FORECASTING AND MATERIAL REQUIREMENTS PLANNING

by Noor Izah Ismail

"Forecasting is a process of estimating a future event by casting forward past data. The past data are systematically combined in a predetermined way to obtain the estimate of the future"[1]

Forecasting is subphase of planning. In a management process, planning, organizing, and controlling are not independent processes, rather they interrelate and overlap. However, if operations are properly planned and organized, control would be smoother and easier. Forecasting, when introduced, can reduce the costs of readjusting operations in response to unexpected deviations by specifying future demand. Therefore, if the planning process is well conceived and actual production is effectively and efficiently carried out, there is a likelihood of high productivity. On the other hand, if the forecast has considerable error, even a well conceived plan and an excellent operating performance may result in a disappointing productivity.

In a production system, one of the ways to achieve productivity is the use of Material Requirements Planning.

REVIEW OF THE MATERIAL REQUIREMENTS PLANNING (MRP) SYSTEM

In recent years, and increasing number of companies have adopted the MRP system as an alternative planning tool to Statistical Inventory Control methods. Basically, the MRP system provides an efficient method of managing inventories by outlining the specific components that are to be placed in inventory, that is, the acquisition of required materials and the actual scheduling of these materials.

MRP is a means to coordinate manufacturing decisions. These decisions support the various aspects of the production plans particularly finished products, the control of raw materials and component part inventory levels and the scheduling of component for fabrication and assembly departments.

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1. *Adam, Everett E. and Ebert, Ronald J.,* **Production and Operations Management: Concept, Model, and Behavior,** *Englewood Cliffs, N.J.: Prentice-Hall, 1982, pg. 112*

Ternise suggests that if the following conditions are met, MRP should be superior to other inventory system.[2]

1. The final product is complex and contains several other items.

2. The specific demand for the product in any time period is known.

3. The final product is expensive.

4. The demand for an item is tied in a predictable fashion to the demand for other items.

5. The forces creating the demand in one time period are distinguishable from those in other time periods.

Since it recogizes the fact that in reality demands are random and erratic in manner, MRP is an inventory and scheduling tool which best suits the manufacturing environment. A MRP system is sensitive to changes which occur from time to time in the master production schedule, the inventory status or product composition. Hence, it replans the net requirements and coverage accordingly.

The principal prerequisites and assumptions implied by the MRP system are identified below. Several of these items will be explored in more detail.[3]

1. A master production schedule exists and cannot be stated in bill of material terms.

2. All inventory items are uniquely identified.

3. A bill of material exists at planning time.

4. Integrity of file data such as inventory data and bill of material data.

5. Individual item lead times are known.

6. Every inventory item goes into and out of stock.

7. All of the components of an assembly are needed at the time of the assembly.

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2. *Tersine, Richard J.,* **Materials Management and Inventory Systems,** *North-Holland Publishing Co., 1978, pg. 168.*

3. *Orlicky, Joseph,* **Material Requirements Planning,** *McGraw-Hall Book company, 1975, pg. 41.*

8. Discrete disbursement and usage of component materials.

9. Process independence of manufactured items.

The three major inputs of most MRP systems consist of the master production schedule (MPS), the bill-of-material (BOM) and the inventory status records. A flow diagram of input-output relationships in typical MRP system is shown in Exhibit A. The MPS "drives" the system, while the BOM and lot-sizing rule (LSR) provide the necessary data.[4] The MPS is a realistic and detailed manufacturing plan which takes into account all possible demands. It is also the fundamental difference which sets MRP apart from other inventory control systems. Without it, the whole MRP system would be paralyzed.

The closed loop approach to master scheduling was made possible by the capabilities of MRP. Its purpose is to keep the master production schedule in harmony with the realities of actual production.[5] See exhibit B.

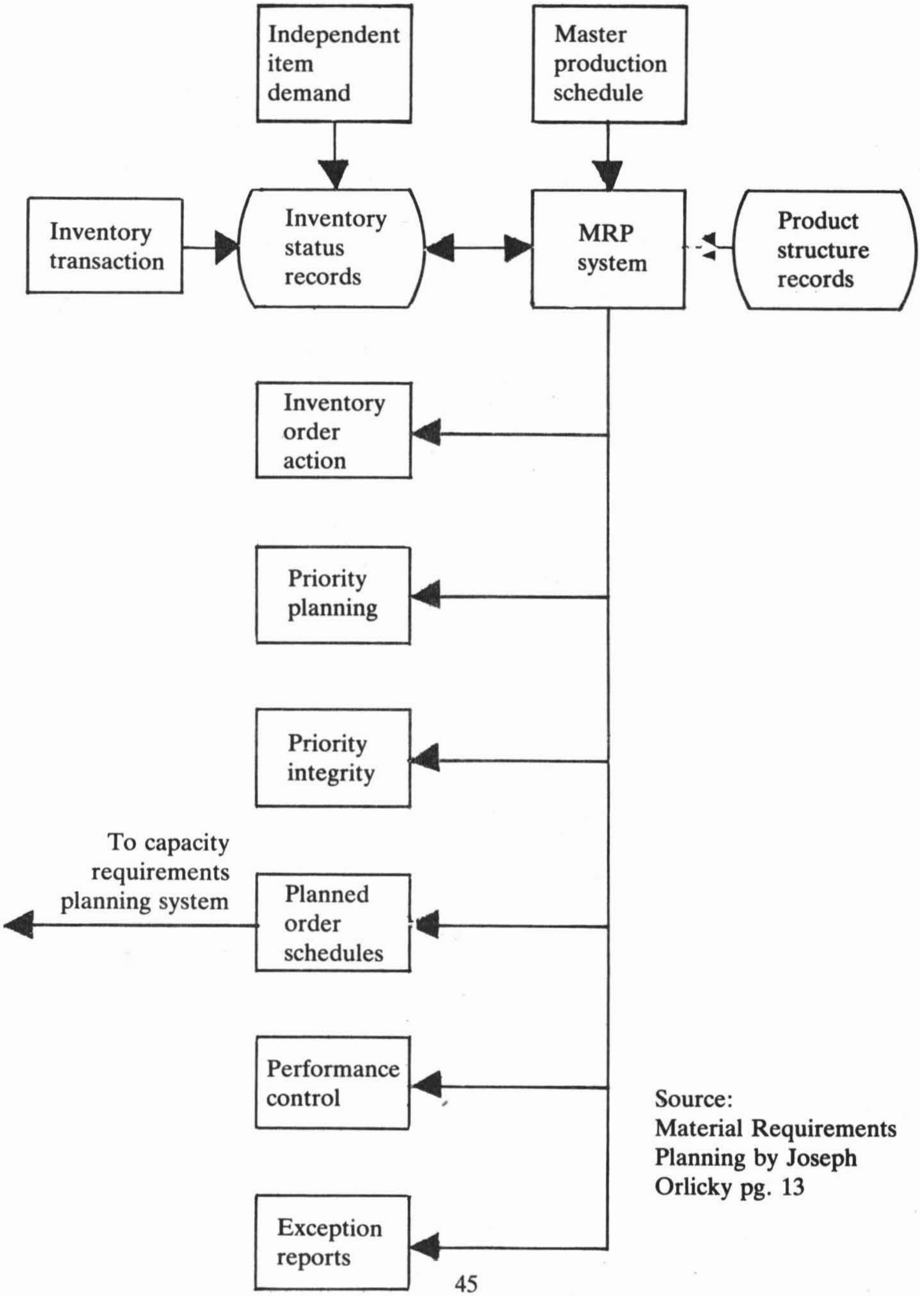
Time spans used for time phasing and requirments collection are called buckets. Requirements are normally reported in the appropriate buckets. Concensus seems to be that one week is the largest bucket size acceptable for a good MRP system. Small internal buckets are essential to prevent excessive lead time inflation, maintain relative priorities and help reduce incentory cost.[6]

4. *Miller, Jeffrey G. and Sprague, Lida G., "Behind the Growth in Materials requirements Planning,"* **Harvard Business Review,** *Vol. 53, September - October 1975, pg. 93.*

5. *Loc. cit. Orlicky, pg. 250.*

6. *Eichert, Edwin S. III, "Accounting for Unplanned Inventory Demands in Material Requirements Planning,"* **Production and Inventory Management,** *First Quarter 1974, pg. 69.*

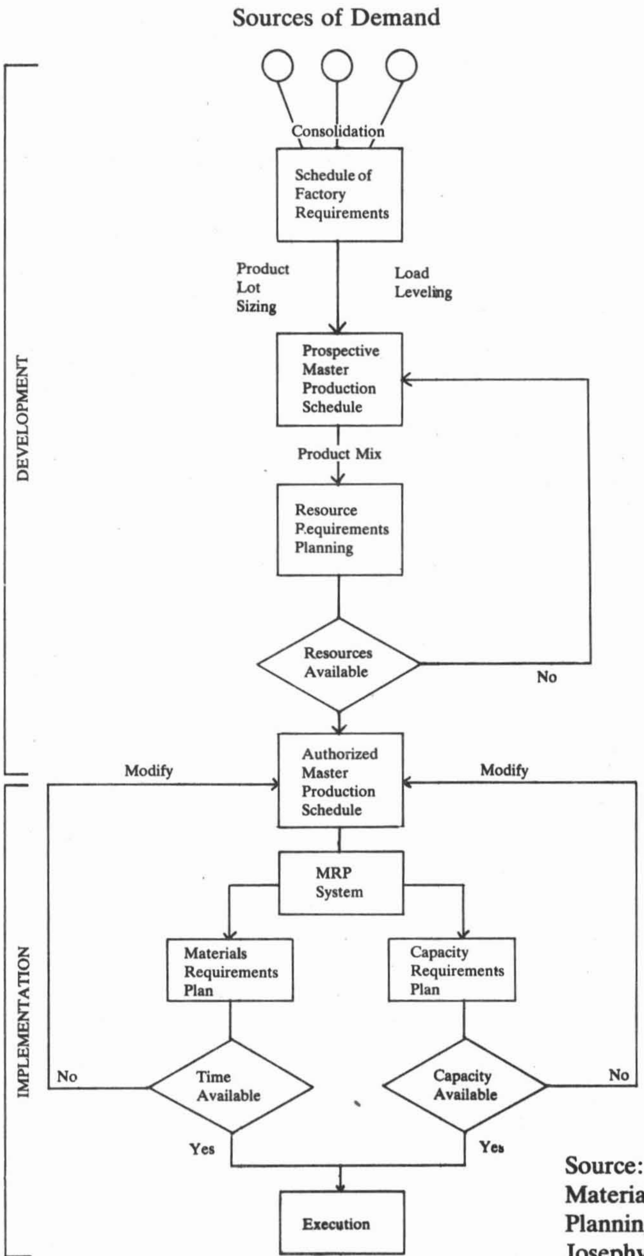
EXHIBIT A
MRP SYSTEM: INPUT-OUTPUT RELATIONSHIPS



Source:
Material Requirements Planning by Joseph Orlicky pg. 13

EXHIBIT B

MASTER PRODUCTION SCHEDULE DEVELOPMENT AND IMPLEMENTATION



Source:
Material Requirements
Planning by
Josephy Orlicky
pg. 251

The implementation of the MRP system requires that a product be broken into its many components and subassemblies. Consequently, plans on the quantity of stock required are determined from these components. A list of these components are known as BOM, the second input to the MRP system. The fundamental principle that determines the applicability of the bill of materials is the concept of dependent versus independent demand.[7]

Independent items are determined and broken into their dependent components. The product structure contains a bill-of-material for the end item and levels representing the way the product is actually manufactured from raw materials to components, to subassemblies and to assembly of of the final product. MRP planning is the process of working backwards from scheduled completion dates and quantities when various components parts and material are to be ordered.[8]

When the individual bills of material are linked together graphically, they form a hierarchical, pyramid like structure. The levels are numbered from top to bottom, beginning with level 0 for the end product.[9] See Exhibit C.

Initially, a MPS for each items is determined. These demand schedules lead into the next phase of the system which is lot-sizing. Lot-sizing determines the most economical way of meeting demand schedules for the different components and sub-assemblies. Some of the methods used to determine lot-sizes are the square root, Economic Order Quantity (EOQ), Least Total Cost (LTC), Least Unit Cost and Period Order Quantity.[10]

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7. *More, Steven M., "MRP and the Least Total Cost Method of Lot-Sizing,"* **Production and Inventory Management,** *Second Quarter 1974, pg. 47.*

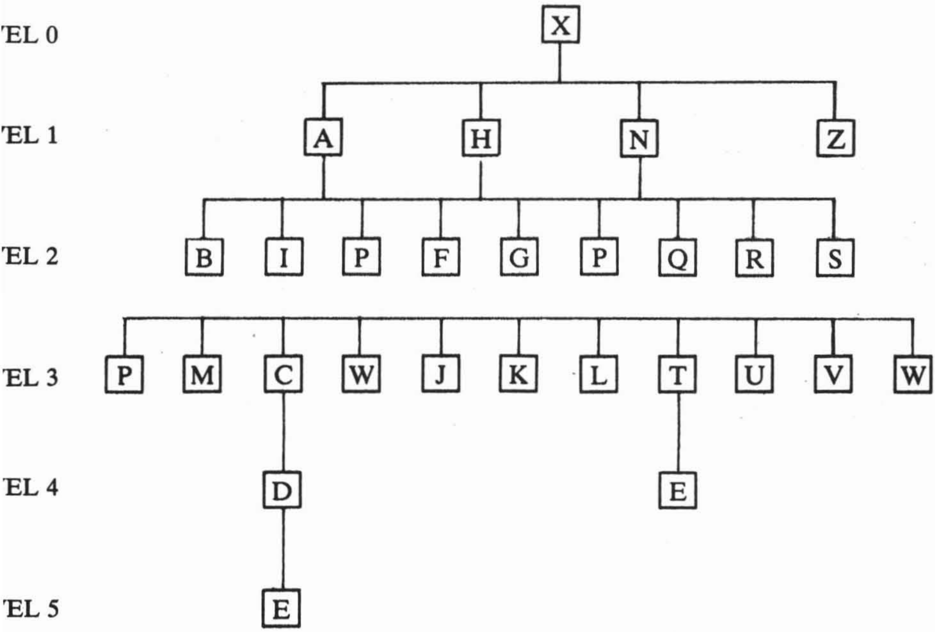
8. *Thurston, Philip H., "Requirement Planning for Inventory Control,"* **Harvard Business Review, May-June 1972, Pg. 69.**

9. *Loc. cit. Orlicky, pg. 53.*

10. *Loc. cit. More, pg.. 49.*

EXHIBIT C

Hierarchy of Bills of Material



Source: Materials Requirements Planning
by Josephy Orlicky pg. 53

Lot-sizing represents a method of computation that forms part of the procedure in order for a complete explosion of the MRP system to be carried out. Its use is highly recommended because of the systematic top-to-bottom and level-by-level procedures that must be followed.

The third information input for the MRP system, the inventory status records, contains the current status of all individual items kept in inventory control. Each item is uniquely identified. Each receipt, disbursement or withdrawal must be documented to maintain record integrity. This way, all the records can be kept up to date. Information on lead times, scrap allowances, lot sizes or other pecularities of various components are also found in the inventory records for ease of operation.

Proper determination of lead time is critical to a successful MRP system. Lead times are used to establish the order priorities and due dates. It is defined by Oliver Wright as, the time that elapses between the moment it is determined that an item is needed and ordered to be replenished, and that moment when the item is available for use.[11]

Lead time can be broken down into the following elements:

Lead time – Setup time + Running time + Move time + Wait time + Queue time.

Lead time is one of the most difficult areas of MRP. User review and manual input are normal ways lead tiemes are determined. This system is subject to a significant number of errors because of the large number of parts often involved, the time constraints that are often imposed and errors because it is not sensitive to changing conditions.

A second method is to calculate lead times mechanically based on routine information in the computer system. The shortcoming of this approach is that it generally ignores the impact of order quantity size that might be in the computer system and extends it by routing standards.

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11. *Wright, Oliver W., "Input/Output Control, a Real Handle on Lead Time,"* **Production and Inventory Management,** *Third Quarter 1970, pg. 10.*

The third technique is to calculate lead time mechanically during requirements planning based on lot-size[12].

As in Statistical Inventory Control methods, there must be some protection against stockouts. Therefore, consideration must also be given tosafety stock and up-dating the system which would finally complete the MRP system. There are three different ways to get safety stock in MRP. These are: Safety Time, increased Master Schedule and Fixed Quantity.[13]

MRP must be continuously updated since it is a dynamic system. The two methods most commonly used to update are:

(a) Regeneration which involves literally throwing away the previous plan and starting over with a new master schedule.

(b) Net change method which reworks the plan by introducing into the master schedule only those changes which have occured since the last plan was made.[14]

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12. *Peterson, Leroy D., "Design Considerations for Improving the Effectiveness of MRP,"* **Production and Inventory Management.**

13. *Loc. cit. More pg. 49.*

14. *Loc. cit. More, pg. 49.*

Since every business depends on data discipline and accurate records, MRP is no exception. The justification for regeneration and net change is to maintain priotities.

At the user's option, an MRP system can provide a great number of outputs in a variety of formats. Six categories of these outputs are as follows:[15]

1. Output for inventory order action.
2. Output for replaning order priorities.
3. Output to help safeguard priority integrity.
4. Output for purposes of capacity requirements planning.
5. Output aiding in performance control.
6. Output reporting errors, incongruities, and out-of-bounds situations within the system.

The advantages that can be realized through the application of an MRP system are:

Inventory

1. Reduced inventory levels
2. Improved inventory turns
3. Reduced obsolete and excess costs

Manufacturing

1. Improvedd utilization of manpower.
2. More accurate determination of manpower requirements
3. Reduced overtime costs

Indirect labour

1. Reduction of indirect staff such as expediating
2. More time available for planning around shortages.

Customer service.

Improved customer service by delivering machine on schedule.

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15. Loc. cit. Orlicky, pg. 142.

Facilities

> Improved utilization of floor space the elimination of storage for partially completed assemblies and the reduction of inventorry.

Production and a operation managers are primarily interested in the cost consequences of forecast error. Many research on MRP and Forecasting have been done to see the impact of cost due to demand uncertaintly.

In the De Bodt and Van Wassenhove research, a single-level MRP and the standard deviation (σ) were used as a basis of research. Since most firms face some kind of demand uncertainty, De Bodt and Van Wassenhove considered the effects of uncertainty on the lot-sizing process. It was found that no matter how small the forecast errors were that the forecast errors had a tremendous effect on the cost effectiveness of the lot-sizing techniques. By using several assumptions (example level demand, single lot-sizing etc.,), it was shown why and how different lot-sizing rules react differently to uncertain demand. Therefore, it was shown in this research that increases in ordering cost and inventory holding cost could be accurately predicated.[16]

J.R. Biggs, on the other hand, used "Factory-2" structure with the mean (μ) being its base throughout the study. In this study, Dr. Biggs stressed that forecasting errors will occur with even the accurate forecasting technique and that various managerial approaches are being used to improve the effects of these errors. For example, the effects of over forecasting demand will manifest themselves as excess machine capacity, excess manpower, and excess inventory.[17]

In conslusion, a simulation process could be introduced to enable production and operation managers to see if the forecasting error would impact the MRP system inventory costs and shortages. Since different operators will use different lot-sizing rules and product structure (BOM), it is hope that these simulations would show that the more complicated the MRP structure, the greater the differentiation among the lot-sizing rules and the greater the cost impact of forecast error.

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16. *De Bodt, M.A.. and Van Waassenhove, L.N., "Cost Increases Due To Demand Uncertainty in MRP Lot-Sizing,"* **Decision Science,** *1983, pg. 352.*

17. *Biggs, J.R. and Campion, W.M., "The Effect And Cost Of Forecast Error Bias For Multiple-Stage Production-Inventory Systems,"* **Decision Science,** *1982, pg. 579-81.*

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