

How Manufacturing Enterprises can benefit from Manufacturing Execution Systems Business Intelligence (MES BI)?

Contents

1. Synopsis.....	2
2. Quality Management - Manufacturing Essentials.....	2
3. Shop-Floor Manufacturing.....	4
4. BI Benefits in Manufacturing.....	8

1. Synopsis

The function of Quality plays a very significant role in Manufacturing Industry. Cost of Quality comprises costs of process assurance, product inspection, reworks and rejects which in turn impacts performance and market perception of the product and the Corporate. Quality is achieved through a combination of quality assurance and quality management. Managing quality is important at every stage in the value chain.

This paper gives an insight into Quality Management within a Manufacturing Enterprise as to how Business Intelligence can be introduced on top of a Manufacturing Execution System (MES) landscape to reduce lead time with minimum cost and improve overall process and hence product quality by creating a contextualized Data Warehouse. The approach is generic and caters to any production strategy (MTS, MTO and ETO). This paper addresses how modern BI solutions can seamlessly integrate with MES systems and help build visibility by providing Manufacturing Enterprise Analytics (MEA) platform and facilitate Root Cause Analysis (RCA).

2. Quality Management - Manufacturing Essentials

The large and diverse industrial manufacturing enterprises face similar challenges due to the combination of their operating modes: Made-to-stock, Made-to-order, and Engineer-to-order (ETO). Critical KPIs monitored by an industrial manufacturer include on-time delivery, inventory turns, manufacturing cycle time and quality. While determining methods to effectively increase productivity and reducing the cost of operations is the key to commercial success; optimizing the execution of complex combined operations improves performance across the manufacturing value chain. This can be achieved by putting an effective Manufacturing Execution System (MES) in place and providing integration between MES and ERP (Enterprise Resource Planning), SCM (Supply Chain Management), PLM/PDM (Product Lifecycle Management), Laboratory Information Management System (LIMS), Control Systems and Legacy Systems.

Manufacturing operations such as transparency of production information and optimizing material flow through a factory are critical to a company's business performance. Enterprises that are implementing lean manufacturing and/or six sigma techniques need to have a single source of up-to-date data from manufacturing operations. This information can be initially used for identifying the areas that require improvement and then monitoring how they perform in order to achieve a performance target.

Quality management is a comprehensive solution that supports the enterprise throughout the product life cycle and along its supply chain. It encompasses a wide range of fully integrated, collaborative functions, which assure the quality of products and assets. It also focuses on prevention and continuous process improvement through collaboration and sustained quality control. Process improvement supports the long-term objective to increase profits by eliminating variability, defects and waste that undermine customer loyalty.

Quality assurance and control involves inspections at all stages, continuous monitoring and quick intervention in order to deal capably with unexpected events. Quality inspections can be triggered by various events such as order release or goods movements, correlation of process parameters and product characteristics, etc. In order to document and streamline product quality, certificates can also be created.

Achieving high levels of performance and quality in a company's business processes is the result of a dedicated and sustained effort to continually improve the company's business processes and quality policy. Identifying problem areas, analyzing possible problem causes and eliminating the root causes of these problems are important activities in achieving this goal.

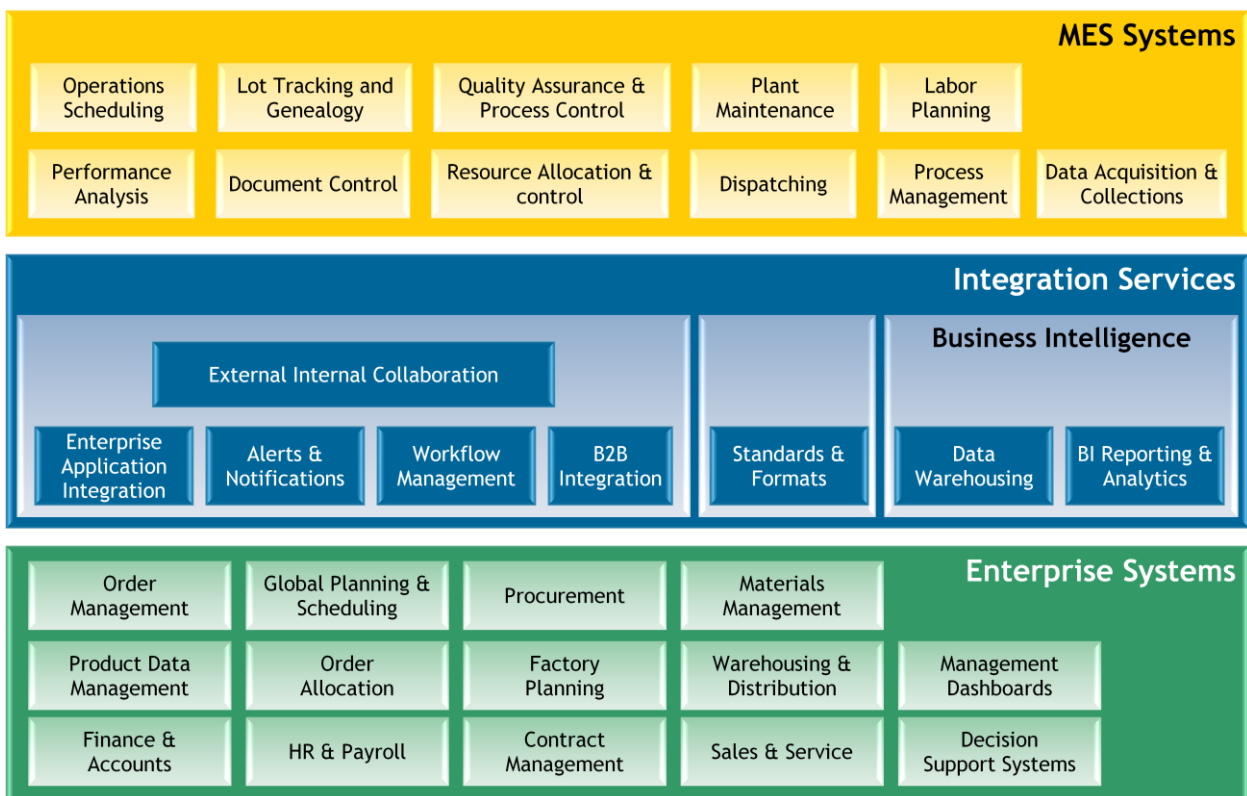
3. Shop-Floor Manufacturing

Real-time integration of sales, production planning, and execution data improves the quality and speed of processes thereby creating a need to track production orders and control production. The confirmation of labor and material activities takes place at the operation level while milestones, back flushing, and automatic goods receipt can reduce the number of business transactions controlling multilevel production processes. The seamless integration to quality management enables quality inspections during production. Other characteristics are the control of rework, batch tracking, and serial number management.

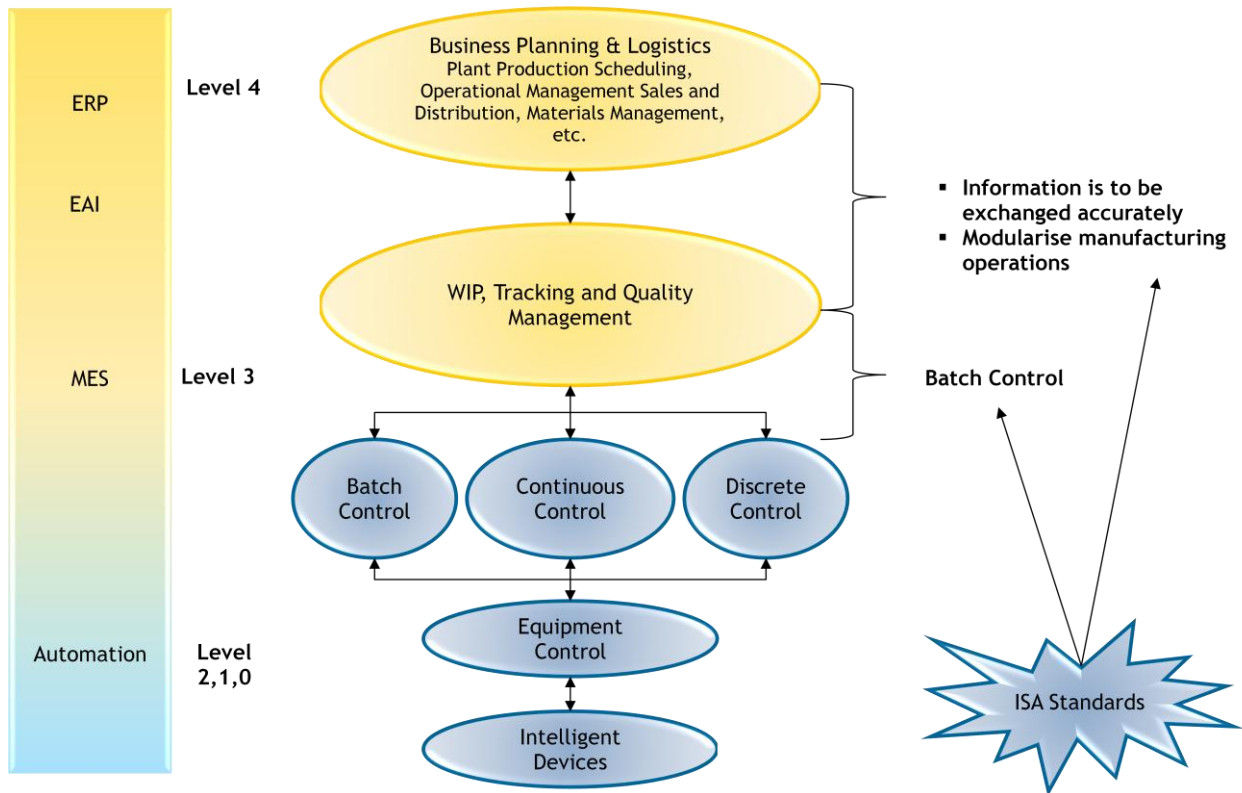
2.1. Manufacturing Execution System (MES)

MES is an electronic interface between personnel, equipment automation, orders, logistics; equipment and processing instructions (batch records). MES is located between the company-wide ERP system and the process control systems and is used to mediate between business administration (covering core functions such as production planning or controlling) and the automation of the production process.

Following application landscape depicts the MES and enterprise systems and various integration services associated with them:



2.2. MES Interfaces



- Level 0, 1, 2 - Upstream: Collectively involved in production of end product
- Midstream- MES
- Level 4 - Downstream: Collectively involved in planning, sales, purchase of raw materials

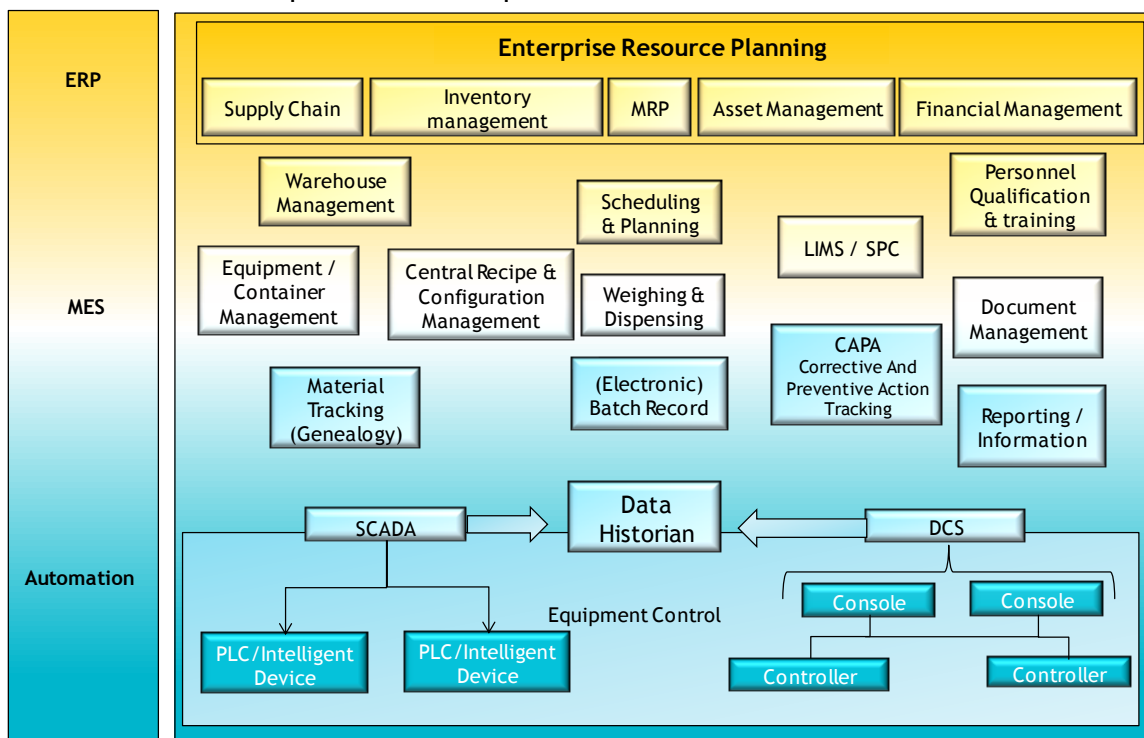
The MES Database serves as the core foundation for bridging the gap between business data, manufacturing data, product data and process data.

2.3. MES Business Intelligence (BI)

MES BI enables manufacturing visibility - manages events throughout the production process from releasing a manufacturing order to transferring the data to the data warehouse, where it is analyzed. During production, not only process steps but exceptions are also reported, ensuring a transparent manufacturing process and the possibility to take counter-measures immediately. It is also important to provide information on events to external stakeholders such as customers, subcontractors and other third parties in order to provide information in real time, ensure the transparency of planned and actual events and continuously improve the manufacturing processes.

Real-time transactional integration between plant floor and enterprise systems can be achieved through:

- Business logic for creating automated events, KPIs and alerts
- Workflow to synchronize plant and enterprise business processes
- Extract Transform Load (ETL) for transferring process KPI and product characteristics from MES, Sales Force Automation (SFA), legacy applications 4.5.1. Laboratory information management system (LIMS) and the ERP system based on industry standards (like ISA-S95, ...)
- Manufacturing Intelligence:
 - Real-time analytics engine that aggregates and delivers unified visualization of events, alerts, KPIs and decision support to production personnel
 - Correlation of process KPI and product characteristics



2.3.1. Laboratory Information Management System (LIMS)

LIMS helps in carrying out the testing of samples that routinely pass through an analytical lab and manage the complete routine, from sample log-in and testing, till the final reporting, along with organizing the inspection results into specific report formats to meet regulatory requirements. Additionally, inventory control and batch tracking is needed as well as problem handling and managing preventive and corrective actions.

2.3.2. Corrective and Preventive Action Tracking (CAPA)

CAPA involves the elimination of an identified problem and includes the activities taken to improve a process to prevent similar occurrences in the future. Corrective measures can be related to the problem in general and to individual nonconformities or deviations in particular.

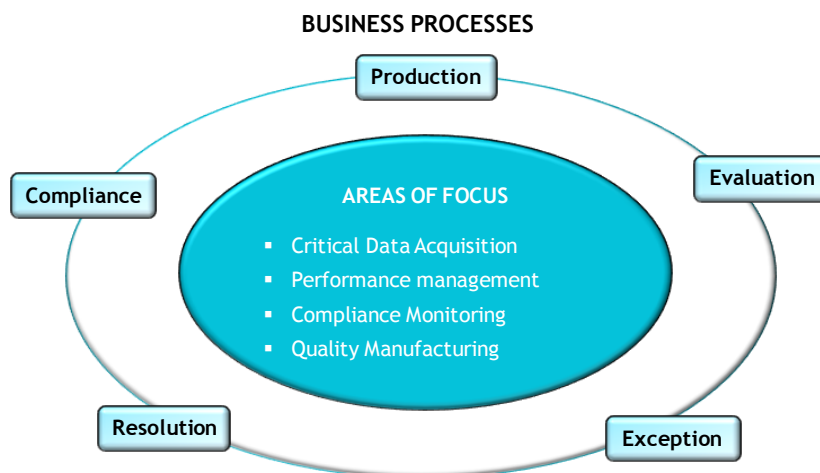
Trigger alerts and quality notifications from the shop floor level can be used to address the handling of corrective and preventive actions.

2.3.3. Statistical Process Control (SPC)

SPC is the application of statistical techniques to control a process. The term Statistical Quality Control (SQC) is often used interchangeably with statistical process control (SPC). Six Sigma approaches include analyzing measured values and non-conformance data, e.g., various quality control charts, capability indicators, Pareto analysis, trend analysis, and exception analysis.

2.3.4. Reporting

Involves integrating data from disparate data sources and provides business intelligence with context-rich data via displays, analysis and reports for better process performance monitoring and improvement, supporting deviations analysis and improved decision making in manufacturing environments.



4. BI Benefits in Manufacturing

Manufacturing enterprise analytics platform can facilitate fact based decision making on all data, for any manufacturing professional, in every department across the manufacturing enterprise.

Factories generate a huge volume and variety of data primarily comprising product parameters, process parameters, process trends, quality parameters, maintenance events, parts and spares, material inventory and more into manufacturing and business systems, at an ever-increasing rate. Gaining insight from the data trapped in these systems assists in business efficiency improvements.

There is a constant need to transform the enterprise from being reactive and report-driven to a proactive and real-time business as follows:

- **Instant insight** - Create exploratory data analysis that is interactive and visual. Combine and correlate data across various sources
- **Reuse and share** - Enable users to create process specific applications that can be re-used, shared with others, automated or published to live web applications

BI enables monitoring process KPIs in real-time and responding to variations by automatically populating root-cause applications with relevant data from multiple sources. Plain Reports help display problems, but analytics help identify root causes and help resolve issues.

If the variation is not from a special cause, but instead a process change, users can re-compute and validate KPI thresholds immediately, using the work in progress data as a context. The new metrics can then be re-loaded to make them instantly effective.

Some of the application areas where MES BI can be useful are illustrated below:

Application Area	Benefits
Process efficacy	Ensures the best performance from expensive equipments, monitoring process capability, and automate data analysis to minimize the time to root cause sourcing
Factory yield	Slice and dice production inventory by any variable, drill and aggregate metrics like throughput and cycle time from months to milliseconds, and get detailed Work-In-Progress (WIP) data on-demand from all sources
Asset management	Measure and improve the effectiveness and timeliness of internal or contracted maintenance resources, right-size spending on parts and spares, and speed equipment qualification and troubleshooting
Product quality and characterization	Correlate product performance to metrology and process variables, and perform fast root cause analysis for quality and reliability issues

About the author(s)



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