

About Manufacturing Execution Systems

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About Manufacturing Execution Systems: *The paper aims to provide a general overview of Manufacturing Execution Systems functionalities and benefits. Starting from the origins of these systems up to challenges that companies should face every day and solutions and benefits of these solutions.*

Key words: *Manufacturing Execution Systems; Functionalities; Benefits.*

BACKGROUND

The origins of MES systems go back to early '80s, when MES concept was still connected to Data Collection System. Many companies, in fact, used a data collection system belonging to CIM Model¹ for an integrated manufacturing model. As years go by and with the change of industries' needs due to an increasing globalization and more specific customer demands, the necessity to create a new model (the MES) appears. MES (Manufacturing Execution System) term was originated in 1992 by AMR Research², as a part of new MES model made of three levels.

This new model was based on three main functional areas – planning, execution and control – in order to allow companies to include in just one system the need to manage all these functionalities, in particular the need to link planning process to control process through the new execution model. Although this evolution, at the beginning of 21st century, ERP systems already helped the business executives with financial and business tools, but plant level executives, who had to take crucial decisions, still could not rely on business level systems. Important data coming from the plant and fundamental to take effective decisions for processes optimization were not available at plant level. MES system had existed from 80s', but it was overtaken by ERP.

In recent years, MES system is becoming again an important element for many manufacturing companies. Despite numerous meanings that are given to the concept "good production management", a new tool that supports the plant management, plant resources, processes and inventories has been developed, giving both accounting and decision makers all the information they require.

This concept is named *MANUFACTURING EXECUTION SYSTEM*.

INTRODUCTION

The benchmark for MES standards has been defined by MESA International, Manufacturing Enterprise Solutions Association (MESA)³.

MESA International says that "Manufacturing Execution Systems deliver information that enables the optimization of production activities from order launch to finished goods. Using current and accurate data, MES guides, initiates, responds to, and reports on plant activities as they occur."

Thanks to MES, manufacturing process becomes an information-driven process and a powerful tool in order to increase companies productivity.

THE SCOPE OF AN MES INCLUDES [5]:

- Management of product definitions;
- Management of resources;

¹ Computer-integrated manufacturing (CIM) is the manufacturing approach of using computers to control the entire production process. This integration allows individual processes to exchange information with each other and initiate actions. Through the integration of computers, manufacturing can be faster and less and less error-prone, although the main advantage is the ability to create automated manufacturing process.

² AMR Research, Inc. was an independent research and industry analysis firm founded by Tony Friscia in 1986 and sold to Gartner Research in 2010.

³ MESA International (Manufacturing Enterprise Solutions Association) was formed in 1992 as a trade association representing developers and vendors of MES software and related products and services. Today it is a worldwide not-for-profit community of manufacturing companies, information technology hardware and software suppliers, system integrators, consulting service providers, analysts, editors, academics.

- Dispatching production orders;
- Execution of production orders;
- Collection of production data;
- Production performance analysis;
- Production track & trace.

A Manufacturing Execution System is a control system for managing and monitoring work-in-process on a factory floor. A MES keeps track of all manufacturing information in real-time, receiving data from robots, machines and employees. The main goal of a manufacturing execution system is to improve productivity and reduce cycle-time — the total time to produce an order.

FUNCTIONALITIES

MAIN AREAS OF EXPERTISE

From their starting role of data collection systems, MES systems developed up to become a centralized control system that connects the management (ERP) to the operational arm (machines and appliances) of a factory floor. These solutions allows users to manage both single automated resources as well as plant integrated automation, granting manufacturing processes optimization. The correlation between plant and decision level's information is a problem that emerges in many manufacturing environments and can be solved with new integrated solutions provided by MES systems that, through the implementation of business intelligence functionalities, make crucial information available to companies decision-makers. Advanced manufacturing execution systems receive information about operations that need to be processed from the ERP and they transform this information in production commands, work instructions and machine commands. Then, they give back to ERP information related to manufacturing times, production operations, and so on [5].

MES FUNCTIONALITIES

According to MESA's standards, main functionalities of a MES solution are [2]:

- **Resource Allocation and Status**

This functionality manages resources including machines, labor, tools, materials, other equipment, and other entities such as documents that must be available in order to allow operators to start an operation.

- **Dispatching Production Units**

This functionality manages flow of production units in the form of jobs, orders, batches, lots, and work orders. Rework and salvage processes are available, as well as the ability to control the amount of work in process (WIP)⁴ at any point with buffer management.

- **Document Control**

This functionality controls records/forms that must be maintained with the production unit, including work instructions, recipes, drawings, standard operation procedures, part programs, batch records, engineering change notices, shift-to-shift communication, etc.

- **Data Collection/Acquisition**

This function provides an interface link to obtain the production and parametric data which populate the forms and records which were attached to the production unit. The data may be collected from the factory floor either manually or automatically from equipment in an up-to-the-minute time frame.

- **Labor Management**

This functionality provides the status of operators in an up-to-the-minute time frame. It includes time and attendance reporting, certification tracking, as well as the ability to track direct and/or indirect activities for each operator.

- **Quality Management**

⁴ WIP-Work in Process: company's partially finished goods that are waiting for completion.

This functionality provides real time analysis of measurements collected from the shop floor to assure proper product quality control and to identify problems requiring attention. It may recommend actions to correct the problem, including correlating the symptom, actions and results to determine the non-compliance cause.

- **Process Management**

This functionality monitors production and either automatically corrects or provides decision support to operators for correcting and improving in-process activities. These activities may be intra-operational and focus specifically on machines or equipment being monitored and controlled as well as inter-operational, which is tracking the process from one operation to the next.

- **Maintenance Management**

This function tracks and manages the activities to maintain the equipment and tools to insure their availability for manufacturing and insure scheduling for periodic or preventive maintenance as well as the response (alarms) to immediate problems.

- **Product Tracking and Genealogy**

This functionality provides the visibility to where work is at all times and its disposition. Status information may include who is working on it, components materials by supplier, lot, serial number, current production conditions, and any alarms, rework, or other exceptions related to the product. The on-line tracking function creates a historical record, as well.

- **Performance Analysis**

This function provides up-to-the-minute reporting of actual manufacturing operations results along with the comparison to past history and expected business result. Performance results include such measurements as resource utilization, resource availability, product unit cycle time, conformance to schedule and performance to standards.

- **Operations/Detail Scheduling**

This functionality provides sequencing based on priorities, attributes, characteristics, and/or recipes associated with specific production units at an operation (for example such color sequencing or other characteristics which, when scheduled in sequence properly, minimize setup). It is finite and it recognizes alternative and overlapping/parallel operations in order to calculate in detail exact time or equipment loading and adjust to shift patterns.

MANUFACTURING INDUSTRIES PROBLEMS

Every day, the operators of manufacturing companies face many challenges: work flow increases and the customers orders delay. In the production plant, thousands of unexpected and connected events occur daily; therefore, working faster means make business, while scheduling is an exception.

The confusion that rules in the factory floor does not correspond to a lack of efforts. Every day the supervisory plant manager spends his time to monitor current activities status and to schedule new activities. His job becomes more complex since schedules usually foresee the events that are occurring in this moment only 2-3 days in advance. Supervisory plant manager, when making his decision, should take into account on the one hand the speed to dispatch the order, on the other hand the lack of information; the result is that many manufacturing companies still manage the production activities like 20 years ago. This is why a MES solution is so important: independently from who or where the operator is, the results are visible thanks to a complete visibility of all resources involved in production processes and the information always available thanks to an efficient data management.

Market and competition are becoming more and more global, and therefore competing in the global market with old model is no more sufficient. According to old theories, the more of a given product you could make at the lowest cost, while charging the highest price to your customers, the greater the profit you could realize. This model caused manufacturers to produce as much of a product as they could store in warehouses.

Nowadays, manufacturing companies do not work anymore following this model. Markets are now global and the number of suppliers who compete for same customers offering high quality products with concurrent prices is increasing. In this new dynamic environment, there is no lack of work but a lack of coordination in assigning the available resources – such as operators, information, material and tools – in order to manage efficiently the manufacturing process.

Manufacturing companies' expectations from a MES solution are the following [3]:

- All data available in real time and everywhere in the factory floor;
- Reports made on requests or as an unexpected event occur;
- Data constantly updated across the plant;
- Simple integration with existing IT systems;
- Immediate answers to requests or as an event occur;
- Proactive maintenance;
- Simple implementation and use;
- Quality control;
- Simple and immediate communication between departments and employees.

SOLUTIONS

A MES system is usually seen like the tool that closes the gap between the management and the production level. Actually, MES systems can communicate and exchange data with quite all other systems, also those ones that belong to the same level, like a Quality Assurance Systems, Maintenance Management Systems or Warehouse Management Systems [4].

Nowadays, more and more manufacturers are feeling the pressures that MES can address. Many production plants are struggling to cope with a proliferation of product variations, which can render even the best human & paper systems ineffective and inefficient. Moreover, manual systems usually cannot keep pace with the continuous speed of change in products, processes, technologies and customers' demands.

Since operations can change very rapidly, the timeliness of MES information is a key benefit, since MES systems allow the users to obtain responses and huge quantity of information in few minutes, or rather, in few seconds. An on time delivery, together with an increased products quality, reduction of prices and speed to market are the key factors that allow each manufacturing company to reach the excellence in production.

Until today, an increasing number of manufacturing companies are replacing their classical paper/manual IT system with more advanced systems like MES, not only because of external pressures that require manufacturers to know in real time where the products and materials are and to grant the supplier a just in time5 delivery, but also the possibility to manage in a more efficient way the work orders progress and their continuous changes.

BENEFITS

MES systems provide a real time visibility of all manufacturing operations and communicate this information to other systems present in the company. Benefits for user are numerous. When specific production activities are improved, benefits coming from these decisions can have a positive impact on the objectives made at corporate level.

Benefits coming from the implementation of a MES system are many; among them we can find [1]:

Benefits at user level:

It refers to plant's operation departments that are directly compared to a inefficient work flow and a lack of information from the planning departments.

At this level, a MES system provides an user-friendly interface that simplify the work flow reducing production errors and increasing information availability.

Benefits at administration level:

it refers to support of IT departments responsible to let the system work properly and regularly.

A MES system can be quickly integrated with other IT systems that can be already present in the factory and can be easily configured according customer's needs. The implementation of this system allows manufacturing companies to reduce maintenance costs, thanks to the continuous monitoring and the continue analysis of information coming from productive plant compared to external regulations or specific customer's requirements.

Benefits at management level:

It refers to companies' planning department. This includes marketing, project management, financial processes and logistic.

A MES system offers a support for the planning and decision strategies of a company. A MES system is able to eliminate the paper work and to improve production flexibility by analyzing data in real time. Thanks to a MES system it is possible to reduce operative costs and increase achievement level of companies objectives.

Benefits at company level:

It refers to the general corporate image. From a marketing point of view it is extremely important to build and maintain a corporate image that makes the entire organization professional.

A MES gives detailed information about employees status, supplier orders, customers orders and so on, by providing an efficient methodology for a easy access to real time data, as well as the creation of a more efficient production cycle that reduces time-to-market and improve companies performances.

To sum up, according to MESA the advantages of MES systems are the following:

- Reduction in manufacturing cycle time (average 45%);
- Reduction in data entry time (75% or more);
- Reduction of work in process (average 24%);
- Reduction in paperwork between shift (average 61%);
- Reduction in lead time (average 27%);
- Reduction in products defects (average 18%);
- Reduction in paperwork (average 56%).

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This paper has been reviewed.