainable growth. Managing resources through measuring utilisation, as one of the key metrics, helps the management ensure better delivery and enhanced profitability. Delivery excellence can be achieved through early visibility of resource demand, identifying and allocating the right skill set to suitable projects, improving communication across all parts of the business, and optimising resource allocation. Also, profitability is enhanced as we can achieve more by investing less and optimising wastage, as one of the core principles of Project Management.



Note: The above dashboard is for representational purposes only. Numbers used shall not be used for any analysis or result-oriented approach.

A well-defined functional structure and identified team of Resource Managers are an indispensable part of the growth story. These Resource Managers aid in the centralised demand-gap analysis of business opportunities, optimising resource-ability to meet the organisation's planned targets, segregate and re-skill resources to meet agile demands and organisation's strategy cost component track, etc.

Resource Management in TCE:
The Journey so far

Corporate Resource Pool was created in 2016. The objective behind creating the Corporate Resource Pool (now CTP) was to manage available resources for the organisation's benefit effectively.

- To facilitate deployment of 'Resource Pool' against 'Resource Demand'.
- Initial focus was on utilisation of resources released by BUs due to Business downturn.
- To manage resources released due to reduced loading on commercial jobs and business opportunities impacted in a sector or industry as a whole.
- Retraining/reskilling to improve exisiting competencies/skills & capabilities to match resource deployment possibilities.

A detailed audit of the existing process was conducted in FY'21, which enabled the release of a structured Standard Operating Procedure (SOP) covering various aspects of resource management and in detail about the process involved in managing the Common Talent pool for effective overall utilisation of all available resources.

Developmental Process:
Prospects for the future

The future of Resource Management is boundless as it can assist in analysing utilisation trends, utilisation to profitability ratio, predictability of revenue realisation per billable employee, utilisation to attrition ratio, segmentation & demand-gap analysis of skill sets, dynamic pricing models, etc.

The capabilities of Resource Management can be increased through introducing Artificial Intelligence (AI-based applications). AI capabilities can enhance resource utilisation analysis to a granular level robustly, producing par excellence recommendations on improving delivery aspects, like visibility on skills sets and effective engagement, and maximising profitability through analysing utilisation to revenue ratios and eliminating non-productive hours.

Author

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EMPLOYEE SPECIFIC INITIATIVES
during the Pandemic

- **Leadership and Managerial Transformation Training**
  To adapt to change and lead was delivered top 2% of TCE leaders. An eight-month-long virtual leadership training module was conducted by Tata Management Training Centre, the group's leadership institute.
- **Enabled Work from Home**
  More than 95% employees were enabled to work from home within the first week of the lockdown, and workstations & devices shipped home wherever required.
- **Actively Communicated with Employees through regular connect calls, Intranet, Internal Social Media Mailers on:**
  - COVID-19 Do's and Don'ts
  - Visual SOPs and Precautionary Protocols
  - Regular TEAM calls and Wellness Sessions

- **Enhanced communication forums & employee touchpoints**
  - Numerous company wide TEAM calls (30+) attended by more than 90%+ employees were conducted.
  - Continuous support and connect was established with employees during the Pandemic.
  - Weekly Connect Calls, Leadership Connects, HR Connect, e-Townhall, DC Communication held with employees.

- **Regular sanitisation, masks and social distancing across Delivery Centers**

- **Launched COVID-19 Kavach Insurance Top Up**
  - Conducted drive for higher enrolment of employees for COVID-19 Specific policy.
  - Encouraged employees to seek additional insurance cover by opting for a top-up on the existing cover.
  - Extensive communication, including emails and virtual group calls across locations, were conducted to clarify employee queries on the available options.
  - Enhanced efforts for employees to opt for Group Voluntary Policy options covering employees family and top up options for voluntary parents' policy.

- **Mutual Family Relief Scheme**
  Money disbursed to employees family for relief in case of untimely demise. Consideration of spouse /children for suitable job roles based on company policies and adequate qualification and skill.

- **Leave Bank Policy**
  Encouraged employees with surplus leaves to donate to colleagues in need.

- **COVID-19 Recovery Retreat**
  - Launched a series of programs for employees who have recently recovered from COVID-19.
  - Recovery Retreat brings a special session on Breathing Techniques to revitalise lung capacity, build immunity and help them achieve an inner equilibrium.

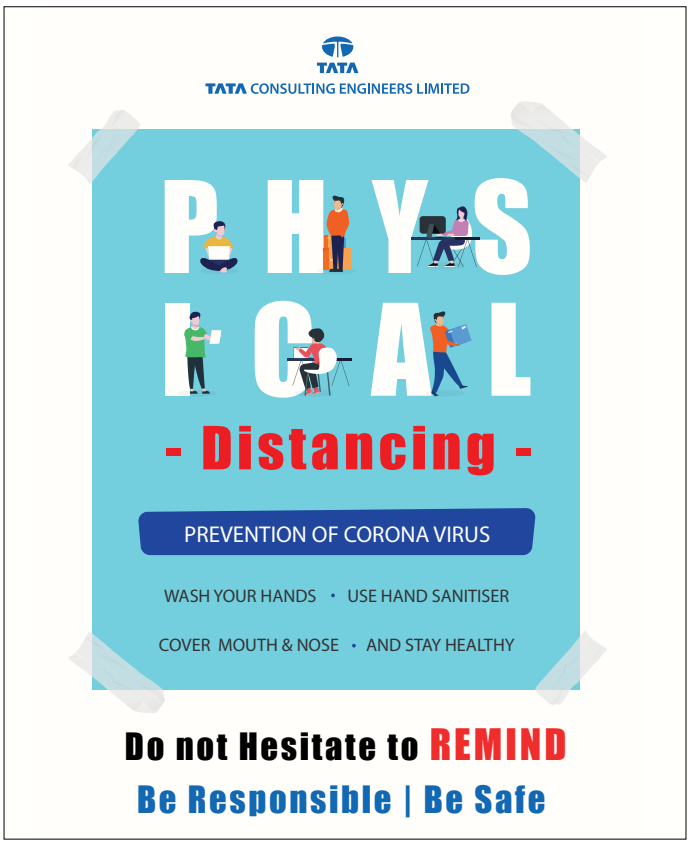
- **Created COVID-19 Care Centres:**
  - Converted Guest Houses and Office space across 7 locations in India to establish isolation care facilities, for employees affected with COVID-19.
  - The centre caters to mild and asymptomatic patients with provision of basic medical facilities, oxygen support by way of oxygen cylinders and concentrators.

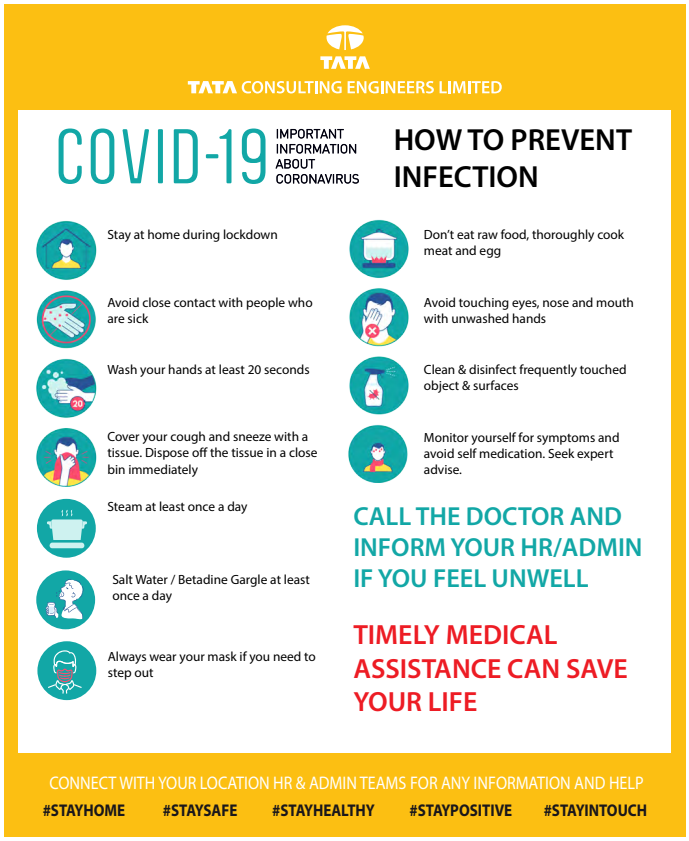
- **COVID-19 Care Centres are equipped with:**
  - 17 Portable oxygen kits (POK) with breathing apparatus of capacity ranging from 2 Ltrs to 12 Ltrs.
  - 13 Oxygen concentrator machines of capacity ranging from 1 Ltrs to 10 Ltrs.

- **Facilitated Hospitalisation:**
  Connected with Hospitals and ensured RTPCR Testing, Tele Consultation, Timely admission and care.

- **Localised 24x7 COVID-19 Task force setup:**
  To address employee concerns & queries related to COVID-19, ensure timely support in isolation infrastructure, medication, transportation and hospital arrangements.

- **Ensured Timely medicine Availability:**
  Established Direct Connects with the Manufacturers for procurement of emergency medicines.

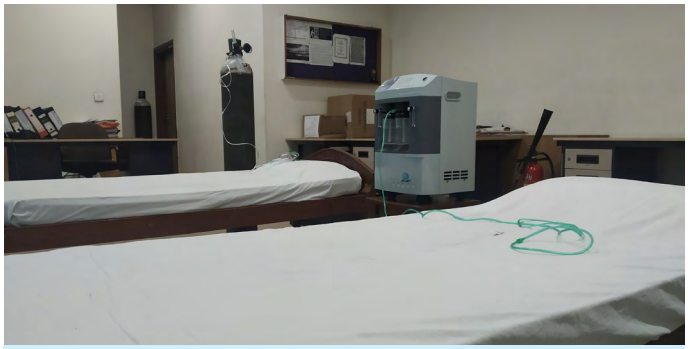

TATA
TATA CONSULTING ENGINEERS LIMITED
PHYSICAL
- Distancing -
PREVENTION OF CORONA VIRUS
WASH YOUR HANDS • USE HAND SANITISER
COVER MOUTH & NOSE • AND STAY HEALTHY
Do not Hesitate to REMIND
Be Responsible | Be Safe


TATA
TATA CONSULTING ENGINEERS LIMITED
COVID-19
IMPORTANT INFORMATION ABOUT CORONAVIRUS
HOW TO PREVENT INFECTION
Stay at home during lockdown
Avoid close contact with people who are sick
Wash your hands at least 20 seconds
Cover your cough and sneeze with a tissue. Dispose off the tissue in a close bin immediately
Steam at least once a day
Salt Water / Betadine Gargle at least once a day
Always wear your mask if you need to step out
Don't eat raw food, thoroughly cook meat and egg
Avoid touching eyes, nose and mouth with unwashed hands
Clean & disinfect frequently touched object & surfaces
Monitor yourself for symptoms and avoid self medication. Seek expert advise.
CALL THE DOCTOR AND INFORM YOUR HR/ADMIN IF YOU FEEL UNWELL
TIMELY MEDICAL ASSISTANCE CAN SAVE YOUR LIFE
CONNECT WITH YOUR LOCATION HR & ADMIN TEAMS FOR ANY INFORMATION AND HELP
#STAYHOME #STAYSAFE #STAYHEALTHY #STAYPOSITIVE #STAYINTOUCH

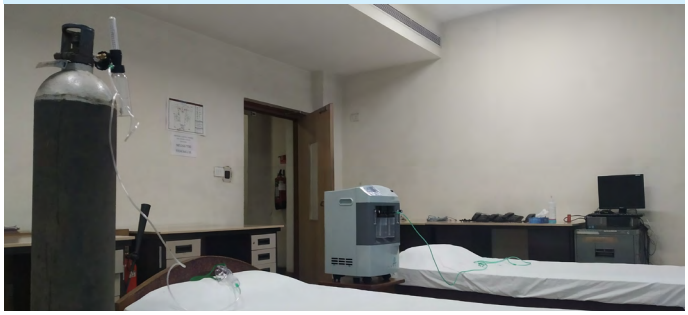

TO ENSURE YOU ARE SAFE, WE...
1
Actively Communicated
• Do's & Dont's
• Visual SOPs
• Regular Employee Connects
• Doctor on Call
• Quarantine Guidelines etc.
2
Encouraged Insurance Top-ups
• >60% Employees opted for insurance top-up for themselves and family including parents
3
Enabled Work from Home
• 100% Employees have been enabled to comfortably work from home
• Systems shipped homes where required
4
Worked on Emotional Well-being
• Conducted meditation & Wellness sessions and Fun-Friday's for employees and their family
5
Facilitated Hospitalisation
• Connected with hospitals and ensured RTPCR Testing, Tele consultation and timely admission and care
6
Ensured Timely Medicine Availability
• Established direct connects with the manufacturers for procurement of emergency medicines
7
Organised TCE Temp Emergency Facility
• Under supervision emergency O2 administration, care and Bed till you get admission
WE ARE ALWAYS BY YOUR SIDE
PLEASE #STAYHOME, #STAYSAFE, #STAYPOSITIVE and #STAYINTOUCH
COVID 19 SAFETY

COVID-19 EMERGENCY CARE CENTRES

17 Portable Oxygen Kits | 13 Oxygen Concentrator | 06 Cities



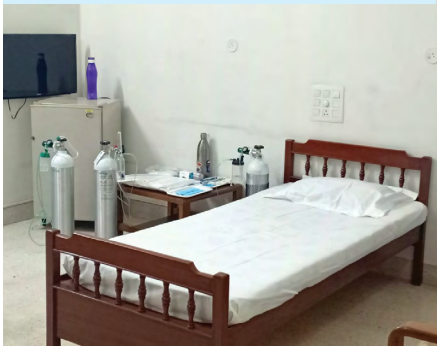
JAMSHEDPUR



PUNE

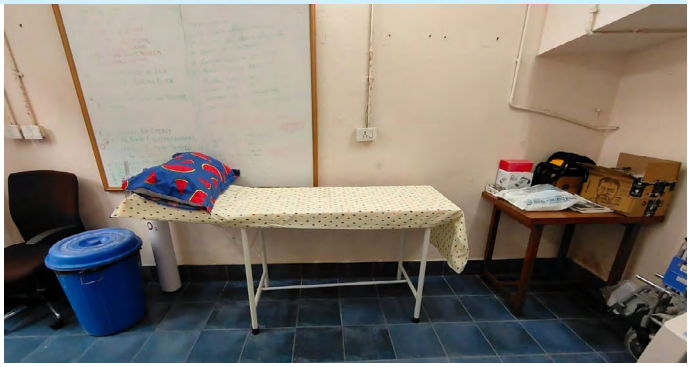
DELHI

BANGALORE



MUMBAI

KOLKATA



COVID-19 VACCINATION DRIVE

The outbreak of the COVID-19 Pandemic has created a global health crisis that has had a deep impact on the way we perceive our world. Not only the rate of contagion and patterns of transmission threatens our sense of agency, but the safety measures put in place to contain the spread of the virus also requires social distancing by refraining from doing what is inherently human, which is to find solace in the company of others.

Currently the entire world is experiencing the desolation and devastation of this deadly disease, affecting more than 200 countries and thousands of people with heartbreaking morbidity and mortality figures.

As COVID-19 Pandemic continues to evolve, Tata Consulting Engineers Limited has taken a proactive approach to help ensure the safety of the employees and their families along with the maintenance staff by arranging a vaccination drive. The drive was organised very systematically. The office had directed the representatives to issue clear instructions to all employees regarding registration and appointment feature and strictly adhere to it. The office building was divided into different rooms & areas with an entry point, a waiting foyer, registration area, vaccination room, recovery room and an exit. In accordance to which the drive was conducted successfully, leaving a sense of safety and positivity in all who got vaccinated.

KOLKATA
170+ *Vaccinated*

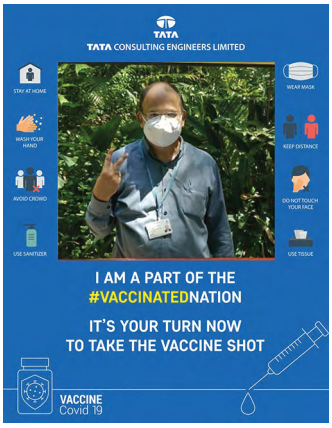




MUMBAI
591+ *Vaccinated*



BANGALORE
272+ *Vaccinated*



DELHI
30+ *Vaccinated*

LIVING THE CODE

Tata Consulting Engineers truly believes in Living the Code instead of avoiding problems due to unethical behaviour. The company believes that it brings out the best in people through imbibing ethical leadership. Engaged employees bring their creativity, innovations, ideas, and enthusiasm to work, helping transform the organisation. To this cause, 'Ethics Week' is celebrated from March 1 to March 5 every year. This year, the campaign further substantiated the importance of living the Code and creating awareness about the Tata Code of Conduct (TCoC) and Leadership in Business Ethics (LBE) framework.

Live session on "Anti-Bribery Anti-Corruption (ABAC), Anti Money Laundering (AML), Whistle Blower Policy, Gifts & Hospitality" were conducted on March 2, 2021, for all Stakeholders, including third Party workforce and supplier / partners by Company's Compliance Officer, Mr Sachin Mishra.

On Founder's Day, March 3, 2021, TCE and Ecofirst employees took an 'Ethics Pledge'. The Ethics Pledge was printed on plaques and tent cards placed at prominent places across delivery centres, notice boards, etc., as a constant reminder of every employee's responsibility to abide by the TCoC.

Location Ethics Counsellors (LECs) conducted Virtual Awareness Sessions called "#MeetYourLEC" on the TCoC & Prevention of Sexual Harassment (POSH) for all stakeholders on March 3, 2021.

A refresher video on the "Do's and Don'ts to Prevent Sexual Harassment @ Workplace" was streamed across the organisation on March 4, 2021. The gamification of concepts like dealing with ethical dilemmas at work was very well received and saw over 1400 responses to the case study-based quizzes, Word Puzzles, etc.

Ethics Flagbearers

The Ethics Week in March 2021 helped identify 9 Ethics Flag Bearers who enthusiastically participated in the TCoC Case Study quiz. The Ethics FlagBearers are employees or associates who contribute by displaying commitment to TCoC and promoting ethics by participating in organisation initiatives.


Mohd Resaal Ansari


Mehak Rekhi


Soumya Das

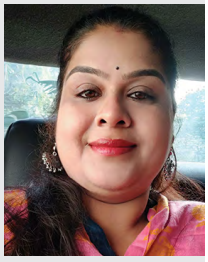

Ananth B N


Keyur Shah

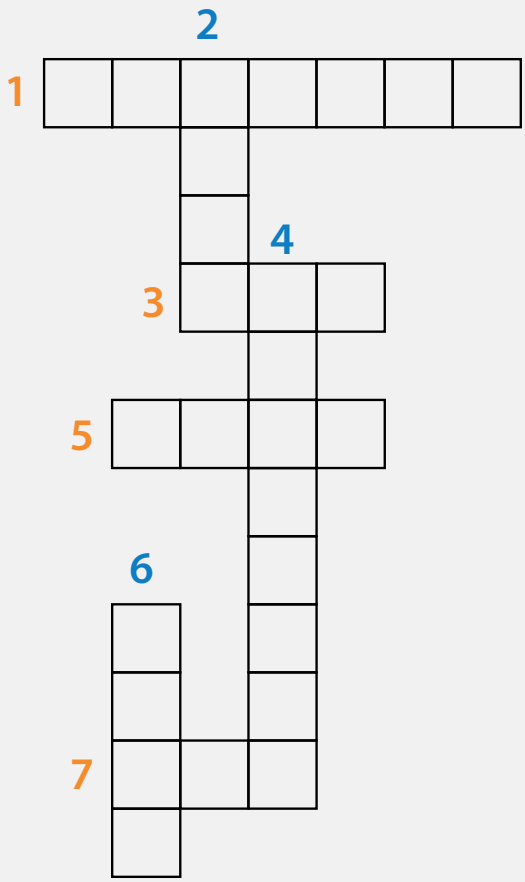

L Dinesh Kumar


Rashmikant Kashyap


Aditya Padmakar Kulkarni


Rajeshwari Harapanahalli

Dr Owlivia, the ardent Ethics Advisor, is here again to help resolve ethical dilemmas and promote ethical conduct!



Solve the crossword puzzle - "Name the Policies related to TCoC". Refer *https://www.tce.co.in/wp-content/uploads/2019/12/Tata-Code-of-Conduct2015-1.pdf*

#DecodeTheCode

ACROSS

1. Improve this, and you will automatically improve productivity!
3. There is no business on a dead planet. So plant a tree even if it is your last deed.
5. The only way to graciously tell someone - "no gifts, please."
7. Luck runs out, but safety is good for life!

DOWN

2. Corruption is like a ball of snow. Once it's set rolling, it goes out of control.
4. Password sharing is not a trust. It's a #dikhava of trust.
6. Say "No" to unwelcome sexual advances

For answers, turn to page number 126 of the magazine.

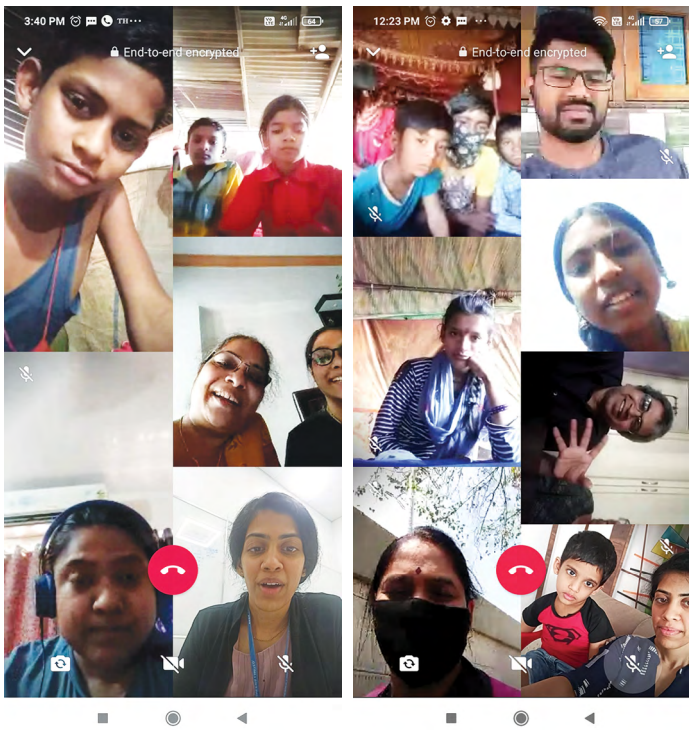
TCEndeavour

CARE | SHARE | RESTORE

TCE BRINGING CHANGE, ONE CHILD AT A TIME

We at Tata Consulting Engineering (TCE) are committed to ensuring the social wellbeing of our people, communities we live and operate in and the country at large. While Education, Healthcare, Sustainable Livelihood and Infrastructure Development continue to be our main focus areas, we have also added Scientific Research as the fifth focus area to our Corporate Social Responsibility (CSR) initiative branded as TCEndeavour.

In this issue, we bring you the story of how TCE is running a Mobile School on Wheels with the help of its NGO partner Society for Door Step Schools (DSS). With this initiative, TCE has impacted and made a difference in the lives of over 1560 children who struggle for basic education. DSS, our CSR partner, caters to the education of children of pavement dwellers, slum dwellers, construction site workers and many other underprivileged families. They endeavour to spread literacy and take primary education to children's doorstep in the age group of 6 to 14 years. TCE has been enabling it to do so since 2016.



Superstition, Street Stunts and More

A man attired in a colourful skirt dancing, twirling and whipping himself, a woman balancing a wooden plank with an idol of a goddess atop her head, walking close behind beating a drum and small children performing street stunts – people in Pune, Maharashtra, witness this scene many times while going about the humdrum of their life. These street performers are the nomads who belong to a tribe called Potraj who make a living by performing on the streets. Even the children of this community join this profession at a very young age.

When DSS first started working with this community, they realised that no one from this community had ever been to school. Therefore, the task was uphill and challenging. Still, after years of working with the community that involved parent counselling sessions and numerous discussions with the tribal heads, DSS overcame the barriers and introduced the Potraj children to school and literacy.

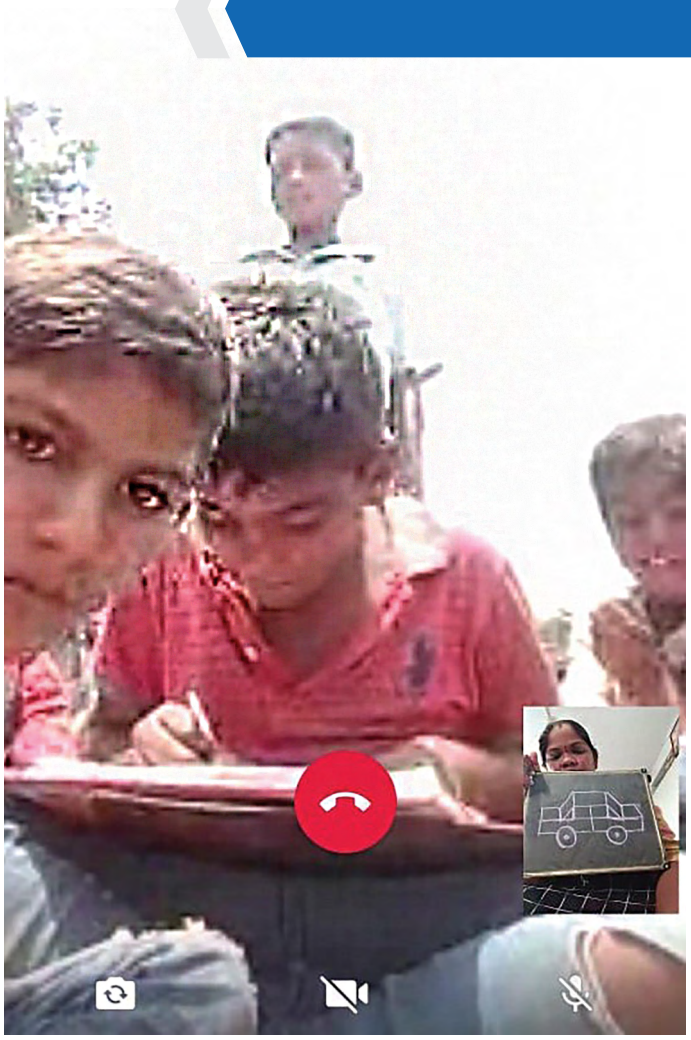
TCE supported the DSS initiative - School on Wheels. A mobile classroom (TCE sponsored buses that double up as mobile classrooms) started visiting these children and worked with them till they enrolled in regular government schools. Sharing her views, Ms Bhavana Kulkarni from DSS said, "Today, after years of work, we see a positive mindset change among the members of the Potraj community, almost all parents have started taking an interest in their children's education and all kids in age group 6-14 years are now enrolled in schools. These children have a high attendance rate in school, can read fluently and respond well to our activities in science and other subjects."

COVID-19 posed fresh challenges. Up to 26 children huddled together to learn from a single phone. "Thanks to the help from corporates like TCE, we are working towards getting them better equipped to take up online learning to ensure that their education does not suffer," she adds.

Reaching Out for a Better Tomorrow

With TCE's support, DSS is also working with communities like the Chittodiya Vasti. The Chittodiyas are Ayurvedic medicine sellers, and most of them are illiterate and against girl child education. They usually while away time playing cards. After many counselling and awareness sessions, most parents of this community have started taking an interest in their children's education. Of the total children population, 64% are now enrolled in schools, and 86% of children in the age group of 6 to 14 years can read.

During the tough COVID-19 times, mothers from the Chittodiya community have been actively involved in their children's (including girls) education. This is important as this community was entirely against girl child education. Other communities like Kadam Vasti and Lohiya Nagar slums in Pune are now also supported by DSS under TCE's Education program.



Towards COVID-19 Relief

With the outbreak of the pandemic, there was a need to prepare the children and their families to deal with it. TCE enabled DSS to run awareness campaigns to encourage COVID-19 appropriate behaviour through WhatsApp campaigns, posters and audio resources like vehicles using amplifiers and mics to spread the word.

TCE plans to partner with DSS to chart educational programs on COVID-19 related health and hygiene issues and vaccination awareness. Girl child menstrual health-related education programs are also in the offing.

TCE employees Make us Proud

TCE employees, families and consultants have supported DSS over the years. In 2020-21, over 247 TCE volunteers spent over 750 hrs working with children under various DSS initiatives. Employees were a part of DSS celebrations on days such as International Literacy Day, Teachers Day, Hindi Diwas, World Safety Day, International Women's Day, World Water Day, and Shaheed Divas. Employees also volunteered in storytelling, best-out-of-waste sessions, drawing competition, virtual heritage tour, and campaigns like save water.

Reference: *Treading a new road | Cities News, The Indian Express*

TATA engage be the change

PROENGAGE-12

Unwan Mohammadali Kazi
Telephonic Spoken English classes for youth

Nishtha Gupta
Conduct online sessions for students

Priya Jadhav
Design a Reward and Recognition Policy

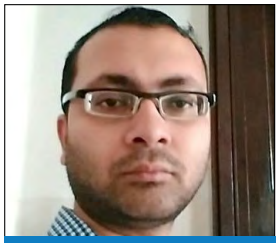
Sampada Rangnekar Pandit
Create a Project Management Framework

Abhay Kumar
Value Based Holistic Education

Dilip Ganpatrao Sonawane
Create a fundraising strategy

Ahmad Ali
Value Based Holistic Education

Prem Nath Prasad
Value Based Holistic Education



Subhojit Mukherjee
Write fundraising proposal

Sudakshina Anand
Write an Annual Report

ProEngage is a part-time, skill-based volunteering programme that offers unique opportunities to contribute domain expertise and lead exciting projects that can help civil society achieve its goals faster. The duration of the activity undertaken as part of the program can range from one to six months, and volunteering is mainly done during weekends and holidays.

Nishanth S
Research on "Climate Action in Rural India"

This year the program saw enthusiastic participation from 14 volunteers, including two family members of TCE employees, who completed their projects across various domains. The volunteers rendered their time and skills in helping partner organisations in projects such as conducting soft-skills sessions for youth, researching "Climate action in Rural India", creating a fundraising strategy, designing a Performance Management System, conducting online sessions for students on various topics, Value-Based Holistic Education, writing out an annual report, creating a project management framework, conducting telephonic spoken English sessions for youth, recording audiobooks for the visually impaired and writing blogs.

FAMILY MEMBERS

Soubarna Chowdhury
Write blogs

Reena Mapari
Record audiobooks for visually impaired

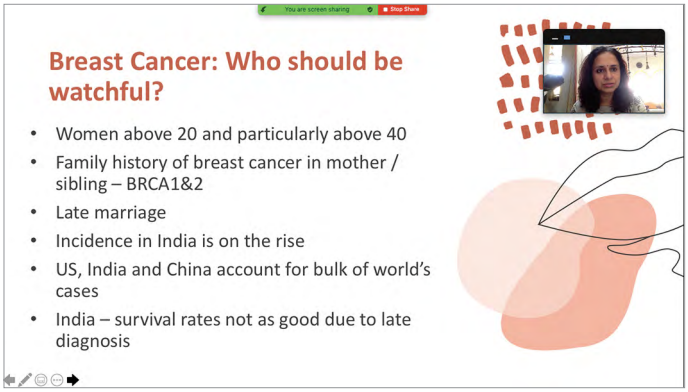
TATA VOLUNTEERING WEEK 15

5027 Volunteering Hours | 1914 Volunteers | 55 Programs | 8450 Lives Touched

The 15th edition of Tata Volunteering Week (TVW15), launched on 3rd March 2021, successfully concluded on 31st March 2021. The theme for the TVW15 edition was Shatter the Status Quo, and the program encompassed unique activities which were executed both virtually and on-ground with utmost safety precautions. We had a total of 55 volunteering programs which included career counselling, e-mentoring, teaching school students, safety awareness for construction site workers, Women's Day celebration, virtual heritage tour etc.

Visit to Old age home at Hosur

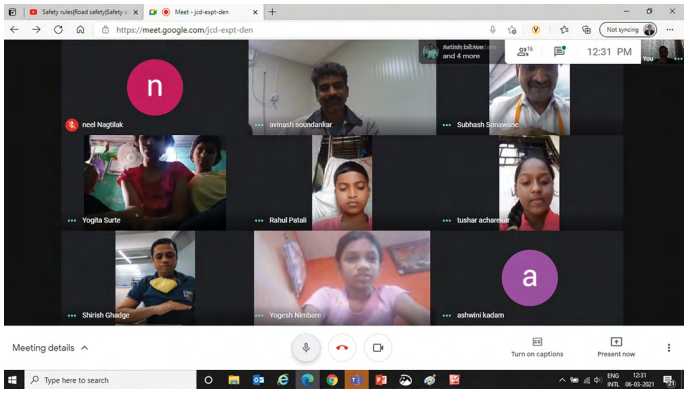
Visit to Old age home at Hosur



Women's Day Celebration

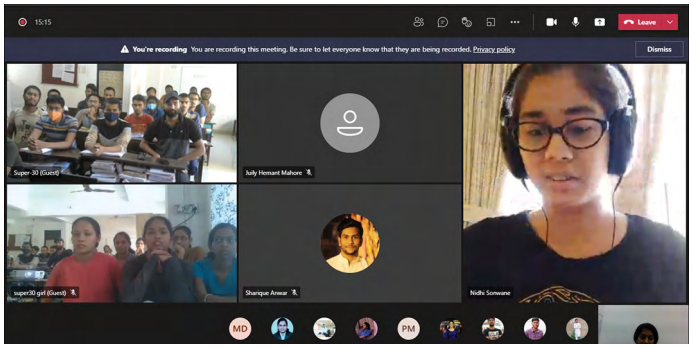
Career Counselling for Government College Engineering Students at Salem

Drawing Competition with Door Step School



Safety Day Celebration

Essay competition for Underprivileged Students

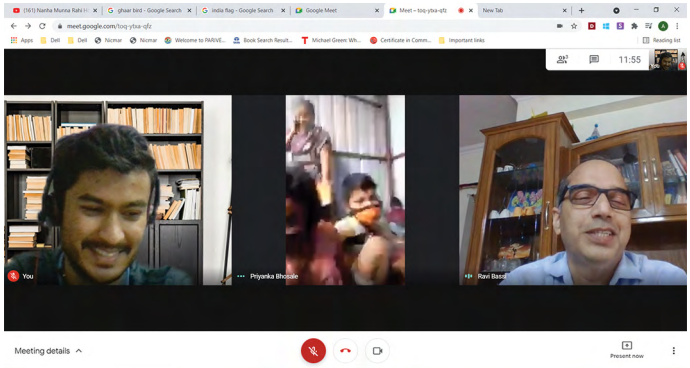


E-mentoring

Safety Day Celebration

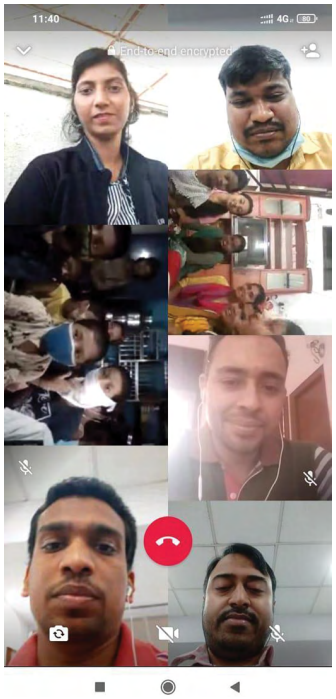
Science Experiments at Orphanage

Visit to Sainele Orphanage

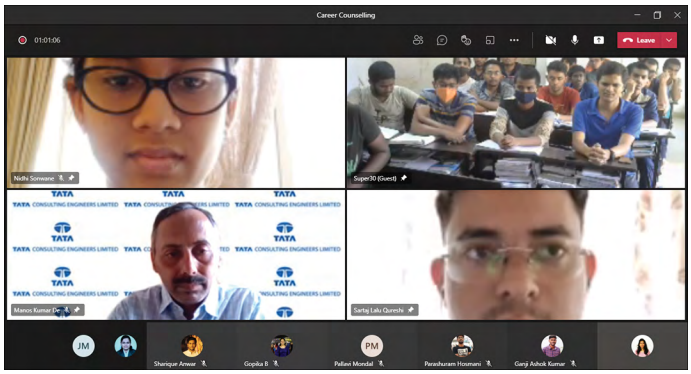


Martyrs Day Celebration

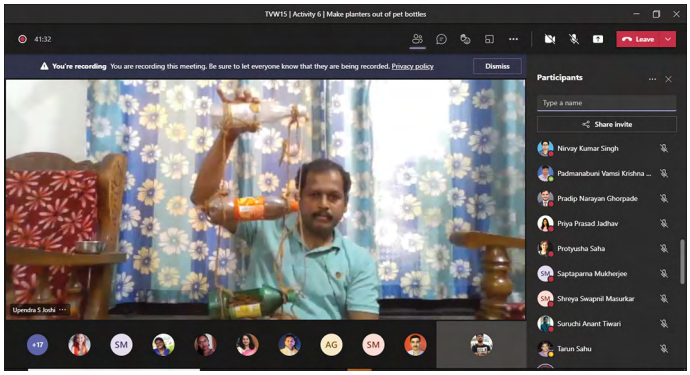
Lunch with Orphanage Kids



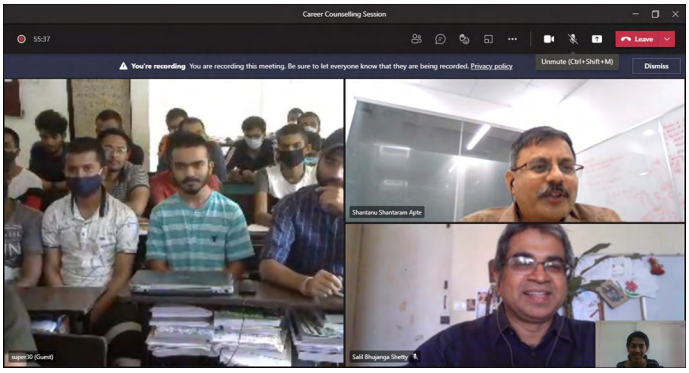
Safety Day Celebration



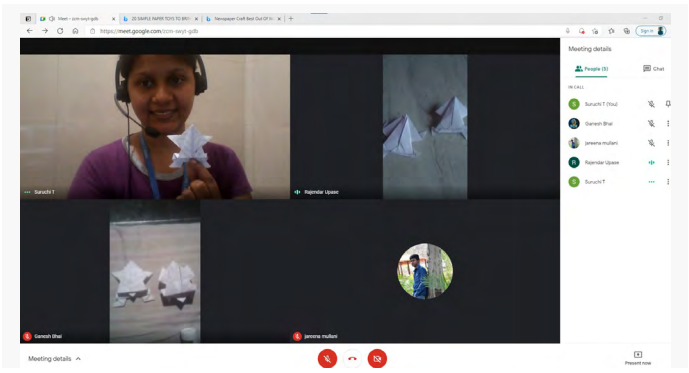
E-mentoring



Making Planters from Pet Bottles



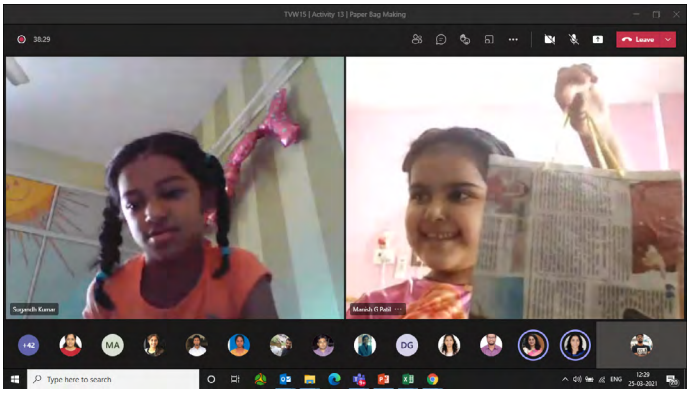
Career Counselling - Super 30 Students



Best Out of Waste

Plantation Drive

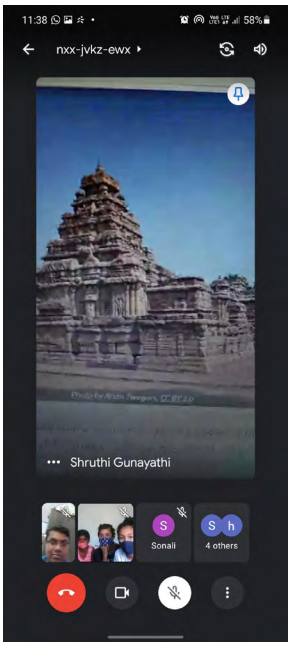
Donation of Meal at Orphanage



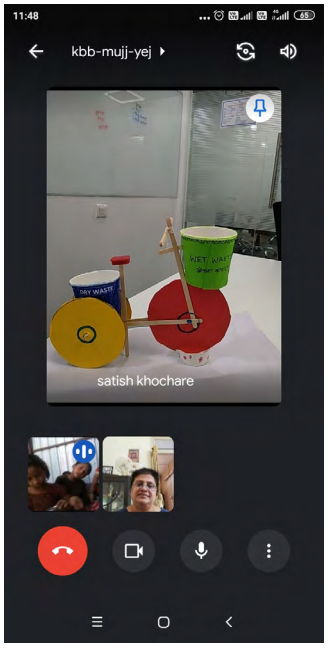
Paper Bag Making

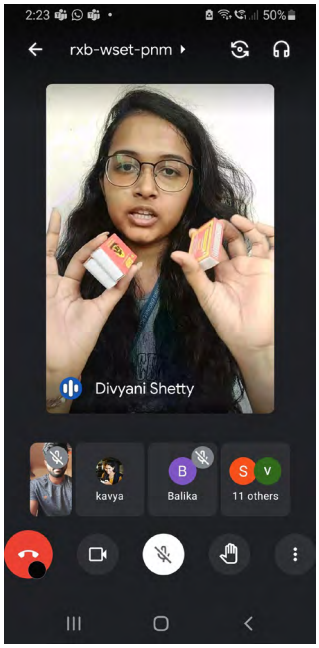
Best Out of Waste

Appreciation for TCE Frontliners

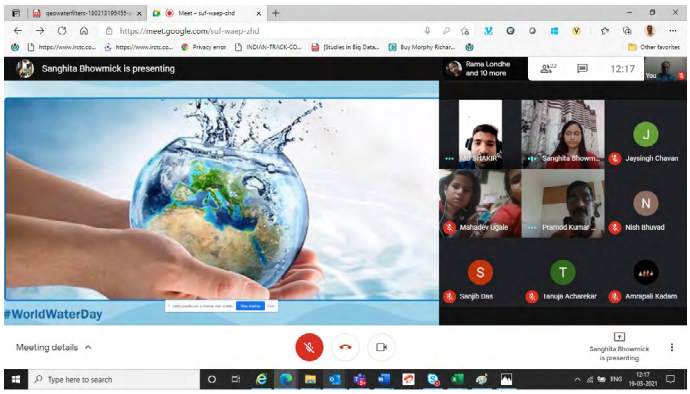


Virtual Heritage Tour

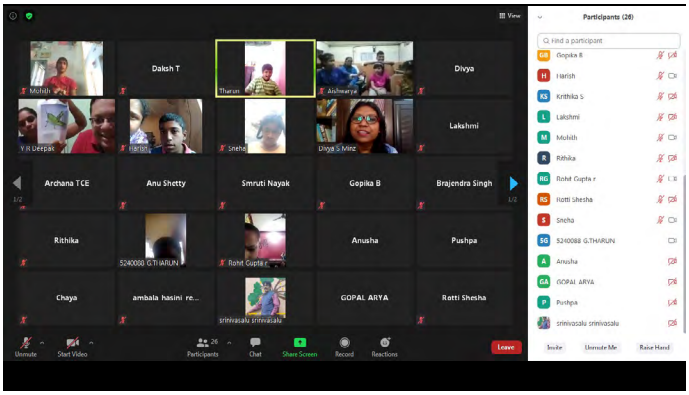




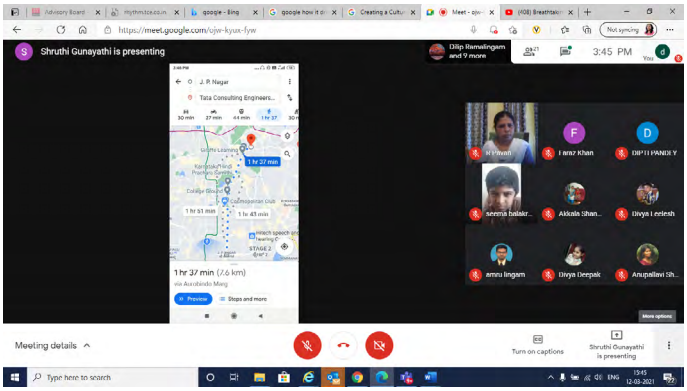
Best Out of Waste



World Water Day



Story Reading Session for Intellectually Disabled Students



Technology Awareness Session for Differently Abled Students

Drawing Competition

A BIG ROUND OF APPLAUSE TO ALL THE CHAMPIONS OF THE CAUSE!

THANK YOU FOR VOLUNTEERING WITH TIME, SKILL AND PASSION TO HELP US IN SHATTERING THE STATUS QUO!

Mr. Raghavan, a senior leader, invested 27 hours and guided students of an orphanage on evaluating various career options and choosing the one most suited for them. He also spent quality time with the students and delivered a lecture while hosting an essay competition

RESPONSIBLE LEADER

R RAGHAVAN

Associate Vice President,
Head of Delivery, Power Business,
TATA Consulting Engineers Limited

1: Quality 2: ABAC 3: CSR 4: SOFTWARE 5: GIFT 6: POSH 7: SHE For #DecodeTheCode, refer page number 118.

In remembrance of our beloved employees who lost their lives fighting COVID-19


Mr Sandip Panda


Mr Sudhindra Gururaja


Mr Arnab Mitra


Mr Vishnu Babu Nair


Mr Shailesh Kumar Agarwal


Ms Kirti Sadarjoshi


Mr Rajesh Nimbhorkar

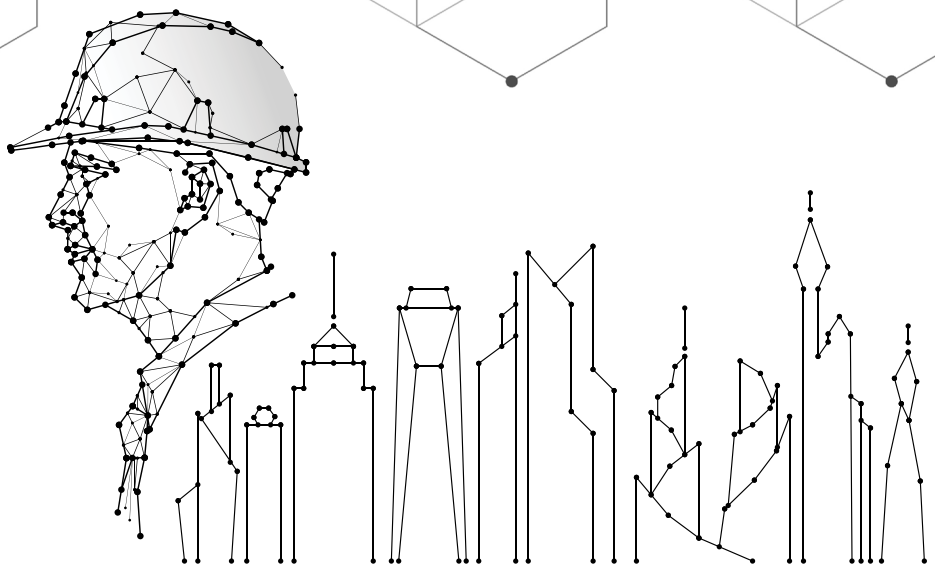

Mr Nitin Borse


Mr Ashish Kumar Swarnkar


Mr Amit Kumar

We miss you...

Though words can do little, our thoughts and prayers are with the families.



VISION

To be an internationally respected engineering consultant offering comprehensive solutions

MISSION

Provide technically excellent and innovative solutions, for adding value for all stakeholders, and operate globally as professional consulting engineers

CORE VALUES

- Customer Satisfaction and Loyalty
- Technical excellence with professional ethics
- Responsibility to society
- Employee dignity and self-respect
- Organisational and individual growth

TATA

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Engineering a Better Tomorrow Since 1962

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