Material Requirements Planning (MRP)

- Framework for managing production systems in discrete time.
- Managing Materials, Worker-hours, Equipment, etc.
- MRP is more of an information-management system, than a decision-making system.
- The end product is described by a product structure diagram: A tree diagram showing which sub-assemblies, purchased parts, or raw materials go to make the final product.
- Forecasting methods are used to estimate demand for the final product. This is called the independent demand.
- The product structure is used to calculate the demands for the items that make the final product. These are called the dependent demands.
- Production, purchasing decisions are based on this information.
Components of MRP

- MPS: Master Production Schedule.
- BOM: Bill of Material.
- INV: Inventory Status.

MRP Database

- Suppose the production facility handles $N$ items. The MRP database consists of $N$ (say Item[1:N]) records one for each item in the inventory as follows:

1. Part_Id /*Unique alpha-numerical identity label*/
2. No_of_comp
3. Component[1:No_of_comp]
   - Id
   - Qty
4. Forecast_Horizon
5. Gross_Req[1:Forecast_Horizon]
6. Scheduled_Receipts[1:Forecast_Horizon]
7. Projected_Onhand[0:forecast_Horizon]
8. Net_Req[1:Forecast_Horizon]
9. Lead_Time
10. Lot_Size
11. Planned_Orders[1:Forecast_Horizon]
Bill Of Materials

- (Single-level) BOM for an item consists of the first three fields of the database.
- It forms a single-level tree, with the item as its root, and the components as leaves. (Fig 5.1)
- Item(i).No_of_comp gives the number of other items that make up item i. The part_id of the k-th component is in the field Item(i).Component(k).Id, and Item(i).Component(k).Qty is the quantity of the kth component that is needed to make one unit of item i.
- The same information can also be kept in a “Goes-Into” file, which lists the parent items for each item.
- If an item is a raw material or a purchased part, its No-of-comp field is 0.
- If an item has no parent item, it is called an end-item.
- A complete BOM for an item is obtained by replacing each leaf by its BOM recursively so that the No-of-comp fields of all the leaves in the tree are 0. (Fig 5.2)
- An item may appear as a component in many items.
MRP LOGIC

- MPS (Master Production Schedule) fills in the remaining fields in systematic way as follows.
- It first creates the gross-requirements for each end-item. This is based upon demand forecasts.
- The amount of item $i$ needed in period $j$ is kept in the field Item(i).Gross-Req(j). $j = 1, ..., \text{Forecast-Horizon}$.
- The Scheduled_Receipts(j) field gives the quantity scheduled to be received at the beginning of week $j$. It is updated every time an order is placed (not just planned), either from an outside source (purchase orders) or from an internal source (shop orders).
- The Item(i).Projected_Onhand(0) gives the current inventory of item $i$. It is updated with every receipt and dispatch of the item $i$ from the inventory.
NETTING

- For each item i, this step computes Item(i).Projected_Onhand(j), the inventory on hand at the end of the j-th week, and Item(i).Net_Req(j), the quantity of item i needed at the beginning of week j.

for j=1:Forecast_Horizon
  Item(i).Projected_Onhand(j) =
  Item(i).Projected_Onhand(j-1) + Item(i).Scheduled_Receipts(j)
  - Item(i).Gross_Req(j);
  If Item(i).Projected_Onhand(j) ≥ 0
    Item(i).Net_Req(j) = 0;
  Else Item(i).Net_Req(j) = -Item(i).Projected_Onhand(j);
  end if;
end j;
OFFSETTING

- This step uses the fields Item(i).Lead_Time and Item(i).Lot_size. The Lead_Time field gives the vendor response time if the item is purchased from outside. If the item is fabricated or assembled internally, then it gives the internal response time. The Lot_Size field gives the order size. Using these two fields the offsetting procedure computes when to place orders, i.e., it updates the Planned_Orders field. Item(i).Planned_Orders(j) gives the quantity that is ordered at the beginning of week j. It will arrive at week j+Item(i).Lead_Time.

Cum_Planned_Orders=0;
For j=Item(i).Lead_Time+1:Forecast_Horizon
If Cum_Planned_Orders + Item(i).Projected_Onhand(j) < 0
Item(i).Planned_Orders(j-Item(i).Lead_Time) =
Ceil(-\frac{Cum_Planned_Orders + Item(i).Projected_Onhand(j)}{Item(i).Lot_Size});
Cum_Planned_Orders = Cum_Planned_Orders +
Ceil(-\frac{Cum_Planned_Orders + Item(i).Projected_Onhand(j)}{Item(i).Lot_Size});
Item(i).Lot_Size;
end if;
End j;
EXPLOSION

- The gross requirements for non-end-items are computed by *EXPLOSION* as follows.

  For \( j = 1 : \text{Forecast\_Horizon} \)
  For \( k = 1 : \text{No\_of\_comp}(i) \)
  Child = Item(i).Component(k).Id
  Item(Child).Gross_Req(j) = Item(Child).Gross_Req(j) + Item(i).Planned_Orders(j)\*Item(i).Component(k).Qty;
  end k;
  end j;

- If the same part appears on multiple nodes, the gross requirements are pooled.
MRP EXTENSIONS

- Capacity Analysis. Use the MRP records to see how much production capacity is needed in each period.
- Resource Analysis. Use the MRP records to see how much of each resource (equipment, labor-hours) is needed in each period.
- Safety Stocks and yields.

MRP LIMITATIONS

- MRP is an information processing tool, not a decision making tool.
- Lot Sizing is not optimized.
- Capacity and resource limitations are not explicitly taken into account.
- Lead times, yields are assumed to be deterministic.
- Demand is assumed to be deterministic.