MATERIAL REQUIREMENTS PLANNING

- A basic tool for performing the detailed material planning function in the manufacture of component parts and their assembly into finished items.
- MRP’s Managerial objective is to provide ‘the right part at the right time’ to meet the schedules for completed products.
- MRP is central to developing detailed plans for part needs of companies assembling end items from components produced in batch manufacturing process.
- Time-phased planning and the associated time-phased records is basic to understanding many other aspects of the manufacturing planning and control system.
- Material requirement planning is characterised by the use of time-phased (period-by-period) requirement records.
- As MRP requires time-phased records, master production schedule also should be represented in time-phased manner.
- Two other inputs for the MRP are Bill of material (BOM) and Inventory status.
- A BOM shows, for each part number, what other part numbers are as direct components.
- The MRP output (time-phased requirement for a part number) can also be used as input to the detailed capacity planning.
- Developing material and capacity plans is an iterative process where the planning is carried out level by level.

THE BASIC MRP RECORD

- At the heart of the MANUFACTURING PLANNING AND CONTROL system is a universal representation of the status and plans for any part number, which is the MRP time-phased record.

<table>
<thead>
<tr>
<th>Period</th>
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<th>2</th>
<th>3</th>
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<td>Scheduled receipts</td>
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<td>Planned order release</td>
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<td>50</td>
</tr>
<tr>
<td>Lead time = 1 period</td>
<td></td>
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</tr>
<tr>
<td>Lot size = 50 units</td>
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</tr>
</tbody>
</table>

Fig. 3 – A Basic MRP Record

Period

- Periods can vary in length from a day to a quarter or even longer. The periods are also called a time bucket. Widely used time bucket is one week.
- The current time is the beginning of the first period.
The number of period in the record is the planning horizon

**Gross Requirements**

- It is the anticipated future usage of or demand for the item during each period
- Gross requirements are time phased which means they are stated on a unique period-by-period basis, rather than aggregated or averaged
- This method of presentation allows for special orders, seasonality, and period of no anticipated usage to be explicitly taken into account
- A gross requirement in a particular period will be unsatisfied unless the item is available during the period
- Availability is achieved by having the item in inventory or by receiving either a scheduled receipt or a planned replenishment order in time to satisfy the gross requirement
- The item must be available at the *beginning* of the time period in which it is required

**Scheduled Receipts**

- It is the existing replenishment orders for the item due in at the *beginning* of each period
- Scheduled receipts result from previously made ordering decisions and represent a source of item to meet gross requirements
- It represents a commitment

**Projected Available Balance**

- It is the current and projected inventory status for the item at the *end* of each period
- It is the projected balance after replenishment orders have been received and gross requirements have been satisfied
- The projected available balance shown at the end of a period is available to meet gross requirements in the next periods

**Planned Order Releases**

- It is the planned replenishment orders for the item at the *beginning* of each period
- Whenever projected available balance shows a quantity insufficient to satisfy gross requirements, additional material must be planned for.
- This is done by creating a planned order release in time to keep the projected available balance from becoming negative
- MRP system creates a planned order by offsetting the lead-time to the beginning of a week
- The difference between the inventory available to a period and the gross requirement of the period is the net requirement
- Orders are placed to meet this net requirement
- A planned order in the most immediate period or current period is in the action bucket

- A quantity in the action bucket means some action is needed to avoid a future problem. The action is to release the order, which converts it to a scheduled receipt

Managing All the Single Part Records

- A single record provides the correct information on each part in the system

- All the single records associated with the parts needed for a complex product is linked together for proper managing

- Key elements for linking the records are the bill of material, the explosion process and lead time offsetting

Bill of Material (BOM)

- BOM shows exactly what goes into what instead of being just a part list

- Two ways the bill of material is represented
  - Product structure diagram
  - Indented bill of material

(See the figure 4 - Snow shovel with component Parts and Assemblies, figure 5 - product structure diagram and figure 6 - Indented bill of material)

Explosion Process

- Explosion is the process of translating product requirements into component part requirements, taking existing inventories and scheduled receipts into account until every part number (purchased parts, raw material, manufactured components, subassembly and assembly) requirements are exactly calculated

- As explosion take place, only the component part requirement net of any inventory or scheduled receipts are considered

- In this way, only the necessary requirements are linked through the system

- Gross to net explosion not only provides the basis for calculating the appropriate quantities but also serves as the communication link between part numbers

- This is the basis for dependent demand estimation and it remove uncertainty from the requirement calculation

- The independent demand items, such as the end item, are subjected to demand from outside the firm

- The need for end items will have to be forecasted

- The concept of dependent demand is often called the fundamental principle of MRP
Fig. 4 - Snow Shovel Shown with Component Parts and Assemblies
Fig. 5 - Product Structure Diagram for Shovel

1605 End product – Shovel
13122 Top Handle Assembly (1 required)
  457 Top handle (1 required)
  082 Nail (2 required)
  11495 Bracket Assembly (1 required)
  129 Top Handle Bracket (1 required)
  1118 Top Handle Coupling (1 required)
048 Scoop-shaft connector (1 required)
118 Shaft (1 required)
062 Nail (4 required)
314 Scoop Assembly (1 required)
2142 Scoop (1 required)
019 Blade (1 required)
14127 Rivet (4 required)

Fig. 6 – Indented Bill of Material
Lead Time Offsetting

- Lead time offsetting is related with when each component and subassembly is needed.
  - The BOM contains **precedent relationships**. They indicate the order in which things must be done.
  - When to schedule each component part depends on **how long to produce the part** (i.e., lead-time). Usually this information is also incorporated in the BOM.

Linking the MRP Records

- The Gross requirements for end items or options come from MPS.
- Gross requirement of a part shows the quantity and timing - when it is required for the parent to make.
- Planned order release of the parent becomes the gross requirements for the components.
- Planned order release quantity is the net of gross requirement, scheduled receipt and projected available balance.
- As MRP record of a part is available, the planned order release of the part is passed down as gross requirement to its components, following the BOM on a level-by-level basis.
- When a part receives its requirement from more than one source, the gross requirement will reflect needs from more than one planned order release source.
- MRP records take account of gross to netting, back scheduling, allows for explicit timings, desired lot sizing procedure, safety stocks and part commonality.
- With the MRP approach, the person planning a part need not explicitly coordinate his planning with planning of component parts. The MRP system accomplishes the coordination.

Example on Linking MRP Records

The master production schedule of *snow shovel* shows the requirements as follows:

<table>
<thead>
<tr>
<th>Week</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
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<td>10</td>
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</tr>
</tbody>
</table>

The lead time to make this item is 2 weeks when the level 1 component parts are available.

The lot sizing procedure for *snow shovel* is lot-for-lot. One of the component part required to make *snow shovel* is *top handle assembly*. The above requirements of *snow shovel* create a ‘gross requirement’ for *top handle assembly* as shown in the MRP record of this item in figure 7. This record shows that there is no order which is outstanding. So there is no ‘scheduled receipt’. There are 25 units available on hand. This is the
‘projected available balance’ which is available as beginning inventory for period 1. The ‘planned order release’ is calculated as follows: First the net requirement is determined.

Net requirement of current period = Gross requirement of current period – Scheduled receipt in the current period – Project available balance of previous period

If this net requirement is a negative quantity, an order has to be planned. The order quantity is adjusted according into the lot sizing method. If the lot sizing method is lot-for-lot, the order quantity is the net requirement. For other method of lot sizing: if the lot-size quantity is greater than the net requirement, the order quantity is the lot size quantity. If the net requirement is greater than the lot size quantity, order the net requirement.

Now, the order quantity shows the quantity required in the period of ‘gross requirement’ for which an order has to be placed. The quantity corresponds to the ‘planned order release’ is the order quantity but, the period in which the order release will occur depends on the lead time of the item. The period of ‘planned order release’ is obtained when the gross requirement period is advanced by lead time. For instance, there is a net requirement of 5 units in period 4 for this item and the lead time is 2 weeks. The ‘planned order release’ will be in the period 2 as you have to advance by 2 periods from the gross requirement period.

*Top handle, nail* and *bracket assembly* are required to make the *top handle assembly*. When ‘planned order release’ is executed, it is assumed that these items are available. Hence, similar to the planning of the *top handle assembly*, a planning has to be carried out for these items also. That is, ‘planned order release’ of *top handle assembly* creates ‘gross requirement’ for these items. For example, the ‘planned order release’ of *top handle assembly* for 5 units in period two generates a ‘gross requirement’ in period two for *top handle*. Similarly for other items – *nail* and *bracket assembly* the gross requirement can be identified. If current status about the items - *top handle, nail* and *bracket assembly* are available, the MRP record of these items can be prepared and these records are available in figure 3. Like this the MRP record of children of bracket assembly can be prepared.
### 13122 Top handle assembly

<table>
<thead>
<tr>
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Lead time = 2 periods  
Lot size: Lot-for-lot

### 457 Top handle

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Lead time = 2 periods  
Lot size: Lot-for-lot

### 082 Nail (2 required)

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Lead time = 1 period  
Lot size: 50

### 11495 Bracket assembly

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Lead time = 2 periods  
Lot size: Lot-for-lot

### 129 Top handle bracket

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Lead time = 1 period  
Lot size: Lot-for-lot
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<tr>
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<th>Period</th>
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</thead>
<tbody>
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<td></td>
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<td>Scheduled receipts</td>
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<tr>
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</tr>
<tr>
<td>Lead time = 3 periods</td>
<td></td>
</tr>
<tr>
<td>Lot size: Lot-for-lot</td>
<td></td>
</tr>
</tbody>
</table>

**Fig. 7 – MRP Records for the Shovel Top Handle Assembly**
Assembly Chart

Fig. Assembly for a caster

Components of caster wheel

Caster wheel

Axle (#7)

Shaft (#1)

Bearing race (#2)

12 Ball bearings (#3)

Ball retainer (#4)

Wheel housing (#5)

Molded plastic wheel (#6)

1. Shaft

2. Race

3. Bearings (12)

4. Retainer

5. Housing

6. Wheel

7. Axle

Pack

Inspect

Assemble wheel and axle to subassembly and rivet one end

Fit subassembly on shaft and stake