Acta Scientific Applied Physics

Volume 3 Issue 6 June 2023

Literature Review

# Scientific Study of Material Need Planning that is Simple and Direct

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**Received:** March 02, 2023

**Published:** May 12, 2023



## Abstract

Manufacturing companies have traditionally controlled their parts using the reorder point (ROP) technique. They gradually realized that some of these components had dependent demand, and material requirements planning (MRP) evolved to better control the dependent items. The method known as "material requirement planning" uses the bill of materials, inventory data, and a master schedule to figure out how much material is required. It also takes into account the relationship between assembly lead times and the organizational structure of the bill of materials. For each item in the bill of materials structure, an MRP plan generates a material plan that specifies the quantity of fresh material required as well as the due date. Dates on the new schedule for the materials that are currently on order if routings with specific labor requirements are available, a capacity plan will be created concurrently with the MRP material plan. The MRP plan can be executed for any number of entities, including distributor inventories, if the system has access to this type of data. These entities may be physically distinct stocks. MRP seeks the best possible balance of maximizing service level, lowering expenses, and avoiding capital lockup. In this paper, we attempt to depict a real-world MRP problem and show how it aids in cost- and service-level optimization.

**Keywords:** Optimization; Inventory; Bill of Material; Planning for Product Specifications; Master Timetable

## Introduction

Manufacturing companies have traditionally controlled their parts using the reorder point (ROP) technique. They gradually realized that some of these components were subject to dependent demand, and material requirements planning (MRP) evolved to better control the dependent items. Since the 1970s, MRP has been a popular and widely used multilevel inventory control method. The use of this popular tool in materials management has significantly reduced inventory levels and increased productivity (Wee and Shum, 1999).

Materials Requirements Planning (MRP I), the first version of the MRP system, was released. Several MRP systems, including Manufacturing Resources Planning II (MRP II) and Enterprise Resources Planning (ERP), were later expanded into other versions (Browne., *et al.* 1996). MRP is a widely used approach for replenishment planning in large corporations. MRP-based software tools are widely used. The majority of industrial decision-makers are familiar with their application. The practical aspect of MRP is that it is based on understandable rules and offers cognitive support as well as a powerful information system for decision making.

Materials requirements planning (MRP) is a technique for inventory planning and control designed to deal with dependent-demand inventories. In its most basic form, an MRP system consists of three basic components: a master production schedule (MPS);

end-item bill-of-material (BOM) files; and inventory status files for various materials, components, parts, subassemblies, and final products [I]. The MPS is a product requirements schedule based on both firm customer orders and preliminary demand forecasts. It is a list of the end-item demand for each time period over a planning horizon. Using the information contained in the various BOM files, the requirements of the lower-level components and parts can be derived given the MPS.

These lower grade prerequisites are then back-scheduled into the appropriate time periods based on the BOM's planned lead times. By consulting the inventory status files, these time- phased gross material requirements are modified by the amount of material on hand and on order for each time period. The net material requirements for each time period can then be calculated. Finally, orders for materials with positive net requirements are placed. Determining the size of production lots from net requirements is an important decision problem in MRP. A "production lot" is a batch of parts that are produced continuously under the same operating conditions. In the literature, the "lot-sizing problem" refers to the problem of determining the quantities of parts to be processed in a batch and the times for completing these batches. Orders, current inventory and forecasts. They ensure that firms will always have sufficient inventory to meet production demands, but not more than necessary at any given time. MRP will even schedule purchase orders and/or production orders for Just in time receipt.

## Literature Review

There is a significant amount of literature on Materials Management and MRP available in the form of research papers, books, and articles in journals, among other things. Among the most important methods are: Yenisey [1] used flow network model to solve MRP problems with a linear programming method that minimized the MRP system's total cost. Mula., *et al*. [2] developed a new linear programming model for medium-term production planning in a capacity- constrained MRP with a multiproduct, multilevel, and multiperiod manufacturing system. Their proposed model included three fuzzy submodels with varying degrees of flexibility in the objective function, market demand, and resource capacity. Wilhelm and Som [3] present an inventory control strategy for a multi-component assembly system. Their model focuses on a single finished product inventory, ignoring the interdependence between inventory levels of different components. Axsater [4] considers a multilevel assembly system with independent random variables for operation times. Their model concentrates on a single finished product inventory, ignoring the interdependence between inventory levels of different components. Axsater [4] considers a multilevel assembly system with independent random variables for operation times. The goal is to select starting times (release dates) for various operations that minimize the sum of expected holding and backlog costs. In an MRP-controlled manufacturing environment, Kanet and Sridharan [5] investigated late raw material delivery, variations in process lead times, interoperational move times, and queue waiting times. They represented demand in such an environment by inter-arrival time rather than by definition from the master production schedule. Kumar [6] investigates a single-period model for a multi-component assembly system with stochastic component lead times and a fixed assembly due date and quantity. The challenge is to time each component order so that the total cost, which includes component holding and product latency costs, is minimized. Chauhan and colleagues [7] present an intriguing single-period model. Their approach takes into account a consistent, fixed demand for a single finished product. This product requires a variety of components to be assembled. The goal is to determine the ordering time for each component so that the sum of expected holding and backlog costs is as low as possible. For planning orders, Van Donselaar and Gubbels [8] compare MRP and line requirements planning (LRP). Their research primarily concentrates on reducing system inventory and nervousness. They also discuss and propose the LRP technique to accomplish their objectives. Minifie and Davies [9] investigated the interaction effects of demand and supply uncertainties by developing a simulation model of a dynamic MRP-controlled manufacturing system. These misunderstandings were modeled as changes in lot size, timing, planned orders, and policy fence on several system performance measures, including late deliveries, number of setups, ending inventory levels, component shortages, and the number of exception reports. For scheduling capacity- constrained MRP systems, Billington., *et al*. [10] proposed a mathematical programming approach. They propose a formulation for discrete-time mixed-integer linear programming. They introduce the concept of product structure compression to reduce the number of variables and thus the size of the problem. MRP requirements for a Make-to-Order Company, Scheduling and Order Release, James R. Ashby, J. Hoey, B.R. Kilmarting, and R. Leonard [11,12]. Optimal positioning of safety stock in MRP for determining the role of inventory safety stock on MRP, E.J. Anderson and A.G. Lagodimos [13], Product

Structure Complexity R. Srivastava and W.C. Benton [14]. According to Keitany Wanyoike Salome., *et al*. [15], materials management is a tool for optimizing performance in meeting customer service requirements while also increasing profitability by lowering costs and making the best use of available resources. The study's main goal was to evaluate the impact of material management on organizational performance. The specific goal of the study was to determine how inventory control systems and lead times affect organizational performance. The ratings revealed that inventory control systems were critical to organizational performance. As a result, organizations must ensure that inventory control systems are heavily involved in material management activities in order to achieve higher organizational performance. According to Krishna Satyanarayana Rao., *et al*. [16], materials are the basic core organs of any product, accounting for 60 to 70% of total production costs. Materials management will make an effort to resolve the issues of material shortages, supply delays, price fluctuations, damage and waste, and a lack of storage space. They concluded that materials are managed in stages such as procurement, transportation, shipping, grading, storage, warehouse maintenance, supplying to production centers, and so on. Minimizing risk at all levels provides management with not only better resource utilization but also a competitive advantage.

## Materials and Methods

Assume that an organization produces a final product X. Each unit of product X necessitates the use of some component of Y. If it takes two months to produce a unit of X and one month to produce a unit of Y over a t-month period, the initial stock level of X is X quantity, and it is the units of X scheduled for receipts at the beginning of month t to avoid deficiency.

Let NRt(X) = the net requirement of X for the period t, GRt(X) = the gross requirement of X during the period t, SRt(X) = the schedule requirement of X during the period t, OHt(X) = the on hand inventory of X at the end of the period t.

NRt(X) = GRt(X) – SRt(X) – OHt-1(X)-------- (1)

OHt(X) = SRt(X) + OHt-1(X) – GRt(X)--------- (2)

The following steps can be taken to solve the problem of material requirement planning:

- **Step 1**: Create a product structure tree and determine the end product requirement for each period using the master production schedule or a forecasting method.
- **Step 2**: Using the Product structure tree, determine the subcomponent requirements.
- **Step 3**: Create a decision matrix table with different time periods in vertical columns and projected requirements. The horizontal row side shows on-hand availability, scheduled receipts, and planned order release.
- **Step 4**: Finish the MRP table by plugging in equations (1) and (2) and filling in all the empty cells.

## Examine this case

A car assembly requires one unit of flywheel, two units of wheel assembly, one unit of engine lock assembly, and one unit of water pump assembly to be manufactured. One unit of wheel is required for each unit of wheel assembly. And four bearing units. Two shafts and four bearings are required for each engine block assembly. Each the water pump assembly, which is designated as E, requires the same type and price bearing as the engine block assembly. (C) represents the wheel assembly, (B) represents the flywheel unit, and (E) represents the engine block (E). The water pump assembly is designatedas (D), and the assembly is designated as (I). Like water, the wheel is labeled F, and bearings are labeled (G), shafts are labeled (H), and engine bearings are labeled (E). Pump bearings, because they are the same type and price. The following is the product structure tree.

Table 1 displays the other information that is available.

| Component | Ordering quality | Lead time/ weak | Safety stock | Quantity |
|---|---|---|---|---|
| A | Variable | 1 | 0 | 0 |
| B | 500 | 2 | 130 | 130 |
| C | 1000 | 2 | 200 | 600 |
| D | 550 | 1 | 50 | 130 |
| E | 3000 | 1 | 140 | 120 |
| F | 1000 | 2 | 140 | 500 |
| G | 5500 | 2 | 220 | 2200 |
| H | 1000 | 2 | 120 | 20 |
| I | 550 | 2 | 130 | 130 |

**Table 1:** Information on ordering quantity, lead time, safety stock to be kept, and available quantity at the start of different car assembly components and subcomponents (the end item).

It is now up to management to design an M.R.P. system for the entire unit. The Demand is established by the Master schedule, which drives the MRP system. The projected demand for the next ten periods is shown below, and it is based on previously received external orders. Table 2 shows the end product requirement for the 10-month period.

| Time | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| End product Arequirement | | 200 | 300 | | 500 | | 400 | | | 600 |

**Table 2:** End Product requirement for the 10 month period.

## Numerical

The requirements for various subcomponents are given below. Assume Product A has a one-week lead time and can be produced in lot sizes that correspond to demand. Then components B, C, and D have a dependent demand that is the same as demand A but occurs one week earlier.

Table 3 shows the projected requirement for B. Because each unit of end items requires one unit of component B, as specified in the product structure tree. The requirements are shown with a one-week delay.

| Order quantity variable | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| Project requirement | 200 | 300 | | 500 | | 400 | | | 600 | |

**Table 3:** The component of Demand B.

Similarly, Table 4 shows the projected requirement for C. Because two units of component C are required for each unit of end items as specified in the product structure tree, the requirement is shown as a one-week earlier offset.

| Order quantity variable Lead time is 2 weeks | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| Project requirement | 400 | 600 | | 1000 | | 800 | | | 1200 | |

**Table 4:** The component of Demand C.

Similarly, Table 5 shows the projected D requirement. Because each unit of end items requires one unit of component D, as specified in the product structure tree. The requirements are shown with a one-week delay.

| Order quantity variable500 Lead time is 1 weeks and safety stock 50 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| Project requirement | 200 | 300 | | 500 | | 400 | | | 600 | |

**Table 5:** The component of Demand D.

Similarly, Table 6 shows the projected requirements of I. Because one unit of component I is required for each unit of end itemas specified in the product structure tree, the requirement is shown with a one-week offset.

| Order quantity variable is500 Lead time is 1 weeks and safety stock 50 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| Project requirement | 200 | 300 | | 500 | | 400 | | | 600 | |

**Table 6:** The component of Demand I.

Similarly, Table 7 shows the projected requirement for F. Because one unit of component F is required for each unit of end item C as specified in the product structure tree, and because two units of component C are required for each unit of end item A. To determine when to produce subcomponents G and F, the order release dates for component C must first be determined. The resultsection includes a material requirement plan for end item A, item C, item F, and item G.

| Order quantity variable Lead time is 2 weeks | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| Project requirement | | 1000 | | 800 | | | 1200 | | | |

**Table 7:** The component of Demand F.

Similarly, Table 8 shows the projected requirement for G. Because four units of item G are required for each unit of end item C as specified in the product structure tree, and because two units of component C are required for each unit of end item A, the total item G required is eight units.

| Order quantity variable Lead time is 2 weeks | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| Project requirement | | 4000 | | 3200 | | | 1200 | | | |

**Table 8:** The component of Demand G.

Similarly, it appears that each unit of D necessitates two units of H. Table 9 shows the material requirement planning for item H.

| Order quantity variable = 500Lead time is 2 weeks, safety stock is 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| Project requirement | 1000 | | 1000 | | 1000 | | | 1000 | | |

**Table 9:** The component of Demand H.

According to the product structure tree and bill of material figure, each unit of component A requires one unit of E to be assembled. Component D is made up of four units of component E. The previously used order releases are assumed to be applicable for A and D. So the order release quantity of product D is multiplied by four, and the order release quantity of A is offset to account for the lead time. As a result, the requirement of E equals the total projected requirement of A and D. The number of units of E is calculated by multiplying the order release of each component of D by four. Table 10 shows the E requirement.

## Conclusions

A practical problem involving material requirement planning was attempted to be solved in this paper. The projected requirement is estimated by starting with the product structure tree, i.e., the bill of materials for making a component. The planned order release is estimated based on the scheduled receipt quantity. In the industrial sector, this approach to solving the material requirement planning problem is extremely valuable. As a result, precise material requirement planning is practiced. As a result, inventory management will be simple. This method of material requirement planning can save a lot of money. There will be a quantity discount option available. The amount of money held in inventory will be reduced. Material handling issues will be alleviated. However, the approach presented in this paper does not address every material requirement planning problem. The economic order quantity is not taken into account in this case. There was no estimation of the safety stock. The lead-time variation is unknown. Furthermore, the dependent inventory demand is not taken into account. The master schedule's independent preparation is not taken into account. Nonetheless, the paper made every effort to link inventory decisions, such as purchasing and storing, to production planning. The presentation of examples of actual scenarios in industry distinguishes this paper. By relating the production planning and inventory management problems, it will encourage the younger generation to take on the assignment of material requirement planning.

| Order quantity variable | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| Requirement of item E for assembly ofeach unit of end item A & I | 200 | 300 | | 500 | | 400 | | | 600 | |
| Requirement of item E for assembly of each unit of item D | 200 | | 2000 | | 2000 | | | 2000 | | |
| Total project Requirement of item E for assembly of one unit of item A | 2200 | 300 | 2000 | 500 | 2000 | 400 | | 2000 | 600 | |

**Table 10:** The component of Demand E.

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