Planning

1. Inventory, Capacity, and Material Check

The system checks if it can fulfill a new customer order based on current inventory, machine load, and material availability.

🔹 AI Capabilities:

- **Forecasts demand:**
  Learn from sales history to anticipate order volumes.
  Example: AI predicts an increase in orders for a product in summer and suggests building up stock in advance.

- **Estimates production load:**
  Determines whether the current machines and shifts can meet the delivery date.
  Example: AI detects a bottleneck in the paint shop and recommends rescheduling to another time slot.

- **Improves over time using data:**
  Gets smarter with every order, tracking what worked and what caused delays.

2. Material Procurement / Reordering

If materials are insufficient, the system triggers a purchase request.

🔹 AI Capabilities:

- **Predicts material shortages in advance:**
  Learn usage patterns and forecasts when a stockout might occur.
  Example: AI notices steel coils are being consumed faster due to a new product run and pre-orders extra stock.

- **Auto-selects suppliers:**
  Chooses vendors based on cost, delivery speed, past reliability.
  Example: AI switches to a faster supplier temporarily due to a rush order.

- **Dynamic reorder points:**
  Adjusts thresholds for reordering based on seasonality or production changes
  Example: AI raises the reorder point for packaging materials before a holiday sales peak.

3. AI-Based Production Scheduling

Schedules production tasks immediately using real-time shop floor data.

🔹 AI Capabilities:

- **Resource optimization:**
  Machine status, operator availability, workers skills, job priorities.
  Example: AI assigns an urgent job to a night shift where a specific machine has open capacity.

- **Real-time rescheduling:**
  Reacts to unexpected changes like breakdowns or absentee workers.
  Example: A machine breaks down; AI reroutes the job to another line and updates the delivery estimate instantly.

- **Optimizes based on business goals:**
  Can be tuned for faster delivery, lower cost, or energy savings.
  Example: AI suggests batching similar products to reduce changeover time.

Reduced Operational Complexity

- Automates planning and execution across departments.

- Reduces human dependency for communication and task alignment.

- Example:
  Instead of sales emailing production about a new order, the system automatically updates the production queue, checks inventory, and notifies purchasing if stock is low.

Manufacturing

- ## Quality control
  - Quality tracking (scrap (unusable and discarded)/rework (additional processing to correct defects))
  - Data from sensors and vision systems to detect product defects in real time.
  - Not until the final product, rather during the process

Basic MES:

- Ideal for manual jobs or basic production tracking.
- Features include: Employee login, work orders, quality tracking (scrap/rework), and basic OEE.

Advanced MES:

- Includes all Basic MES features plus:
  - Stock transfer and request options.
  - Data from IoT sensors and PLCs.
  - Fully customizable themes and advanced modules like maintenance or APS.

  - What it does:

    Tracks product quality in real-time and flags issues as they happen during production.

  - AI Role:

    Uses sensor and vision data to detect defects before final assembly.

  - Example:

    A camera inspects car parts for tiny surface cracks. The AI model flags a cracked piece midway through production, allowing a human operator to intervene before more defective products are made.

- Predictive Maintenance
    - **Using I2C input for vibration sensors**: Using AI models on Heat, Humidity, Vibration, and Current Data from machines to **predict failures before they occur**. AI models trained on historical "normal" vibration data can continuously monitor incoming data from I2C sensors and flag any deviations or anomalies that might indicate a problem. This is crucial for early fault detection

    - What it does:
      Monitors machine conditions using connected sensors (vibration, temperature, etc.)

    - AI Role:
      Learns from historical machine behavior, detects abnormal patterns, and predicts failures in advance.

    - Example:
      A CNC machine starts showing slightly higher vibration and heat. The AI model detects this subtle deviation, predicts that the motor bearing may fail soon, and schedules maintenance before a breakdown occurs.

- Process Optimization
    - AI algorithms analyze workflow and machine data to **suggest improvements** that reduce downtime and increase output.

How MSF Digitizes Production

- Real-time machine and employee monitoring for optimized planning.
- Integration across supply chain, logistics, and production systems.
- Fully networked production capacity to ensure seamless workflows.

Example: Imagine a self-sufficient production process where machines automatically adjust schedules, detect bottlenecks, and update plans in real-time. In case of a malfunction, production capacity is instantly reallocated to other machines, ensuring minimal downtime and maximum efficiency.

- What it does:
  Analyzes workflow and machine data to find and eliminate inefficiencies.

- AI Role:
  Suggests process improvements, like rescheduling steps or adjusting workloads, to reduce bottlenecks.

- Example:
  The system notices that Machine A is always idle waiting for Machine B. AI suggests running the two processes in parallel instead of in sequence, increasing output by 15%.

- MSF acts as a central nervous system for the plant, constantly processing live data to:
    - Provide proactive guidance.
    - Automate responses to events.
    - Keep stakeholders informed in real-time.
    - Drive efficiency and maintain control over the manufacturing processes.

MSF can deliver information that enables the optimization of production activities from order launch to finished PCBs. Using current and accurate data, MSF guides, initiates, responds to, and reports on plant activities as they occur.

Dispatching

AI-powered auto-dispatching technology:

- **Task assignment:** AI decides who should do what — whether it's assigning a delivery to a driver, a production task to a machine, or a service call to a technician.
  - **How AI helps:**
    - Consider location, skill level, availability, deadlines.
    - Prioritizes tasks based on urgency and resources.
  - **Example:**
    - There are 10 orders and 3 delivery vehicles. AI assigns the most urgent orders to the closest vehicles and balances workload so no driver is overwhelmed.

- **Order scheduling:** AI schedules the when — when an order should be processed, picked, packed, and shipped.
  - **How AI helps:**
    - Avoids scheduling overlaps or machine overloads.
    - Aligns with delivery windows and customer SLAs (service-level agreements).
  - **Example:**
    - An urgent order comes in for a VIP client. AI reschedules less critical jobs to make room, ensuring that the high-priority order goes out first — without manual interference.

- **Routing & delivery execution:** choose the best route dynamically (consider multiple variables), to ensure delivery on time.
  - **What it is:**
    - AI selects the **best route** for deliveries in real-time, considering multiple variables.
  - **How AI helps:**
    - Uses live traffic, road closures, and delivery time windows.
    - Optimizes for speed, cost, fuel efficiency, or all three.
  - **Example:**
    A delivery truck is supposed to take Route A, but there's a traffic jam. AI reroutes it through Route B, which is slightly longer in distance but faster in time.

- **Dynamic reallocation during disruptions**: If anything changes — a delay, machine failure, traffic issue — AI instantly reshuffles the plan.
    - **How AI helps:**
        - Reacts to real-time data and reassigns tasks, drivers, or delivery slots.
        - Maintains smooth operations with minimal human input.

    - **Example:**
      A delivery driver calls in sick last minute. AI reassigns their orders to two nearby drivers, adjusting routes so deliveries still happen on time.

Computer Vision Application

1. Product defect detection
    - Use Case scenario-based. Different products have different detection. Ex: in the session, the use case shared is some sort of transparent liquid, the defect detection is just to check if the liquid has any unwanted substance inside the liquid.

2. Safety measurement
    - Check if the worker does follow the safety practice. Ex: wearing a safety helmet on the field.