

Enhance the performance of MRP (Material Requirement Planning) System by using proposed Designed Software

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Abstract - Material Requirement planning is a widely used method for production planning, Scheduling & inventory control. Integration of MRP with technologies, make it more useful, efficient tool for production planning & scheduling. Now a day's many firms/organization using various software tools for solving problems related with production planning, inventory control & scheduling. In this paper proposed software (Designed in C#.net language) is used for solving the MRP problems and enhancing the performance of MRP system.

Keywords - Material Requirement Planning, MRP inputs, MRP outputs

I. INTRODUCTION

Material requirement planning (MRP) system can be more effective manufacturing system which utilizes the best attributes of each manufacturing system need to accommodate the best planning features of MRP. The main theme of MRP is “getting the right materials to the right place at the right time. According to Joseph Orlicky (1975)⁷ “A MRP system, narrowly defined, consists of a set of logically related procedures, decision rules, and records (alternatively, records may be viewed as inputs to the system) designed to translate a master production schedule into time-phased net requirements, and the planned coverage of such requirements, for each component inventory item needed to implement this schedule”. According to Stevenson (2005)⁸, MRP is a “computer-based information system that translates master schedule requirements for end items into time-phased requirements for sub-assemblies, components, and raw materials”

MRP is a time phased priority-planning technique that calculates material requirements and schedules supply to meet demand across all products and parts. The main theme of MRP is “getting the right the right material to the right place at the right time”.

The main objectives of an MRP system are

1. Ensure the availability of materials, components, and products for planned production and for customer delivery,
2. Maintain the lowest possible level of inventory,
3. Plan manufacturing activities, delivery schedules, and purchasing activities.

1.2 Components of material requirement planning: Major inputs of MRP system are Master Production Schedule (MPS), Bill of Material (BOM) and Inventory status records. MRP system cannot function without these inputs.

BOM contains the composition of finished product and shows the all parts in structure tree form; MPS details how much finished product is desired and when; and an inventory record file gives detail how much inventory is on hand or on order.

The mechanism of MRP starts with dividing the time frame into the small time interval and exploring BOM into various levels, according to product structure tree. Properly structured BOM is required for proper functioning of MRP system. If there is any problem find in BOM file, it limits the MRP system functioning, and makes inaccuracy in output data. A BOM is a hierarchical structure which defines and relates the components of each assembly and subassembly of a product. MRP also sometimes called a functional balance between sales orders, MPS, BOM, lead time one side and purchase order, WIP and inventory on other side.

Overall view of the input to a standard material requirement planning program and the report generated by the program has shown in figure 1.1.

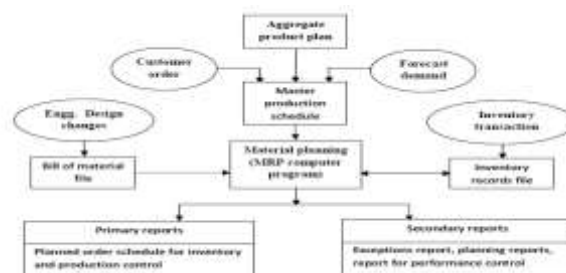


Figure 1.1: standard material requirement planning program (Chase et al, 2006)¹

MRP inputs

The MPS is one of three primary inputs in MRP stating which end-items are to be produced, when these are needed, and in what quantities. Normally, the master schedule is formed after disaggregating the aggregate planning which consists of demand for groups of end-items. Based on the customer orders, forecasts, and orders from warehouses to build up seasonal inventories, the demand for each particular end-item within the groups is specified. Following figure shows what a master schedule looks like.

Table 1.1

Item: X	1	2	3	4	5	6	7	8
QUANTITY		550					800	

To ensure good master scheduling, the master scheduler (the human being) must

1. Include all demands from product sales, warehouse replenishment, spares, and interplant requirements.
2. Never lose sight of the aggregate plan.
3. Be involved with customer order promising.
4. Be visible to all levels of management.
5. Objectively trade off manufacturing, Marketing, and engineering conflicts.
6. Identify and communicate all problems. (Chase et al, 2006)¹

BOM contains a listing of all of the assemblies, subassemblies, parts, and raw materials that are needed to produce one unit of a finished product. A product structure tree is useful in illustrating how the BOM is used to determine the quantities of each of the ingredients (requirements) needed to obtain a desired number of end items. The BOM file contains the complete product description, listing not only the materials, Parts, and components but also the sequence in which the product is created. This BOM file is one of the three main inputs to the MRP program. (The other two are the MPS and the inventory records file.)

The BOM file is often called the product structure file or product tree because it shows how a product is put together. It contains the information to identify each item and the quantity used per unit of the item of which it is a part.

Following figure shows the bill of material of end product A. Product A is made of three units of Part B and four units of Part C. Part B is made of two units of Part D and four units of Part E. Part C is made of two units of Part F, five units of Part G, and four units of Part H.

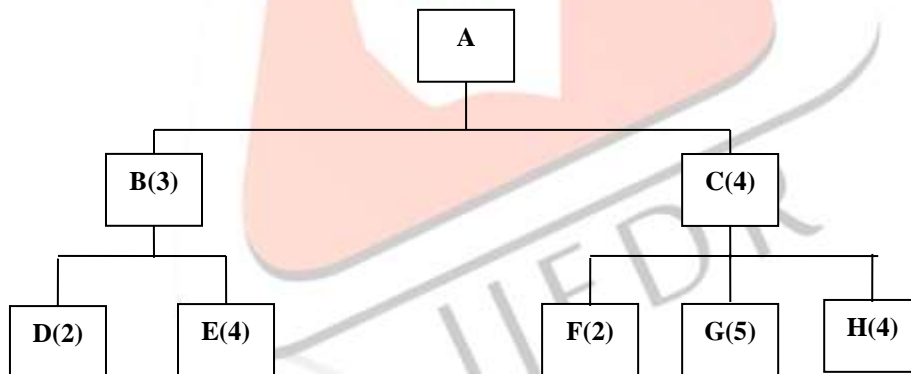


Figure1.2: Bill of Material (product structure tree) for product A

Inventory records include information on the status of each item by time period or time buckets. This contains gross requirements, scheduled receipts, and expected amount on hand. It also includes other details for each item, such as supplier, lead time, and lot size policy. This file also contains Changes due to stock receipts and withdrawals, cancelled orders, and similar (Stevenson, 2005)⁸.

MRP Output:-The MRP system has the ability to provide broad range of outputs. These are often classified as primary reports, which are the main reports, and secondary reports, which are optional outputs.

Primary reports:-

- Planned orders: indicating the amount and timing of future orders.
- Order releases: authorizing the execution of planned orders.
- Changes: Revising planned orders, including changes of due dates or order quantities and cancellations of orders.

Secondary reports:-

Performance-control reports: evaluating the system operation by measuring deviations from plans, including missed deliveries and stock outs, and by providing information that can be used to assess cost performance.

1. Planning reports: including purchase commitments and other data that can be used to assess future material requirements.
2. Exception reports: calling attention to major discrepancies such as late or overdue orders, excessive scrap rates, reporting errors, and requirements for nonexistent parts.

2. LITERATURE REVIEW

Review Related to MRP- Many key issues related with MRP system had identified by many researchers. these key issues are- Whybark and Williams (1976)⁹ identified uncertainty in material requirement planning. They developed a model to show the preference for using either safety stock or safety time in MRP system. In simulation experiments they found preference for safety stock or safety time in different conditions like- When quantity uncertainty is involved, higher service levels are achieved by the use of safety stocks.

Melnyk and Piper (1985)⁵ identified different lot sizing rules on lead-time error and investigated the effect of different lot sizing rules on MRP system. They examined the interaction between lot sizing rules and lead-time estimation methods. They found that lot size and lead-time are two inter dependent functions and inflation in PLT (planned lead time) influences lot size effectiveness. Melnyk and Piper proposed a forecast method for the lead time which is issued from the used methods for random demand:

$$\begin{aligned} \text{Planned lead time} &= \text{lead time forecast} + \text{safety lead time} \\ &= \text{lead time mean} + k \text{ lead time standard deviation.} \end{aligned}$$

Karmarkar, et al.(1985)⁴ suggested an open queuing network model, which is then embedded in an optimization routine that searches for optimum lot sizes. They also described the importance of WIP inventory cost and modified the objective function of the conventional lot-sizing models by adding the WIP inventory cost. Because of the complex computations, the method which they proposed cannot be implemented easily. They did not describe any method which explains how an optimization routine can be embedded on an open queuing network model.

Mohan and Ritzman (1998)⁶ investigated the MRP performance under impact of planned lead-time. They used four different levels of planned lead-time. At each level, they used different magnitudes of inflation. They concluded that planned lead-time does affect customer service, but it has a lesser effect on WIP than that of lot size. They did not consider the interdependent nature of both lot size and planned lead-time.

Guide and Srivastava (2000)² observe different buffering techniques used for tackling the uncertainty in MRP systems. Their study report indicates that only a few research efforts have been made in the area of lead-time uncertainty in MRP systems. Most of the research has tackled lead-time uncertainty using the safety lead-time factor and they have all used independent approach for estimating lot-size and planned lead-time.

Zlatko, et al. (2009)¹⁰ presented a different approaches and algorithm to implement BOM. In their study they proposed a multiple linked list BOM which is used to represent the relationship between products, parts or components. Data structure of multiple linked lists BOM contains the information about the element name and information about tree nodes of parts of components used in production.

Hyoug-gon lee et al. (2009)³ defined the part explosion process of MRP systems. Which generate the plans for raw material and sub assemblies in the right amount, at the right time? In their study they found that in actual practice process takes up much time when it interacts with database. In their study they worked for improving application performance, data access and enhanced services.

3. PROBLEM FORMATION

From the above detailed literature survey it can be found that MRP has faced several problems like finding the exact lot size with minimum cost, finding the exact time period for planned order release and planned order receipt, integrity of data, exploring the BOM file, finding a correct forecasting demand.

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.

In this paper proposed software (Designed in C#.net language) is used for solving the dummy problem and optimizes the MRP output results. This MRP software works very easily and easy to understand for user by its framework

Problem statement: - company produces item **Z**, for making one unit of item **Z** it required one unit of **A** item at LLC1, four units of **B** item at LLC1 and four units of **C** item at LLC2. **A** item composed of two units of **C** item and four units of **D** item. **D** item composes of two units of **E** item. Lead time of end item **Z** has 0, **A** and **E** have 1, and items **B**, **C**, **D** have 2. Lot size 100 and 1000 are used for item **A** and **E** respectively. Lot -for- lot (L4L) lot sizing is used for items **B**, **C**, **D**. item **A** has an on-hand inventory 30; **E** has an on-hand inventory 900 and safety stock 200; all other items have zero on-hand inventory. The master schedule for an end item **Z** is shown in table. Assume ordering cost and holding cost \$100, \$2 respectively.

Table 3.1 Master schedule for Z

Week number	1	2	3	4	5	6	7	8
Requirement			30		75			95

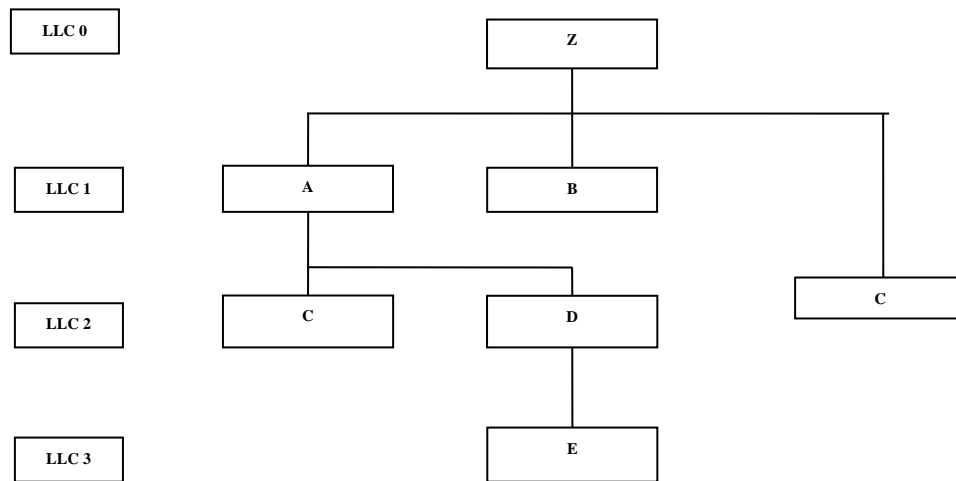


Figure 3.1 Product structure for an end item Z

4. PROPOSED METHODOLOGY

4.1 MRP software overview

Suitable software developed for calculating the MRP problem in c#.net & its database store in Microsoft access. In this MRP software many modules presented in toolbar which can be configure to support manufacturing, distribution, retail or many other types of business operation. Software toolbar contains the different modules.

4.2 Prerequisites of MRP system

Now a day's MRP systems imply several prerequisites and features for implementing the system. MRP system becomes the standard by using these features. The first prerequisite is the existence of a MPS, in which ensure that how much end items are to be produced and when.

MRP system generated separate id-code to each parts/ items. This unique id-code is useful for identify the specific material, components parts, subassemblies, and end item. Each assembly and inventory items identified through a unique code. This requirement extends also to the identification of every manufactured items component material and to each items disposition (where used it is use?)

At planning time, of a BOM containing such information is also prerequisite. The BOM must not merely list all the components of a given product, but must be, so structured as to reflect the way the product is actually made, in steps from raw material to component part to subassembly to assembly to end item.

The availability of inventory records for all items under the systems control is called inventory status data.

An MRP system presupposes that lead times for all inventory items are known and can be supplied to the system. The lead used for planning purposes normally must have a fixed value. This value can be changed at any time.

An assumption for effective system is file data integrity pertaining to inventory status data and BOM data. For effective MRP system it is necessary that file data must be accurate, complete, and up to date.

4.3 Purpose of system

MRP systems are a highly effective tool for manufacturing inventory management the following reasons:-

1. Easily handle inventory management at minimum cost.
2. Easily provide a future plan, on an item by item basis.
3. Easily handle all information in database.
4. Easily find out the time phase requirements, and order action.

4.4 Factors affecting the computation of MRP system

The computation of requirements is affected by these factors:

1. BOM contains information about different levels of materials, components parts, and subassemblies. If any change occurs in BOM file than it affects the MRP calculation.
2. Order quantity of lot size must be exceeding than net requirements quantity.
3. Lead times of the individual inventory items are a complicating factor in the computation of material requirements. It is the lead times that will determine the timing of releases and scheduled completion for the orders. For this reason each different items have individual lead time that makes up the product.

MRP software inputs and outputs

A MRP system properly designed and used for MRP purpose, can generate a number of desirable outputs containing valid and timely information. This MRP software comes complete with different modules and these modules categories into two categories.

Input module:- Input modules contains the following modules, these are

Item entry module:- Following procedure is use for item entry, Select item setup from toolbar, and then enters on item entry module. After clicking item entry module an item entry frame is open shown in figure. MRP item entry module allows to user to enter, edit the part/ item name, code, location, type of parts (inventory/ assembly), part level, and detail about inventory, lead time, lot size quantity and costs related to part.

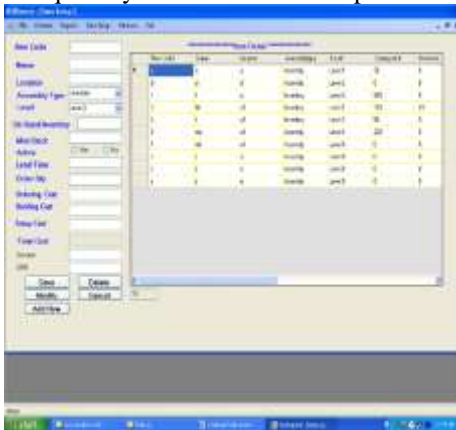


Figure4.1 Item entry module

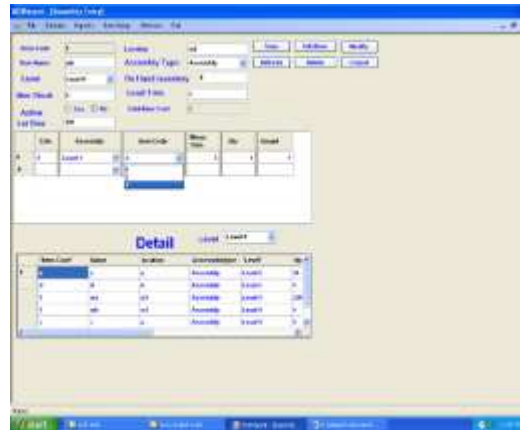


Figure4.2 Assembly module

Assembly module:- Following procedures is use for assembly module, Select item setup from toolbar, and then enter on assembly module. After clicking assembly module an assembly frame is open shown in figure. Assembly module allows user to make assembly from items/parts. In assembly module after choosing part levels a detail field fill with assemble parts, which will be assemble. After choosing the assemble type part from detail field, all details filled in the form related to assemble type part. Now we can make assembly by choosing level of child part of assembly, which are already stored in the item setup module. Select the sub assembly level, item codes shown of that level. Then choose the item code of child part/ item of assembly. Assembly module frame shown in following figure.

MRP calculation module:- Following procedure is use for MRP module, Select item setup from toolbar, and then enter on MRP calculation module. After clicking MRP calculation module a frame is open shown in figure. MRP module allows user to make MRP calculation of assembly parts, components by select item code then click on show button, after click show button list of sub assembly shown in sub item button. After choose sub assembly all required field filled with existing data of item entry module. In this module we can plan MRP calculation for number of weeks by time duration button. MRP calculation module is based on MRP processing logic which calculates projected on-hand inventory, net requirement, planned order receipts, planned order release for week.

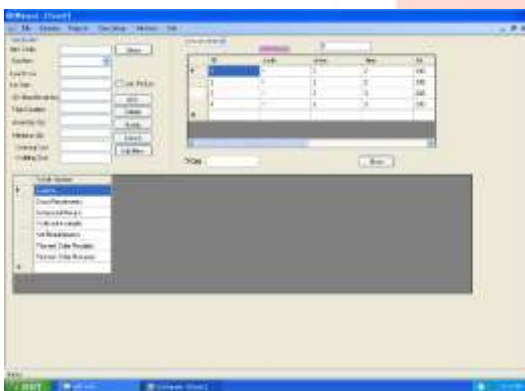


Figure 4.3 MRP calculation module



Figure 4.4 Supplier/ customer entry module

Supplier/ customer entry module: - Following procedure is use for item entry, Select item setup from toolbar, and then enter on customer module. After click customer module a frame is open shown in figure. By this user enter the detail of customer/ supplier such as name, contact, and address.

Purchase entry module:- MRP's Purchasing Module allows user to enter, edit purchase orders. Purchase entry contains the information about Vendor, item /part code, quantity, amount in this module. Entering a PO automatically increments the on-order quantity in inventory which is shown in current stock report.

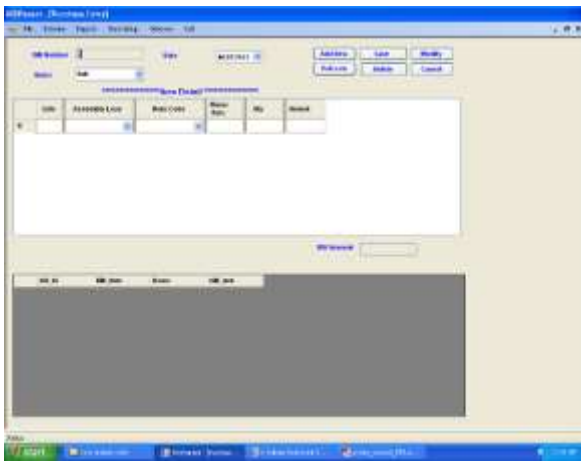


Figure 4.5 Purchase entry module



Figure 4.6 Sales entry modules

Sales entry module:- MRP Sales Module allows user to enter, edit the sales orders. Entering a sales order automatically decrements the on-order quantity in inventory which is shown in current stock report.

Output modules

All output modules of MRP software has shown in report toolbar of proposed MRP software. These all output module used the detail of all inputs modules for generating output reports. All output modules allows user to export, save report into different format such as word (.doc), pdf, excel and rich text format. Detailed view of output modules has shown in appendix .Output modules contain the following desired reports.

1. Purchase report- purchase report contains the information about all purchased items which item when purchased? In which quantity? From which supplier?
2. Current stock- current stock shows the on-hand available quantity of each items/ parts and parts transaction according to time.
3. Sales report- purchase report contains the information about all sales items which item when sold? In which quantity? To which customer?
4. Item detail- item detail report contains information about on-hand inventory, order quantity (lot size), lead time of all items/ parts.
5. Single level BOM- in this MRP software a single level BOM is used because this BOM is more efficient for storing the information on computer. In this single level BOM each entry contains only an item or part number followed by a list of part numbers of components needed to make up the parent item only.
6. Inventory master report- inventory master report contains the all information about each parts/ items. This module shows the all detail of item which is filled in item entry module.
7. Planned order receipt- Planned-order receipts are the quantities expected to be received by the beginning of the period.
8. Planned order release- planned order release, determines when orders should be placed so that they are received when needed.

5. ANALYSIS OF DATA

Proposed MRP software programming has to be done in c#.net framework and its database stored in M.S. access. This language is very convenient for making this software. According to my proposed software of MRP, contains the many modules of MRP system. For example item set up module which has many field containing the information related to item such as name, code and location of the item, assembly type, level, on hand inventory. It also calculating the items related cost. It can also save, modify, add, and delete information related to items. All functions of these modules are helpful for getting the desired and exact output. Analysis of proposed software based on these experiments.

5.1 Analysis of proposed MRP software:-First experiment based on finding the performance and output of MRP software. In this experiment, calculate the gross requirement of each items in consider problem by this proposed MRP software and find out the output reports of each items. In this section input and output modules have used for analysis work. The input section covers the information about various input modules and data of considered MRP problem. Output section is a presentation and detailed analysis of results obtained from the calculations.

Input modules of MRP software:- Different input modules already discussed in proposed methodology such as item entry module, assembly module, MRP calculation module, customer entry etc.

Item entry module:- All items detail have entered according to propose problem in item entry module of this MRP software. In item entry module, enter the all details manually. For making end item Z , we need to entered the all sub assembly parts/ items A,B,C,D,E, detail in MRP item entry module.

Assembly module:- Assembly module allows user to make assembly from items/parts. In this module we can assemble different levels assembly parts/items. Table shows the single level BOM, generated by MRP software by using assembly module. By using

MRP software assembly have made for item Z, A and D. Z assembly has made by three sub components A, B and C. sub component A has made by sub parts C and D and sub component D has made by sub part E.

MRP calculation module:-MRP calculation module is use for calculating the net future demand of the item. It is basically technique for determining the quantity and timing dependent demand items. In this module, we calculate the MRP calculation for item A, B, C, D, and E of our considered MRP problem.

MRP calculation for item A & B - Following figure 5.1 & 5.2 shows the MRP calculation, planned order receipt, planned order release and total cost for item A & B by using MRP software.

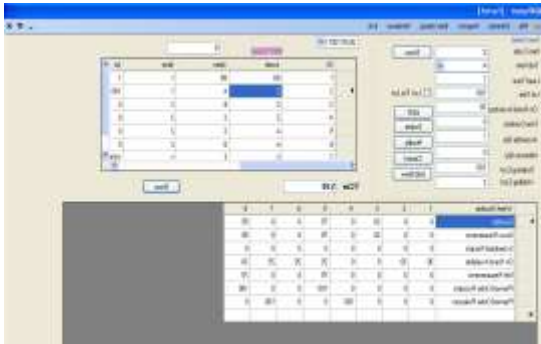


Figure 5.1

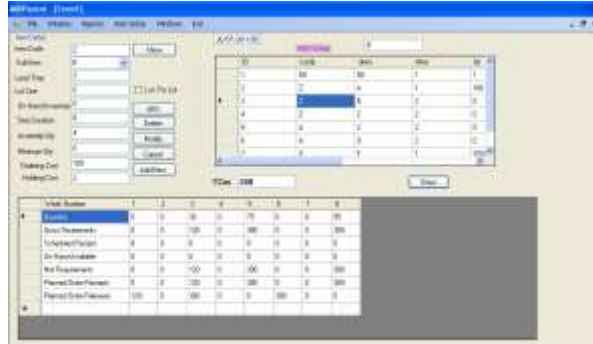


Figure 5.2

MRP calculation for item C- Following figure 5.3 -5.4 shows the MRP calculation, planned order receipt, planned order release and total cost for item C by using MRP software.



Figure 5.3



Figure 5.4

MRP calculation for item D & E- Following figure 5.5 & 5.6 shows the MRP calculation, planned order receipt, planned order release and total cost for item D & E by using MRP software.



Figure 5.5

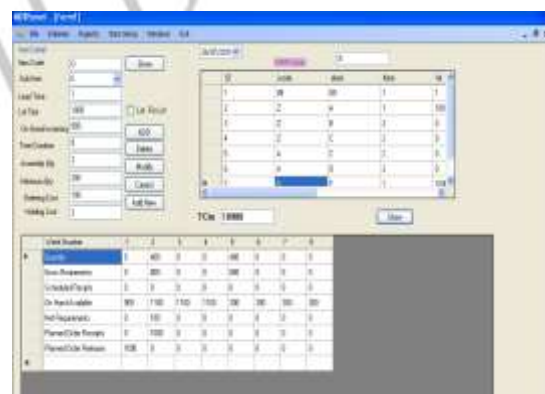


Figure 5.6

5.2 Summary of Results:-

All quantitative results generated by output modules such as item detail, inventory master report, single level BOM, planned order release and receipt. These are summarized and presented in following Tables.

Table 5.1 Item detail report

PARTS	ORDER QUANTITY	LEAD TIME	INVENTORY ON-HAND
A	100	1	30
B	0	2	0

C	0	2	0
D	0	2	0
E	1000	1	900

By using output module item detail it generates the report file related to item detail shown in table. Following table contains the order quantity, lead time, inventory on-hand of sub components and sub parts A, B, C, D and E.

Table 5.2 Inventory master report

Item Code	Name	Type	Level	O.S.	M.O.	Ord Cost	H. Cost	S. Cost	Item Cost	Lead Time	Lot
A	A	Assembly	Level 1	30	0	100	2	0	300	1	100
B	B	Inventory	Level 1	0	0	100	2	0	50	2	0
C	C	Inventory	Level 2	0	0	100	2	0	50	2	0
D	D	Assembly	Level 2	0	0	100	2	0	40	2	0
E	E	Inventory	Level 3	900	200	100	2	0	20	1	1000

By using output module (inventory master report) we have given all the input parameter like item code, item type, assembly level, opening stock, safety stock, ordering cost, holding cost, setup cost, item cost, lead time and lot size has shown in table.

Following table 5.3 & 5.4 shows the single level BOM of all assembly parts and MRP gross requirement of each part.

Table 5.3 Single level BOM

Z	A B C
A	C D
D	E

Following table 5.4 shows the total demand obtained for all required components of considered problem.

Table 5.4 MRP gross requirement of each part

Serial no.	Item name	MRP quantities (period wise)							
		1	2	3	4	5	6	7	8
1	A	0	0	30	0	75	0	0	95
2	B	0	0	120	0	300	0	0	380
3	C	0	0	120	0	300	0	0	380
4	C	0	400	0	0	400	0	0	0
5	D	0	0	0	400	0	0	400	0
6	E	0	800	0	0	0	800	0	0

Following table shows the planned order release, planned order receipt, quantity and lead time for all items A, B, C, D and E by using MRP software.

Table 5.5 Planned order release and receipt report

Item code	Name	Planned order release and receipt				quantity	Lead time
		Week	Release date	week	Receipt date		
A	A	4	25/08/2011	5	01/09/2011	100	1
		7	15/09/2011	8	22/09/2011	100	
B	B	1	04/08/2011	3	18/08/2011	120	2
		3	18/08/2011	5	01/09/2011	300	
		6	08/09/2011	8	22/09/2011	380	
C	C	1	04/08/2011	3	18/08/2011	120	2
		2	11/08/2011	4	25/08/2011	400	
		3	18/08/2011	5	01/09/2011	300	
		5	01/09/2011	7	15/09/2011	400	
		6	08/09/2011	8	22/09/2011	380	
D	D	2	11/08/2011	4	25/08/2011	400	2
		5	01/09/2011	7	15/09/2011	400	
E	E	1	04/08/2011	2	11/08/2011	1000	1

5.3 Validation of MRP software

Problem statement1:- Product S is made by one unit of P. P component has lead time 2 weeks, on-hand inventory 220 units and 500 fixed order quantity. Gross requirement of product S has shown in table¹⁴.

Table 5.7 MPS for product S

Week	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Gross requirement			100			320					80		510	

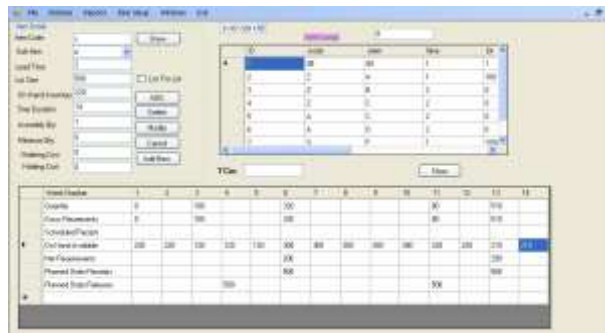


Figure 5.12 MRP calculations for component P

Result obtained by manually of problem1-

Result obtained by software of problem1-

week	4	11
Planned order release	500	500

week	4	11
Planned order release	500	500

5.4 Implementation

Proposed MRP software has advantage that it can work in fluctuating demand, if demand exceeds in any specific time-period, which is not handled by order quantity (lot size). In this condition proposed MRP software will select an order quantity for that time-period according to varying demand and will not affect the order quantity of other time-periods.

6. CONCLUSION AND FUTURE WORK

Major findings

1. Propose MRP software capable for handle all complexity of MRP system and give quick response to user and its database has large capacity for storing information.
2. Proposed MRP software has capability to work in fluctuate demand.
3. According to analysis work all modules such as item entry, assembly, MRP calculation, item detail, single level BOM, inventory master etc are working properly for giving relevant result and best suitable for industrial purpose.

Future work

Any type of research is an ongoing process in which a continuous improvement with respect to time is expected. The evaluation of such work should be done considering the usage of techniques and resources available at the time. With that perspective, the present study has certain limitations too. Proposed MRP software has limitation of features such as calculating the dynamic lot size, planned lead time. Therefore need exists to develop methodology, which determine dynamic lot size, planned lead time.

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