

Basics of Manufacturing and Production Scheduling for INT Project

Overview

The system we aim to create is essentially an MES (Manufacturing Execution System)—software that manages production execution, scheduling, and real-time shop-floor operations in a manufacturing environment.

MES is a part of the **Automation Pyramid**, aligned with Industry 4.0 initiatives.

Refer to these resources for background:

- Automation pyramid explanation:
<https://www.realpars.com/blog/automation-pyramid>
- Industry 4.0 research:
<https://pmc.ncbi.nlm.nih.gov/articles/PMC8309547/>
- Smart manufacturing systems review:
[https://www.researchgate.net/publication/342693197_Smart_manufacturing_process_and_system_automation -
A critical review of the standards and envisioned scenarios](https://www.researchgate.net/publication/342693197_Smart_manufacturing_process_and_system_automation_-_A_critical_review_of_the_standards_and_envisioned_scenarios)

Key Concepts You Need to Know

1. Types of Manufacturing

Discrete Manufacturing

- Uses *X materials* to produce *Y components*.
- Output can usually be disassembled or reversed.
- Most common type; used across many industries.

Process Manufacturing

- Combines materials to create a final product that is usually perishable or irreversible.

2. Types of Production

Make to Stock (MTS)

- Manufacture goods first, store them in the warehouse, and ship when orders come.

Make to Order (MTO)

- Production begins when a customer order is received.
- Can also be based on **anticipated demand**, not only actual customer orders.

3. Materials Resource Planning (MRP)

MRP translates predicted demand into actual production steps:

- Production schedule
- Ordering data
- Storage/warehouse planning
- Production cycle planning

4. Manufacturing Order (MO)

- Represents the **number of items** to be produced.

Work Order (WO)

- A part of the MO.
- Contains the individual steps or components required.
- There may be one or multiple WOs per MO.

5. Bill of Materials (BOM)

- Contains all data describing how the product is made.
- Also includes cost structure (material + labor).

6. Routing

- Takes the BOM and converts it into a **step-by-step manufacturing workflow**.

7. Machine Shop

- Tailors materials based on order requirements.
- Used mostly in low-volume or custom B2B environments.

8. Warehouses

- Store raw materials.
- Store finished goods.
- Maintain logs of incoming and outgoing inventory.

9. Lean Manufacturing / Kaizen / Six Sigma

- Continuous process improvement methodologies.
- Helps reduce waste and optimize throughput.

10. Bottlenecks

- Stages in production where constraints slow down the process.

11. Sales & Prediction

- Forecasting sales so that stock levels match demand.

Software Examples

1. E2 Shop System

Features:

- Customer, vendor, shop control, and quality modules.
- PDF generation for billing.
- Automatically generates inventory requirements and purchase orders.
- Production scheduling with:
 - Gantt charts
 - Bottleneck identification
 - Production flow visualization
- Data collection:
 - Employee work hours (via an app using REST API)
 - Machine runtime/output (via API)
- Quality control and statistics for operators/machines.
- Shipping features (packing slips, labels, customer confirmations).

- B2B/B2C partner app integration.
- Delivery partner API for real-time logistics updates.
- Accounting dashboard.

2. Fishbowl Manufacturing

Features:

- Scheduling based on MO/WO/BOM.
- Create custom manufacturing orders, work orders, and BOMs (with or without templates).
- Quick access shipping rate lookup for multiple carriers.
- Integrations with:
 - Amazon
 - Salesforce
 - Shopify
 - And more
- Detailed manufacturing status tracking:
 - Inventory → Work in Progress → Finished Goods
- Custom routing where additional machine steps/nodes can be added.

Project Scope

To build the **baseline MES**, we will implement the following **first**:

Stage 1: MES Core Features

From E2 Shop System

Shop Control

- Operator/machine progress tracking
- Real-time job visibility

Production Scheduling

- Gantt chart
- Bottleneck detection
- Visual production flow

Real-Time Data Collection

- Employee work hours tied to job execution
- Machine runtime/output data (via API)

Quality Control

- QC sampling, inspection results
- Operator/machine performance statistics

From Fishbowl Manufacturing

- Scheduling using MO/WO/BOM
- Custom manufacturing/work order creation
- Status tracking (Inventory → WIP → Finished Goods)
- Custom machine routing and additional operation steps

Stage 2: Additional Quality-of-Life Features

- Customer management
- Vendor management
- PDF billing generator
- Shipping features:

- Packing slips
- Labels
- Order confirmations
- B2B/B2C partner ordering app
- Delivery partner logistics API
- Freight rate lookup
- Integrations:
 - Amazon
 - Salesforce
 - Shopify

Stage 3: ERP Features

- Predict inventory requirements using demand forecasting
- Auto-generate Purchase Orders
- Accounting/financial dashboards

CRM (Customer / Vendor Management)

- Customer management
- Vendor management
- B2B/B2C ordering front-end

References

- Production/Operations Management — William J. Stevenson
- Manufacturing order & work order basics (Odo):
<https://www.odoo.com/slides/slide/manufacturing-order-work-order-basics-5960>
- Basic manufacturing process video:
<https://www.youtube.com/watch?v=zR36urTYC4k&t>
- Additional manufacturing workflow reference:
https://youtu.be/Ko_m9mMK8qM?si=eUc8FIzFtMxH5hq