What is MRP (I, II, III)

1. MRP-I

Introduction:

Material Requirements Planning (MRP) is a software based production planning and inventory control system used to manage manufacturing processes. Although it is not common nowadays, it is possible to conduct MRP by hand as well.

An MRP system is intended to simultaneously meet three objectives:

- Ensure materials and products are available for production and delivery to customers.
- Maintain the lowest possible level of inventory.
- Plan manufacturing activities, delivery schedules and purchasing activities

The scope of MRP in manufacturing:

Manufacturing organizations, whatever their products, face the same daily practical problem - that customers want products to be available in a shorter time than it takes to make them. This means that some level of planning is required.

Companies need to control the types and quantities of materials they purchase, plan which products are to be produced and in what quantities and ensure that they are able to meet current and future customer demand, all at the lowest possible cost. Making a bad decision in any of these areas will make the company lose money. A few examples are given below:

- If a company purchases insufficient quantities of an item used in manufacturing, or the wrong item, they may be unable to meet contracts to supply products by the agreed date.

- If a company purchases excessive quantities of an item, money is being wasted - the excess quantity ties up cash while it remains as stock and may never even be used at all. This is a particularly severe problem for food

manufacturers and companies with very short product life cycles. However, some purchased items will have a minimum quantity that must be met, therefore, purchasing excess is necessary.

- Beginning production of an order at the wrong time can cause customer deadlines to be missed.

MRP is a tool to deal with these problems. It provides answers for several questions:

- ***What* items are required?**
- ***How many* are required?**
- ***When* are they required?**

MRP can be applied both to items that are purchased from outside suppliers and to sub-assemblies, produced internally, that are components of more complex items.

The data that must be considered include:

- The *end item* (or items) being created. This is sometimes called Independent Demand, or Level "0" on BOM (Bill of materials).
- How much is required at a time.
- When the quantities are required to meet demand.
- Shelf life of stored materials.
- Inventory status records. Records of *net* materials *available* for use already in stock (on hand) and materials on order from suppliers.
- Bills of materials. Details of the materials, components and subassemblies required to make each product.
- Planning Data. This includes all the restraints and directions to produce the end items. This includes such items as: Routings, Labor and Machine Standards, Quality and Testing Standards, Pull/Work Cell and Push commands, Lot sizing techniques (i.e. ***Fixed Lot Size***, ***Lot-For-Lot***, ***Economic Order Quantity***), Scrap Percentages, and other inputs.

Outputs:

There are two outputs and a variety of messages/reports:

- Output 1 is the "Recommended Production Schedule" which lays out a detailed schedule of the required minimum start and completion dates, with quantities, for each step of the Routing and Bill Of Material required to satisfy the demand from the MPS.
- Output 2 is the "Recommended Purchasing Schedule". This lays out both the dates that the purchased items should be received into the facility AND the dates that the Purchase orders, or Blanket Order Release should occur to match the production schedules.

Messages and Reports:

- Purchase orders. An order to a supplier to provide materials.
- Reschedule notices. These *recommend* cancelling, increasing, delaying or speeding up existing orders.

Note that the *outputs* are *recommended*. Due to a variety of changing conditions in companies, since the last MRP / ERP system Re-Generation, the recommended outputs need to be reviewed by *trained* people to group orders for benefits in set-up or freight savings. These actions are beyond the linear calculations of the MRP computer software.

MRP/ERP Systems were first introduced by George Plossl and Joseph Orlicky in the late 1960s. Oliver Wight contributed the evolution to MRP II, to include more than the factory production and material needs. ERP evolved with the change in hardware / software capability and "Interface" interpretations between software.

Problems with MRP systems:

The major problem with MRP systems is the integrity of the data. If there are any errors in the inventory data, the bill of materials (commonly referred to as 'BOM') data, or the master production schedule, then the outputted data will also be incorrect. Most vendors of this type of system recommend at least 99% data integrity for the system to give useful results.

Another major problem with MRP systems is the requirement that the user specify how long it will take a factory to make a product from its component parts (assuming

they are all available). Additionally, the system design also assumes that this "lead time" in manufacturing will be the same each time the item is made, without regard to quantity being made, or other items being made simultaneously in the factory.

A manufacturer may have factories in different cities or even countries. It is no good for an MRP system to say that we do not need to order some material because we have plenty thousands of miles away. The overall ERP system needs to be able to organize inventory and needs by individual factory, and intercommunicate needs in order to enable each factory to redistribute components in order to serve the overall enterprise.

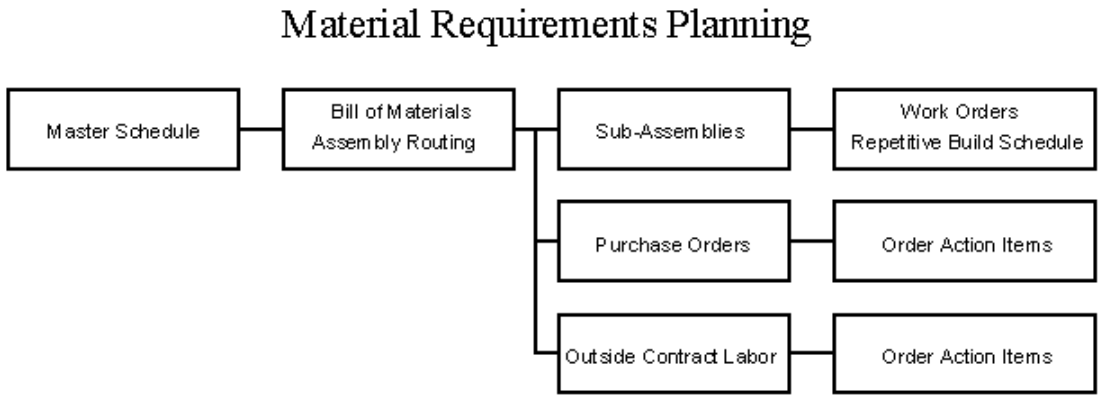
This means that other systems in the enterprise need to work properly both before implementing an MRP system, and into the future. For example systems like variety reduction and engineering which makes sure that product comes out right first time (without defects) must be in place.

Production may be in progress for some part, whose design gets changed, with customer orders in the system for both the old design, and the new one, concurrently. The overall ERP system needs to have a system of coding parts such that the MRP will correctly calculate needs and tracking for both versions. Parts must be booked into and out of stores more regularly than the MRP calculations take place. Note, these other systems can well be manual systems, but must interface to the MRP. For example, a 'walk around' stocktake done just prior to the MRP calculations can be a practical solution for a small inventory (especially if it is an "open store").

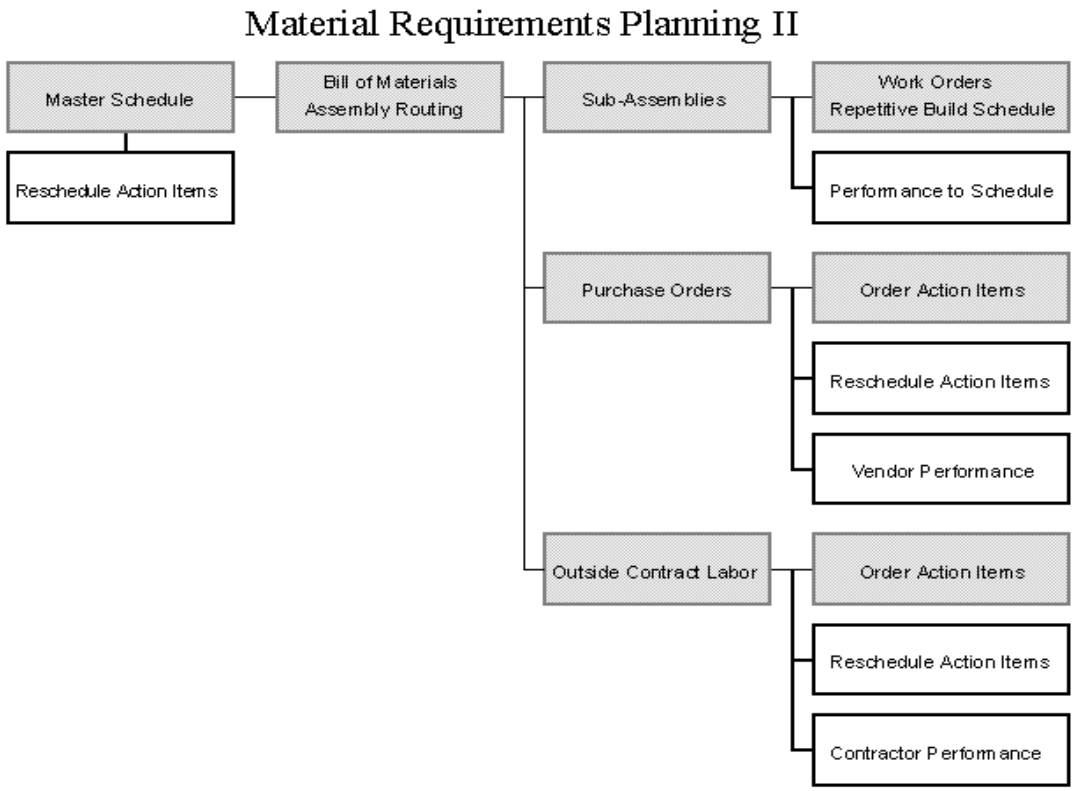
The other major drawback of MRP is that takes no account of capacity in its calculations. This means it will give results that are impossible to implement due to manpower or machine or suppler capacity constraints. ***However this is largely dealt with by MRP II***.

Generally, MRP II refers to a system with integrated financials. An MRP II system can include finite / infinite capacity planning. But, to be considered a true MRP II system must also include financials.

In the MRP II (or MRP2) concept, fluctuations in forecast data are taken into account by including simulation of the master production schedule, thus creating a long-term control[2]. A more general feature of MRP2 is its extension to purchasing, to marketing and to finance (integration of all the function of the company), ERP has been the next step.



2. MRP-II



To assist planners in tracking some of the problems associated with inventory control, some kind of 'feedback loop' is needed in the M.R.P. process, not only to automatically re-schedule certain items (when possible), and avoid excessive manual effort in controlling the process, but to detect and report performance that is 'out of spec' (such as a vendor performance report to track on-time delivery performance). This 'feedback loop' is the defining factor for an 'M.R.P. II' system. Though many systems **CLAIM** to be an 'M.R.P. II' system, few actually fit the mould exactly. Still, with automatic rescheduling capabilities for work orders and/or repetitive build schedules, and 'reschedule action' reports for purchase orders and outside contracting, the amount of actual analysis is reduced significantly. Other information, such as vender performance reports and process utilization reports, also help to measure the 'performance to plan' capability of the manufacturing plant.

Even when the production plan is running at optimum performance, companies still often have serious problems with the manufacturing process. 'Hidden Cost' issues associated with manufacturing increase the total cost of manufacturing, but are extremely hard to track. Some of these 'Hidden Costs' can be caused by excessive

P.O. rescheduling or excessive ‘crash buy’ programs, excess and/or obsolete inventory, or planning problems that cause incorrectly stocked finished goods (too much of one, not enough of the other) that result in shortages. Another ‘hidden cost’ issue might be frequent line stops related to a ‘limiting process’ (such as a wave solder machine or component inserter), as well as material shortages and excessive ‘kitting’ of common components. In addition, potential revenue losses from excessively long customer order lead times, or poor on-time customer delivery performance, are real problems, but very difficult to track and measure. As such, none of these problems are tracked nor reported by any ‘standard M.R.P.’ or ‘M.R.P. II’ system. To help solve these problems, and improve the company’s competativeness and profitability, beyond existing capabilities, the M.R.P. system must go beyond the standard definition of ‘M.R.P. II’.

Manufacturing Resource Planning (**MRP II**) is defined by APICS (American Production and Inventory Control Society, Estd. 1957) as a method for the effective planning of all resources of a manufacturing company. Ideally, it addresses operational planning in units, financial planning in dollars, and has a simulation capability to answer "what-if" questions and extension of closed-loop MRP.

This is not exclusively a software function, but a marriage of people skills, dedication to data base accuracy, and computer resources. It is a total company management concept for using human resources more productively.

MRP II is not

Many items on this list can be part of an MRP II, but are not solely what it is.

- a computer system
- manufacturing control system
- inventory reduction plan
- Sales & Purchase System
- Material Management

Purpose

MRP II integrates many areas of the manufacturing enterprise into a single entity for planning and control purposes, from board level to operative and from five-year plan to individual shop-floor operation. It builds on closed-loop Material Requirements Planning (MRP) by adopting the feedback principle but extending it to additional areas of the enterprise, primarily manufacturing-related.

Key functions and Features

MRP II is not a proprietary software system and can thus take many forms. It is almost impossible to visualise an MRP II system that does not use a computer, but an MRP II system can be based on either purchased / licensed or in-house software.

Almost every MRP II system is modular in construction. Characteristic basic modules in an MRP II system are:

- Master Production Scheduling (MPS)
- Item Master Data (Technical Data)
- Bill of Materials (BOM) (Technical Data)
- Production Resources Data (Manufacturing Technical Data)
- Inventories & Orders (Inventory Control)
- Purchasing Management
- Material Requirements Planning (MRP)
- Shop Floor Control (SFC)
- Capacity planning or Capacity Requirements Planning (CRP)
- Standard Costing (Cost Control)
- Cost Reporting / Management (Cost Control)
- Distribution Resource Planning (DRP)

together with ancillary systems such as:

- Business Planning
- Lot Traceability
- Contract Management
- Tool Management

- Engineering Change Control
- Configuration Management
- Shop Floor Data Collection
- Sales Analysis and Forecasting
- Finite Capacity Scheduling (FCS)

and related systems such as:

- General Ledger
- Accounts Payable (Purchase Ledger)
- Accounts Receivable (Sales Ledger)
- Sales Order Management
- Distribution Requirements Planning (DRP)
- [Automated] Warehouse Management
- Project Management
- Technical Records
- Estimating
- Computer-aided design/Computer-aided manufacturing (CAD/CAM)
- CAPP

The MRP II system integrates these modules together so that they use common data and freely exchange information, in a model of how a manufacturing enterprise should and can operate. The MRP II approach is therefore very different from the "point solution" approach, where individual systems are deployed to help a company plan, control or manage a specific activity. MRP II is by definition fully integrated or at least fully interfaced.

MRP II systems can provide:

- Better control of inventories
- Improved scheduling
- Productive relationships with suppliers

For Design / Engineering:

- Improved design control

- Better quality and quality control

For Financial and Costing:

- Reduced working capital for inventory
- Improved cash flow through quicker deliveries
- Accurate inventory records
- Timely and valid cost and profitability information

Industry Specifics

MRP II systems have been implemented in most manufacturing industries. Some industries need specialised functions e.g. lot traceability in regulated manufacturing such as pharmaceuticals or food. Other industries can afford to disregard facilities required by others e.g. the tableware industry has few starting materials – mainly clay – and does not need complex materials planning. Capacity planning is the key to success in this as in many industries, and it is in those that MRP II is less appropriate.

This is not exclusively a software function, but a marriage of people skills, dedication to data base accuracy, and computer resources. It is a total company management concept for using human resources more productively.

MRP and MRPII: History and Evolution

Material Requirements Planning (MRP) and Manufacturing Resource Planning (MRPII) are predecessors of Enterprise Resource Planning (ERP), a business information integration system. The development of these manufacturing coordination and integration methods and tools made today's ERP systems possible. Both MRP and MRPII are still widely used, independently and as modules of more comprehensive ERP systems, but the original vision of integrated information systems as we know then today began with the development of MRP and MRPII in manufacturing.

The vision for MRP and MRPII was to centralize and integrate business information in a way that would facilitate decision making for production line managers and increase the efficiency of the production line overall. In the 1980s, manufacturers

developed systems for calculating the resource requirements of a production run based on sales forecasts. In order to calculate the raw materials needed to produce products and to schedule the purchase of those materials along with the machine and labor time needed, production managers recognized that they would need to use computer and software technology to manage the information. Originally, manufacturing operations built custom software programs that ran on mainframes.

Material Requirements Planning (MRP) was an early iteration of the integrated information systems vision. MRP information systems helped managers determine the quantity and timing of raw materials purchases. Information systems that would assist managers with other parts of the manufacturing process, MRPII, followed. While MRP was primarily concerned with materials, MRPII was concerned with the integration of all aspects of the manufacturing process, including materials, finance and human relations.

Like today's ERP systems, MRPII was designed to integrate a lot of information by way of a centralized database. However, the hardware, software, and relational database technology of the 1980s was not advanced enough to provide the speed and capacity to run these systems in real-time, and the cost of these systems was prohibitive for most businesses. Nonetheless, the vision had been established, and shifts in the underlying business processes along with rapid advances in technology led to the more affordable enterprise and application integration systems that big businesses and many medium and smaller businesses use today (Monk and Wagner).

MRP-I and MRPII: General Concepts

Material Requirements Planning (MRP) and Manufacturing Resource Planning (MRPII) are both incremental information integration business process strategies that are implemented using hardware and modular software applications linked to a central database that stores and delivers business data and information.

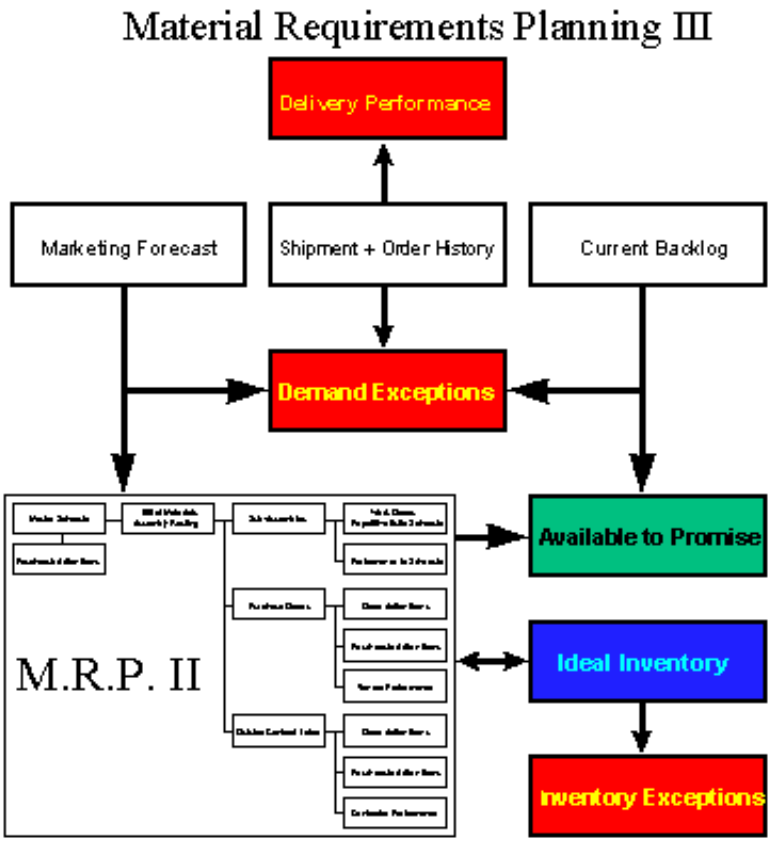
MRP is concerned primarily with manufacturing materials while MRPII is concerned with the coordination of the entire manufacturing production, including materials, finance, and human relations. The goal of MRPII is to provide consistent data to all

players in the manufacturing process as the product moves through the production line.

Paper-based information systems and non-integrated computer systems that provide paper or disk outputs result in many information errors, including missing data, redundant data, numerical errors that result from being incorrectly keyed into the system, incorrect calculations based on numerical errors, and bad decisions based on incorrect or old data. In addition, some data is unreliable in non-integrated systems because the same data is categorized differently in the individual databases used by different functional areas.

MRPII systems begin with MRP, Material Requirements Planning. MRP allows for the input of sales forecasts from sales and marketing. These forecasts determine the raw materials demand. MRP and MRPII systems draw on a Master Production Schedule, the break down of specific plans for each product on a line. While MRP allows for the coordination of raw materials purchasing, MRPII facilitates the development of a detailed production schedule that accounts for machine and labor capacity, scheduling the production runs according to the arrival of materials. An MRPII output is a final labor and machine schedule. Data about the cost of production, including machine time, labor time and materials used, as well as final production numbers, is provided from the MRPII system to accounting and finance (Monk and Wagner).

3. MRP-III



The 'M.R.P. III' process begins with an **Accurate Demand Forecast**, for it is this Demand Forecast that drives the remainder of the business. Using the best possible demand forecast, a *Master Schedule* is developed. Ideally the total number of master scheduled items will be minimized, so that the M.R.P. system can appropriately generate build schedules for components and 'accessories' automatically, and will be derived directly from the Demand Forecast with little or no changes.

From the *Master Schedule*, the 'M.R.P. III' system derives the individual component and assembly requirements, and recommends new purchase orders, just like a 'standard M.R.P.' system, and also generates recommended purchase order reschedules, and automatically reschedules non-master scheduled assemblies based on the availability of components/resources and material requirements, just like an 'M.R.P. II' system. The M.R.P. III system also monitors and reports vendor performance and 'performance to plan' by the assembly line, similar to an 'M.R.P. II'

system. However, to minimize the total amount of ‘detail information’, the ‘M.R.P. III’ system concentrates on only reporting those items that fall outside of the allowed tolerances, thus minimizing the number of reported items.

When the M.R.P. system has been fully integrated with the Order Management system, it becomes possible to calculate ‘Available to Promise’ inventory, based on a combination of existing order backlog, the current inventory, and the projected availability of a product over time as it is built from the current production schedule. In this way, if a customer orders a product within lead time, and delivery is already promised to another customer, order management personnel can use this information to negotiate a realistic delivery schedule with the customer. Also, delivery re-schedules would become easier to manage, since order management personnel can view the current ‘available to promise’ inventory, and use this information to determine when partial or full shipments could be re-scheduled. In all likelihood, there will be available inventory to ship ahead of schedule, should the customer need to perform a ‘crash buy’. An ‘M.R.P. III’ system must therefore include the ability to view the ‘available to promise’ inventory, based on current inventory, current backlog, and the current production plan.

Finally, the ‘M.R.P. III’ system bases its operating parameters on the principles of ***Bandwidth Management***, dynamically adjusting parameters such as lead times and ‘ideal inventory’ according to the historic data (when needed), and measuring performance to a set of statistically derived ‘control bands’, rather than fixed parameters. The ‘M.R.P. III’ system then generates exception reports for those items that fall outside of the control bands, and automatically maintains as much of the manufacturing planning process as possible, with little or no human intervention.

A process such as ‘M.R.P. III’ would help to eliminate certain kinds of errors that currently plague manufacturing businesses on a nearly universal level. By far, the greatest single factor in ruining a perfectly good manufacturing plan is the tendency for the Demand Forecast to change on a regular basis, typically inside planning lead time. Or, the Demand Forecast may be completely useless for manufacturing purposes, forcing the person responsible for the master schedule to literally generate his own forecast in an attempt to predict what the demand actually will be. Often times, a combination of both of these conditions exists, where the marketing forecast is so inaccurate as to make it useless, forcing the master scheduler to perform this task

of generating a forecast. And, without some kind of forecast, there is no master schedule. And, without a master schedule, there is no 'M.R.P.'. Any 'M.R.P.' system without a demand forecast analysis capability is thus severely limited in its ability to help reduce overall inventory and simultaneously meet the requirements of the production plan. After all, **"Garbage In, Garbage Out."**

Still, with all of the potential for automating the manufacturing planning process, people still need to use their skills and judgement within critical points in the planning process. Using 'exception planning' will minimize the amount of items that people need to look at. This 'exception planning' process is derived directly from *Bandwidth Management*, so that only those items that need attention will be addressed. It is still the planner's responsibility to implement purchase order re-scheduling or 'crash buy' programs, outside contracting, and so forth, and (potentially) any manufacturing schedules oriented around a process or piece of equipment that is considered a 'critical path' in the manufacturing process. The 'M.R.P. III' system must therefore supply as much useful information to the planner as possible, to help him make informed decisions, yet also limit this information to only those items that may actually require his attention.

References

1. Waldner, Jean-Baptiste (1992). "CIM: Principles of Computer Integrated Manufacturing [1]": p47. John Wiley & Sons Ltd.

2. Monk, E. and Wagner, B., Concepts in Enterprise Resource Planning, 2nd Edition, 2006, Editor, Mac Mendelsohn, Canada: Thomson Course Technology.