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CII Foreword

Engineering and construction are vehicles for the technological and infrastructure progress. A strong infrastructural backbone is essential to sustainable economic growth. The government’s focus on infrastructure development is evident from the Honorable Prime Minister’s remark in Brisbane, “We must focus on generation-next infrastructure”. Infrastructure growth holds the key to the engineering & construction equipment industry realizing its potential in India. Investment and implementation of key projects are key concerns of the engineering and construction equipment industry. Corrective measures and industry friendly policies of the government would greatly help for the infrastructure development in the country. This summit is focused on tabling the challenges and discussing ways to achieve accelerated growth and utilize the opportunities that lie ahead.

Construction and Engineering are fields, which heavily compliment each other. Engineers provide both skilled manpower and trained talented human resources to the construction sector. They also develop several raw materials and provide technological inputs that further spark innovation in the same.

Undoubtedly, engineering and construction sector’s future outlook is promising. Drivers like power projects, other infrastructure development activities, industrial growth and favorable policy regulations will drive growth. While the opportunity for India is significant, it would require a determined and effective execution of developmental plans to emulate some of the other successful high growth countries.

Last but not least, I want to thank Summit Steering Committee, our speakers, facilitators and participants for their participation and for helping us to better articulate an opportunity and vision for the future of engineering and construction. The Summit was well attended by over 200 delegates from 105 esteemed organizations.

Mr. Ashwin Gandhi
Chairman
CII Central Gujarat Zonal Council & Director, Express Group
“The reasonable man adapts himself to the world; the unreasonable one persists in trying to adapt the world to himself. Therefore, all progress depends on the unreasonable man.”
George Bernard Shaw

We are pleased to bring to you this exclusive proceeding report on the Engineering & Construction Summit organized by Confederation of Indian Industries – Central Gujarat Region.

Change, and the massive opportunities it brings, only increases in pace as time goes by. Ability to drive and manage change lies with the unreasonable ones who aspire to craft a world which is more livable. This summit and report intends to provide a platform to all the unreasonable and forward looking people who with the tools – techniques and concepts of engineering and construction look to maximize their potential.

The opportunity is to construct a coherent and viable future. We must integrate, collaborate, pool resources, share information, and work together with the widest range of partners, to make the most of our opportunities. Here, we set out the ideas on the same which were bounced upon during the event.

The domain of Engineering and Construction in the Central Gujarat region has a rich heritage stretching back to 1800s. The region has consistently given engineers to innovate, work together and influence society and to engineer a better world. We recognize that the changing world has created the need for viable route to sharing knowledge. While the last 150 years have seen change in the fundamental of engineering and construction, the next 20 years will require a radical re-think about how best it can serve society.
Let's be open. Change will come whatever we do. The world will not stand still. We can neither prevent nor control change. What we can do, however, is position ourselves to maximize the opportunities it brings.

The world is changing, but the need for impartial, trusted advice from an expert engineering community has never been greater. The vision of Engineering and Construction Sector success of the region will be achieved only with the help of the people that live, study and work here – our universities, schools, communities, third sector partners and businesses. They bring the innovation, creativity, ideas and ingenuity that will enable us to share a better, more sustainable future.

On behalf of the Team Faber, I would like to express my sincere thanks to the Confederation of Indian Industries for providing this opportunity and all the participants of the summit who have worked closely with us to arrive at this proceeding report. I would welcome your view on the report to help shape future of Engineering and Construction Sector in the region. If you have any comments, I would be keen to hear from you.

Let's engineer a better world, together!
The Thanjavur Brihadeeswarar temple
Karnataka
Background

The history of India defines many facets of its culture and progression over the centuries. Beginning of engineering and construction in the country can be dated back to pre-historic times.

Actual inception of Indian history begins from the Indus Valley Civilization. Types of engineering such as Irrigation engineering, Transportation engineering were also established during this period. The history of India began since then and it correlates with the rest civilizations thereafter.

Throughout the period of 3000 BCE - 1500 BCE, urban cities developed and included advanced developments for that time, such as brick houses, drainage systems, water harvesting, sanitation systems and many more.

The Indus valley civilization achieved great accuracy in measuring length, mass, and time. They were among the first to develop a system of uniform weights and measures. Their smallest division, which is marked on an ivory scale was approximately 1.704 mm. Harappan engineers followed the decimal division of measurement for all practical purposes, including the measurement of mass. They evolved some new techniques in metallurgy and produced copper, bronze, lead and tin. The engineering skill of the Harappans was remarkable, especially in building docks.

Several examples can be listed where India has done marvels as far as engineering and construction sector is concerned like Konark’s Sun temple, Sanchi temple, Hoysala architecture, Taj Mahal, Mountain railways of India, Chenab Bridge and others. To quote a couple,
'The Thanjavur Brihadeeswarar temple', an architectural wonder that has stood for a little over a thousand years. The entire temple is made of granite; the closest known source was about 60km away. The tower, or the vimana stands at 66m, one of the tallest of its kind. The greatest feat in the construction must be the capstone at the top of the tower - carved out a single block of granite, the massive bulb weighs about 80 tonnes. It was taken to the top using an inclined plane that stretched for over 6km.

‘The Iron Pillar of Delhi’, which stands as high as 7.21 m with 1.12 m below the ground is estimated to weigh more than six tonnes. The pillar has attracted the attention of archaeologists and materials scientists and has been called "a testament to the skill of ancient Indian blacksmiths" because of its high resistance to corrosion. The corrosion resistance results from an even layer of crystalline iron hydrogen phosphate forming on the high phosphorus content iron, which serves to protect it from the effects of the local Delhi climate.
**Current Scenario**

Central Gujarat region commands a special place in India. Several factors like raw material availability, product demand, and skillful mobilization of human, financial and material resources by the government and private entrepreneurs have contributed for it to become one of India’s foremost industrial centers. The discovery of oil and gas in Ankleshwar and it being at the center of action has led to the industrial development in a big way.

The region is set to emerge as one of the largest global engineering hub as well as highly established construction hub. It pioneered well before modern times as seat for engineering and construction, which in years has participated in growth of India with various offerings.

The region is now also known as the ‘Gateway to the Golden Corridor’, as all the rail and road arteries that link Delhi, Mumbai and Ahmedabad also connect the region, including the Delhi Mumbai Industrial Corridor (DMIC). It will be at the fulcrum point of DMIC.

The Vadodara region is the largest beneficiary in the process of this industrialization. In Vadodara various large-scale industries have come up in the vicinity of Gujarat Refinery and all of them are dependent on it for their fuel and feedstock.

The establishment of large industrial units in a region automatically brings into existence a number of smaller enterprises. The region is no exception and is today humming with industrial activity.

Considering the trend, industries of the Central Gujarat region could participate in the growth of India and help to retain the position in engineering and also build diverse and ancillary industries. It could also facilitate these by delineating such zones (Special Education Zones) and seeking support from the state government in attracting investments.
The Indian Engineering sector has witnessed a remarkable growth over the last few years driven by increased investments in infrastructure and industrial production. The engineering sector, being closely associated with the manufacturing and infrastructure sectors of the economy, is of strategic importance to the economy. Growth in the sector is driven by various sub-sectors such as infrastructure, power, steel, automotive, oil and gas, consumer durables etc.

India on its quest to become a global superpower has made significant strides towards the development of its engineering sector. The government has appointed the Engineering Export Promotion Council (EEPC) to be the apex body in charge of promotion of engineering goods, products and services from India. India exports transport equipment, capital goods, other machinery/equipment and light engineering products such as castings, forgings and fasteners to various countries of the world.

Coupled with favorable regulatory policies and growth in the manufacturing sector, many foreign players have started to invest in the country.

India recently became a permanent member of the Washington Accord (WA) on June 13, 2014. The country now joins an exclusive group of 17 countries that are permanent signatories of the WA, an elite international agreement on engineering studies and mobility of engineers.

Driven by strong demand for engineering goods, exports from India registered a double-digit growth at more than 10%. This growth can be credited to the robust expansion in shipments of aircraft, spacecraft parts and automobiles. The second best performing sector was non-ferrous metals and metal products.
Engineering exports from India are expected to cross US$ 70 billion in FY 15 registering a growth of 15 per cent over the previous fiscal, as demand in key markets such as the US and the UAE is on the rise. Apart from these traditional markets, markets in Eastern and Central European countries also hold huge promise.

India exports its engineering goods mostly to the US and Europe, which accounts for over 60 per cent of the total exports. Recently, India's engineering exports to Japan and South Korea have also increased with shipments to these two countries rising by 16 and 60 per cent respectively.

The engineering sector in India attracts immense interest from foreign players as it enjoys a comparative advantage in terms of manufacturing costs, technology and innovation.

The foreign direct investment (FDI) inflows into India's miscellaneous mechanical and engineering industries during April 2000 to January 2015 stood at around US$ 3,948.17 million, as per data released by the Department of Industries Policy and Promotion (DIPP).

Current spending on engineering services is projected to increase to US$ 1.1 trillion by 2020. With development in associated sectors such as automotive, industrial goods and infrastructure, coupled with a well-developed technical human resources pool, engineering exports are expected to touch US$ 120 billion by 2016-17.

Also, the Union Budget 2014-15 has allocated funds for several infrastructure projects, which are further expected to provide a boost to the engineering sector. The industry can also look forward to deriving revenues from newer services and from newer geographies with Big Data, Cloud and Internet of Things becoming a reality.
Chand Baori - Rajasthan
A key driver of the economy, Infrastructure or Construction is highly responsible for propelling India’s overall development. The industry enjoys intense focus from the top officials of the government for initiating policies that would ensure time-bound creation of world-class infrastructure in the country. This sector includes power, bridges, dams, roads and urban infrastructure development.

The Indian power sector has an investment potential of, providing immense opportunities in power generation, distribution, transmission and equipment. India is witnessing significant interest from international investors in the infrastructure space. Many Spanish companies are keen on collaborating with India on infrastructure, high-speed trains, renewable energy and developing smart cities.

The total approximate earnings of Indian Railways on originating basis during FY 2014-15 were Rs 1,57,880 crore (US$ 23.76 billion) compared with Rs 1,40,761 crore (US$ 21.19 billion) in FY 2013-14, registering an increase of 12.2 per cent. The total approximate earnings from goods during FY 2014-15 were Rs 1,07,074 crore (US$ 16.17 billion) compared with Rs 93,476 crore (US$ 14.07 billion) in FY 2014-15, an increase of 14.5 per cent.

The number of export and import containers moving through major ports in India expanded 7.34 percent year-over-year from April to October 2014. Foreign direct investment (FDI) received in construction development sector from April 2000 to June 2015 stood at US$ 24.09 billion, according to the Department of Industrial Policy and Promotion (DIPP).
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Engineering & Construction Summit 2015 focused on the theme “Engineering – The Way Forward in Construction” and covered key areas such as:

- Mega Trends -Engineering & Construction
- Engineering Overview-Best practices to overcome the Flaw
- Innovation in Construction Balancing Environment
- Transformation in Protection Weathering & Paint
- Re- Engineering Transformation Jugaad
- Challenges to Delivery-Proactive or Reactive
- Typical Cost Overrun & Contract Conditions
- Innovative Design Engineering & Construction
- Construction Method, Safety & Audits
- Exclusive EXCON 2015 Roadshow
This summit witnessed participation from select group of CEO’s & MD's, Policy Makers, Unit/Plant Heads, Engineers, Professionals, Executives, Leaders, Corporate Representative, Practicing Managers & Executives from a wide range of Industry like Transport, Defense, Explosives, Manufacturing, Electricity Boards, Railways, Power, Energy, Cement, Steel, Sugar, Distilleries, Hotel, Refineries, Pharmaceuticals, Paper, Automobiles, Fertilizers, Chemical, Petrochemicals, Petroleum and Natural Gas, Service and others.

The ‘Make in India’ campaign by the Prime Minister of India, to the world market is set to expand business in India where various conglomerates & corporations would look to expand their current facility as well as set up new to implement their manufacturing hub in India. Engineering and Construction are the major contributors in the industrial growth of the economy thereby enabling to grow the economy. The Indian Engineering and construction has witnessed a remarkable growth over the last few years driven by increased investments in infrastructure and industrial production.

This Summit had deliberately covered the needs of ‘Make in India’ campaign, all the speakers were experienced and experts from different industries. They raised various issues in the sector that are being faced now a days, and also identified the bottlenecks and discussed about reducing the same enabling achieving productivity with consistent quality, meeting the requirements of both domestic and international markets to most optimum acceptable standards.
Globalization where experience to innovate add relevance to Engineering Implementation is now an important role in deliverance for humans to attain a better life. Modern Engineering Methods provide significant contribution from various disciplines of Engineering. Indian Engineering Sector has marched to the level of being one of the major contributors in world. In order to add finesse to current Engineering Practices, it is important to evolve to the next step of Global Exchange. Where the world has embarked to make living of humans more comfortable, Engineering also has a significant role in delivering what is Constructed either in form of Homes, Roads or Super Highways including Power Plant installation or Industry. Mankind has achieved most practical end solution without eliminating the understanding and use of Modern Engineering Methods resulting to Best Construction Practices, integrating skills from across boundaries thereby leading to Global Exchange which forms a significant important role in Modern Engineering Practices.

The plenary had included the important decision makers with experience in Engineering & Construction and those who had the matter to give an overview for significant path to all Practicing Engineers, Manager and Industry leaders.
Engineering and Construction sectors are growing at its peak in this growing Indian Economy. All the traditional technology has become obsolete and Automation - Technology is growing faster. This has reduced the barriers and bottlenecks of both industries. This new era of technology has brought in increased business opportunities, change in the customer requirement/ demand, which leads to mergers and acquisition in India and around the world.

As far as infrastructure of India is concerned, it has also achieved an incremental growth and has also reduced the barriers to achieve the excellence in this sector. Following are some of the pointers, which can describe the same:

- Government has taken certain initiatives like the project of Chenab Bridge, building of metro stations with best amenities, increasing the no of highways and others.
- Engineering and construction sectors are now full of equipped tools, which may lead to excellence in both the sectors.
- India’s 12th five-year plan has estimated 1 trillion dollar investment for Engineering and Construction sector.
- Expected future growth of Engineering and Construction Sector is 7.2%
- It is estimated that 20 billion dollar turnover will be there till 2020 in India
- Indian government is currently spending INR 399852 crores on construction of highways

India should focus on the key drivers, which can help the Indian Economy to grow at faster pace. Couple of the key drivers is Power Projects and Policy Regulations.
We as Engineers are unique. On a lighter note, ‘Engineers love to solve problems, if there is no problem we create it.’

Each and every engineer is unique and we love to struggle and face as many challenges that come our way. Our creativity and uniqueness is our tool to create the world that we see around us. They have the power, tools and resources to turn a dream into the reality.

As far as growth of both the sectors is concerned, yes we can say that both are growing but the pace of the growth is steady. We as an engineer need to understand the gap between incremental growth and exponential growth and also try to reduce the gap eliminating the waste of resources.

The way we can achieve excellence is optimizing the use of resources without wasting it and implement correct tools for the same. We have to excel what we are, try to improve upon our weaknesses and be the change. This is the only clear path to excellence via continuous learning.

Today each and every citizen is contributing towards excellence and the end result of it is government taking the initiative to build 100 smart cities in India with all the modern facilities and amenities which can be comparative with the countries across the world.

Noticeable improvements are done in terms of road broadening, power projects, water logging and many more. However adequate attention needs to give to overcome the disruptive technology leading to development in the sector as a whole.
‘Change is the only constant we have in this globe. Change is inevitable. However, change begins from you – ‘within you’. It needs determination, dedication and efforts to bring change. Same thing will go in case of Lean. If you want to implement the change you have to start with you. Lean yourself - inside you to improve the scenario outside. Knowledge sharing is the next generation. Knowledge is the only wealth, which will increase if you share with others. And continuous learning is the path, which can lead to success.

Engineering and Construction sector has seen marvels as far as technology is concerned. The journey has been started by bullock carts and now it has reached to the next generation metro trains and it is endless. As far as our organization is concerned, we have been in the domain of technology excellence. Our current projects are also technological advanced and will bring a better life to our society. It includes: Bus Terminal, Bhuj Resort (It was a government property which was transformed into a well-designed resort as a part of PPP project) and we are working on the Slum development programme with government. We have used the state of the art technology for the constructing these projects.

Diversify yourself and your company for the betterment of the society. Both public and private sector are working for the development of the nation as a whole. If these sectors come under the partnership and work together the development can be quick and the whole society will be benefited. If private sector can contribute for the society as well then development can be more accurate and fast as compare to the current one. Therefore every engineer should start thinking in the same lines, this will surely lead the whole society towards development and progress.

Chairman and Managing Director, Cube Construction Engineering Ltd.

Mr. Sanjay C Shah
Implementation is the major aspect for excellence deliverance as far as Engineering and Construction is concerned. India has several examples where it can prove this statement. Few of the examples are campaigns like ‘Make in India’, ‘Digital India’, ‘Startup India’ and so on.

Our Prime Minister has taken the initiative to drive India towards being Super Power by introducing the Make in India Campaign. Today India is experiencing sustainable growth but, we need to transform this into exponential growth. That can be achieved by adapting the technology, which are being used globally.

Engineering and Construction sector are closely related to manufacturing and IT companies which can together lead India towards becoming super power. For this we have to focus on the key areas, which are
Business excellence, Technology up gradation, Entrepreneurship

India is having a wealth of young and dynamic engineers. So India can take a turn and should start encouraging the young engineers towards entrepreneurship. As today, nationally entrepreneurs are changing their approach to work and adapting news ways of working.

To be globally competitive, India will have to undertake certain steps:
- Adapt to new technology, new regulations system and best equipment across the globe.
- Encourage the foreign companies to invest in Indian Engineering and Technology Industries.
- Facilitate new insights and ideas to make this sector effective and efficient.
- Track the processes at each and every level in every organization.
- Maintain the health & safety of each employee.
- Encourage the new working patterns and upcoming trends in the world.

All the above efforts will make Engineering and construction sector profitable, sustainable and at the same time make India a super power in the coming future.
India is a growing economy, but as compare to the growth of other countries it is still lagging behind. The reason behind the same is that the people in India do not believe in Benchmarking. Benchmarking is the best practice as far as global competition is concerned. So one needs to Benchmark self with the global practices.

This practice can lead to many opportunities, which can make money and bring in business into India. The total GDP of the world is approximately 73 trillion USD in which India is contributing only 3-4%. So we need to find opportunity for the exponential growth.

Engineering Excellence itself means to build the best practice. And to identify the best practices across the globe benchmarking is important. Today in this 21st century the major role of the society is to be sustainable and then move towards exponential growth. The prime method to attain the exponential growth is to reduce the usage of resources as the availability is reducing.

So can you reduce the usage of resources? The answer is no so we have find the ways to increase the availability of the resources rather than strategies to reduce the usage. As resource neutral society is the future in each and every sector, be it engineering or construction or any other.
India needs to develop the construction sector for becoming super power economy. In order to achieve the above certain steps should be taken:

- Quality control practices should be focused more in every industry.
- If not six layered quality control system adopted by the IT majors in the country, at least three tiered quality control system should be deployed
- At each and every stage of the organizations Quality control should be implemented i.e from the operations level to the top management.

If the above standards are maintained then anything which is built shall last longer for sure.

As far as our company is concern it has initiated various technics:

- Proofing Area
- Water soluble chemistry (It absorbs water in every surface without blocking).
- Flexible concrete.

Roads of India are not good quality roads because the quality of material used and also the concrete used is not water resistant. Water resistance is one of the key features to be considered and hence, water resistant roads should be made and that can be built by deploying concepts of surface chemistry. Technology should be adapted that will make the soil water resistance and so that it can be used in construction of ‘Green roads’. And this is where the engineering excellence comes in where nanotechnology can be used to construct the same. The end result of the same shall improve the quality of roads and highways.

Innovation, quality control & Lean are the three pillars for the successful engineering and construction sector.
He is chairman of MHI since past 5 Years in India. It is the same company that manufactured state of the art Japanese Zero Fighter Plane.

India is very renowned in manufacturing sector and so it can invite as many company as it can for Make in India Campaign to be successful. India has an incremental growth in the domestic engineering sector.

Further construction sector is the second largest sector after agriculture. India has great potential in construction sector specifically in last 1 year; it has grown in infrastructure sector. In 2014 alone, construction sector in India has seen investment of 157 Billion USD. 1 trillion USD was invested for the roads and infrastructure.

As per one of the Goldmann Sachs report, India is estimated to grow at 8% from 2016 – 2020. Manufacturing sector is also seeing an incremental growth in India. India has several opportunities for its stakeholders as far as ‘Make in India’ Campaign is concerned.

Mr. Kubo further noted that Engineering and Construction sector is key driver of the growth in India for the Globalization to take place and also to be competitive with other countries across the globe. He lauded the efforts of CII and the Central Gujarat region.
India is at the forefront of the development in the Indian Economy and the 12th five-year plan is more focused on the Engineering and Construction sector. The future of this sector looks positive and next 5-10 years are promising as far as the growth is concerned.

Now a days, the perspective of the economy is changing globally. Hence, the most important thing is timely delivery along with the quality products.

Following are key areas of focus related to engineering and construction sector:

• Customization
• Re-engineering
• Innovation
• Standardization
• Human resource

Standardization and providing the correct manpower will make the country more competitive. India will have more potential for both the sectors. However the biggest challenge for the infrastructure is the cost of money. The Government Policies, which are blocking the growth potentials in the country, should be relooked.
Engineering as generally understood by all is not just Tin Bashing or Turning a Screw in a Metal Plate, neither it covers enumeration of lines to depict an artist’s designs culminating into multiple lines known as drawings, while a lot more goes with it, till a final product is delivered - in an effort to reach what goes from concept to commissioning or deliverables. As technologies emerge with new dimensions, standards and concepts have been redefined all over the changing world with new definitions of Global Benchmark.

State of the art global deliverables have become Mega Trends - the most important facet starting from Engineering and implementing the same in Construction domains. The Mega Trends of Global Benchmark need to be leveraged with latest technology and methods, thereby enabling to meet the challenges of ever-growing technological upgrade and with a view we visit the best practices where we eliminate the flaw, which happens in meeting this challenge.

This session set the path for all to achieve the Global Benchmark that is contributed by the Indian Industry towards its best practices in Engineering & achieve the most optimum deliverable in case of Construction.
Presence of flaws will be present in each and every stage of any organization - flaws in products, processes, key performance indicators or health and safety. However, how to improve the flaw is a major task. Following are some of the methods for the same Systematic Problem solving method can be adopted for solving the problem with the common language for continual improvement approach to be implemented. Standard Improvement methodology for sustainable results should be maintain to reduce flaw. Another tool is Management by problem solving which is also known as Management by objectives in management terminology and spread the culture of continual improvement in any organization.

Many problem-solving methodologies can be implemented in order to eliminate the flaws. Few of them are Six Sigma, A3/ 8D/ Quality Circles, Kaizen, PDCA: Plan-Do-Check-Act by Dr. Edward Deming, Lean Production (Toyota Production System) – Removing non-value adding wastes, Theory of Constraints (TOC) and many more methodologies are reduce in several organizations.

At ABB, we adopted the four-quadrant methodology to solve a particular problem, which is also called as 4Q process:

**4Q PROCESS**

1. **Measure**
   - Define opportunity.
   - Investigate to understand the current state in detail.

2. **Analyze**
   - Identify and confirm root causes of the problem.

3. **Improve**
   - Develop, pilot, and implement solutions that eliminate root causes.

4. **Sustain**
   - Maintain the improvements by standardizing the work methods or processes.
This 4Q process can be compared with the other problem solving methodologies, which can be described as follows:

<table>
<thead>
<tr>
<th>4Q</th>
<th>PDCA</th>
<th>DMAIC</th>
<th>GLOBAL-8D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre 4Q</td>
<td>Plan</td>
<td>Define</td>
<td>0-Plan</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>1. Identify team</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>2. Define problem</td>
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<td></td>
<td></td>
<td></td>
<td>3. Contain symptom</td>
</tr>
<tr>
<td>Measure</td>
<td></td>
<td>Measure</td>
<td>4. Identify root causes</td>
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<tr>
<td>Analyze</td>
<td></td>
<td>Analyse</td>
<td></td>
</tr>
<tr>
<td>Improve</td>
<td>Do</td>
<td>Improve</td>
<td>5. Choose corrective action</td>
</tr>
<tr>
<td></td>
<td>Check</td>
<td></td>
<td>6. Implement corrective action</td>
</tr>
<tr>
<td>Sustain</td>
<td>Act</td>
<td>Control</td>
<td>7. Make change permanent</td>
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<td>8. Recognise the team</td>
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</table>

The next stage of the problem solving is what triggers the solution. There are different aspects and concepts that help the solution to trigger. What triggers this methodology of problem solving?
- Voice of the customer- Customer Complaints
- Voice of the Process – Gemba (Real place of work) Round
- Voice of Business – COPQ (cost of poor quality) or KPI (Key Performance Indicator)
- OHS - Occupational Health & Safety e.g. Accident
Why to use 4Q process in engineering and construction sector?
The answer of the above question is simple for the continuous improvement in any organization. Continuous improvements from repeated use of 4Q will the organization towards the excellence and reduction of flaw in each process. It also helps in fast flawless execution in entire value chain with the major tool of cost savings and a structured way to achieve targets as well for achieving the continuous improvement.

How 4Q Process Works?
There are majorly four steps for the 4Q process which are as follows:

1. Tools of 4Q
There are several tools for the 4Q process
Quadrant 1 includes Pareto Analysis, histogram, check list, control chart
Quadrant 2 includes Fish bone Diagram (Ishikawa Diagram), 5 whys, Brain storming, Value Stream Mapping
Quadrant 3 includes Brain Storming, Five S (Sorting - Set in order - Sweeping - Standardizing - Sustain), 7 wastes or Mudas and Kaizen, Constraint Management, Pull system, Action lists
Quadrant 4 includes Standardization, control charts, Visual Management, PokaYoke, Training

2. Output of 4Q
Quadrant 1 refers to Clear view of what is the problem
Quadrant 2 refers to the Root cause of the problem
Quadrant 3 refers to the New Process implemented & means for continuing improvement
3. Documentation from 4Q
Quadrant 1 includes Historical data
Quadrant 2 includes Data Analysis, Root Cause Analysis
Quadrant 3 includes Pilot Measurement, action lists, new process
Quadrant 4 includes Measurement data

4. Change Management for 4Q
Quadrant 1 includes Convince people to do measurements
Quadrant 2 includes Brainstorming with open mind
Quadrant 3 includes Explain why we need to test new processes
Quadrant 4 includes Sustain new ways of working

For carrying out 4Q process it needs a Team Process which will be common for all the team members, a team leader to have a helicopter view on the whole team and involvement of each and every team member because it is not a one-man show, but total involvement of all required for the successful implementation of this process.

End results of 4Q process includes Customer satisfaction for the concerned product, Increased Market share and Reduced order to cash cycle time which will lead to increase in profit.
Practical example of 4Q process is as follows:

<table>
<thead>
<tr>
<th>Q 1: Measure - Understand the current state</th>
<th>Q 2: Analyze-pin point and verify root causes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Goal : .15%</td>
<td>1. Coil winding errors (crimping defects / Wrong strip used)</td>
</tr>
<tr>
<td>By When : 2008</td>
<td>2. Low Torque on LV connections.</td>
</tr>
<tr>
<td>Responsible: Penberthy</td>
<td>3. High and inconsistent resistance measurements on LV bus and ring terminals for 400-600mcm copper cable.</td>
</tr>
<tr>
<td></td>
<td>4. Poorly crimped dragon teeth connectors for HV coil connections.</td>
</tr>
</tbody>
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<thead>
<tr>
<th>Q 4: Sustain - Implement &amp; Institutionalise</th>
<th>Q 3: Improve - Pilot Solutions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Is all planned actions completed ?</td>
<td>What Action</td>
</tr>
<tr>
<td>Yes</td>
<td>Coil winding process for material handling and checking wire / strip sizes – feedback given to supervision for review. Complete Miller</td>
</tr>
<tr>
<td>No</td>
<td>Continually checking new parts that purchasing is bringing in to ensure there are no resistance issues with them. Complete Penberthy</td>
</tr>
<tr>
<td>Is the result trend ( in Q1) moving towards the goal ?</td>
<td>(Previous Actions Complete and Q4 items created based on these actions - see Q4)</td>
</tr>
</tbody>
</table>

Cultural change in each stage of the organization is to be implemented and mindset of the people should be to change then only we can solve any problem or bring the change in any organization.
Today innovation is required in private construction, public construction and infrastructure. For innovation, it is also important to check the environment whether it will accept innovation or not and hence environment-balancing innovation is required.

There are various factors that are affecting the environment like Carbon emission, Solid waste/Water pollution and Noise pollution.

The ways to protect the environment from all of the above factors is to reduce the carbon emissions, zero waste campus and energy independent buildings. In order to save human life from the natural calamities like earthquakes, the need is to build the earthquake resistant buildings that have to be low budget and high performance.

The salient features of structures built are Earth Quake Resistant Structure, Reduction in Weight up to 40%, 30% Saving in Energy Consumption, Carpet Area to Build up Area 0.8 : 1, Use of Innovative Building Materials have increased, Natural Cooling System are adapted, and Flexible roofing will improve the structure of any building in coming future.

The college in Kakanpur is Zero Waste Campus where all the above features are used leading to 100% Conversion of Waste into Energy. In the hostel campus Rain Water is Harvested, Toilet is connected to Digester, Bathroom/Kitchen Water is used for Irrigation and Biodegradable Solid Waste is composted.
Even APMC of Vadodara has received the following benefits:

- Disposal of 2 Tons Vegetable Waste per day, which was a burning problem
- To Day Same Waste Has Become Source Of Energy
- The Gas Produced From Digester Runs 20 K.W. Generator
- Manure Is Sold At 5 Rs/Kg To Farmers
- Entire Waste Water Is Used In Digester To Maintain Solid/Water Ratio
Further adding to this government has taken the initiative and hence Engineering Seva Trust has submitted a proposal for constructing and maintaining 100 smart cities in India. They have estimated that if one engineer is allotted one acre land in the center of one lac population & the cost incurred by government for disposal of waste is paid as subsidy, he/ she can earn more than an engineer of a multinational company so let us convert problem in to opportunity and create an environment of collaborative efforts towards excellence and waste can be an employment generator which will ultimately solve the problem of unemployment in engineering sector.

For the further improvement of structure of the building, scope for the further innovation can be Solar Air Conditioning in the building, Structure Cooling/Heating tools should be identified and apply in practice, High Performance Insulation should be used, Weather Controlled Auto Window Closing should be implemented, Flexible Terrace Covering can be used to avoid the waste of the resources, Terrace Gardening should be done so that the temperature of the roof as well as the room is maintained and use of air condition can be reduced, Solar Charging Of Vehicles to save the fuel, Waste Water should be used for Recharging Roads and Micro Level Processing of Waste should also be undertaken, so that at each and every level waste of resources can be reduced for the coming next generations.

The major challenge for our country is that in spiritually illiterate country, corruption has major effect on decision-making. However we have to continue our efforts in order to fulfill the objective of making India a Super power.
Transformation in Protection Weathering & Paint

Engineering and Construction sector is also related to the high performance building which includes coating of walls with good quality of paint.

ISO 4618-1 defines paint as ‘A pigmented coating material in liquid or paste or powder form which when applied to a substrate forms an opaque film having protective, decorative or specific technical properties’. This paint will get affected by corrosion. Corrosion is a natural electrochemical phenomenon, which takes place between the surface, and the environment. Downtime of the equipment is increased due to corrosion, which will result in Degradation of Metals, Formation of Oxides / Salts and Erosion.

In order to project our high performance building we need to provide concrete protection with good quality of material. However, concrete structures deteriorate with time because of two reasons - High humidity and Contaminants like Salts, Carbon dioxides, Chlorides. We need to protect it with metal, as corrosion is the oxidation of a metal due to an electrochemical reaction. And if corrosion is caused then the replacement cost is huge. There are several other cost of corrosion and it caused economic and safety losses which includes Reduced Strength, Downtime of equipment, Escape of fluids, lost surface properties, Reduces value of goods and Collapsing of structure.

Certain protection steps must be taken in order to protect them:

- Formation of non-porous film
- Barrier to moisture and chemicals
- Galvanic protection
- Elastomeric coating to address minor crack and stresses
- Abrasion resistance
For the above steps we need to have the modern coating system, which can project the concrete and project from corrosion. This modern coating system is to be implemented because it will lead to faster productivity, maintenance cost will be less which will lead to long term durability with high replacement cost and Complex environment which can be used for the betterment of the society as whole.

Every coin has two sides positive and negative. So there are several challenges and opportunities of this modern coating system also like Anti-reflective coating, Dirt repellent coating, Self-healing coatings, Cool coatings, Tar Free coatings, Anti-microbial coatings, Isocynate free coatings, Intumescent coating, Fire retardant coatings, Low smoke coatings and many more.

One of the examples of Modern Coating system is the upcoming Railway bridge of Chenab in Jammu and Kashmir which is coated with this modern coating system for protection against corrosion.
Productivity Driver or Blackholes Challenge to Delivery

As far as India is concerned, people here focus on how to improve output, but we are ignoring inputs. Output has major impact however; it is the end result of our inputs. And hence, we need to focus on improving our inputs. Another important factor is waste elimination. Productivity is not always about how to do things better but also about what not to do.

So we need to focus on waste elimination and change the structure and discipline in order to be the change.

For improvement in the organizational health, we need to bring the change. Change can either be proactive or reactive. We need to go for the proactive change i.e. to plan in advance. Don’t wait for the crisis/ market; change it before market forces it.

However, one time change is not sufficient we need to have continuous change, which will lead to improvement called as continuous improvement that will proceed towards going Lean.

The Lean mission is to develop leaders that live the lean system, transform the company into a true learning organization that continuously improves, meets the needs of its customers, and positions itself for long-term success.

Traditionally, improvement of quality has a negative impact on price and delivery time. But now things have changed, today Lean leads to higher quality, shorter delivery time and lower cost. Hence, to maintain the quality with lean implementation, it is important to change the culture and to implement it, we need to have effective leaders leading any organization to Lean enterprise.
Lean enterprise refers to no compromise on quality, delivery time is shorter and cost is also reduced. We should start implementing lean from the bottom line to eliminate waste and to increase profits leading to higher productivity and efficiency.

Each and every process of the operations adds value in the value chain and lean management has the potential to improve at each stage. If we implement lean management in the production, it may increase productivity by 10%. However, if the same is implemented at each and every stage, it will yield 10 times more results.
Panel Discussion: Engineering Tipping Point to Modern Construction

Engineering as generally understood by not only Design and Drawings but also as a continuous process - an adaption to new design and detail in the modern world. All practicing engineers generally understand the role and responsibility of their work and try to build around the available resources and culminating to make-to-do arrangements. In the modern world, it is essential to use latest techniques to conclude the end by adapting to the latest technology, which is generally defined as – Effective Engineering from Technology Adaption to Change and achieve results by using resources and expanding its utility. The next challenge, which emerges out of the same, is converting the Engineering to a Deliverable where Modern Technology, Machine and Adaption make it grow. This leads to the synergy of Engineering to Construction.

The session panel members with collective experience of over various disciplines of Engineering and Construction have successfully implemented Technology Adaptation achieving Effective Engineering Results. The panel discussion was the learning curve for audience to implement Effective Engineering with New & Emerging Technology where Engineering reaches Tipping Point to Achieve Modern Construction.
India has evolved itself from the old traditional engineering practices to the latest technology excellence and automation, from the handmade products to industrialization. Research and Development is less in India as compared to the other countries across the world. The need to improve our R & D efforts – collect information, increase our knowledge and utilizing it in our practices will aid India to become a growing economy.

Research and development is the fundamental point for India and we need to improve upon it to grow and excel in the international market.

Mr. Nitin Mankad
Past Chairman
CII Central Gujarat Zonal Council
Managing Director
Innovative Tyres & Tubes Ltd.
Indian government is turning its stone slowly and gradually towards the modern construction practices. Our Prime Minister Narendra Modi has the target of constructing more than 5 lakhs houses in the near future.

For the high performance building, flat slab system should be introduced with the modern coating system. The main objective of using this system is the completion of the project within the stipulated time.

Certain states have implemented the flat slab systems and have already experienced reduction in the construction time by almost 30-40%.

Power Build Pvt. Ltd. is one of the largest manufacturers of geared motors in India. They are manufacturing energy efficient motors and also drivers of equipment.

Today, we have developed from the old traditional simple motors to geared motors. It is use to reduce the speed and enhance the power of any machine.

As far as engineering sector is concerned, we should be more focused on eliminating waste and also reducing the cost and build an appropriate strategy. Day by day, the stretch of the product and expectation from the customer is increasing. Hence, we need to start practicing lean – making a quality product at the right cost and deliver on time and all the three factors should be maintained.

India has to be competitive across the globe for which competitive attributes have to be built in to lead the market globally. We should change our focus from domestic market to international market and still have to move further to ensure that the Indian product is competitive enough to compete in the global markets.
India has to produce the type of quality, which can be accepted worldwide. India has reached at its tipping point where it is growing with rate under 7.5%.

In the engineering growth, we are lagging behind as compared to the other countries. It is primarily because of the rework as quality standards are not maintained and customers are returning the product, which directly affects the budget and delivery timeline.

Not addressing the above issues on time, may lead to budget overrun, time overrun and dissatisfied stakeholders of any organization. Various advantages and benefits can be reaped if the concerns are identified well in advance. Issues, which need to be fixed during the project, should be estimated on the prior notes.

There is a lot difference between the theory taught in the colleges and the actual application or work in the industries. Change should be implemented in the academic syllabus such that organizations/industries should get people (employees) which are deployable on the sites.

There is a huge gap between the industries and study material of the engineers. Engineers lack skills in certain areas like Documentation, roles and responsibility, reliability and many others. If the documentations are properly implemented in each and every organization then it will add to the value adding activities of the industries.
• Efforts have to be put in and implementation should start to balance the academic syllabus and industrial practices so that the engineer is deployable as soon as he/she completes academics.
• Modern and latest updated study material should be introduced in the universities and educational institutions for engineers.
• Proper linkage should be generated in between the educational institutions and industries.
• Industries and the Universities should encourage the students for entrepreneurship for the development of the nation.
• Appropriate research facilities should be constructed and made available.
The single greatest challenge faced by owners & managers in the developed countries and those who are developing in the world is to raise the productivity of knowledge of those engaged in deliverance. This challenge, which will dominate the management agenda for the next several decades, will ultimately determine the competitive performance of companies.

Even more important, it will determine the very fabric of society and the quality of life in every industrialized nation. Now is the time for another productivity revolution. This time, however, history is on our side. In the past century, a lot has been learnt about productivity and how to raise it — enough to know that a revolution is required and, enough to know how to start one. However, the first questions in increasing productivity—and working smarter—have to be, ‘What is the task? What are we trying to accomplish? Why do it at all?’ The easiest, but perhaps also the greatest, productivity gains in such work will come from defining the task and especially from eliminating what does not need to be done and how not to overrun the cost.

Technical Plenary II: Challenges to Delivery - Proactive or Reactive
Cost overrun is the extra cost that customer is not willing to pay, or the cost which is wasted. The typical cost overrun in a contract/project has several elements of cost - Time, cost, quality, safety, risk and sales.

Sales phase are concerned with Client specifications & requirements, Nature of Products & Materials, Contract Terms, Environment and Penalty.

Expectation management has to be done keeping in mind the following things:
- Client
- Consultant
- Approving Authority
- Other Stake Holders

If risks are not well calculated then it will result in cost overrun and to avoid this proper planning is required which includes:

- Project Plan
- Cost Planning
- Risk Assessment
- Quality Plan
- Stake Holder Analysis
- Deployment of Right Resources
- Clarity of Roles & Responsibility

In Design Engineering, if resources are not well planned then it will lead to cost overrun. One needs to have the scope clarity so as to avoid failures and subsequent cost overrun.
Scope creeps is uncontrolled changes in a project scope. Reasons for Scope Creeps:

- Poor Change Control
- Lack of initial identification of Project objectives
- Weak project manager
- Poor communication between parties

Conclusion:
Any organisation should first understand what their client wants to achieve then they should take steps for the collaborative approach for the client but each client is unique so the solution may differ. Project scope should be defined well to avoid any confusion and every individual’s roles and responsibility should be cleared and lastly clear documentation of the scope should be prepared and maintained for the future use.

To control the cost overrun we should design the cost effective design rather than low cost design and also the quality of the products should be maintained. One needs to sense and identify the change taking place in the organisation.

There are various tools which can help any organization in controlling cost overruns which will ultimately lead towards the continuous improvement. It includes Cash Flow Management, Design Verification, Stake Holder Analysis, Periodic Review, Phase Gate Review, Change Management, Cost Control Chart, Multi Level Project Plan, RACI Matrix and many more.

85-95% is the cost out of which 80% is hardcore material cost. If it is managed well than cost overrun can be controlled and managed!
Today Engineering and Construction are adopting the collaborative approach and growing at high pace. Even then India is facing certain challenges and is lagging behind. Some of the challenges are:

- European Quality at Chinese price at Chinese speed
- Pressure to reduce cost, early delivery – Superior quality
- Value Engineering through Optimized Engineering solutions
- Unique Project requirements – lack of repeatability
- Material Wastages

In order to overcome the above challenges we need to adapt and integrate Engineering Design, Conventional Engineering & Construction Practices:
- Planning and Engineering – separate activities
- Construction – a separate activity
- Silo Working – Focus on Local Optima and absence of collaboration during planning phase
  - Engineers don’t visualize construction difficulties
  - Constructors’ difficulties not shared with engineers

Today innovation is very necessary as far as change management is concerned. Innovation which is happening in today’s engineering sector should be harnessed and the creativity and innovation should be deployed with the latest tools and equipment.

Engineering Innovations are as follows:

- 3D Environment for Integrated Engineering are used as far as modern engineering is concerned.
- Automation is a major tool for the engineering practices which includes timely delivery, consistent quality and process driven approach for any organization. A part from the practices and innovation, knowledge management is again an important tool which includes past experiences, construction feedback and lessons learnt.
In India there is a gap between the understanding of the workers who actually produce a machine and the engineers who design it. Hence, appropriate 2D/3D models can bridge this gap and bring in the clarity, further maintaining the roles and responsibilities as specially for the workers who are producing the machine or constructing a project.

Innovation in Engineering & Construction—A collaborative Way:

- Constructability review
- Virtual Intelligent Models - before construction

- Live Feed of site at Engineering centers
  - Live monitoring and speedy query resolution
  - Time optimization on local travel

- Engineering verifications for construction material availability to reduce wastages
- Repeatability of construction forms
- Placement and operation check for cranes

Project collaboration tools should be used for the successful implementation which includes common Database, integrated Engineering, intelligent 3D Models, intelligent Drawings, effective Interface Management and plant Walk-Through.

We should execute a faster, efficient and effective approach to reduce our dependability on human resources. We need to explore new technology to be implemented in the Engineering and Construction sectors for the betterment and overall progress of India.
3D model of a factory before Construction

Actual Factory after Construction
Way Forward

Engineering is the drawing board and we have to build a construction model by utilizing this drawing board.

Smart cities are the future of our nation and to build and maintain it is challenge we need to live up to. The engineering and construction fraternity should come together and commit to the society to build infrastructure, which is world class and at par with the rest of the world.

Academic institutions and industries should collaborate for the better quality engineers and their capabilities.

Further, if we want to execute a faster, efficient and effective approach towards engineering and construction sector, we need to reduce our dependability on human resource and increase the use of technology and best practices.

We need to explore new technology for development of the industries and to be competitive economy globally. Also, the existing best practices and standards should be leveraged upon as stepping-stones for the continual improvement journey. Concepts and frameworks for continual improvement, which have helped in carving other super economies, should be deployed after suitable customization, fit for the region and industry.

The efficiency and effectiveness of the industry is extremely important at the inflection point. We are poised at a point where we need to implement & enhance best practices, to build on right legacy and try to reach the next peak with engineering and construction being the key drivers for the same.
About CII

CII is a non-government, not-for-profit, industry-led and industry-managed organization, playing a proactive role in India's development process. Founded in 1895, India's premier business association has over 7400 members, from the private as well as public sectors, including SMEs and MNCs, and an indirect membership of over 100,000 enterprises from around 250 national and regional sectoral industry bodies.

CII charts change by working closely with Government on policy issues, interfacing with thought leaders, and enhancing efficiency, competitiveness and business opportunities for industry through a range of specialized services and strategic global linkages. It also provides a platform for consensus-building and networking on key issues.

Extending its agenda beyond business, CII assists industry to identify and execute corporate citizenship programmes. Partnerships with civil society organizations carry forward corporate initiatives for integrated and inclusive development across diverse domains including affirmative action, healthcare, education, livelihood, diversity management, skill development, empowerment of women, and water, to name a few.

In its 120th year of service to the nation, the CII theme of ‘Build India – Invest in Development, A Shared Responsibility,’ reiterates Industry’s role as a partner in national development. The focus is on four key enablers: Facilitating Growth & Competitiveness, Promoting Infrastructure Investments, Developing Human Capital, and Encouraging Social Development.

With 64 offices, including 9 Centres of Excellence, in India, and 7 overseas offices in Australia, China, Egypt, France, Singapore, UK, and USA, as well as institutional partnerships with 300 counterpart organizations in 106 countries, CII serves as a reference point for Indian industry and the international business community.

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About Faber Infinite

Faber Infinite Consulting is one of the finest global management consulting and capacity building (training) organizations in Business Excellence/ Organizational Transformation domain.

The primary objective is to create value by assisting client organizations to become more effective, efficient and flexible. Faber Infinite is closely working with clientele across Asia Pacific, Africa & Middle East.

Team Faber Infinite supports enterprises to discover ways to ‘unlock hidden value in the businesses’ by improving revenue and profit maximization. Team Faber Infinite brings in hands on implementation experience in designing innovative strategies and improving operations for organizational transformation projects across different sectors and geographies.

We strongly believe that organizational success is primarily driven by the ‘People’ with focus on aspects of Strategy, Operations and Design. Faber Infinite strives towards the sole purpose of ‘Crafting Growth Opportunities!’ Faber Infinite enables clients to achieve exponential value growth by leveraging the 360-degree transformation philosophy, with key focus on Operations and Strategy solutions.

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# Acknowledgement

We would sincerely like to express our gratitude and acknowledge the following for providing their valuable inputs for the report (In Alphabetical Order):

1. Ashwin Gandhi, Chairman – CII Central Gujarat Zonal Council & Director, Express Group
2. Dr Ajay Ranka, Managing Director, Zydex Industries Ltd.
3. Dr Bimal Shah, Applied Mechanics Department, Faculty of Technology & Engineering, The Maharaja Sayajirao University of Baroda
4. Gaurang Joshipura, Managing Director, Zeppelin Systems India Pvt. Ltd.
6. Masayuki Kubo, Chairman, Mitsubishi Heavy Industries India Pvt. Ltd.
7. Nailesh Desai, Senior General Manager – Production Dept., Schott Glass India Pvt. Ltd.
8. Nitin Mankad, Past Chairman-CII Central Gujarat Zonal Council, Managing Director-Innovative Tyres & Tubes Ltd.
10. Prashant Amin, Immediate Past Chairman, CII CGZC & Executive Director, Elecon Engineering Co. Ltd.
12. Prerak Shah, General Manager – Civil, Cube Construction Engineering Ltd.
13. Rupinder Singh’ Head High Voltage Business, ABB Ltd
14. Sanjay C Shah, Chairman and Managing Director, Cube Construction Engineering Ltd.
15. Shashwata Dutta, Whole Time Director, Power Build Ltd.
16. Srikant Jainapur, Chief Executive Officer, L&T Sargent & Lundy
19. Shashi Shah, Trustee, Engineering Seva Trust

This report would also not have been possible without the contribution and commitment of certain individuals within Faber Infinite. The initiative for this report is led by Raveena Rathi and supported by Aakash Borse. Special thanks to CII Central Gujarat Zone Team for sharing all the information required for the report.
Proceeding Report

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