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THE ROLE OF MES FOR SMART MANUFACTURING IN ELECTRONICS

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ABERDEEN

As Best-in-Class electronics manufacturers move towards smart manufacturing, Industry 4.0, and Internet of Things-connected equipment in the plant, manufacturing execution systems (MES) are becoming more important than ever, because they enable real-time unification of electronics and mechanical production information. This report explores how Best-in-Class organizations deploy MES for smart manufacturing in electronics and the performance boost they receive for doing so.

The Rise of Smart Manufacturing in Electronics

Electronics manufacturing must undergo a digital transformation to remain competitive. **E**lectronics **manufacturers are facing new challenges in today's** era of smart manufacturing**, which consists** of fully-integrated, collaborative manufacturing systems that respond in real time to meet changing demands and conditions in the factory, in the supply network, and in customer needs. In th**is** new era, all phases of the smart manufacturing flow – from design to production execution **–** are connected via closed-loop feedback.

In the smart manufacturing world, manufacturers realize greater efficiencies by merging the real and virtual worlds (cyber-physical systems), using the digital twin to achieve entirely new levels of product innovation **(**as well as manufacturing efficiency and effectiveness**)**, while eliminating risk and maximizing performance. IoT-connected operations are integral to smart manufacturing, connecting machines to gather data and monitor the production process throughout a plant.

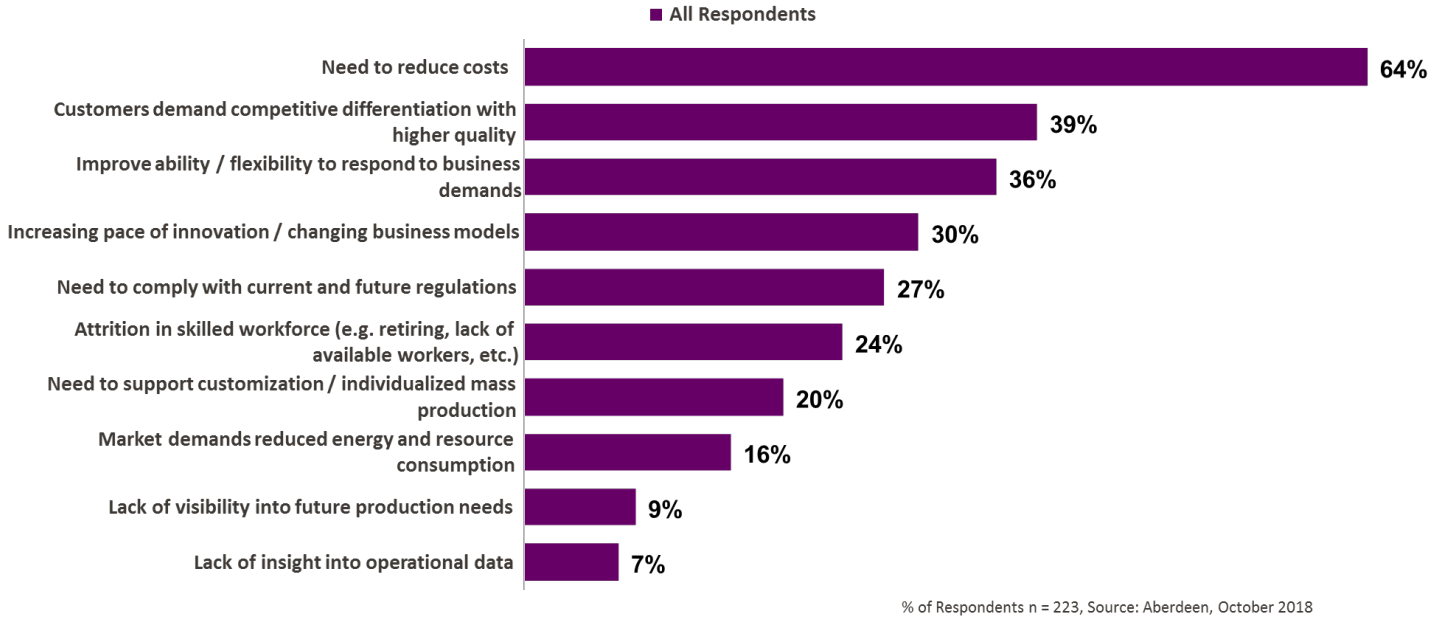
In this connected world, MES requirements have changed. Electronics manufacturers require a high-performance solution so they can be flexible and agile. They need consistent, normalized data across all phases of the smart manufacturing flow (design, virtual commissioning, design for manufacturability, process engineering, production execution). Smart manufacturing now demands a scalable, end-to-end, enterprise-level MES that is up to the task**;** a solution specifically optimized for smart manufacturing in electronics.

Manufacturing execution systems (MES) manage, monitor and synchronize the execution of real-time, physical processes involved in transforming raw materials into intermediate and/or finished goods. They coordinate this execution of work orders with production scheduling and enterprise-level systems. MES applications also provide feedback on process performance, and support component- and material-level traceability, genealogy, and integration with process history, where required.

Pressures and Challenges Drive End-to-End MES Usage

Manufacturing today faces many pressures and challenges. These include rising costs, operational inefficiencies, and shortened product release cycles. To meet these challenges and improve manufacturing operations, manufacturers are turning to manufacturing operations management (MOM) and end-to-end MES. As Industry 4.0 ushers in the IoT, Cloud, and big data analytics, MOM / MES leverages this new influx of data, makes sense of it, and drives value across production, quality, and compliance. MOM / MES provides end-to-end, real-time process visibility and traceability, along with the ability to manage, monitor, synchronize, and optimize physical production processes.

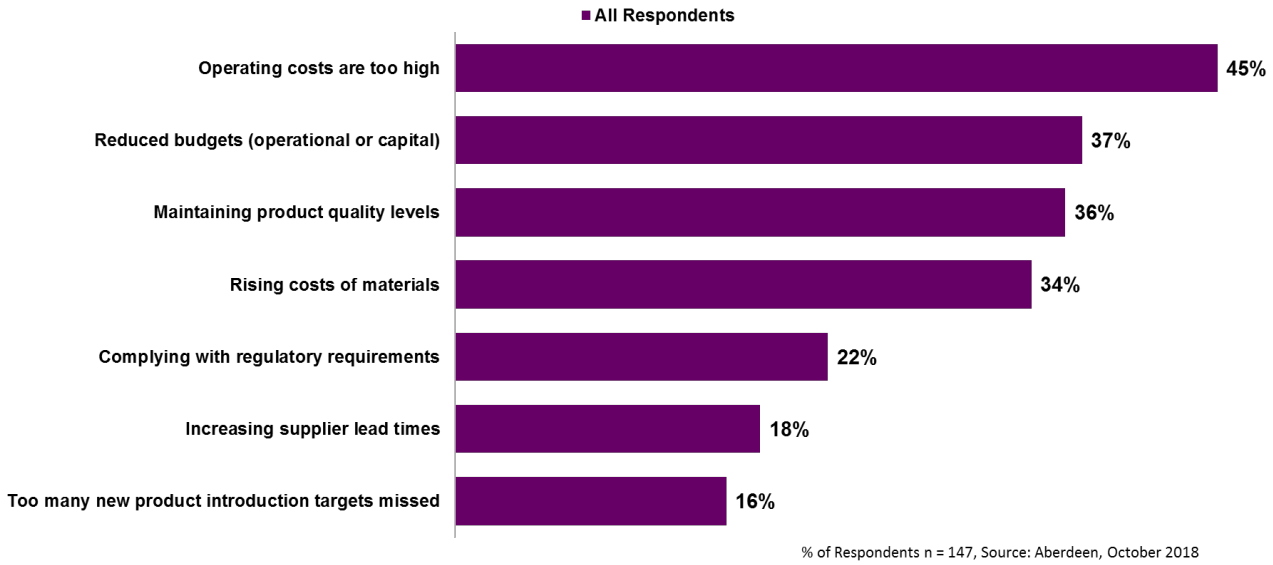
Figure 1: Top Pressures on Manufacturing



% of Respondents n = 223, Source: Aberdeen, October 2018

The need for better operational efficiency stands out as a major pressure for all companies. Forty-five percent of respondents say that operating costs are too high, and 64% cite the pressure of needing to reduce costs. Thirty-seven percent are challenged by reduced budgets (operational or capital), and 36% by managing product quality levels. The need to comply with current and future regulations is a pressure felt by 27% of respondents.

Figure 2: Top Challenges in Managing Manufacturing Operations



% of Respondents n = 147, Source: Aberdeen, October 2018

Overall, 55% of survey respondents say that too many operational inefficiencies (e.g., waste, delays, false starts, rework) are a huge challenge for their organization. Additionally, manufacturers are pressed by expectations for real-time, critical decision making across operations (i.e., a shorter decision window).

The demands on manufacturers are significant. Best-in-Class organizations are responding to these pressures and meeting these challenges by pursuing operational excellence through MES; Best-in-Class firms are 50% more likely to implement MES than All Others. A Best-in-Class MES for electronics is based on an enterprise-level platform, granting a high-level of scalability, rapid implementation, and (when needed) configurability. Such a solution also incorporates production optimization via closed-loop scheduling.

Defining the Best-in-Class

To identify best practices in MES for manufacturers, Aberdeen used three key performance indicators (KPIs) to distinguish the Best-in-Class from Industry Average and Laggard organizations. These are:

- **Complete and on-time delivery:** Percentage of complete products delivered on time as compared to total commitment.
- **Overall equipment effectiveness (OEE):** Measured in percent as: Availability *x* Performance *x* Quality.

- **Manufacturing cycle Time:** Measured in percent of improvement over the past two years.

Table 1 summarizes the aggregate performance of Best-in-Class, Industry Average, and Laggard organizations (see sidebar for maturity class framework definition).

Table 1: Top Performers Earn Best-in-Class Status

Maturity Class	Mean Class Performance
Best-in-Class:	98% complete and on-time shipments 98% OEE 25% improvement in manufacturing cycle time (2 years)
Industry Average:	92% complete and on-time shipments 91% OEE 8% improvement in manufacturing cycle time (2 years)
Laggard:	77% complete and on-time shipments 74% OEE 0% improvement in manufacturing cycle time (2 years)

Source: Aberdeen, October 2018

Best-in-Class manufacturers realize higher performance results both in customer metrics — by delivering 98% of products promised on time — and internal plant metrics — by effectively utilizing assets (98% OEE) and achieving at 25% improvement in manufacturing cycle time over the past two years.

Clearly, the Best-in-Class enjoy significantly lower manufacturing costs coupled with better customer services. The key to this benchmark report is to determine just how the Best-in-Class are achieving these results via end-to-end MES.

The Aberdeen maturity class framework identifies three groups of survey respondents. The data determines overall company performance, based on self-reported performance across several key metrics. Each respondent falls into one of three categories:

► Best-in-Class: Top 20% of respondents based on performance

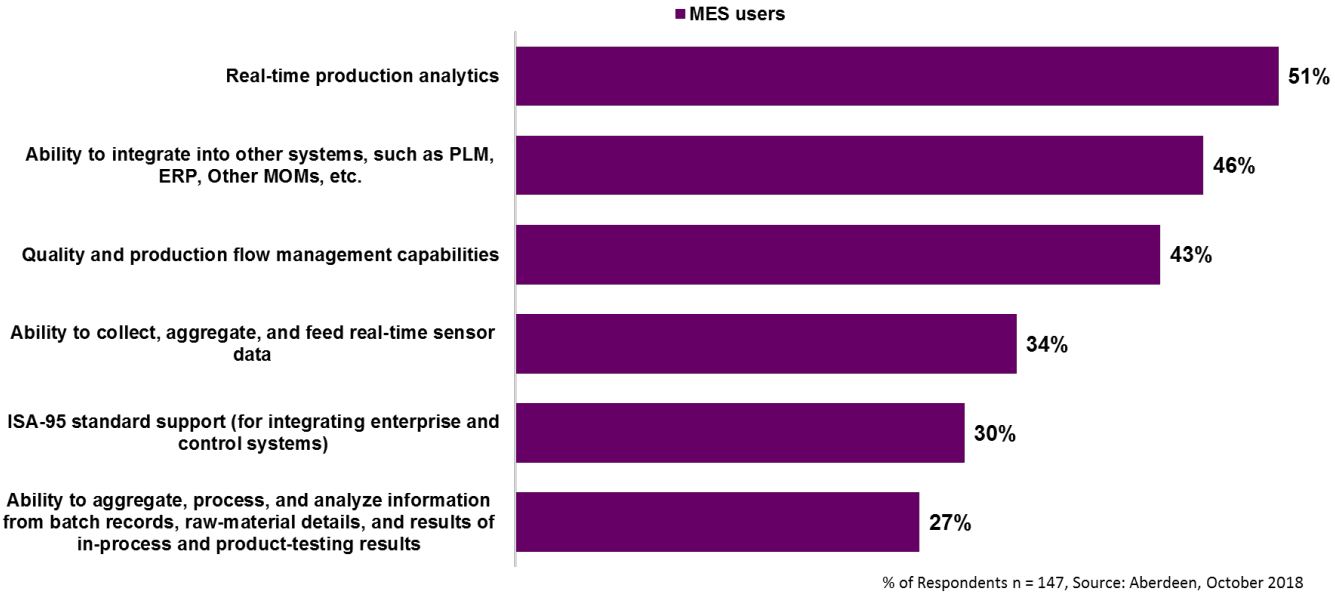
► Industry Average: Middle 50% of respondents based on performance

► Laggard: Bottom 30% of respondents based on performance

MES Capabilities for Smart Manufacturing in Electronics

What do organizations seek from their MES? The most highly-prized capabilities relate to production flow management, real-time production analytics, integration into enterprise applications such as ERP, and quality (Figure 3).

Figure 3: Capabilities for End-to-End MES



% of Respondents n = 147, Source: Aberdeen, October 2018

As these capabilities strongly suggest, a true end-to-end MES solution for electronics must support the realities of smart manufacturing production flow (design, virtual commissioning, design for manufacturability, process engineering, and production execution). An MES solution for smart manufacturing in electronics must:

- Support smart manufacturing via IoT-based real-time sensor data collection from the shop floor, transforming it into actionable insights, and using real-time production analytics to generate closed-loop feedback to support continuous improvement in product quality and execution. There are two levels of feedback:
  - Closed-loop manufacturing: Direct feedback from shop floor operators highlights product defects on 3D product models or other images / platforms. This qualitative

feedback is usually generated through MES and then sent to PLM.

  - IoT analytics: Another level of feedback is more quantitative and related to IoT analytics, usually collected by MES or edge devices and shared in cloud-based environments. Other systems (e.g., PLM, ERP, SCM, etc.) can have access to the same cloud, analyze reports, and close the loop.

- Support Best-in-Class electronics-industry-specific functionalities, covering both printed circuit board (PCB) design / production and mechanical / box-build issues. Today, electronics manufacturers need an MES solution that truly adds value; they still create PCBs (*electronics systems*), but in the end they are measured on the products they build (*mechanical systems*). Whether a manufacturer builds smart TVs, mobile phones, or entertainment systems, they also deal with plastics, metal press fit, CNC, and assembly work. *Electronics* and *mechanical* systems manufacturing have traditionally been completely disconnected. However, the role of MES for smart manufacturing in electronics demands an end-to-end enterprise-level MES that ensures production execution for both electronics (PCB) and mechanical (box build) aspects of manufacturing.

- Integrate into other enterprise systems such as product lifecycle management (PLM), enterprise resource planning (ERP), and other MOMs, and scheduling programs (Figure 4). Integration with scheduling engines, for example, is especially important in smart manufacturing. In a closed-loop scheduling solution, the MES sends data to a scheduling engine, which manipulates it to create an optimized schedule and returns it to the MES. The MES then uses the optimized schedule to generate the queue for order dispatching and operation view. The benefits of closed-loop scheduling include lower inventory levels, reduced costs, faster response to shorter lead times, and improved product quality.

Figure 4: Integrated MES is Key for the Electronic Industry

% of Respondents n = 223, Source: Aberdeen, October 2018

Best-in-Class Pursue Better Path to Operational Excellence

Best-in-Class companies are pursuing a better strategic path than All Others and have achieved superior results for their efforts (Table 2).

Table 2: Best-in-Class Firms Achieve Superior Results

Best-in-Class Key Performance Indicator	Best-in-Class	All Others	Best-in-Class Performance Edge
Complete and On-time Delivery	98%	87%	13% better
Overall Equipment Effectiveness (OEE)	99%	85%	16% better
Capacity Utilization	97%	83%	17% better
Raw Material Utilization	96%	83%	16% better
Manufacturing Cycle Time Improvement over 2 Years	25%	5%	5 Times better
Operating Margins Improvement over 2 Years	25%	5%	5 Times better
Time to Decision Improvement over 2 Years	25%	5%	5 Times better

n=223, September 2017

How do the Best-in-Class achieve these superior results? Here is Aberdeen's analysis of Best-in-Class operational excellence, especially as it as relates to MES:

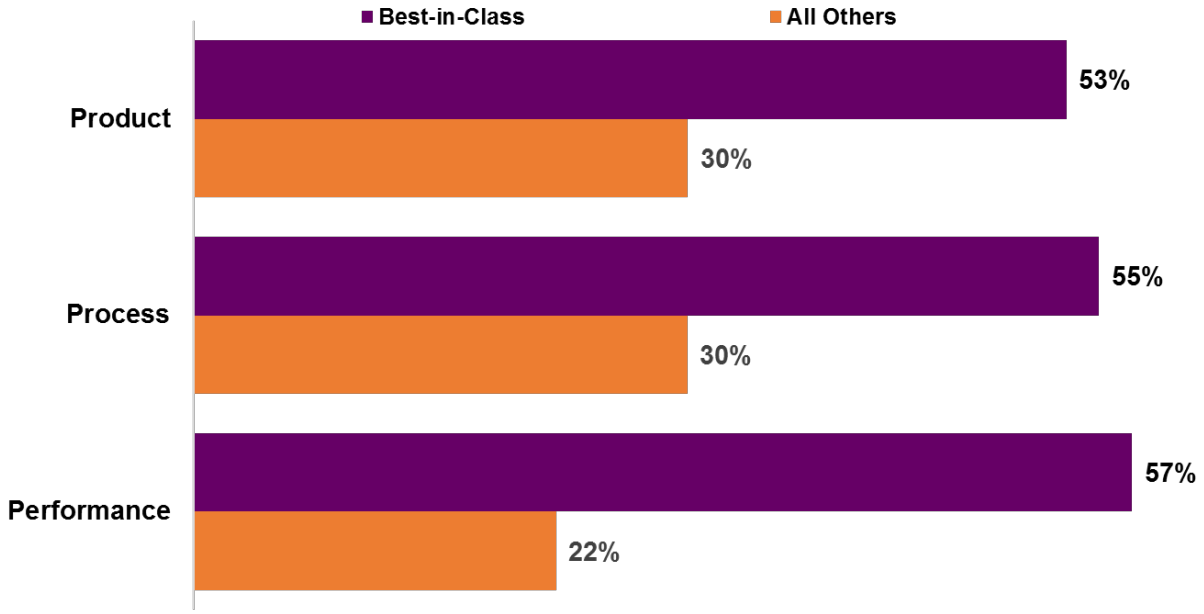
1. **Tracking and Traceability:** The Best-in-Class are 50% more likely than All Others to build compliance and traceability into production processes. Being able to track every relevant part, process, and final product means manufacturers quickly isolate defects, stop adding value to defective works in process, and limit the need for costly rework through product recalls. Twenty-nine percent of the Best-in-Class deploy or plan to deploy track-and-trace via Industrial IoT (IIoT) technology.

   The Best-in-Class also contribute to trackability with digital twins (Figure 5 and sidebar). The digital twin is important for product, process, and performance. In addition, normalized data across the smart manufacturing production flow via open, intelligent data exchange formats creates a digital thread.

Definition: Digital Twin

A virtual representation of a product, process, physical asset, or service as an integrated system of data, models, and analysis tools maintained over the entire lifecycle.

Figure 5: Extending the Digital Twin to MES

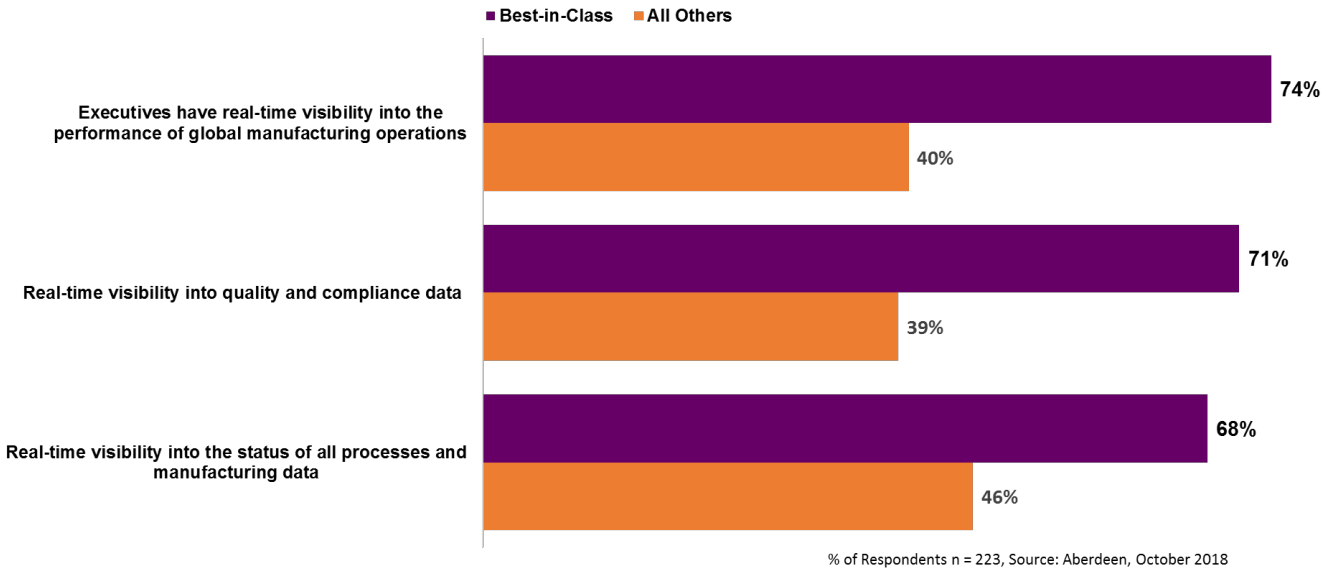


% of Respondents n = 223, Source: Aberdeen, October 2018

Best-in-Class firms are 1.8 times more likely than All Others to deploy the digital twin in designing products and in their manufacturing processes. In product performance, the Best-in-Class edge jumps to 2.6 times more deployment of the digital twin than All Others. In this era of smart manufacturing, as MES providers fully extend the digital twin to manufacturing execution, MES' position as a bedrock system becomes even stronger.

2. **Visibility:** For 74% of the Best-in-Class, it begins with real-time visibility into the status of all processes and manufacturing data (Figure 6).

Figure 6: MES Enhances Visibility



Visibility extends to centralized manufacturing data, with 71% of the Best-in-Class locating their manufacturing data in a centralized repository — 1.8 times greater than All Others.

The MES Performance Edge

MES plays a foundational role in the success of manufacturing leaders in achieving tracking, traceability and visibility. Best-in-Class firms are 50% more likely to implement MES than All Others. Moreover, organizations deploying MES receive a pronounced performance boost (referred to as *The MES Edge)* from such deployment (Table 3).

Table 3: The MES Performance Kick

	Key Performance Indicator	MES Implemented	MES not Implemented	The MES Edge
Production	Complete and on-time shipments	92%	87%	**6% better**
	Overall Equipment Effectiveness	90%	85%	**6% better**
	Capacity Utilization	90%	84%	**7% better**
	Raw material utilization	89%	85%	**5% better**
Product (% of products)	Product launch dates met	73%	68%	**6% better**
	Product cost targets met	70%	67%	**4% better**
	Quality targets at design release met	75%	67%	**12% better**
	Product revenue targets met	70%	65%	**8% better**
Business (over past 2 years)	Time to decision improvement	14%	6%	**2.3 times better**
	Operating margin improvement	13%	6%	**2.2 times better**
	Total cost per unit improvement	12%	6%	**2 times better**
	Manufacturing cycle time improvement	14%	7%	**2 times better**

n=223, Source: Aberdeen, October 2018

The MES Edge extends across production, product, and business metrics. For example, a comparison of the Best-in-Class manufacturing cycle time improvement in Table 2 (5x) to MES user manufacturing cycle time improvement in Table 3 (2x), implies that MES is responsible for 40% of the total Best-in-Class edge, and that makes MES very important indeed!

Summary: 10 Reasons for End-to-End MES in Electronics Manufacturing

1. Electronics manufacturing must undergo a digital transformation to remain competitive.

2. The electronics manufacturing industry is entering an era of smart manufacturing consisting of fully integrated, collaborative manufacturing systems that respond in real time to meet changing demands and conditions in the factory, in the supply network, and in customer needs.

3. MES plays a foundational role in the success of smart manufacturing leaders in electronics, enabling tracking, traceability, and visibility. Best-in-Class firms are 50% more likely to implement

MES than All Others. Organizations deploying MES receive a pronounced performance boost from such deployment.

4. Smart manufacturing demands an MES that is up to the task: a solution specifically optimized for smart manufacturing in electronics. A Best-in-Class MES is based on an enterprise-level platform, granting a high level of scalability, rapid implementation, and (when needed) configurability.

5. MES for smart manufacturing should support IoT-based real-time sensor data collection from the shop floor, transforming it into actionable insights, and using real-time production analytics to generate closed-loop feedback to support continuous improvement in product quality and execution.

6. An end-to-end MES for electronics should include support for electronics industry requirements, including those for both electronics (PCB) and mechanical (box build) production.

7. Don't waste time on a non-integrated MES solution. An effective solution offers deep integration with PLM, ERP, and other MOMs. Integration with production-optimization scheduling software is very important.

8. Although fundamentally about production execution, the modern end-to-end MES supports the entire activity flow of smart manufacturing.

9. Don't overlook the potential of the digital thread; Digital twins must be implemented for product, process, and performance, but a full MES solution for electronics must create a digital thread that normalizes data at all phases of the smart manufacturing process flow.

10. Today, an industry-specific MES is *de rigueur*. Don't settle on a general MES solution or a niche player who does not fully support the needs of the electronics industry. It should support specific Best-in-Class functionalities for the electronics industry, and add value to all manufacturing activities, both electronics (PCB activities) and mechanical (box build activities).

Despite their considerable success in achieving operational excellence through MES, the Best-in-Class are not finished. They have begun their journey to smart manufacturing, and MES is a key part of that journey. As

Best-in-Class managers move towards IoT-connected equipment in the plant, MES turns out to be more important than ever as the unifying force to bring all production information together in real time.

Related Research

The MOM/MES Performance Kick: Better Tracking and Traceability, Visibility, and Quality; June 2018

The MOM/MES Edge: The MES Performance Kick; October 2017

A Consolidated Approach to Manufacturing Operations Management (MOM); June 2016

Manufacturing Operations Management (MOM): A Guide to Business Process in the Factory; July 2015

About Aberdeen Group

Since 1988, Aberdeen Group has published research that helps businesses worldwide to improve their performance. Our analysts derive fact-based, vendor-neutral insights from a proprietary analytical framework, which identifies Best-in-Class organizations from primary research conducted with industry practitioners. The resulting research content is used by hundreds of thousands of business professionals to drive smarter decision-making and improve business strategies. Aberdeen Group is headquartered in Waltham, Massachusetts, USA.

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