Digital Disruptions in Engineering and Manufacturing Industry

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Abstract: This paper holds that, as the 'digital' wave of 'disruption' has changed the global 'engineering' and 'manufacturing' landscape, radical impact is seen in the overall business scenario. There are opportunities to be grabbed as the old guard gives way to the new guard, cracks developed in the traditional channels paving ways to the smart players to make their footprint. Need is to evolve with the changed strategies to ride the wave in search of transformation and opportunities with it based on the backbone of a strong strategy backing the technologies to make this happen. There will be a need of trained manpower along the way, inquisitive minds, good mentors to meet the challenges. Collaborative partnerships, sharing of data, data lakes and bridges of connectivity, mobility, Internet of Things and Big Data Analytics will be the terms seen floating around. Agile methods will be used to farm this data with the cloud security and ethical behaviour as a social norm personifying a global citizen. Digital Design Houses, Digital Manufacturing, Digital Services and Digital Distributions are the newer pastures for the business houses in the near future. Robots and automation obeying the masters sitting in different continent driving the man-less factories, employees riding in their self-contained driverless automobiles would soon be a reality. Digital Twins --the continuing convergence of the real and the virtual worlds will be the main driver of innovation and change in all sectors of our economy. This article discusses the impact, challenges and opportunities of digitization and concludes with examples of recommended actions to meet the objectives.

Keywords: Digitalization, Disruption, Engineering and Manufacturing Industry

Introduction

Taking advantage of the opportunities to make changes to the business in terms of Products, the processes to build those products and the overall business model by converting analogue information to the digital information with the help of various innovative strategies and technologies available in the market can be defined as 'Digitization'. The current trend and belief makes it pertinent to note that digitization is seen as a panacea to correct many wrongs in the existing businesses to drive home the advantages of cost benefits/revenue generation, efficiencies and productivity with a large improvement in quality. Experts have started calling this as a new mantra for growth, reliability and cost saving up to 25% compared to their conventional peers in the same industry—due to automation that comes with it. This was termed as IT overhead during the bygone era, and was looked down upon as the whim of the management. However, the game plan has changed in the recent times and has led more credence to the claims that IT has been making for years on the benefits of the digitization, though the terminology for the change may have been very different. Interestingly, the companies that are leading the charge for making the strategic infrastructure for the digitizing and shifting the trend globally is mere 6% -8% of the entire industry. These are the Amazon's, the Apple's, the Facebook's, Twitter's and the Oracle's

of the world we are talking about. They are the high-tech trailblazers who are the trendsetters causing enormous disruptions in the marketplace and have made the industries such as Automotive, Pharmaceuticals, Traditional Manufacturing, Retail, Banking and many others change the way they have been traditionally doing their business. It will be interesting journey to see how the transformative companies navigate this disruptive era successfully and the adamant aka inflexible ones bite the dust. Digitization, they say, is at the inflection point where the business and technologies work together in unison. The trends in the past suggest that the Engineering industry, especially the Mechanical and Manufacturing are close followers of the high tech companies mentioned above. The cycle of the change used to be a lag of 7–10 years and it was an accepted norm. However, with this disruption, the gap has closed and the players are switching roles as well. The service providers have rolled up sleeves and are seeking the market pie that used to be the traditional players' market. That has made the conventional players sit up, take notice and act to meet this disruption with a knee jerk action in some cases. Nevertheless, the ecosystem is changing and the world is taking notice of this digital disruption.
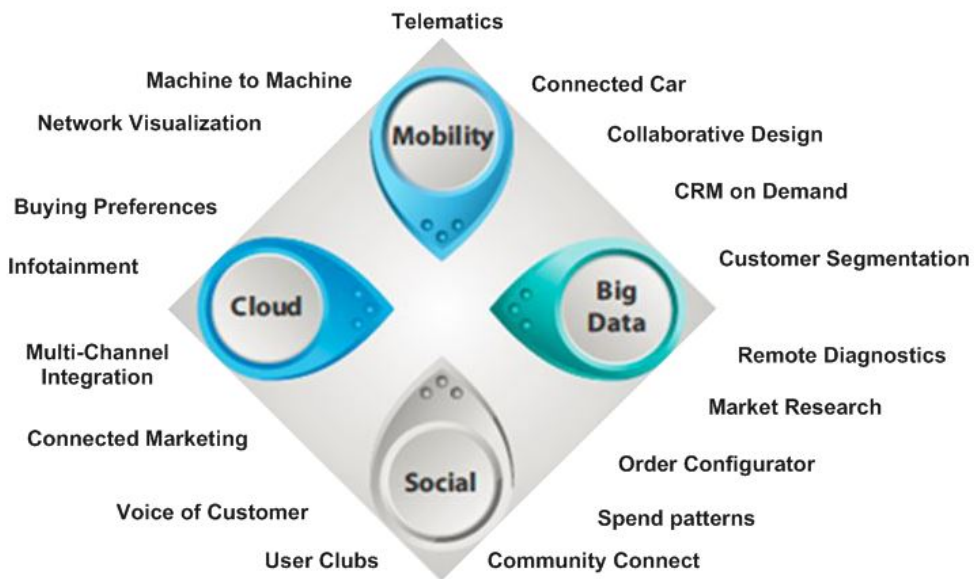

Fig. 1: Digital Wave

The cutting edge technologies, as depicted above, have provided the momentum for a fresh digital wave. The current wave of digital disruption-led commercialism is an outcome of the influence of mingling technologies such as big data, high performance computing cloud, mobility, and social media. This has enabled engineering industries to seek new business models and contrasting opportunities, both on the manufacturing side as well as the consumer engagement side of the business.

Literature Review

'How close is the revolution to our factory doors, and where I should make investments in infrastructure, cyber security, and partnerships?' is the question Brian Hartmann, consultant in McKinsey's Detroit office, is asking. This is the representative question that the manufacturers are seeking answers from the manufacturing gurus of the world. With the advent of the Big Data Analytics, the Internet of Things and the expert advice that the software makers and the consulting companies are offering, it has become prudent of the traditional production shops to look at the existing workflows and the amount of data that is generated in their factories. Can this data be collected, farmed with the latest technologies, analyzed to the good effect and used for the overall improvements the author is talking about. Author points out the dangers lurking around if the players do not change and use this wave of innovation to their own benefits. Adapt to the change or fall aside that is clear by the day.

Chet Namboodri, in his Cisco blog, takes a holistic approach in explaining the connectivity that is impacting the production shops. Predicting that 40% of the players would be impacted, the ones who are ready to change would be hugely benefitted in the next 5 years to come. Going digital is not a option but it is an opportunity to lead the market- that is the message Chet gives and rightly so. Connected shops add more power, control, convenience to the management.

Adrian Bridgwater in *Forbes* mentions 7 steps towards the digitalization and he takes us through the journey of industrialization. The core of this revolution is Artificial Intelligence, augmented reality and new neural networks. Experimentation, funding, Data Lake, strategy, role definition, operations and culture are the building blocks of this disruption. Though the article is short, it gives us a flavour of the different jargons like IoT (Internet of Things), Data Analytics, ERP (Enterprise Resource Planning), EAM(Enterprise Asset Management) that are used by various experts in this transformation process.

Product Lifecycle Management (PLM) is the area that is not left untouched as well due to this disruption. IBM Data Analytics blogger Oleg Shilovitsky takes a holistic view of the emerging trends in the PLM world. He talks about the connecting devices and its impact on expanding the PLM to the non-traditional areas. The traditional domain that the PLM has been talked in the recent past has been focused on the Computer Aided Design, Engineering and Manufacturing (CAD/CAE/CAM). The future of PLM will be based on big data, messaging and mobility; Internet of Things; and the explosive growth of electronics and software in manufacturing. That is a loud message for the design and manufacturers of the world. Maintenance, Repair and Overhaul (MRO), requirements management, product performance monitoring are some of the expanded areas that PLM is capturing the imagination. A switch from traditional workflows to the interactive user experiences is the new mantra in this age of digital disruption is the takeaway here. The picture below demonstrates the entire engineering cycle that Digital PLM as epicenter envisions driving the manufacturing, retail, suppliers, customers and others via cloud, mobility, connectivity and social media.
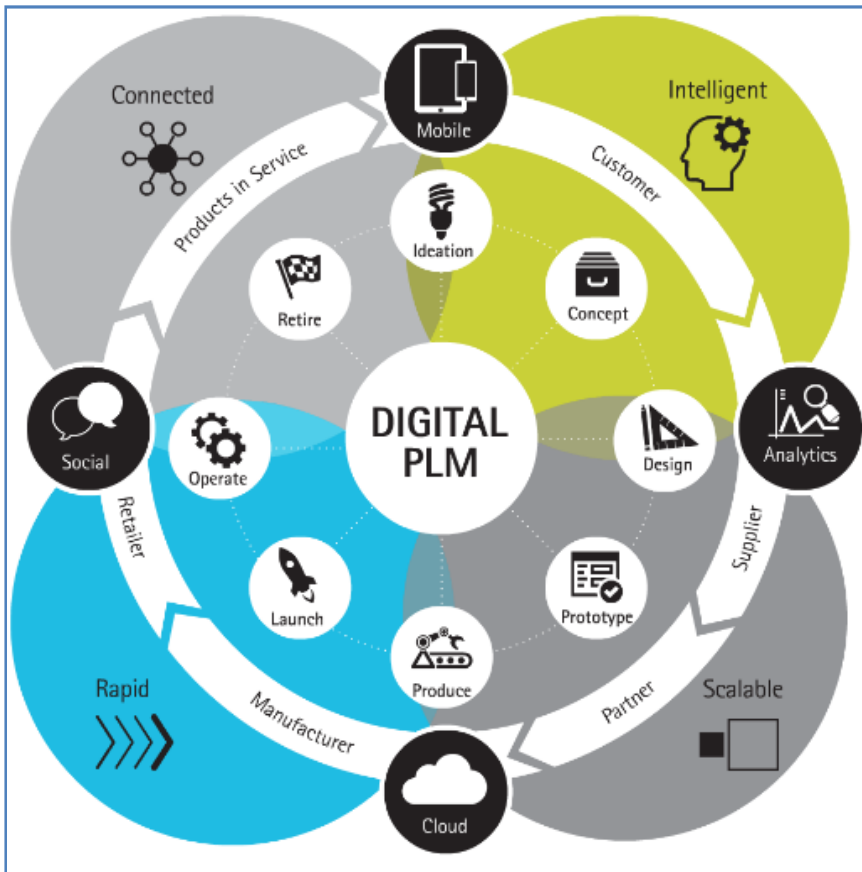
Fig. 2

Picture Courtesy: Accenture Consulting.

Objectives

The businesses around the world are always on the lookout for the ways to streamline their processes. It would be prudent to delve at the various objectives that compelled the industry to drive digitalization:

- *Improved Efficiencies*: There were instances where the old guard used to claim caveman knowledge as the sledge hammer or arm twister. This has been the story of ages that is proving out to be not that relevant anymore. Yes, the older techniques are definitely wanted, but the smart intelligent technologies that are evolving will soon make that redundant. Artificial Intelligence had proved that in a sense, but with the advent of the digital smartness, it has helped drive efficiencies in the system that is proving out day in, day out in the practical world out there. The virtual reality has improved so much over

the years, making the requirement to build physical prototypes in the automotive manufacturing world almost a wasteful milestone that can be completely eliminated. There are universities in UK that have active labs to manage the smart factories. The pilots being undertaken are the attempt to control the overall processing and day-to-day operations from remote places. This is achieved for improved piece flow and output due to the closeness to planned process.

The image below demonstrates a sample smart factory showing the various improved production efficiencies and warehouse management accuracy.
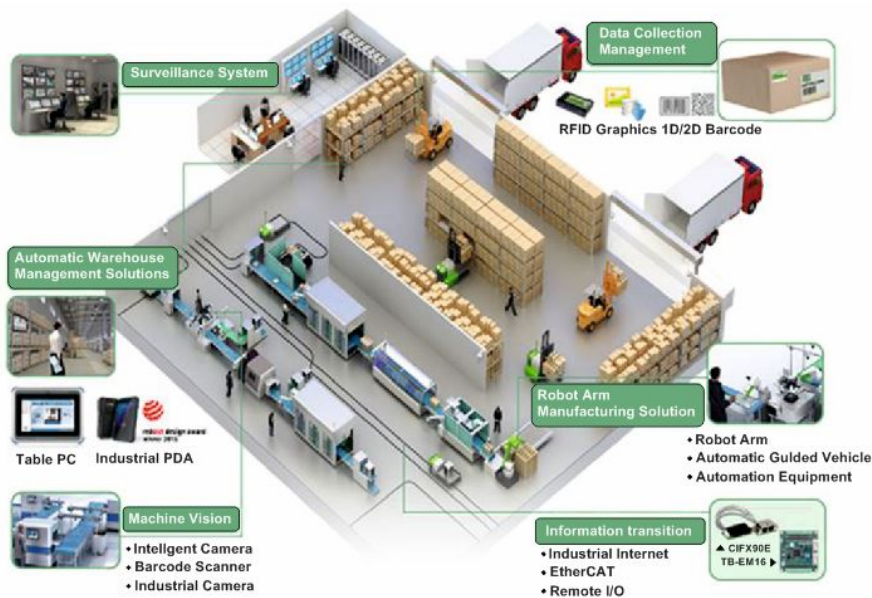

Fig. 3

Image Courtesy: IEI Smart Factory Solution Industry 4.0

- *Trailblazers*: That is what Angela Arhendts, the then CEO of Burberry used as objective to turnaround the stagnant fashion brand from traditional, also ran, enterprise to a savvy business. The objective she used was to break ground and create something nobody has tried before in this fashion industry as disruptive force. The objective was set to shake up the conventional thinking and challenge the digital minds by starting a real-time online business catalogue for the users to interact with the featured online inventory. Internet was the medium that was used to shake the market then, but the underlying principle was the innovation using digitalization. Another giant biting the dust in 2013 due to lack of clear objective coupled with lack of courage using the technology was DVD chain Blockbuster. Netflix had a clear strategy of renting DVDs online coupled with streaming.

Later, with the advent of the broadband, backed by a strong objective, it killed the brick and mortar DVD rental stores completely. Ford has been trailblazer in the field of digital manufacturing, pushing the technology far to realize the benefits of the revolution. The area of traditional and conventional manufacturing has been replaced by the vision of digital factories, smart objects, standardized plant layouts in 3D, Reverse engineered point cloud data that ushers in global plants and the plant runoffs using the live videos from the plant leading to reduced product launch. These are some of the objectives that were envisioned by the Alan Mullaly and Mark Fields of the automotive world.

- *Outstanding Customer Service*: Listening to the customer via feedback seems a very trivial step in the business. Do this at your own peril though. Online feedback has been used by a few meticulous companies to the hilt. Case in point is zappos.com online portal company which Amazon is undertaking now. There is this special case of going to any extent to make the customer happy. This company used to take customer to even competition site if it could not satisfy the customers' requirement at that instant. The return customers grew exponentially due to the transparency and the happy customer service. The customer calls were seen as the marketing opportunities and special emphasis was made when the customer service was hired in. Legend is that the agents were paid $2000 to quit as a test of enthusiasm. Another example is the PLM industry software distribution which has improvised so much making good inroads on the distribution. The entire cycle of software distribution is made online and even cloud based. This has added large efficiencies in the system eliminating the overall media requirements such as DVDs, USB drives and such. Few other examples are that of Onstar like service that automotive industry has seen that has the users getting help for the directions, to maintenance and service requests captured with online app that is tied to the automobiles that send request to the dealerships and the useful reminders to the users. Predictive and reactive maintenance using the digitalization in the area of Oil and Gas has been touted as one of the huge cost saver where the pipe leaks are the norm of the days and millions of barrels are wasted in this issue. Adding the big data analytics angle in the smart pipelines that can capture the volume data and the predictive model of input outputs at various terminals makes it easy to track the leakage and in effect plug it as well.

- *Market Leadership*: The sudden rise of the Google and Tesla in the automotive field is a major disruption that is seen recently. This has been the representative example of usage of the IT driving the innovation that has led the companies to look for disruptions such as driverless automobiles and the non-conventional vehicles. Similarly, the advent of apps such as WhatsApp that started as the simple chat application grew its customer database multifold and took the giants like Google and Facebook by surprise due to the customer base and its overall popularity. Eventually, it was bought out by Facebook management

to make it win-win for both the companies. Leadership in the shared ownership business by the likes of Uber is a legendary story. The objectives set were to capture the domain that is saturated by the established players like Toyota, Honda, GM, Ford and Hyndai. It was not an easy objective to envision and the implementation plans very tough, but the digitalization paved the way.

Research Methodology

Interactive Response Techniques, Surveys and Networking for recent years on this topic were used to good effect for the research.

- The samples used were primarily the participants during the conferences, seminars, meets and the connections made over the years working for various giants such as Boeing, Electrolux, Siemens IT, Ford to name a few. The samples chosen were randomized based on the verticals and the area of function. Attempts were made to take a cross-section of experiences at various levels of the organizations from suppliers, IT vendors, and internal businesses such as Supply Chain, Finance Accounting, IT, Manufacturing, Production, Quality, Marketing and many other functions.

- Study material used was prominently from the leaders in the digital revolution such as Siemens, IBM, Oracle, Capgemini, Google, Autodesk and other small and large players in this domain. These giants have employed an army of market research experts who share immense knowledge in the form of presentations, forums, blogs, flyers, and primary and secondary surveys.

- There are various executive summaries and various reports that were made as a part of presentations, summary reports and deductions made, based on the research done to evaluate the impact of the digitalization on the businesses in the various industries. Roadmaps to present the futuristic vision based on the deductions of the studies made applicable to the current automotive, aerospace, consumer goods and product life cycle related Information Technology business was the basis of the research paper.

- Various factors studying the impact of digitalization on the above mentioned businesses were concluded based on the methodologies mentioned above with various parameters such as return on investment, innovation impact on the competition, profitability due to the disruption, advantage due to the innovation and being first in the game, risks involved and opportunity cost were the few researched.

- Descriptive and inferential statistics clubbed with some of the univariate analysis was used to understand the trend of the disruptions in question. The descriptive statistics allow the audience to understand the basic feature of data to the audience.

Data Analysis

Process digitalization in future is seen as the force to accelerate and convert the big data analytics and overall industry models that the engineering business has been following. Based on the research done at various suppliers, clients, peers and the internal business has revealed that nearly one-third of the sample that was interviewed over the course of one and-a-half year from the 200 plus executives in the US market, 15 from Germany, 20 from UK and 30 from India mentioned improvement in the reliability, dependability and the mute question of the usefulness of the Information Technology in the overall engineering business.

The respondents attributed the return on investments being realized finally by the organizations due to the seamless processes that are achieved due to the evolved processes, standardization that is forcing the costs down enabling the faster product launches and squeezed global releases. Tighter and easier integrations across the organizations are relevant to all this and the technologies that are discussed in this paper and more are seen as major contributors and prime movers towards the disruptions.

Synergies were the theme of many discussions which were held via surveys and forums. Transactional relationships have turned into interactional. Some call that as concurrent engineering where the production teams are able to work from day one of the programme launches straight away with the design engineering and purchase teams. The tighter integrations allow everyone to be on the same page, without having to throw over the wall attitude. More meaningful work interactions save a lot of time and dollars, not forgetting high moral.

Outsourcing was one of the other topics that were asked to comment upon when the efficiencies are discussed with the cost and quality of the data. The technology barriers were pointed out as the major bottlenecks while sending the data back and forth across the continents. With the advent of the cloud-based computing and replication easiness across the globe, round-the-clock operations at lightning speeds are a reality. However, the advent of 3D Printing or additive manufacturing as it is called is taunted as a technology that may eliminate the low cost labour advantages given as a reason for outsourcing. Some of the 3D-printing consultants pointed out that the ability of the 3D printers have grown immensely and the programmed robots on the digitalized offline programmed plants are able to assemble these parts at a lower costs. This may push the businesses to *restore* the work that is currently outsourced. As the political tone in the recent elections got heated up, efforts to move the jobs back in the country as seen in US, more governments may be inclined to support their own economy to demonstrate their nationalism.

Customer service was one of the objectives that were listed in our research. Engineering industry is driven towards the connected devices and mobility. Remote monitoring of connected devices offers a new growth path for customer services as well as improved, efficient and effective maintenance approaches. Majority of the sample to the range of $3/4^{th}$ of the population agreed that this will enhance the brand image in general, adding repeat business. Consumer products customers and peers reviewed were a bit lower percentage to the tune of half of the population as

usually the aerospace, automotive and the heavy equipments industries lead the way for the consumer goods to catch up later. Participants were of the opinion that corrective or preventive maintenance model which is termed as traditional maintenance model is inefficient and expensive model. That will go away with the smarter tools and evolved technologies to be replaced by predictive maintenance. Service organizations will need to start to contend with the chance presented from data analytics and remote monitoring to improve maintenance processes. This campaign will require fresh data analytic proficiencies within the service organization that are currently lacking.
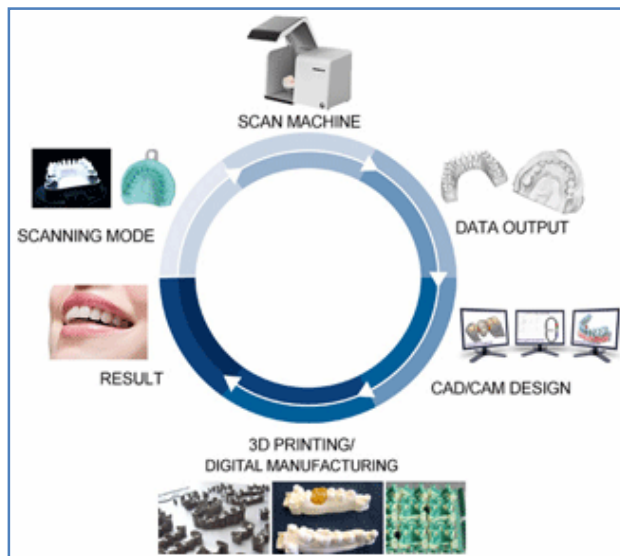

Fig. 4

Picture Courtesy: *Shining 3D*, depicts the sample workflow of the product that can be manufactured quickly at a reasonable cost.

Trailblazer and ground breaking traits have been appreciated by the respondents immensely. Almost 85% participants thought that this is the way to gain the larger footprint to make the market rock. Innovation is the key and the IT would be playing a major role in formulating these strategies. Majority of the samples interviewed were aware of what the self- driving cars, non-conventional technologies and mobility was; 30% relayed examples of use of big data that can be used to bring the cost of car insurance down when they are on the hunt. The points that are supposed to be added for safe driving transforming in reduced cost of driving can be automatically applied if this technology can be seamlessly incorporated in the product; half of the of the participants wanted to make the consumer goods industry move faster to take orders from remote place so that the time they reach home, cooking robots are ready with the dinner and the self-programmed equipments are completed with the clean house. This is no more a wish list but some of the things are already happening, cited by many participants. However, one-fourth of the

participants warned of the system getting hacked just as with any computerized equipment. Data security while sharing the data seems to be another important aspect that has come to the front. Market leadership was seen as the offshoot of the trailblazer behaviour and Apple evolution in the smart phone market was known to majority of the sample.

Digital factory seemed close to the heart of the sample. The fully-automated plants and self-running operations add a lot of glamour for sure. Majority of the participants had seen the robotics demonstrations during the auto shows and many tradeshows. However, the details were missing as to how this was planned. As many automotive businesses are in the process of starting technology centres in the Silicon Valley close to the digital developers, the grapevine has truly reached the audience. At least three-fourth of the audience have seen the usage of the digitalization on the shop-floor, manufacturing offices and the design centres. The advantages and the future impact seemed to be well known as well. Picture below depicts the usage of technology to build digital plants before the products are manufactured on the floor.
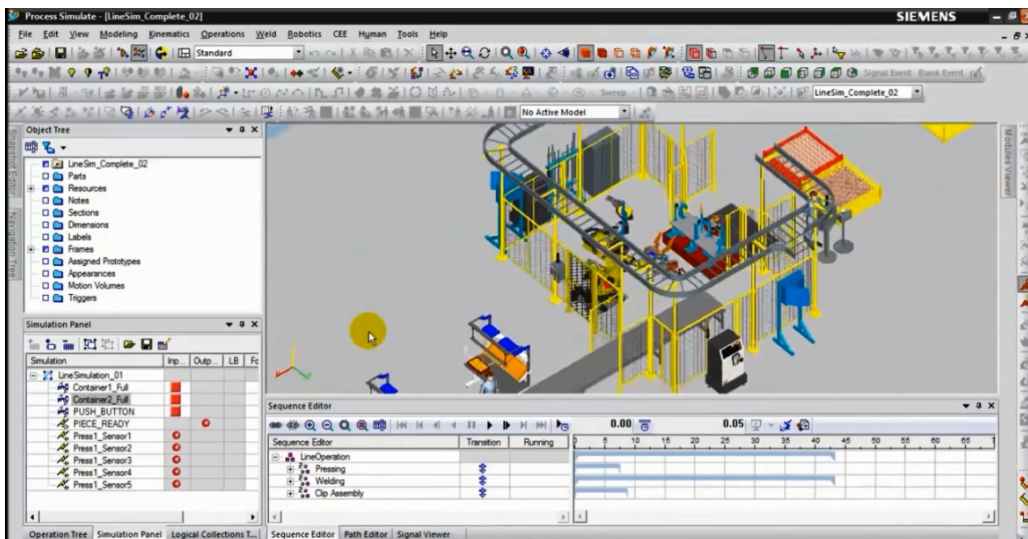

Fig. 5

The service department's comments and feedback revealed that 65% of the complaints were about staff behaviour and competency, compared to just 35% about the quality or reliability of products, functionality solutions and services provided. Expanding the scope of service means that the customers want the service, purchase, inventory management and sales to act in unison to provide single point solution reducing customer hassles. Product dealerships are seeing this pattern of self-service kiosks which still has relevance along with the face-to-face sales. Survey participants did not completely rubbished the brick-and-mortar showrooms, but customized likes of consumers based on the big data analysis would be preferred mode of encounter with the sales representative.

Limitations/ Scope for Future Work

It is always easy to get blind sighted by looking at the rosy picture that is being painted by the disruption. If we do the checks and balances, it is seen that there are dangers and pitfalls that we need to be aware of. The experts and the samples we examined were of the opinion that an analytical and neutral mindset is needed to clearly understand the caveats so that those can be overcome by use of commonsense and some development efforts. Here are a few of them listed below

- *Data Security*: The idea of big data which is so crucial to the success of the digitalization in the engineering and manufacturing industry, hinges on the data being collected. Many challenges have been faced as it is when there are questions being asked that are used to track the user preferences. There is a very thin line between being inquisitive and breaching one's personal space. Just imagine what would be the situation when your household is robbed; or even worse, when your bank password is hacked. Here, we are talking of handing the entire life span data to the unknown hands. There are demands of firewalls and audits on the cloud security. Satisfying the scared minds is a challenge while digitalization bandwagon keeps marching.

- *Experience cannot be Replaced*: Change overnight is not possible. However, there needs to be a phased out approach to completely get rid of the traditional systems. The older systems have their own benefits and to leverage some of those, it needs to be a smoother transition, though the word disruption suggests otherwise.

- *Assumptions*: The boundary conditions and the scenarios that are worked out in the virtual environment created is more or less a cookie cutter environment based on the various subject matters who have guided to create that digital domain. However, sometimes that may not be sufficient and there are times when on-the-feet things need to be done to make the system work. If this is not paid attention to, it would yield wrong results.

- *Fear of Job Loss*: Rapid automation makes people wary of the sudden vacuum that is created. Imagine entire shop floor being robotized and the digitalization takes over the automated factory that is managed remotely. It all sounds perfect except the people who made that happen get laid off the next few months. Similar waves have happened before and each time there has been solutions that are customized to that situation. It is always better to be prepared for these scenarios.

- *Training Quality*: Sudden surge in the demand for the niche skill-set may cause shortage of trained manpower in specialized areas. It is always good idea to be prepared for these contingencies.

- *Good Support Staff*: What if the driverless cars refuse to stop in chaotic conditions? What if it gets hacked? What if there are lockdowns in the robotized shops that are

beyond human repair? Lots of hypothesis; but are we geared up for the worst scenarios? That is the question, average minds will be curious to know.

- *What Happens to the Older Generations*: Are they outdated? Will the new wave wipe out the older generation and make it useless if they are not ready to change guard. There would be much legality involved that needs answers.

- *Environmental Issues*: Due to the heavy digitalization, are there any side effects to the planet? Are there any climate issues that may pop up due to the excessive use of power to keep this running? Food for thought!

Conclusion

Forward looking companies are developing plans and strategies to confront the challenges of digital interventions by jumping to the interactive relationship with their interfaces. That could be a supplier, real customer or collaborative partner. They are seeking the interfacing parties to submerge and participate concurrently in the development, design, manufacturing and market process. The end-to-end involvement of all concerned parties would enhance the level of service and accountability. To become a significant player and succeed in the digitalization disruption, embracing innovation and finding brand new engagement models along with business models is much needed. Smartness to look forward for the new waves of the disruptions and riding the waves to the benefits breaking the traditional walls of strategies would be the norm of the coming future. Need of the hour is to gather the smart minds together and strategize to align the social commerce, connectivity and thwart commoditization. This requires a proactive leadership and a clear mind. Leaders may, or may not, be tech savvy; however, they need to understand the outcome of the crossing of technology and the business. Vision of business transformation due to the digitalization would be really essential. Change predicted could to be very fast and intense and the path could be long.

Based on the research it can be concluded that:

- Businesses are ready with digital technology vision but implementation challenges are still pending.

- Players are for innovation, but data security concerns are for real.

- Due to the power of digitalization, there is diminishing power of experience and traditional thinking and more thrust for results using the disruption. It is hard to hide behind the traditional norms.

- Users are attracted to the softness of the technologies and the coolness behind it. Agreement with the sample on the improved customer experience and its inherent business benefits.

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