

Manufacturing operations management (MOM) Manufacturing execution system (MES)

Information systems in industry ELEC-E8113

Start at 12.15!



- Manufacturing operations management (MOM)
- Manufacturing execution system (MES)

Rationale of the lecture: MOM is an essential part of the EA of a manufacturing company. MES is an information system designed to support the <u>human</u> activities of MOM.



Situation





Basic concepts

- Manufacturing operations management (MOM) refers to the business processes needed for managing (not actually performing) production activities in industrial companies
- Manufacturing execution system (MES) is an information system designed to support the human activities of MOM.



Manufacturing operations management

- Four different types of operations management: production, inventory, quality and maintenance
- The two basic groups of people in MOM are managers of manufacturing activities and workers
- The four different operations affect each other.
 - Production operations typically request inventory and quality operations
 - Maintenance operations typically interrupt and are requested by other operations





Production operations management

- Typically the most important operations of MOM in discrete part manufacturing
- Starting from schedule of production orders from ERP and process plans from PLM
- Proactive planning of schedule of jobs that can be translated to operational commands for automation
- Recording response for reporting, analysis and traceability
- Varies in different industries



Planning and execution



Production capability (resources) data

- Resources are modeled according to their production capability and capacity
- Resources are of different types, e.g. material, equipment and personnel
- Production capability defines which parts of production processes (as defined in production definition) the resources can be used for and how
- Production capacity is available at certain time and is reserved during planning of the production schedule





Product definition data

- Products are modeled according their production process, i.e. which steps are needed to produce them
- Products as types!
- The model of a production process is ordered and may be hierarchical
- Each step requires specified production capabilities and capacities of the resources for certain time





Production schedule data

- Production schedule from ERP consists of a set of production requests, i.e. which products should be ready and when
- In detailed scheduling production requests are decomposed into more detailed production work orders according to product definitions
- Work orders are then assigned (in time) to resources according to their capabilities and capacities
- Products as instances!





Production performance data

- Performance data is the counterpart of schedule data for tracking
- Production performance consists of a set of production responses
- Production response describes the actual start and end times of production requests
- Production response may also describe the actual usage of resources
- Reality, not a plan!





Key performance indicators (KPI)

- Production performance analysis typically consists of calculating industry specific selection of KPIs
- A few common KPIs:
 - Delivery reliability (on-time delivery)
 - Total manufacturing lead time
 - Throughput (time)
 - Production costs
 - Own quality (in terms of reclamations, post-deliveries and warranty costs)
 - Supplier quality
 - WIP (work in progress)
 - OEE (overall equipment effectiveness)
- Longer time period!



Broad view to the data of MOM

- Data of MOM can be divided into three groups
 - Data exchanged with ERP, PDM/PLM and other possible information systems, which is most abstract (production orders)
 - Data within the MOM itself, which is more detailed (work orders)
 - Data exchanged with automation, which is dependent on type of the production process and its automation (jobs)





Manufacturing execution system (MES)

- MES are information systems
 designed to support MOM
 - Support most of MOM activities
 - Extensive data storage of MOM data
 - Central point of communication about MOM
- MES is intended as an integrated information system for MOM for replacing older separate systems and manual work
- MES is different than SCADA!

Plant Information Model

Before MES Implementation

that work with the management systems, people and

practices to support operations excellence.



Automation, Instruments, Equipment



MES system architecture

- MES is a database oriented server application with multiple user groups
 - Separate user interfaces for management and shop-floor personnel
 - Application server is typically divided to modules and provides interfaces to automation and information systems
 - Database server provides a common data storage
- All three parts have to be configured for an application in a company





Example: Delfoi Planner

Gantt chart for detailed scheduling
 and tracking

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Modules of MES

- An archetype of MES would consist of the following parts:
 - Planning modules
 - Monitoring modules
 - Historian
 - Information system interfaces
 - Automation interfaces
 - User interfaces
- In addition, there would be application development tools for configuring the system

| MES | | | |
|---|---|--|---------------------|
| Information system interface, e.g. SOA | Planning modules Detailed scheduling Dispatching | Monitoring modules • Tracking • Analysis | terface, b-based |
| | Automation interface • Execution • Data collection • e.g. OPC UA | Historian • Data collection | User in e.g. We |



Interface of MES with other information systems

- Interface between ERP and MES, i.e. which activities are in scope of either system, varies in different companies
- Beside is an imaginary example of allocating MOM activities to ERP and MES
- Maintenance and part of inventory operations management is usually out of the scope of MES (in EAM and ERP)





Interface of MES with automation systems

- Interface between MES and automation varies in different industries depending which systems are used for automation
- DCS, PLC and historians may be used to implement some of the MOM activities
- A consequence of varying interfaces of MES with both information and automation systems is differences in integration. Sometimes no MES is needed at all.





Intended benefits of MES

• MES is expected to facilitate the following positive effects in the activities of MOM:

- Monitoring related benefits: more timely data about relevant aspects of manufacturing, better tools for data analysis, increased data-based decision-making both during production and afterwards (traceability, development)
- Planning related benefits: Better tools for more real-time planning of manufacturing operations
- Integration related benefits: Better vertical data transfer between ERP and manufacturing
- The positive effect of MES to KPI depends on the type of industry, e.g.
 - Shorter lead time and more reliable deliveries
 - Decreased WIP and costs
 - Better quality to customers
 - Enhanced OEE



Beyond MOM and MES

- There are business processes partially similar to MOM and information systems to some extent similar to MES in associated application areas
- No production, but materials management
 - Warehouses with their Warehouse management systems (WMS) are a typical example
- No products, but services
 - Maintenance services for customers is a common example of this
 - Also other types of services, e.g. logistic services (vs. WMS)
- Resources are not local, but accessible over the Internet
 - Resources do not need to be geographically local, e.g. demand response in power systems

