IDC Manufacturing Insights

I D C C U S T O M E R S P O T L I G H T

Designing and Implementing the Factory of the Future at Mahindra Vehicle Manufacturers

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By Christopher Holmes, EngD.

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The need for manufacturing organizations to be hyper-efficient while providing extreme flexibility with mass production capabilities for individual customization is driving companies to consider "factory of the future" initiatives. However, moving from a traditional factory to a next-generation factory is a daunting task. It requires not only an empowered management team to drive the change and implement the vision, but also the need for rethinking the traditional organization and a substantial investment in new technologies. All of which need to be fully integrated to fully realize the benefits. This IDC Customer Spotlight explores how Mahindra Vehicle Manufacturers has implemented a factory of the future platform utilizing Cisco's Connected network architecture and solutions at its plant in Chakran, Pune, India.

Situation Overview

Why is the Factory of the Future Required?

With globalization, all companies are now competing with other global companies, rather than just local players. The world has also become a common marketplace, and the need to have a hyper-efficient plant that is also flexible to meet changing customer demands is driving companies to explore factory of the future initiatives. IDC Manufacturing Insights has identified four key trends that are driving this transformation:

- **From capacity to capability.** Manufacturing flexibility is critical to respond to variable market demand and achieve high levels of customer fulfillment.
- **New production models.** Leading manufacturers are moving away from mass production. Enterprises will give up the basic make-to-stock (MTS) approach. They will embrace more make-to-order (MTO), configure-to-order (CTO) and engineer-to-order (ETO) production models, and become more demand driven.
- **Profitable proximity sourcing and production.** Manufacturers across different sectors are busy creating more modular products based on common platforms and configurable options. An increasing number of manufacturers will adopt hybrid production and sourcing strategies to implement this change. Manufacturers will produce modular platforms centrally, while leveraging suppliers, distributors, or retailers to tailor final products locally to better serve local customer demands.
- **Workforce engagement.** Despite a continuing trend to greater plant automation, people will remain at the center of the factory of the future. People will provide the degree of flexibility and decision-making capabilities required to deal with increasing operational complexity. This workforce will have to be more fully engaged with the overall business and at every level of the company including front-line workers on the plant floor, sharing knowledge to further improve production processes. Factories will be managed through higher levels of

collaboration, with a greater emphasis on involving employees, customers, and partners in both processes and strategic decision making.

Mahindra Vehicle Manufacturers: Factory of the Future

The Indian automotive industry has expanded dramatically over the last few years, transitioning from a two-wheeler to four-wheeler passenger and commercial truck market which, despite the recent slowdown, looks set to continue to grow. However, with growth comes competition. With stagnating markets in the west, global automotive players are constantly seeking new markets, with India being the prime target. Coupled with this competition is the change in consumer behavior, in which consumers are harder to satisfy with just whatever product they could purchase.

Overview of Mahindra Vehicle Manufacturers

Mahindra Vehicle Manufacturers is part of the Mahindra Group, with over 180,000 employees spread across 100 countries. The automotive group started in 1947 with the Willys Jeep, and the acquisition of the SsangYong group in Korea brought access to new markets. In 2007, Mahindra Vehicle Manufacturers was established with the intent to manufacture and market globally a series of vehicles ranging from small SUVs to large size trucks; therefore, a new greenfield plant was designed and developed in Chakan, Pune.

The Start of the Journey

Embarking on a new greenfield plant gave Mahindra the opportunity to rethink the way the manufacturing operations were to be designed for flexibility and agility. A traditional approach to automotive production could have been introduced, using existing processes and prevailing traditional technology; however, Mahindra took the decision to develop what is called “A Benchmark Automotive Manufacturing Plant," in tune with their vision for: "Future Ready Manufacturing: Vibrant. Versatile. Sustainable and Frugal."

Coupled with these attributes was the desire to use the latest technologies. A benchmarking effort identified the key technologies driving industrial transformation currently in use across other leading automotive manufacturing plants. These include IP/Ethernet based unified communications model to accomplish seamless connectivity and tight integration between enterprise and plant floor production, industrial wireless, security, unified communications, digital video surveillance, real-time location services, all being widely adopted by over 50% of the top 20 players. It also identified that RFID and convergence of building systems and information systems, while being considered by some, are having lower adoption rates.

The ethos for the factory included a desire to "future proof" the factory. The reality of this was that the plant needed to be adaptable to rapid changes in customer demand, technologies, equipment and processes. This required the plant to operate in a dynamic, integrated, mobile, real-time connected environment. This included the support for shop floor connectivity and collaboration, logistics, asset and supply chain tracking, operations workflow automation, unified communications, control system flexibility, security and personnel tracking, and integrated business and plant data.

Creating a new factory proved to be a massive task. Mahindra embarked on a two-pronged approach with the development of a manufacturing process using digital manufacturing tools, and the development of the high-level IT architecture for the plant. These two approaches worked concurrently to ensure the manufacturing process could be concurrently supported on a converged network through to controls and automation.

The Totally Integrated Factory: Top Floor to Shop Floor

The team developed a detailed “High Level Design Document” to connect the "top floor to shop floor" based on the actual detailed business processes and requirements with an inventory of all the information and data to be shared in real time between all shops and enterprise resource

planning (ERP) layer. The key objective was to be able to answer questions such as: “Can I produce the demand driven quantities with quality to satisfy customer promised dates?” To answer this question would require information and data to be brought together from across all the shops in the plant from production to maintenance to supply chain. This includes order management data, production scheduling, maintenance schedule, quality rates, and supplier information. The reference architecture was built on the ISA-95 standard.

The high-level design initiated jointly with Cisco had a clear objective to migrate from a traditional IT system to a dynamic, integrated, real time and connected environment with unified communications; and the Level 2 design by Wipro detailed the technical standards and best practices to implement. Cisco’s deliverables in Phase 1 were technology evaluation, benchmarking, planning, roadmap creation, high-level design and bill of materials development (for the integrated plant network). The Phase 2 process was post implementation quality audits. The scope included the detailed networks for the plant and the building systems. The application and infrastructure consisted of a number of applications and technologies from different suppliers, as shown in Table 1.

Table 1

Suppliers and Applications

	Supplier and Application
Enterprise Application Systems	SAP for Enterprise Resource Planning (ERP), Supply Chain Management (SCM), Supplier Relationship Management (SRM), Human Resources (HR) and Time and Attendance monitoring. Siemens PLM for Product Lifecycle Management and Digital Manufacturing
Manufacturing Execution Systems	Rockwell Factory Talk Production Center (FTPC)
Plant Infrastructure	Cisco’s Plant Floor and Control Networks (PFCN) and Cisco Network Technologies Rockwell – Body-in-White, Paint Shop, ASRS and Intershop (DeviceNet) Siemens – Powertrain, Press Shop (ProfiBus/ProfiNet)

Source: IDC Manufacturing Insights, 2014

Making the Factory of the Future Work: The Connected Factory

Key enablers to making the factory of the future work is the need to connect all the disparate applications that exist within the factory, allowing a seamless transfer of data throughout the factory to the applications that need the data. The data moves seamlessly from the shops to the local datacenter, and is also shared between shops for production sequence broadcast, etc. The approach that this team has moving forward is to "Manage in Real Time." IT has visibility from the command center and a view of all 20,000 devices across the plant floor and the engineering offices. These include production equipment, utility management, applications and databases.

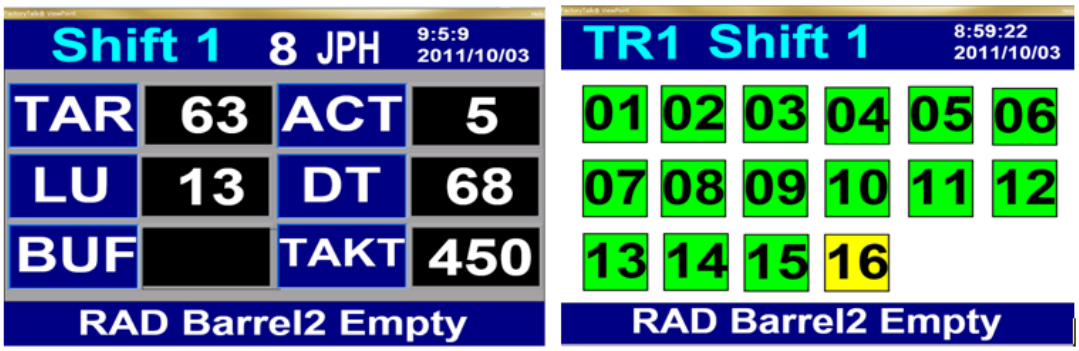
Within Mahindra Vehicle Manufacturing, MES/MOM and Digital Manufacturing are seen as the key IT enabled applications to leverage IT innovations into the plant. The manufacturing execution system is the factory of the future running multiple applications within it, some of them being order management and build sheet, shop tracking, Andon Boards, poka yoke (error proofing), genealogy and traceability, ERP backflush, line stops, JIT/eKanban, reports and dashboards, asset management and interface to other systems (ASRS).

Visualization – Andon Displays

The Andon Displays are located across the factory and provide real-time updates (from the MES) on the production status as well as messages to maintenance personnel. Shots of the Andon Boards are shown in Figure 1. The Andon Boards give the visual feedback on current performance of the production run and also indicate to the management and maintenance personnel where there is an issue in production.

Figure 1

Example of Andon Board Displays



Source: Mahindra Vehicle Manufacturers

Digital Manufacturing

The use of digital manufacturing technology was a key enabler to the design and development of the assembly plant to digitally simulate the manufacturing process with "What If" scenarios and alternative thinking for optimal, frugal facilities, tools and equipment procurement, as well as proactive clearance and interference analysis. Figure 2 shows the uses of digital manufacturing in the design and development of the plant. These range from virtual factory design, process validation, capacity planning, robotic integration, virtual commissioning, and buffer sizing.

Figure 2

Digital Manufacturing

Source: Mahindra Vehicle Manufacturers

Plant Floor Control Network

Industrial Ethernet was selected as the de facto backbone for the entire plant and the entire campus spread over 280 acres. The Shop Floor Lan, IBMS Lan, and Office Network Lan going across the shop floor, were consolidated in the local datacenter and connected to WLAN the enterprise applications connectivity. PFCN was selected as it provided the capability to handle the widest range of applications and integration and is considered an "open standard." The plan for the factory when fully completed was to have 3.6GB of data transferred per day, which is considerably more than the 0.23GB daily transfer rate today. However, when designing the network, future plans for factory expansion were also taken into account.

Wireless technology has been used in the real-time production (within the control loop) for frame and chassis carriers and coordinated union in the final assembly area. Wireless controls were deployed for conveyor controls, automated storage-retrieval systems (ASRS) stacker operations.

Current Benefits of the Factory of the Future

With the Chakan Plant being a greenfield site development, there was no before and after performance measurements metrics available to assess the change in performance from the implementation of the technology. However, in order to gauge the targets for the plant, previous experiences from other new product rollouts in other plants were used as a guide in setting targets. From the design of the plant to the actual implementation, the performance of the plant is within 5% of what was planned. Specific targets that were achieved include:

- Changeover time reduction on the shop floor
- Improved quality with the ability to track the manufacturing process in real time leading to early identification of issues, faster analysis and rectification backed by easier data collection
- Improved reporting with the ability to drill down to gain a deeper understanding
- A centralized control room giving visibility to manage all shops with Andon as a primary tool to manage shop floor activity.

The Future for Mahindra Vehicle Manufacturers

The factory of the future initiative can be seen as a journey. There is no real end state, as the factory can be continually updated using the latest processes and technologies. The journey for Mahindra will continue. With Phase 1 of the journey completed, the focus now is on Phase 2 for optimization with manufacturing intelligence. Phase 3 is the continued scan for new technologies that can disrupt the current operations. It is the key element in which the notion of the "journey" continues, with new technology always disrupting the existing. If we think of this from a technology perspective, two areas that are currently undergoing review are:

- Predictive analytics. The use of predictive tools to support both business and manufacturing applications will be a key investment area moving forward.
- Connected vehicles. The move toward the introduction of connected vehicles whether for maintenance management, infotainment or other service provision will become essential for Mahindra to support moving forward with IT playing a critical role in enabling it.

Future Outlook

Challenges

The Chakan plant has achieved great results in its journey to the factory of the future. One of the areas that stood out was that it was not the technology that was an issue in achieving the vision, but rather the people and the process. The internal issues in supplier selection, in which engineering had worked with a supplier to ensure the vision and to ensure interoperability, were challenged by the purchasing department.

One of the challenges that the engineering department had to overcome was internal, in which engineering worked with the suppliers to develop a plan moving forward for future proofing the investment at the beginning of the project. This would yield benefits at later points in the journey to the factory of the future, such as when technology could be upgraded, rather than replaced. This required the engineering team to do a detailed analysis of every aspect of the technology and what impact it would have. Obsolescence of technology was also considered as it is proven that over 20% of the initial group of tech suppliers are no longer in business in the last few years, which meant that their technology had to be replaced.

Another big challenge to overcome was the need to bring in skills to support the new technology being introduced in the plant. The approach is to adopt standard technology, as finding people familiar with these technologies is considerably easier than looking for people with knowledge of new or obscure technology. This challenge was somewhat alleviated by collaborating with large established suppliers.

Conclusion

The Factory of the Future: What is it?

The factory of the future today is automated, connected, and integrated. It is also a journey rather than an absolute end state. It is also dynamic in nature. A key attribute is the culture of the organization: to be able to proactively act upon the real-time information and insight into the manufacturing process, and to be able to continuously improve the process is fundamental to making the factory of the future successful.

Parting Thoughts

The Factory of the Future is a journey, and it is one that many companies are considering. Key benefits are flexibility and efficiency, flexibility being achieved by having total control of the manufacturing and business processes, and efficiency through having total visibility of the machines and operations at the production level, and feedback loops allowing for instant update and response. The combination of technology, business process and company culture is key to success, and requires considerable effort to drive through the change required to achieve a factory of the future.

Methodology

The project information was obtained from multiple resources including information supplied by Cisco and questions posed by IDC to the Mahindra team.

Asia/Pacific Headquarters: 80 Anson Road #38-00 Fuji Xerox Towers Singapore P.65.6829.7757 P.65.6220.6116
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