Aalto University
School of Electrical
Engineering

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

Information systems in industry
ELEC-E8113

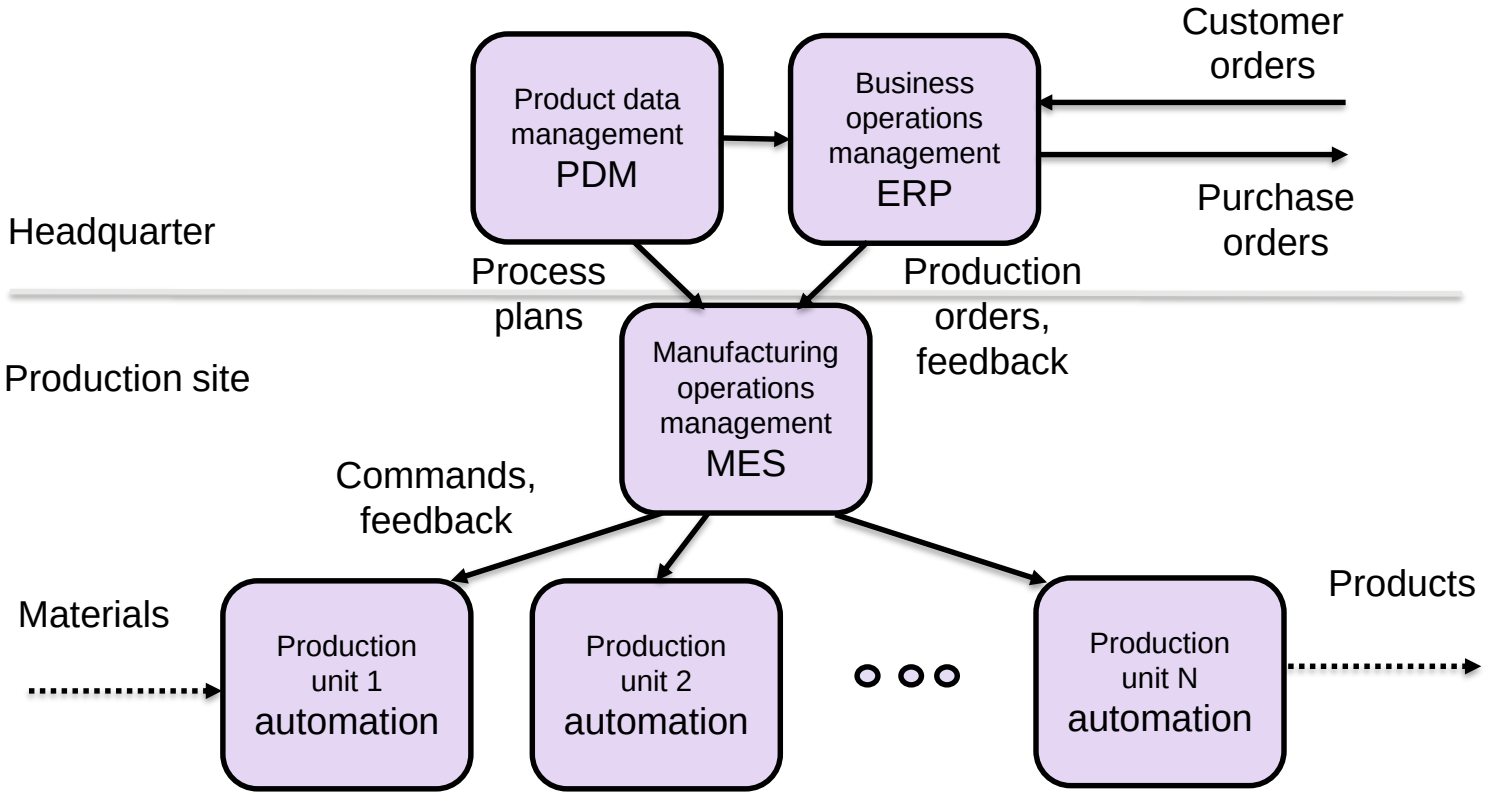
Start at 12.15!

Contents

- **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 human activities of MOM.

Situation

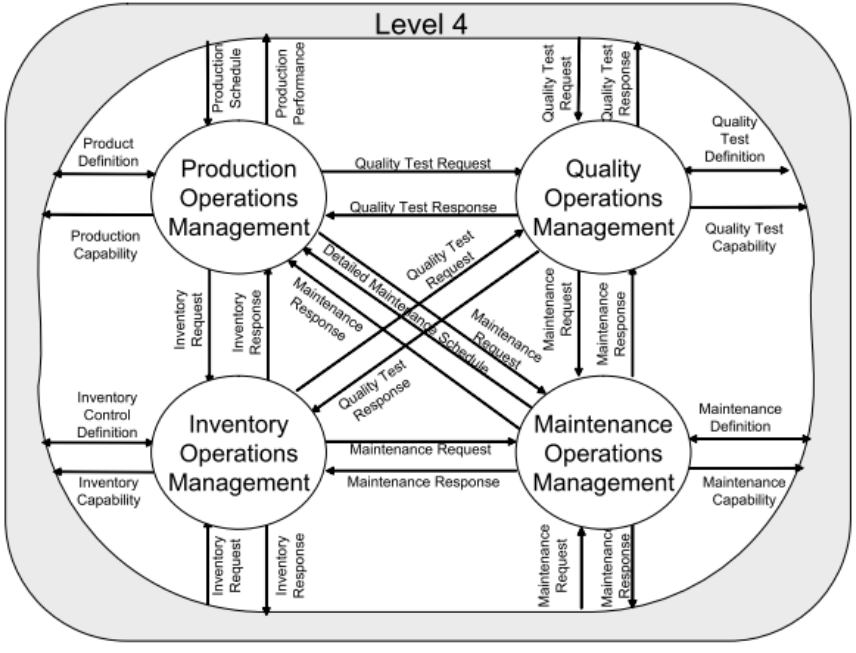

Product data management PDM
Business operations management ERP
Customer orders
Purchase orders
Headquarter
Process plans
Production orders, feedback
Production site
Manufacturing operations management MES
Commands, feedback
Materials
Production unit 1 automation
Production unit 2 automation
Production unit N automation
Products

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.**

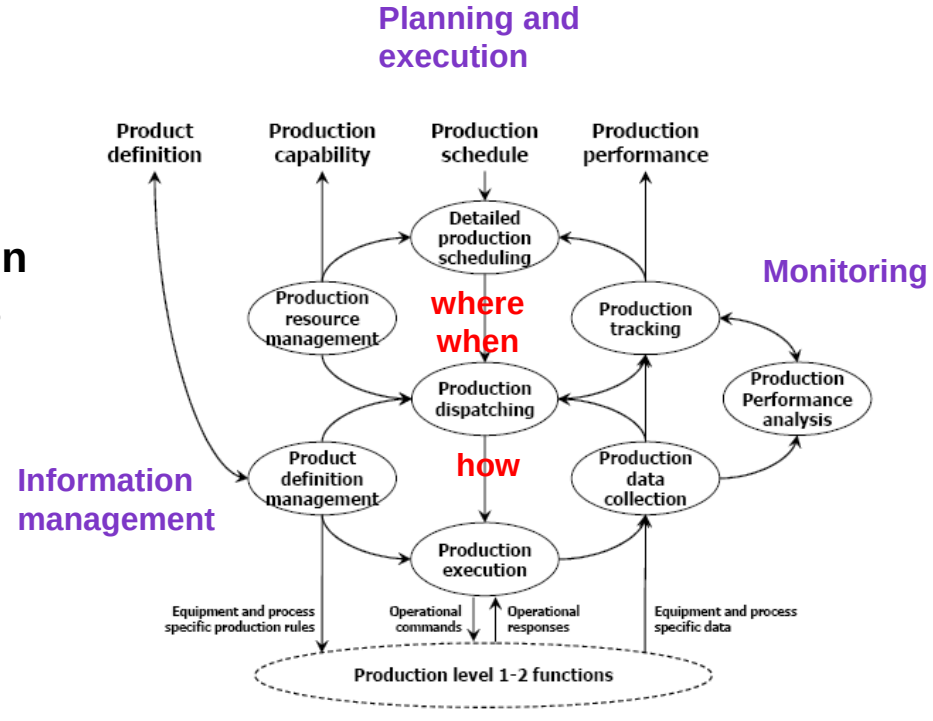
Manufacturing operations management

- **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



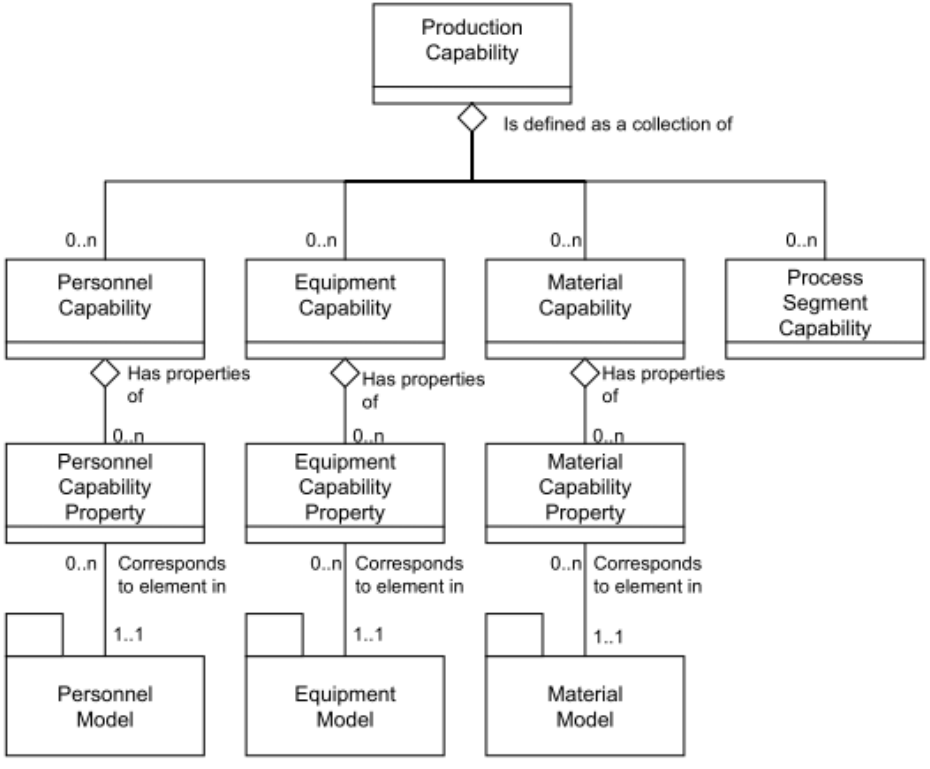
Production operations management

- 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



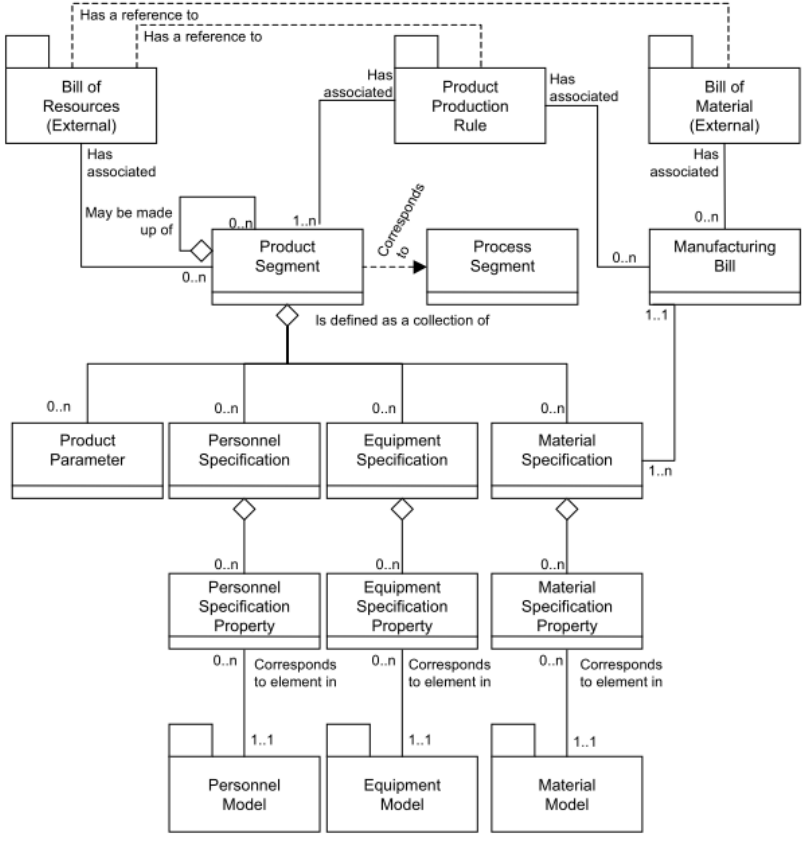
Production capability (resources) data

- **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**



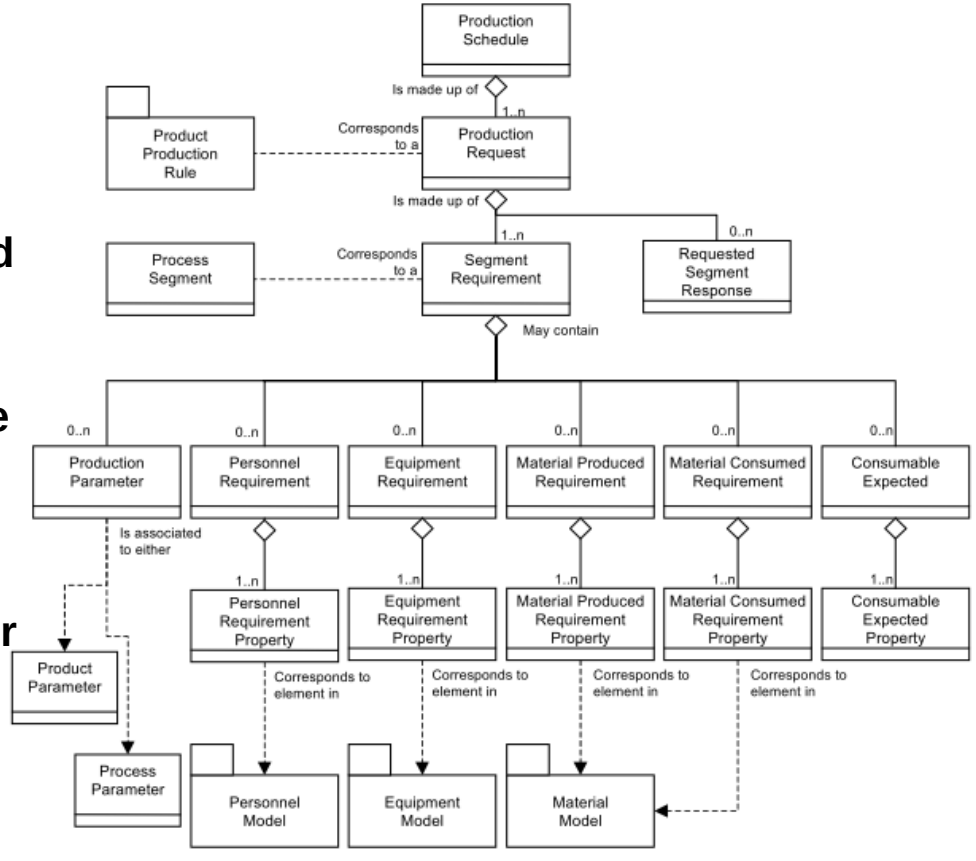
Product definition data

- **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**



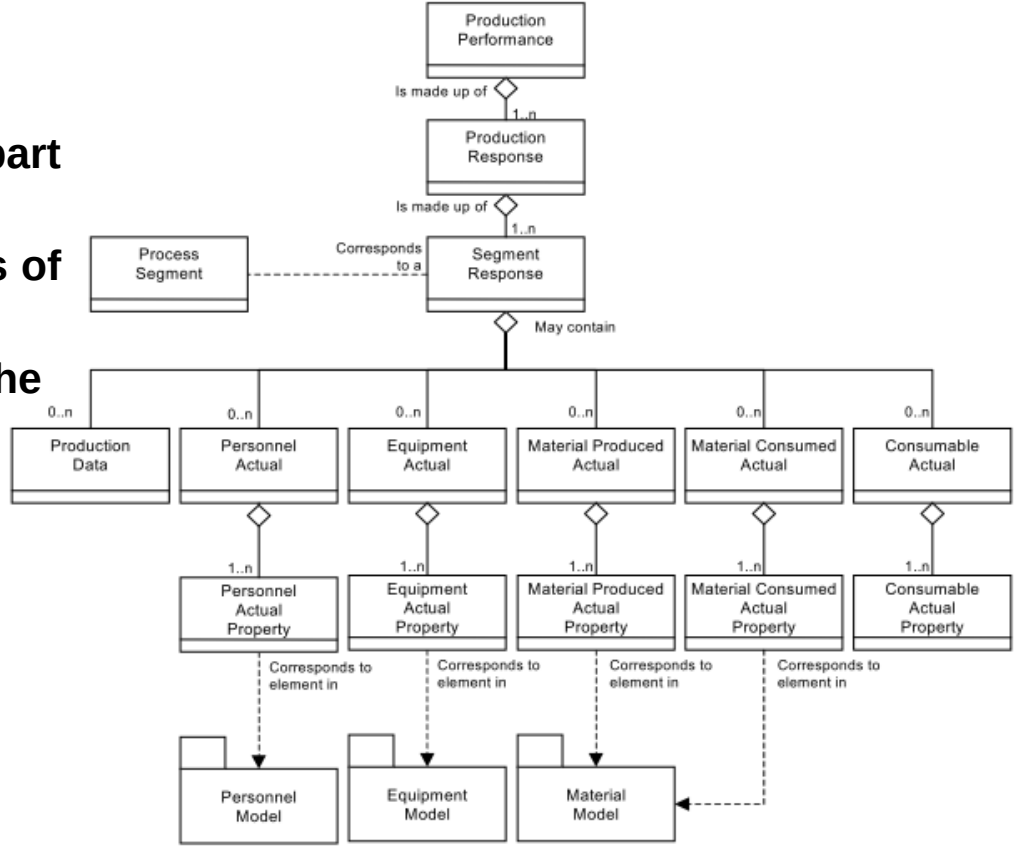
Production schedule data

- **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!

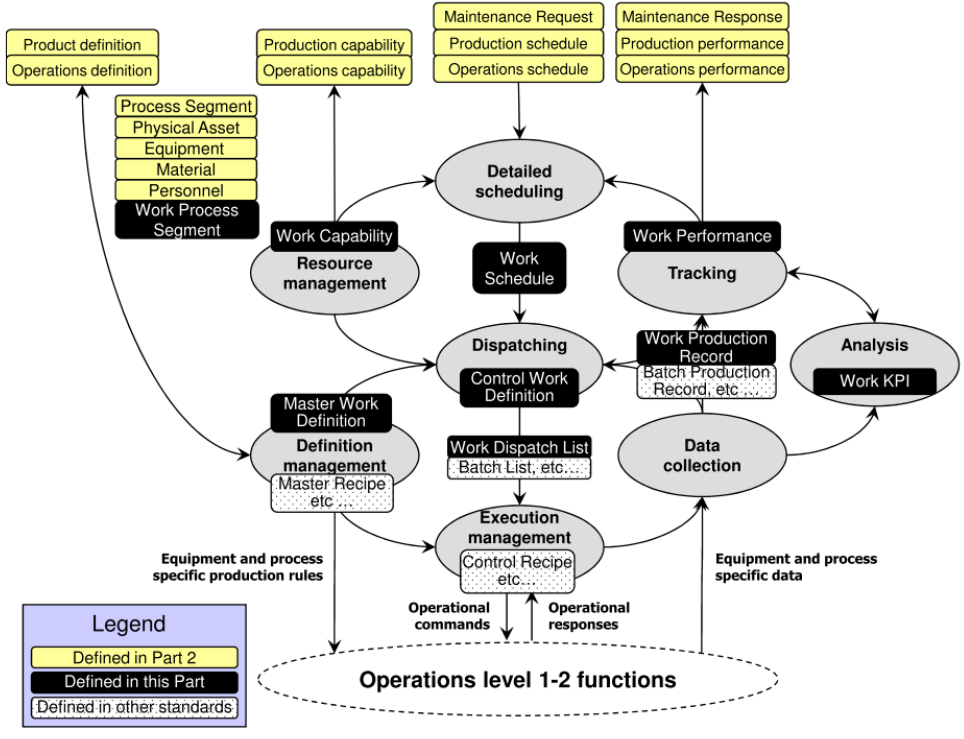


Key performance indicators (KPI)

- **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!**

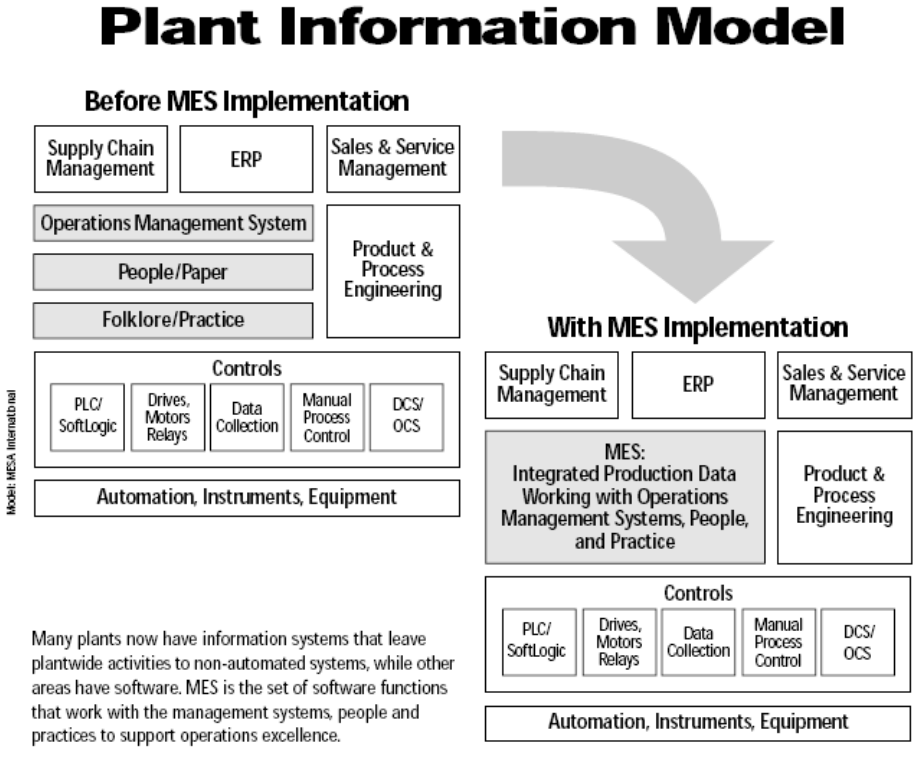
Broad view to the data of MOM

- **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)



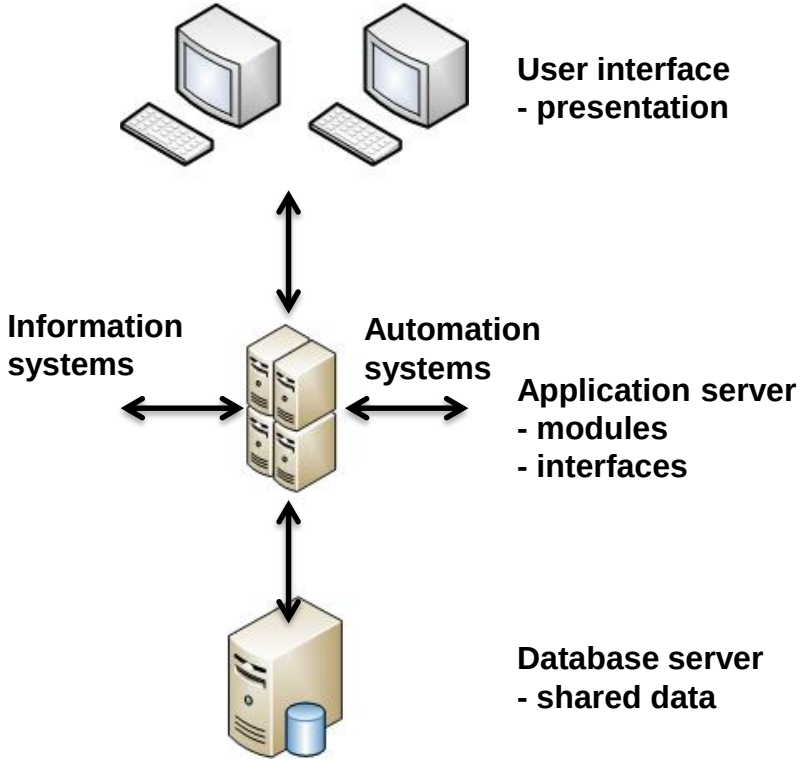
Manufacturing execution system (MES)

- **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!**



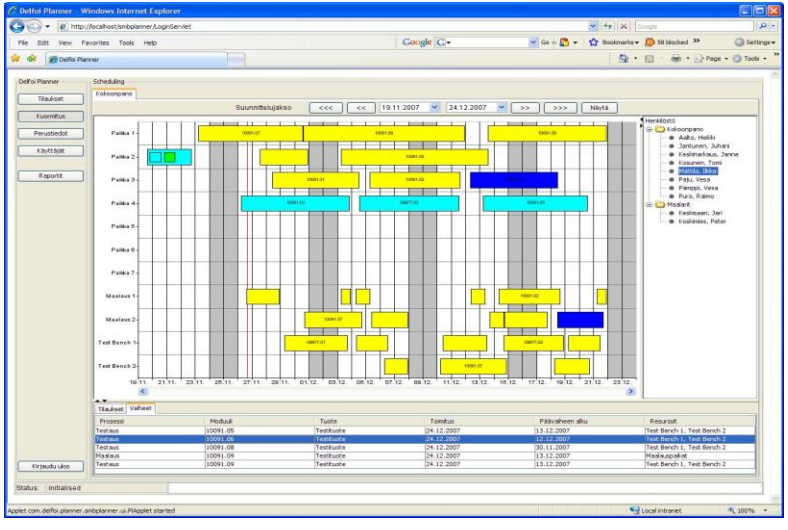
MES system architecture

- **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**

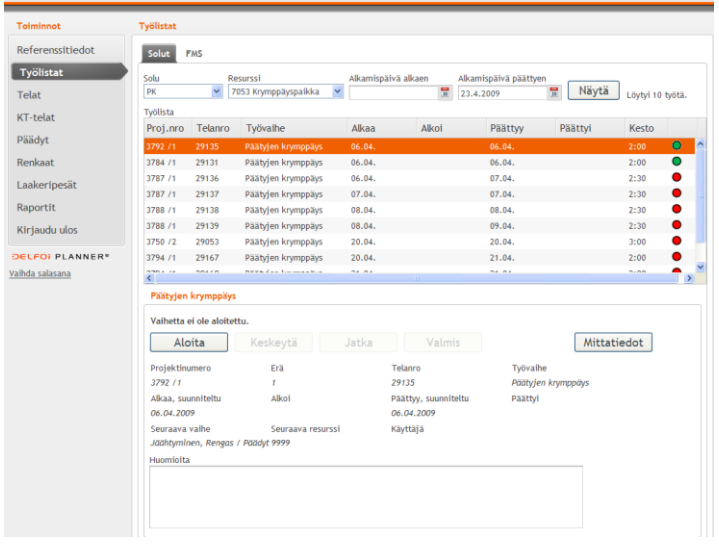


Example: Delfoi Planner

- **Gantt chart for detailed scheduling and tracking**

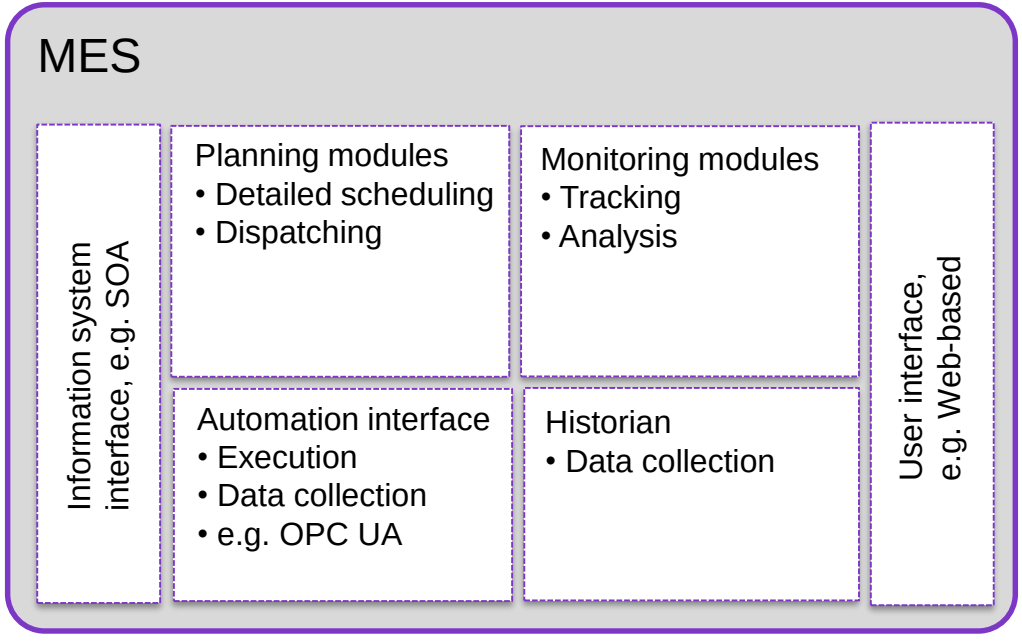


- **Dispatch list for shop-floor personnel**



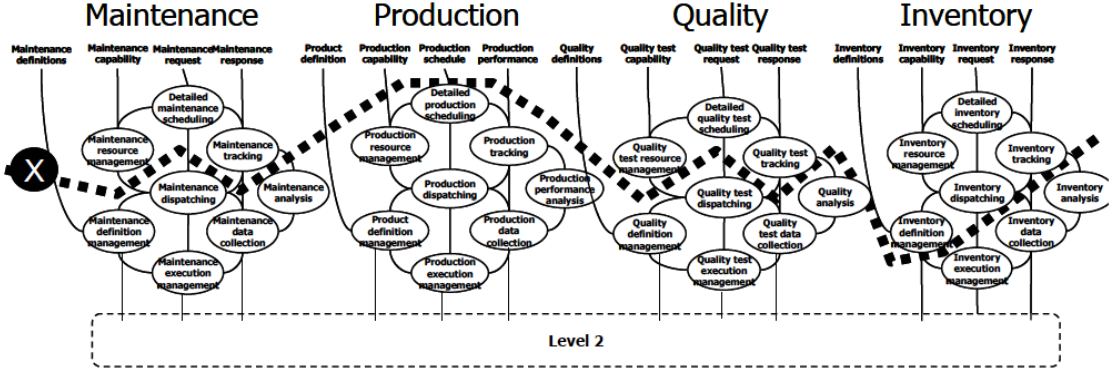
Modules of MES

- **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**



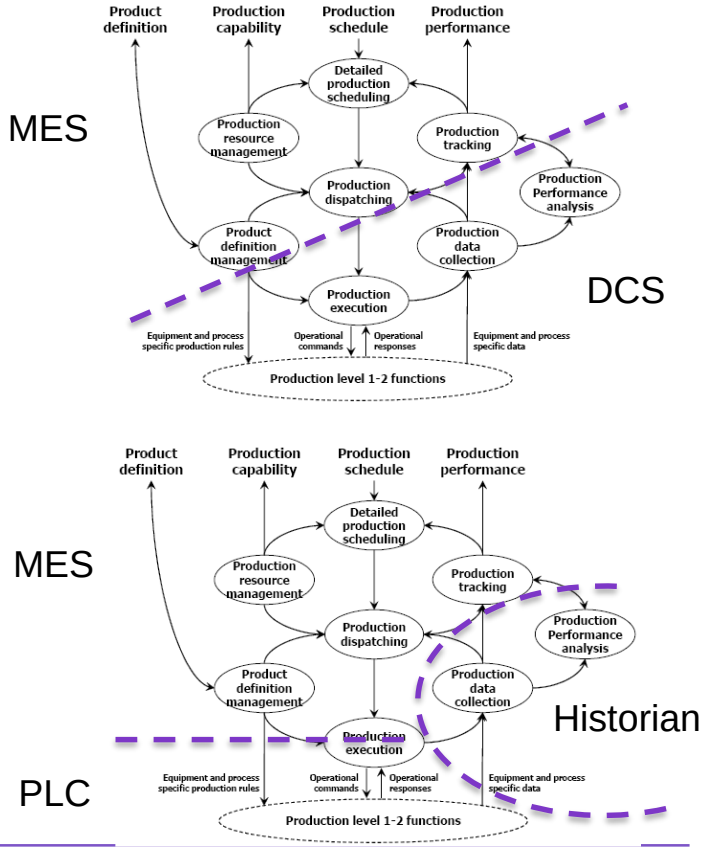
Interface of MES with other information systems

- 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