Inside the Firm: A Network of Interdependent Decision-Making

A customer wants to know the price and availability of a Volkswagen Golf Station Wagon, silver, 75 horsepower engine.

What is necessary so that Volkswagen can answer his inquiry?

1. Which parts are necessary for building this car? Which parts are necessary for building the parts for building this car? Which parts are necessary for building the parts necessary for building the car? Which parts are necessary for building the parts necessary for building the parts necessary for building the car?
2. Which of the needed parts are on stock, which need to be ordered?
3. What are the prices for each component and the cost for internal labor and use of machinery (-> cost accounting)?
4. What is the delivery delay for ordered parts and what is the production delay for the parts made in house?
5. Which machinery and workstations are needed for production and assembly? What is the duration of each step in the production and assembly?
6. In which order should the tasks be scheduled and how long will it then take to build the car, assumed that some machinery might be occupied by pending orders?

Enterprise-wide Planning Scope

- Due to the complexity and degree of interdependencies, local planning scope will be very inefficient. Examples:
  - ordering the same part for each order individually
  - ordering a part that is already on stock in another department
  - blocking one scarce workstation with an unimportant order
- Enterprise-wide planning will result in better decision-making regarding inventory, procurement, production, and scheduling.

But:

- This requires a consistent, normalized representation („one fact in one place“; Codd).

The Idea of Enterprise Resource Planning (ERP)

- Planning of the usage of resources from the perspective of the overall enterprise.
- Capital, machinery, parts, human resources,...
- Usually on the basis of ERP software

MRP – Material Requirements Planning

- Determines the amount of parts needed.
- Demand between products can be interrelated.
- Input
  - Master Production Schedule (MPS)
  - Bill of Material (BOM): lists the component part numbers for each part
  - Inventory status data

From Pending Orders to Material Requirements

- Input:
  - Pending orders
  - Inventory levels
  - Bills of Materials
- Example
  - see following slide

Material Requirements Planning

1. Decompose Master Production Schedule into required components
   - E.g. 5 Pens -> 5 pen bodies, 5 springs, 5 blue ink cartridges
2. Deduct available parts from resulting quantities
3. If a part cannot be further decomposed, take the respective quantity as a gross ordering quantity
   - might be adjusted due to lot size and more economical ordering quantities
4. If a part can be further decomposed, go through steps 1 and 2 until step 3 is reached.

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Example: Material Requirements Planning

Master Production Schedule

- 10 blue ball pens
- 20 black ball pens
- 10 assorted pens (2 blue, 3 black, gift box)

Inventory

- 17 springs
- 1 m of spring Wire
- 20 ink cartridges blue
- 10 ink cartridges black
- 10 body upper part
- 5 gift boxes

Bill of Materials

Blue pen: 1 spring, 1 body, 1 blue ink cartridge

Black pen: 1 spring, 1 body, 1 black ink cartridge

Spring: 10 cm of spring wire

Assorted pens: 2 blue pens, 3 black pens, 1 gift box

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A Special form of Bill of Materials: **Variant Parts Lists**

- **Problem:** The amount of BoMs can explode due to variants that are distinct only in a small detail
- **Idea:** Variants can be described by taking a existing part or final product and removing old and adding new parts
- Example:
  - Golf Turbo = 1 Golf Standard
    - 1 Standard Engine
    + 1 Turbo Engine

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Advantages and Constraints of MRP

Advantages:

Demand, Inventory, Ordering, and Production is based on consolidated planning accross all levels of production

Disadvantages:

Use of machinery, workstations, and human resources is not included

No support for production scheduling

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MRP I and MRP II: Manufacturing Resources Planning

- Instead of just looking at materials and their quantities at all levels of the production process, availability of machinery and workstations will also be included in the planning (MRP I)
  - Planning of quantities (materials) and time (scheduling) are two separate steps
- In MRP II, economical and strategic aspects will also be considered.
- General principle of MRP: **Sequential planning**
  - Some information needed is not available until a next step in the planning or executing will have been performed
  - In this case, estimates will be used
  - No simultaneous planning

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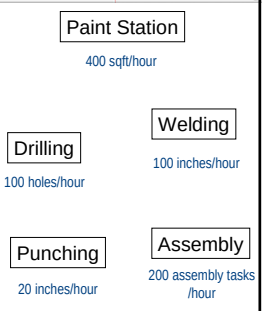
Scheduling Problems

1. In which order should a stack of pending orders be produced?
2. Should pending orders be split in batches?
3. If there is choice in the sequencing of tasks, which is the ideal sequence?



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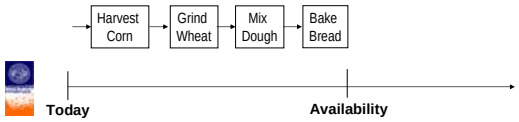
Forward Scheduling

Goal: Determine earliest availability date if production run is started today



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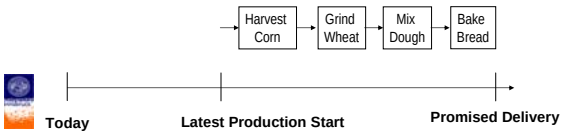
Backward Scheduling

Goal: Determine latest production start for a given delivery date



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Stochastic vs. Deterministic Inventory Planning

- **Stochastic:** Based on past consumption
  - requires a rather stable demand
- Often used: First-order exponential smoothing
  - Predicted Demand = Predicted demand for last period + α(Actual demand for last period - Predicted demand for last period)
  - α = Smoothing factor
- **Deterministic:** Based on pending orders
  - for varying demand or costly parts
  - more precise
  - delays production

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Safety Stock

- Minimum inventory level; inventory should never fall below that limit
- Keeps production running
- Determined based on experience and statistical analysis

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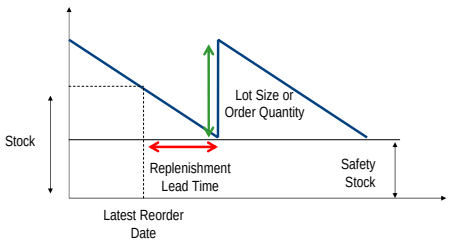
Inventory Management: Reorder Time



cf. Wigand et al. (2003)

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ABC Analysis

- Classification of Products and Parts into
  - A: Important and huge part of the inventory value
  - B: Medium importantce and impact on the inventory value
  - C: Low importance, low impact on the inventory value
- Can be done automatically
- Important for Sourcing Strategy
  - Single vs. Multiple Sourcing
  - Type of Reordering Approach (stochastic vs. deterministic)
  - Focus of improvement efforts to category A parts

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XYZ Analysis

- Idea: Classify goods by the amount and cause of variance in demand

Category	Amount and cause of variance	Predictibility
X	Rather constant demand	High
Y	More significant variation in deman, often due to seasonal effects	Medium
Z	Lack of pattern in demand; chaotic	Low

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ERP: One Integrated Planning System

- One database and data model across the enterprise
  - e.g. human resource data and staffing data for production planning come from the same database
- Consolidated and harmonized planning on all levels
- Best Practise Process Library

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Three Ways of Deploying an ERP System

- **The Big Bang**—cast off all their legacy systems at once and install a single ERP system across the entire company.
- **Franchising strategy**— Independent ERP systems are installed in each unit, while linking common processes, such as financial bookkeeping, across the enterprise.
- **Reengineering and ERP modification**

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Advantages of ERP

- Eliminates costly, inflexible legacy systems
- Improved technology infrastructure
- Improved work processes
- Increased data access for decision making

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The Hidden Costs of ERP Deployment

- Training
- Integration and testing
- Customization
- Data conversion
- Data analysis
- Consultants ad infinitum
- Replacing your best and brightest
- Implementation teams can never stop
- Waiting for ROI
- Post-ERP depression

http://www.cio.com/research/erp/edit/erpbasics.html

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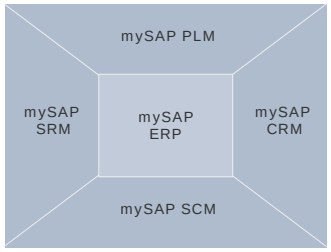
mySAP Business Suite



Industry Best Practices

Adaptive Operations

Extensible with xApps

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