WHITE PAPER

TATA CONSULTANCY SERVICES

Raising the Bar for Manufacturing Productivity, Quality, and Safety

How augmented reality is transforming manufacturing execution systems on the shop floor

Abstract

Manufacturers over the last decade have sporadically implemented manufacturing execution systems (MES) for operations management. Though MES adoption shows robust growth, certain gaps in the solution continue to exist, preventing organizations from making the most of it. The weak link in an MES implementation is often the operator interaction with human machine interfaces (HMI). Today's HMIs are mostly scanners and touch-screen panels that require operator intervention distracting them from their core work and disrupting the core manufacturing process.

This paper highlights how manufacturing organizations can improve productivity, quality, and process compliance by replacing fixed HMI devices and barcode scanners with augmented reality (AR)-enabled wearables. It also explores how manufacturing operations will continue in the new touch-less work environment amid COVID-19 and the possibility of making line balancing improvements using analytics on process time data collected by AR devices.

Limitations of Conventional MES Implementations

The global MES market is expected to expand rapidly at a compounded annual growth rate of 4.5%, reaching $14.9 billion by 2025[1]. As the functional scope of integrated MES expands, manufacturers are increasingly adopting it to develop and produce high-quality customized products, while retaining the flexibility and cost effectiveness of mass production. In essence, MES is enabling manufacturers to respond to today's rapidly changing customer expectations with agility.

What hinders an effective MES implementation is that most of the major MES product vendors offer solutions with conventional HMIs and scanners, which need to be mounted at a fixed location. This requires users to walk towards an HMI every time they want to interact with it. For instance, during login or log out, filling task completion confirmation, issuing step overrides, or picking and placing barcode scanners after every use. Further, due to the ongoing pandemic, manufacturers will have to relook at how HMIs and scanners are operated and will implement mechanisms to prevent direct physical touch by multiple operators in different shifts.

To illustrate the major hindrances of implementing MES (see Figure 1), consider the auto industry. On average, in an automotive assembly workstation, the movement of an operator towards an HMI constitutes approximately 8% of the total station TAKT time. The pick and place activity of scanners constitute approximately 4% of the total station TAKT time. This means the estimated number of HMIs and scanners required for an automotive plant with a capacity of 300,000 cars per annum are 400 and 200, respectively. This translates into productivity loss and high capital costs for MES implementation.

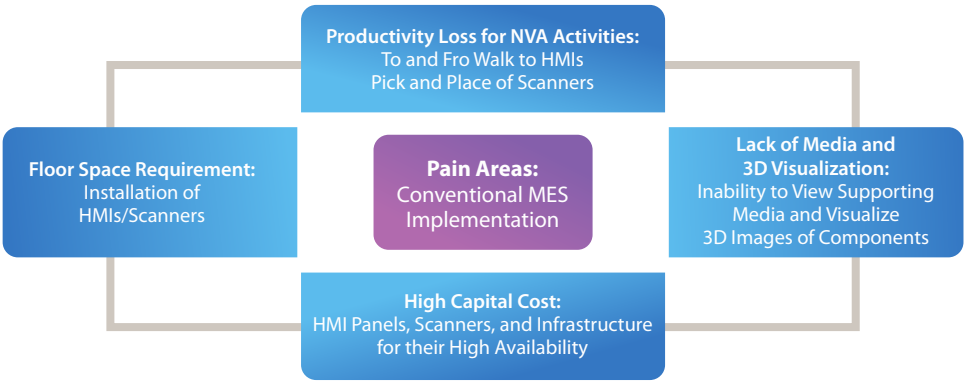

Figure 1: Major limitations of current MES implementation

[1] *Markets and Markets; Manufacturing Execution System Market with COVID-19 Impact - Global Forecast to 2025; June 2020; https://www.marketsandmarkets.com/Market-Reports/manufacturing-execution-systems-mes-market-536.html*

Reimagining MES with Augmented Reality

AR technology can transform MES implementation as it generates a composite view for the user by augmenting the real space viewed by the user with the virtual space generated by the computer. It allows users to enrich the real space captured by the camera with additional information such as graphics, video, or text along with audio.

The key capabilities of AR devices are related to optics (resolution, field of view) and user interactions (voice recognition, gesture input). The devices can also leverage and optimize the use of other technologies such as mobility, location, 3D content management, imaging, and recognition.

With growing technological advancements, the benefits of AR technology are becoming increasingly evident: AR technology can eliminate physical user training infrastructure for original equipment manufacturers (OEMs); it can help in remote servicing or maintenance not only for service stations/retailers but also for equipment with 3D views, video assistance, machine catalogue, and more. OEMs can leverage their ecosystem partnerships to change how MES' are implemented. They would need to develop partnerships at multiple levels, right from requirements gathering (use-cases) to design/testing and commissioning. To realize this, OEMs will need to partner with product owners, system integrators, and AR wearable firms.

The key features of AR-enabled MES are as follows (see Figure 2):

- User authentication through face recognition or voice signature, eliminating the need for manual typing of a username and password.
- Viewing and performing work instructions for an order on a virtual screen along with step-by-step audio and video assistance.
- Viewing and validating inspection checklists on virtual screens supported by step-by-step audio and video assistance.
- Performing barcode label or QR code scanning with the help of AR devices, eliminating the need for picking and placing barcode scanners and physical touch.
- Viewing and performing kitting and sequencing activities with the help of AR devices.
- Viewing order-specific repair history on a virtual screen along with manuals, 3D drawings, and so on.

- Repairing a product or vehicle using step-by-step audio and video-based assistance along with 3D visuals of parts, manuals, and assembly or dis-assembly instructions.
- Remotely performing step override activities of workstations, eliminating the need for physically walking towards an HMI station.
- Viewing plant KPIs and their status on a virtual screen along with the ability to connect with operators or supervisors in real time to proactively deal with issues.
- Ensuring manufacturing shop floor operations are conducted in a touch-less manner.
- Analytics on workstation data to further improve productivity and quality.

Figure 2: Key components of AR-enabled MES

Use Cases and Challenges of Implementing AR-Enabled MES

To better understand how an AR-enabled MES operates, let's analyze use cases for different user roles within an automotive OEM or a tier 1 automotive supplier organization, as illustrated in Figure 3.

Figure 3: Use cases of AR-enabled MES

While an AR-enabled MES solution has multiple use cases, several challenges stand in the way of effective implementation. Manufacturers must ensure that the AR devices are integrated in real-time with the MES or other manufacturing shop floor applications. Moreover, the virtual screen resolution must be compatible with shop floor requirements, and the audio and video instructions must accommodate the higher noise levels of the

shop floor. Further, manufacturers must also factor in the industrialization of AR wearable devices in terms of size, weight, cost, architecture for data security and safety, and ergonomics of operators as per industry norms. Change management, especially for brownfield plants, is also a major consideration to ensure seamless implementation and adoption of the devices. Most of the challenges associated with AR technology can be effectively addressed by partnering with domain experts and deploying small use cases, before moving on to large-scale implementations.

Manufacturing's AR Makeover is Coming Soon

According to Gartner[2], 2020 is the year when technology-literate people will be replaced by people-literate technology. Termed 'multi-experience' by Gartner, traditional computing will develop into a multi-sensory and multi-touchpoint interface, which will be enabled by AR/VR wearables and advanced computer sensors. AR technology has advanced to a point where organizations can safely use it as an internal tool to complement and enhance business processes, workflows, and employee training. In the near future, AR will have a significant impact on the way MES and other manufacturing applications are developed and managed, such as text-to-speech capabilities, 3D views, and more. Further, it will significantly redefine manufacturing operations, making production facilities more coordinated, leaner, and safer (touch-less), with proactive alerts of critical events delivered to the right stakeholders.

[2] Gartner; Gartner Top 10 Strategic Technology Trends for 2020; October 21, 2019; https://www.gartner.com/smarterwithgartner/gartner-top-10-strategic-technology-trends-for-2020

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