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VIEWPOINT

# INDUSTRY 4.0 TO BUILD A "LIVE ENTERPRISE"

A lean, modular manufacturing execution system is a key Industry 4.0 component to integrate factories with the rest of the enterprise. Challenging, unplanned situations like the COVID-19 pandemic highlight MES' importance to provide agility and resilience to execute rapid business changes. Western Digital's smart factory initiative is a good example of how one company got it right.

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In a fast-changing market, organizations must continually sense and observe their environment, and respond in an agile and innovative manner, much like an organism adapting to its environment. In short, they strive to be a Live Enterprise.

Yet manufacturing organizations often struggle to plan ahead and translate business objectives into operational requirements. Typically, they merely measure manufacturing capacity, rather than actual activity. This means they are unable to quickly respond when there are issues on the shop floor.

To address this challenge, manufacturers need to implement a lean, modular manufacturing execution system (MES) that digitizes factory operations and integrates them into the rest of the enterprise . Western Digital's global enterprise resource planning (ERP) cloud transformation is an example of such an initiative.

Manufacturers need visibility of factory operations to notice deviation from plans and to take timely action. However, finance, business leaders, product owners, marketing, supply chain, and the rest of the enterprise have limited visibility into actual operations and factory floor performance. Most only get delayed data on production — and this makes it a challenge to make timely strategic and tactical decisions regarding inventory, supply chain, distribution, pricing, and sales.

> A lean, modular manufacturing execution system can help manufacturing organizations respond quickly to operational issues

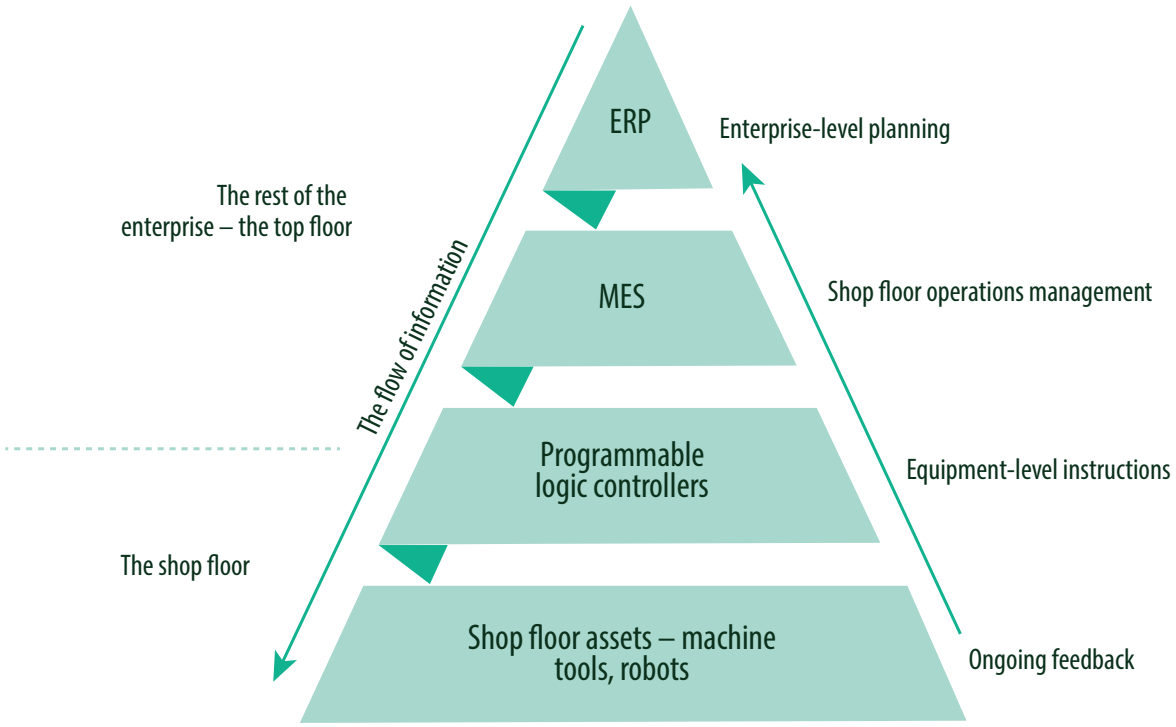
This is even more critical in an economy affected by COVID-19. Manufacturers are having to scramble to deal with ever-changing global lockdown restrictions that have thrown their supply-and-demand forecasting techniques into chaos.

Additionally, the rapid pace of change for new product introductions, production schedules, product mixes, upgrades, customizations, and price changes need a flexible and agile manufacturing application to adapt to each situation.

The solution is to create direct, real-time connections between the MES, which runs the equipment on a factory floor, with the inventory, finance, and planning tools that reside in the company's ERP software suites (Figure 1).

These integrations enable the head office to execute production plans based on financial, market and supply chain data — and monitor and adjust these plans in real time based on the actual production status at the factories. Large enterprises with multiple business units, plants and systems globally face an acute need for this type of real-time data in a consolidated view.

Figure 1. MES/ERP systems integrate the shop floor or 'operations technology' with the rest of the enterprise or 'information technology'

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# Western Digital's road to manufacturing agility

Western Digital Corp. is one of the world's leading data storage manufacturers, producing hard disk drives (HDDs) and flash storage. With the ever-increasing demand for data storage, Western Digital's business is on a growth trajectory in terms of the sheer gigabyte volumes of storage it must produce. But at the same time, the product is continuously under the pressure of commoditization, with the average price per gigabyte falling rapidly.

Western Digital incurred a loss of $754 million in its 2019 net income, down from a profit of $675 million the previous year. This was on a revenue of $16.6 billion in 2019, compared with $20.6 billion in 2018. This was primarily due to lower average selling price per gigabyte of storage devices based on competition and over-supply, and specific incidents such as a power outage and higher inventory costs, as shared in its annual report.

Part of the challenge is that there was a patchwork of archaic systems across the company's facilities. Western Digital had 10 plants globally producing HDD products and components. Each factory had a different MES application. Sometimes these were not integrated to their associated ERP applications, which were themselves highly customized across both SAP and Oracle e-business product suites.

To tackle this issue, the company decided to take a two-pronged approach. One was to implement a smart factory system.[1] The system enables data gathering from millions of its products on the shop floor. Each storage device that is produced is scanned using machine vision for quality issues during the manufacturing process. Machine learning is used to spot defects using image classification. Shop floor equipment has been fitted with sensors to collect critical parameters and predict when repairs are needed. This setup is critical for Western Digital to ensure the quality of its products and improve yields in manufacturing.

Additionally, Western Digital decided to do away its legacy ERP applications in favor of more agile and modern cloud-based ERP software, provided by Oracle. With a multiyear rollout plan, WD intends to completely transform

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its operations including integrating its multiple shop floor systems. An intentional strategy was to separate MES and ERP implementation to limit the change and disruption to business. It was very important that all MES applications (now and future) should integrate with a common design architecture with the freshly implemented Oracle ERP cloud. This architecture allows manufacturing to continue 24X7 operation in spite of planned or unplanned down time of the cloud.

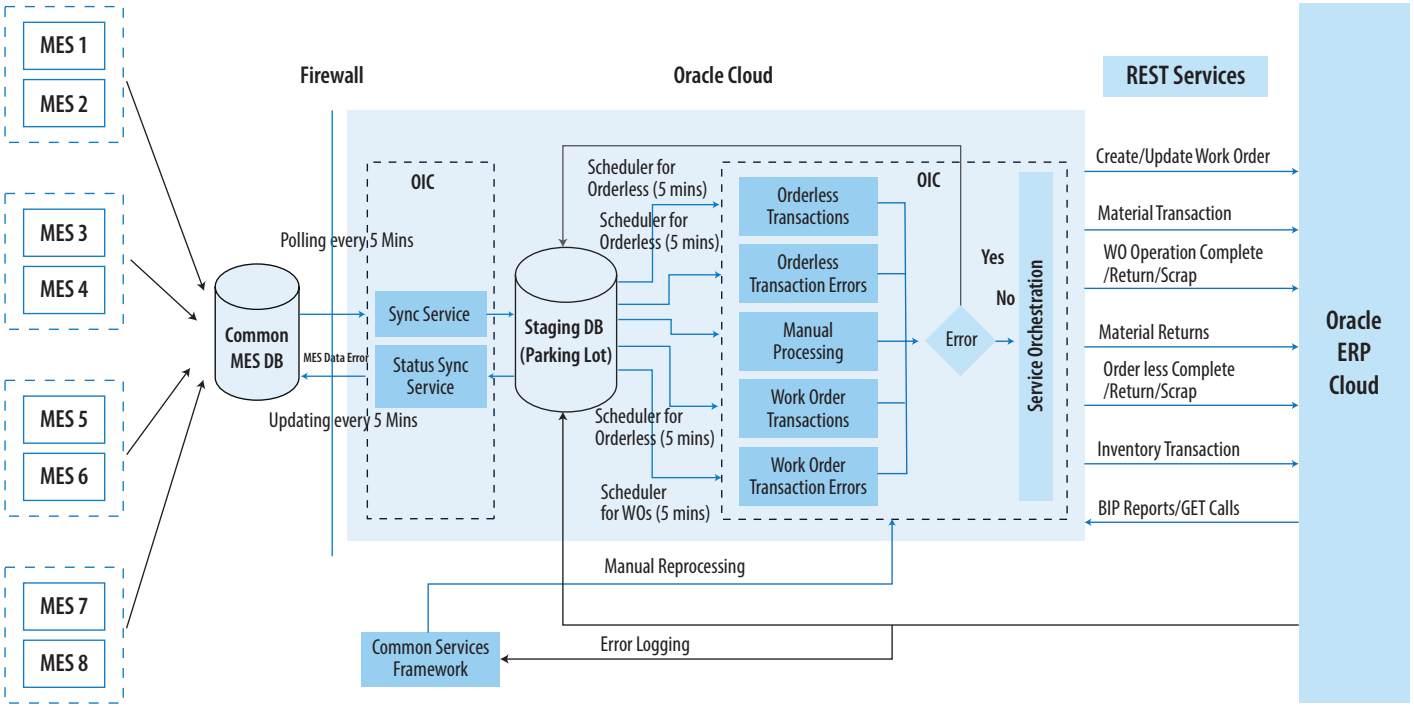
> WD has ensured that all its existing and future MES applications can be integrated with its newly implemented Oracle ERP cloud

At the time of writing, eight of Western Digital's component factories have adopted the new manufacturing cloud application integrated with 10 MES systems, with more than 8 million total records successfully processed. The implementation is underway in two of the HDD factories as well. This architecture provides simple aggregation for ERP in Level 4 with operation steps whereas MES deals with complex Level 3 with hundreds of operation steps. The following business benefits have already started to accrue:

1. Common master data definitions across the enterprise: removal of more than 2,000 duplicate parts and associated work definitions.
2. Financial compliance where shop floor system, ERP system reflect the same data, in near real-time.
3. Accurate inventory and WIP reporting, resulting in better inventory turns and less inventory obsolescence.
4. Removal of manual non-value-added steps of reconciliations and manual journal entries (single-digit manual journal entries since go live, which was a regular practice prior to implementation).
5. Better capacity utilization and planning of manufacturing resources.
6. Standardized, harmonized business processes.

But designing and implementing this architecture alongside an ERP cloud transformation is not straightforward, and two critical facets must be done right: master data management and manufacturing process design.

Figure 2. MES architecture design and integration with the ERP system




REST – Representational State Transfer architecture

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## Master data management

The first and generally most challenging step to implement manufacturing on the cloud is to define the master data management system across the enterprise.

With multiple legacy systems and uncontrolled processes, this exercise can be challenging, as it entails bringing in aspects from across all functional areas. The following are the key master data elements and considerations especially for MES integration:

- **Unique item numbers and bill-of-materials (BOMs) for parts with automated item creation workflow -** The item creation workflow connects the dots for item definition, from engineering drawings to various functional and physical attributes required for part definitions. Assignment to the appropriate inventory organizations can be automated based on business requirements, largely driven by the business and supply chain model.

  In times of global manufacturing, it is important to drive toward global master definitions of BOMs. This ensures uniformity across the company with respect to quality, cost, and operations. Local market variation can always exist, but then they could be created as another version of the BOM or another BOM itself. The idea is not to have duplicate item numbers for the same physical items. As we relook at designing our BOMs (levels), it is important to keep in mind the postponement strategy to ensure high capacity utilizations at the factories along with high customer service levels.

- **Definition of substitutes –** Sometimes in the BOM creation, organizations have a requirement to define alternate parts or substitutes for some components. These could be sourced from different suppliers or from the same supplier at a different or the same cost. A quick and easy workaround is to define such substitute components with zero quantity in the BOM until they become active.

- **Work definition –** This defines the manufacturing process, or the sequence of steps involved in the making of the finished goods. Every manufactured sub-assembly has its own work definition that is version controlled to track the periodic updates it undergoes for changes in the BOM, material cost, resources and their rates.

- **Costing/Item costs -** There are two broad variations in how cost is defined. One is for finished goods and another is for components. For components, the standard cost is generally pre-setup for a certain period, as close to the procurement cost as possible. This is re-visited at the end of a period based on variance analysis and new costs setup for the future. Another way is for finished goods where the cost needs to be rolled up based on the component or the resource cost defined in the work definition.

## Manufacturing process design

Once the master data considerations are complete, the next big decision concerns the design of the manufacturing process itself. One key decision is the number of count points in the process. With the ERP and MES as different applications, the advantage is one can have a 100 step process in MES or shop floor while ERP may still be having only 4 count points which are relevant from a WIP valuation perspective. Another decision to be made is whether to use orderless processing or work order-based processing as the core manufacturing construct.

> While designing the manufacturing process, it is important to decide between orderless processing and order-based processing as the core construct

In traditional manufacturing where products have a long lead time (more than seven days), a work order is placed for the parts and process required to make the finished good. Suppliers provide parts based on purchase orders raised on their name. But in fast-moving industries like high-tech, orderless manufacturing is a leaner approach. The time taken to make the product is short. It is assembled by using a pre-ordered inventory of parts rather than through parts ordered specifically for that product. The inventory and costs are reconciled in the ERP cloud by counting the finished goods and simply deducting the quantity of components used in making each one.

Within the manufacturing process design, there are additional considerations around the below sub-processes:

1. **Line start process:** The line-start process can be automated based on the MES signal once the lot/shift starts. Leveraging this, relevant quantities can be moved to the WIP supply. This will help in better inventory planning and visibility.
2. **MRB (Material Review Board) process:** A quality process needs to be integrated with each back-flush point. A quality inspection output can put the goods on hold for further review. This would mean moving goods into a separate sub-inventory, which should be non-nettable but could be allowed


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for manual reservations depending on the hold reason. This will ensure better inventory levels and less waste.

3. **Rework process:** Rework has multiple permutations and therefore the rework process is seldom uniform. It is important to allow additional components and resources to be used for performing work order transactions.
4. **Modeling process yield:** Overall yield is an important design element. How do we want to measure (at each stage or overall), capture data, conduct simulations, and confirm for usage? This needs to be revisited each quarter, or more often if there are significant changes happening to the manufacturing process. Unlike other applications such as a Warehouse, the production process is complex and runs into hundreds of steps. The complexity is compounded with processes such as lots, split lots, merge lots, inline rework and down binning. Modeling these processes and testing them in production like environments is a challenge. Parallel runs can be conducted on a simulated MES to analyze it for accuracy and completeness.

Other design considerations are the frequency of interface between ERP and the MES, and a three-to-four-times factor of transaction volumes for performance considerations that help ensure a smooth implementation. To avoid any surprises, the best option is to leverage production MES data for testing during the implementation cycle, as it would give both variations and required volumes.

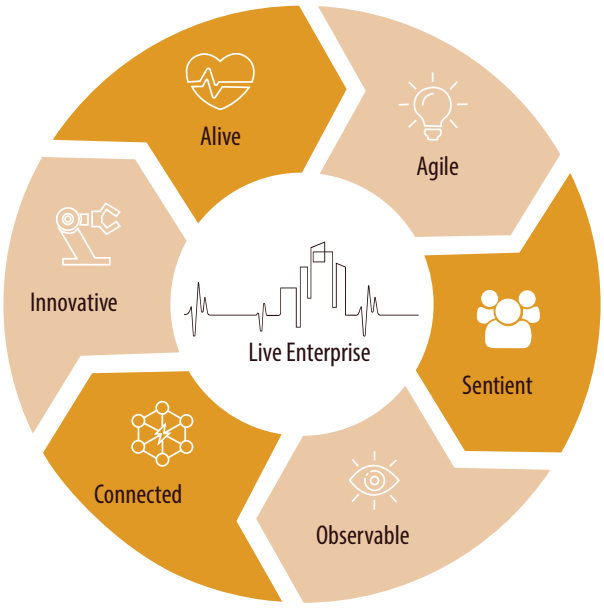
## Industry 4.0 for building Live Enterprises

Western Digital is a great example of a dynamic, fast-moving manufacturer in an industry that has high levels of product demand, new product introduction, and changes to existing configurations — but also has a product with a short shelf life. Not all industries face this unique combination of fast-moving product, highly competitive market, and consolidating pressure on pricing.

Yet, in general, most industries face increases in product complexity, the processes to make them, and the business models through which they are sold. Additionally, the pandemic has highlighted the need for resilience and real-time responsiveness in the face of unplanned situations that could disrupt the supply chain, increase workforce absenteeism, and close off routes to market.

Investing in an integrated, flexible manufacturing application with a smart manufacturing facility has helped Western Digital transition to become a Live Enterprise across several facets (Figure 3). It has opened pathways for increased automation, autonomous decision making, servitization, and circular manufacturing practices. Being cloud-based also gives strategic flexibility to a company's manufacturing investments. It enables easy expansion or contraction of facilities, and seamless integration, if and when operations are acquired and merged or divested. It provides resilience to manage situations such as the COVID-19 pandemic, which no organization was fully prepared to handle.

Figure 3. Facets of a Live Enterprise

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