MRP II: Manufacturing Resource Planning Systems

The Evolution of MRP II

- 1960's and 1970's
  - MRP: Material Requirement Planning
    ➔ Assumed infinite capability
- 1980's
  - MRP II: Manufacturing Resource Planning
    ➔ Assumed limited capability
    ➔ Closed loop system
- 1990's
  - ERP: Enterprise Resource Planning

The Fundamental Logic of MRP System

- What are we going to make?
  - The Master Production Schedule
- What do we (already) have?
  - Inventory Record
- What is it made up of?
  - The Bill Of Materials
- How will it be made?
  - The Routings

The Modules in MRP II System

- Master Production Scheduling
- Inventory
- Bill Of Materials (BOM)
- Material Requirements Planning (MRP)
- Purchasing
- Receiving/Quality Control
- Shop Floor

Typical MRP II Architecture

Dependent vs Independent Demand

Suppliers
Dependent Demand
Raw materials & Semi-finished products

Company

Market
Independent Demand
Finished products
Material Requirements Planning (MRP)

- **Inputs**
  - Master Production Schedule
  - Bill Of Materials
  - Inventory Data.

- **Outputs**
  - Replenishment Orders
  - Reschedule Notices

Master Production Schedule

- **Inputs**
  - Master Production Schedule
  - Bill Of Materials
  - Inventory Data.

- **Outputs**
  - Replenishment Orders
  - Reschedule Notices

Master Production Schedule

- **Forward looking plan**
- **Objectives**
  - To support sales
  - To run operations effectively
- **Fundamental factors**
  - What we intend to make
  - How much we intend to make
  - When we intend to make
- **Input : sale plan**
  - Must consider the capacities available by ‘rough cut’ routing

Master Schedule

- **Inputs**
  - Sales forecasts
  - Customer orders
  - Orders from dealers or other distribution centers
  - Inventory of finished products
  - Currently produced and expected finished product delivers
  - Rough-cut routing
- **Outputs**
  - Quantities, types and due dates of required products

Bill Of Material (BOM)

- **The list of the end items**
- **Characteristics**
  - Part Numbering
  - Parents and Child Relationship
  - Bill Of Material Levels
  - Explosions and Implosions
  - Phantom Bills

A Sample BOM Structure

- **A**
  - **Assy B**
  - **Assy C**
  - **Assy D**
    - **E**
    - **Subassy F**
    - **G**
    - **H**
    - **I**
      - **K**
      - **L**
      - **J**
Part Numbering

- The unique identifier
  - Called a part number or item number
- Three ways to define the number
  - Random numbering
    - Is used as an identifier only, not as a descriptor
  - Significant numbering
    - Describes specific information about the item, such as source, material, shape, etc
  - Semi-significant numbering

Example

Random Numbering

- Part Number: 37-7213
  - Type of Item: Ink Cartridges
  - Four digit: 7213 = Random

Significant Numbering

- Part Number: 37-1-3-16-432
  - Type of Item: Ink Cartridges
  - Type: Screw-in-type
  - Point type: Fine Line
  - Color: Blue
  - Length: 4.5 inches long

Parents and Child Relationship

Children are the objects that are assembled together to make a parent object

BOM Levels

Explosions

- Two different ways to display the BOM
  - Explosion and implosion
- Explosions: going down the BOM
  - Single level explosions
    - Displays the immediate component parts (children)
  - Indented explosion
    - Parent on left-hand side and each additional level indented farther to the right
  - Summarized explosion
    - Arranges an indented explosion into total quantity order or part number order
      - Adds together the total requirement for each part number

Examples of Explosion Types

<table>
<thead>
<tr>
<th>Single Level Explosion of D</th>
<th>Indented Explosion of A</th>
<th>Summarized Explosion of A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Part # Qty</td>
<td>Level Part # Qty</td>
<td>Level Part # Qty</td>
</tr>
<tr>
<td>E 2</td>
<td>1 B 1</td>
<td>1 B 1</td>
</tr>
<tr>
<td>G 1</td>
<td>2 E 1</td>
<td>1 C 1</td>
</tr>
<tr>
<td>H 1</td>
<td>2 F 2</td>
<td>1 D 2</td>
</tr>
<tr>
<td>1</td>
<td>1 C 1</td>
<td>2 E 5</td>
</tr>
<tr>
<td>2</td>
<td>2 D 2</td>
<td>2 F 2</td>
</tr>
<tr>
<td>1</td>
<td>2 E 2</td>
<td>2 G 2</td>
</tr>
<tr>
<td>2</td>
<td>2 G 1</td>
<td>2 H 2</td>
</tr>
</tbody>
</table>
| 2                            |                         | (Ordered by Part #)
Implosions

- Implosions: going up the BOM
  - Single level implosion
    ➢ Displays the immediate parent of a given component
    ➢ Called ‘where used’ list or ‘goes into’
    ➢ Useful when a design change for the ‘imploded’ part is under discussion
  - Indented implosion
    ➢ Displays all of the parent of a given component, all the way up to the top level part
    ➢ Used for the two main reasons
      ➢ To detect commonality of parts in different assemblies
      ➢ To reassess the impact of a design change made to a part on various assemblies that make use of it
    ➢ Summarized implosion

Phantom BOM

- The items ‘Motor’, ‘Housing’, and ‘Heating Element’ are Phantoms
- To create individual Bills of Materials we would need 12 different product structures
  ➢ 2 motor types * 3 plastic housing types * 2 heating element types = 12
- Phantoms cost and lead time are always zero

Product Planning BOM

- Phantom items are transparent to MRP. They are completely ignored
- Based on the percentage figures associated with each option (from statistical data from past sales), MRP will generate the appropriate gross requirements
- For example, For 500 ‘Master Schedule’ hair dryers MRP will generate a requirement for 100 200V motors and 400 110 V motors etc

The Difference Between An Engineering BOM and Manufacturing BOM

- Note that only manufacturing items may have a routing
- Each routing is identified by a unique routing number
- Necessary records for a routing
  ➢ Manufacturing division
  ➢ Work station
    ➢ Group of machines or subdivision
  ➢ Work center
    ➢ Machine or assembly facility
  ➢ Description of operation
  ➢ Tooling
  ➢ Labor craft code
  ➢ Standard labor hours
  ➢ Labor rates per hour by craft code
Routing

- Used for rough cut capacity planning
- Incorporates with master schedule for forecasting rough capacity requirement
- Detail routings (setup time, moving time, etc) are used for shop floor capacity

<table>
<thead>
<tr>
<th>Assembly line:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Setup time:</td>
</tr>
<tr>
<td>List of tools and fixtures:</td>
</tr>
<tr>
<td>Tool ---</td>
</tr>
<tr>
<td>Fixture ---</td>
</tr>
<tr>
<td>Production rate:</td>
</tr>
<tr>
<td>42 assemblies/hr</td>
</tr>
</tbody>
</table>

Basic Transactions in Inventory Control

- Receipts
  - Identified by part numbers
  - Purchased items, Manufacturing items, etc
  - Tow types:
    - Planned receipts: purchasing, manufacturing, subcontracting orders with vendors or subcontractors
    - Unplanned receipts:
- Issues
  - Related to raw materials, component parts and assemblies
  - Individual or sets of components for manufacturing or to the customer (finished goods) including shortages
  - Subtracted from on hand quantity
- Transfers
  - From one stores location to another or between warehouse

Basic Transactions in Inventory Control (2)

- Scrapping
  - Disposal of scrap purchased or manufactured items
- Adjustments
  - For quantities on hand after physical counts
- Reports
  - ABC class reports with quantities and/or dollar value, rate of consumption per item etc.

Impact of Inventory Volume

- A. High Inventories
- B. Low Inventories

Inventory Control Interfaces

- Provides MRP with on-hand balances to enable the computation of net requirement
- Obtains product structures from BOM to prepare kitting list
- Standard costs are furnished from purchasing and routings to evaluate stock holding
- Purchasing and manufacturing orders are signaled from MRP to prepare for upcoming receipts and issues respectively
- Completed manufacturing orders from Shop Floor Control module are received and closed

Material Requirements Planning (MRP)

- Basic Functions
  - The right parts
    - Identified in the BOM module
  - The right quantities
    - Identified in the BOM module, an then compares to the on-hand quantities held in inventory control
  - The right timing
    - Calculated within MRP, based on purchasing and manufacturing lead times held in the BOM/Routings module
Material Requirements Planning

BOM's

→

MRP

Netting

Inventory

Quantity

Available

Net = Gross - Available

+ Manufacturing Orders

+ Purchasing Orders

Material Requirements Planning (MRP)

Example of MRP page 76, 77, and 78

Regenerative MRP

- Regenerates all requirements
  - All material requirements are regenerated once every planning period (usually a week)
  - All previous plans are erased and replaced by new one
  - Several parts are planned although there has not been changed in their plans

Net Change MRP

- A Transaction Driven System
  - Updates the changed data
  - Only those parts needing re-planning are affected
  - Computer processing time is significantly reduced
  - More frequent run is required

Selection Criteria for Net Change and Regenerative MRP

- A Net Change System is best for:
  - Complicated product designs
  - Short production runs for many products
  - Frequent design changes
  - Unstable purchased part supplies
- A Regenerative System is best for:
  - Simple product designs
  - Long and stable production runs
  - Few design changes
  - Stable purchased item supplies

Key Points In MRP

- Maintain accurate data input
  - Forecasts, orders, on hand balances, and routing
- Proper treatment of expedited orders
  - E.g., the addition of extra resources
- Close collaboration between marketing and manufacturing
- Proper shop floor feedback and tracking
- Early notification of changes
**Fundamental Requirements To Successful Run MRP**

- Absolute accuracy in Bill of Materials
- Design changes timely recorded together with their effectively start dates
- Accurate inventory records
- Accurate routings and purchasing records
- Full understanding of the system’s algorithms and logic

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**Purchasing**

- Vendor information management
  - Retrieval by vendor number or name
  - Should get vendor record to evaluate
- Vendor/item cross reference
  - Price quotations, discounts and lead times should be available
  - Used by the receiving module for part recognition
- Purchase orders management
  - Vendor selection, order release, purchase order history, etc
- Vendor performance
  - Basic criteria
    - Quality of products supplied, On-time deliveries, price competitiveness, etc.

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**Purchasing Module**

- Vendors
- Items Supplied by Vendors
- Current Quotes & Lead Times
  - Expected Receipts by Part or Vendors
  - Overage Purchase Orders by Part or Vendor
  - Vendor Performance
  - On Time Deliveries
  - Price

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**Receiving**

- Material Receipts
  - Material recognition and count for purchase receipts
  - Matching with purchase or manufacturing orders
- Material transfers
- Order Closing and Interfaces
  - MRP, Purchasing and Shop Floor Control are notified and the appropriate records are updated
  - Updates stock quantities
- Updates MRP, Shop floor control, inventory control, etc

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**Receiving Module**

- Receipts
- Inspections
- Stock Receipts
  - Update Inventory Records
  - Rejects

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**Shop Floor Control**

- Fundamental Functions
  - Input of manufacturing orders from MRP and execution
  - Maintenance of work-center and labor data
  - Capacity planning and control
  - Capacity over/under loading detection and reporting back to MS and MRP for rescheduling
  - Manufacturing order status reporting
  - Manufacturing order closing and reporting to MRP
Shop Floor Control Module

- Work Orders
- Load
- Master Schedule to reschedule
- Capacity 'Available'
- Time
- Delivers
- Rejects

MRP II/CAD/CAPP/CAM Integration

- Accounts
- Master Schedule
- Bill of Materials & Routings
- Inventory Control
- Material Requirement Planning
- CAD
- CAPP
- Shop Floor Control
- Receiving
- Purchasing

Data Base

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