

Development of a Materials Requirements Planning (MRP) Software.

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ABSTRACT

Lack of affordable, efficient, and user friendly inventory management tools, for adequate planning has been identified as a major cause of the high inventory cost in many Nigerian manufacturing firms. This study focuses on the development of a Materials Requirements Planning (MRP) that can be used by the local industries for inventory management in a job shop manufacturing environment. Four types of lot-sizing techniques were analyzed and MRP algorithms developed for each of these lot-sizing techniques. A process of Bill of Materials (BOM) explosion was developed and incorporated. An overall flow chart of the MRP process sequences and a graphical user interface (GUI) based software of the MRP process was developed using Microsoft Visual basic. Evaluation tests of the software were carried out using various products ranging from those with simple structure of single product to complex structure with multiple products sharing common items. The software was shown to be user friendly and allow for easy data input and output allowing for product structure to be saved and retrieved for future planning.

(Keywords: inventory, MRP, lot-sizing software, planning)

INTRODUCTION

Materials Requirements Planning (MRP) is a computer-based production planning and inventory control system which is concerned with both production scheduling and inventory control. It is a material control system that attempts to keep adequate inventory levels to assure that required materials are available when needed. The main purpose of MRP software is to facilitate the calculation of requirements of materials and timing (Slack et al., 2001) by converting three inputs, bill of material, inventory data and master production schedule, into two main outputs

namely planned order releases and reschedule notices (Lunn and Neff, 1992). Thus it is a technique for determining the quantity and timing for the acquisition of dependent demand items needed to satisfy master production schedule requirements.

MRP has been one of the productivity tools used by industries in the developed economies to create competitive advantage in the global economy. It has played important roles in inventory management of manufacture of complex industrial products (Schuster et al., 2000). For instance the number of MRP Systems in use by American Industry grew from a handful in the early 1960's to 150 in 1971. By 1981, the number of MRP Systems in the USA is reported to have risen to over 8,000 and by 1989 \$1.2 Billion worth of MRP software was sold to the American Industry (Ozgun et al., 2006).

While computer based production and inventory systems have been massively deployed to develop the economies of the highly industrialized nations, Nigeria and other developing nations have not taken advantage these useful computer-based integrated manufacturing tools in her production systems (Ogendegbe et al., 2002; Oladokun et al., 2009; Charles-Owaba and Oladokun, 2007).

There is the need to develop MRP Systems that are tailored towards the peculiar environment of the Nigerian economy. Prevailing factors such as epileptic power supply can affect the delivery dates from suppliers; a company with a robust MRP can maneuver within such uncertain environment. The need for locally developed MRP Systems is therefore important. The adoption of such locally developed industry-friendly MRP software that can suit the need of small scale enterprises would help these industries to be able to confidently make delivery commitments and satisfy them and also reduce the amount of resources tied down to inventory.

MRP is generally applicable in situations of multiple items with complex bills of materials and is especially suited to manufacturing settings where the demands of many of the components and subassemblies depend on the demands of items that face external demands. While demands for end items are independent the demands for components used to manufacture end items depend on the demands of the end items. The distinctions between independent and dependent demands are important in classifying inventory items and in developing systems to manage items within each demand classification (Starr, 1996).

Essentially, MRP systems were developed for effective and efficient management of dependent demand items. While MRP is not useful for job shops or for continuous processes that are tightly linked (Volman et al., 1997), the MRP system is suitable for products that do not satisfy the order point policy (OPP) models, wherein the demand of the end product is independent or an end product orders may be placed periodically (Starr, 1996).

MRP systems depend on information input from other planning functions components. The Master Production Schedule (MPS) is a significant input that drives the MRP system. Primarily, MPS identifies the quantity of the particular products that manufacturer is going to produce by combining two independent demands namely customer orders and forecasted demand. Sources of MPS data include forecast, firm customer orders, safety stock requirement and internal demands. In actual practice and in the production management literature the use of forecasting is generally an accepted input into master production scheduling (Campion, 1982)

Bill of Material (BOM) is another input of MRP system, which clarifies the structure of an independent demand item (Slack et al., 2001). Another prerequisite for an effective MRP system is a correct inventory status record. The inventory status records contain the status of all items in inventory, including on hand inventory and scheduled receipts. These records must be kept up to date, with each receipt, disbursement, or withdrawal documented to maintain record integrity.

A key variable in MRP system design is the selection of lot-sizing rule (how much to order) based on the lead time. The problem of lot sizing is one of satisfying the requirements while trying

to minimize holding and setup costs. There are basically two major classes of lot sizing techniques namely Static and Dynamic. A static lot-sizing rule orders the same quantity each time an order is placed and often generating higher average on-hand inventory for extra safety stock (Steinberge and Napier, 1980).

Dynamic decision rule changes the order quantity with each order such that each order is just large enough to prevent shortages over a specified time period by tying lot-size to gross requirements. It generally causes instability with lower-level components unable to respond sufficiently fast to changes in requirements (Biggs 1979; Lynn, 2006).

Vollman et al., (1997) recommend the use of different lot-sizing rules for different levels in the BOM, with Fixed Order Quantity (FOQ) for end items, either FOQ or Lot For Lot (LOT) for intermediate levels and Periodic Order Quantity (POQ) for the lowest levels so as to avoid the propagation of the bullwhip effect to the lowest items. This approach has been adopted in this work.

METHODOLOGY

The methodology used in developing the proposed MRP software adopts the following 4 components of the traditional (Mall, 2004) system development methodology namely, 1) System Analysis 2) System Development 3) System Testing, and 4) System Deployment.

System Analysis

This involves the analysis of how the various inputs to the MRP are combined. The underlining rules for deriving the Order Releases, the lot-sizing algorithms and the compression technique for handling complexities of multi-occurring items were analyzed for programming. Flow charts were developed for the various instances of input combinations. The following notations have been adopted.

NOTATIONS

GR	Gross Requirement
LT	Lead Time

SR	Scheduled receipt
OC	Order Receipt
Lot Size	Lot Sizing Technique
P.O.Q	Periodic Order Quantity
F.O.Q	Fixed Order Quantity
L.F.L	Lot for Lot
M.O.Q	Multiple Order Quantity
Q	Ordered quantity of a F.O.Q
P	Period of a P.O.Q
M	Ordered quantity of a M.O.Q
(N.R) _C	Net Requirement of Current period C
(P.O.H) _{C+1}	Projected On Hand in the period (C+1)
(O.R) _{C-L.T}	Order release in previous period (C- L.T)

Specification interface, MPS/ Inventory Status/ MRP output interface, Order Releases Output and the Help file. The design is done to ensure the ease of verification and correction of mistakes. The Object Oriented Programming technique was used to avoid unnecessary repetition of procedures for those items that share similar lot sizing technique. Microsoft Visual basic 6.0 was adopted in developing the software which is compatible with the Microsoft windows operating system.

For ease of future improvement and maintainability comments on each block of codes are included. A help file, which explains to the user on how to use the software and the limitations of the software such as the maximum number of period, maximum number of products and items it can be used in planning has been included. It explains how to enter data in the various interfaces and how result can be read. The help file can be accessed by simply pressing the F1 key. Refer to (Olaitan, 2008) full details of the codes.

The MRP processing logic analysis is as summarized in Figure 1 with associated flowchart shown Figure 2. The flowchart of the item compression logic is shown Figure3.

System Development

System Development involves operationalizing the process conceptualized in the preceding stage through the software interface development and algorithm coding. The coding consists of sets of instructions that are executed by the program when the user clicks on a control. The MRP software has all the interfaces combined in one screen for ease of data input and result display.

The interfaces are the MRP Specification interface, BOM interface, Component

- Step 1: The user specifies the planning horizon (number of periods) and the name of the product.
- Step 2: The user draws the product structure.
- Step 3 a: For each item starting with the end items the user enters the POH, SR, LT and GR (for end items)
- Step 4: Product structure Analysis is carried out. For multiple occurring items Step 201, illustrated in figure2 is adopted for the MRP compression technique.
- Step 5: Starting from the end items, the lot sizing technique and the associated algorithm selected. Four lot sizing rules, the Periodic Order Quantity (P.O.Q), the Fixed Order Quantity (F.O.Q), the Lot for Lot (L.F.L), and the Multiple Order Quantity (M.O.Q) rules are available in the MRP system.
- Step 6: Obtain the GR of non end items from their direct parent by multiplying the Order Releases of the direct parents by the number of units of the child item that goes into the parent.
- Step 7: If a component occurs more than once the Order Release are added.
- Step 8: System displays the periodical Order Release for each of the items. In cases where the Order Release falls before planning period, it shows the number of weeks by which the order should be expedited in order to meet up with the master production schedule.

Multi-Occurring Item Compression Technique

Step 201: (Compression Technique) for a multi-occurring item at a level, it is checked to know if it is at the lowest level. If it is not the lowest level the (G.R) only is calculated and added to the GR obtained at the higher level where it occurs. At the lowest point of occurrence, the ORs are calculated using the accumulated GR.

Figure 1: MRP Processing Logic.

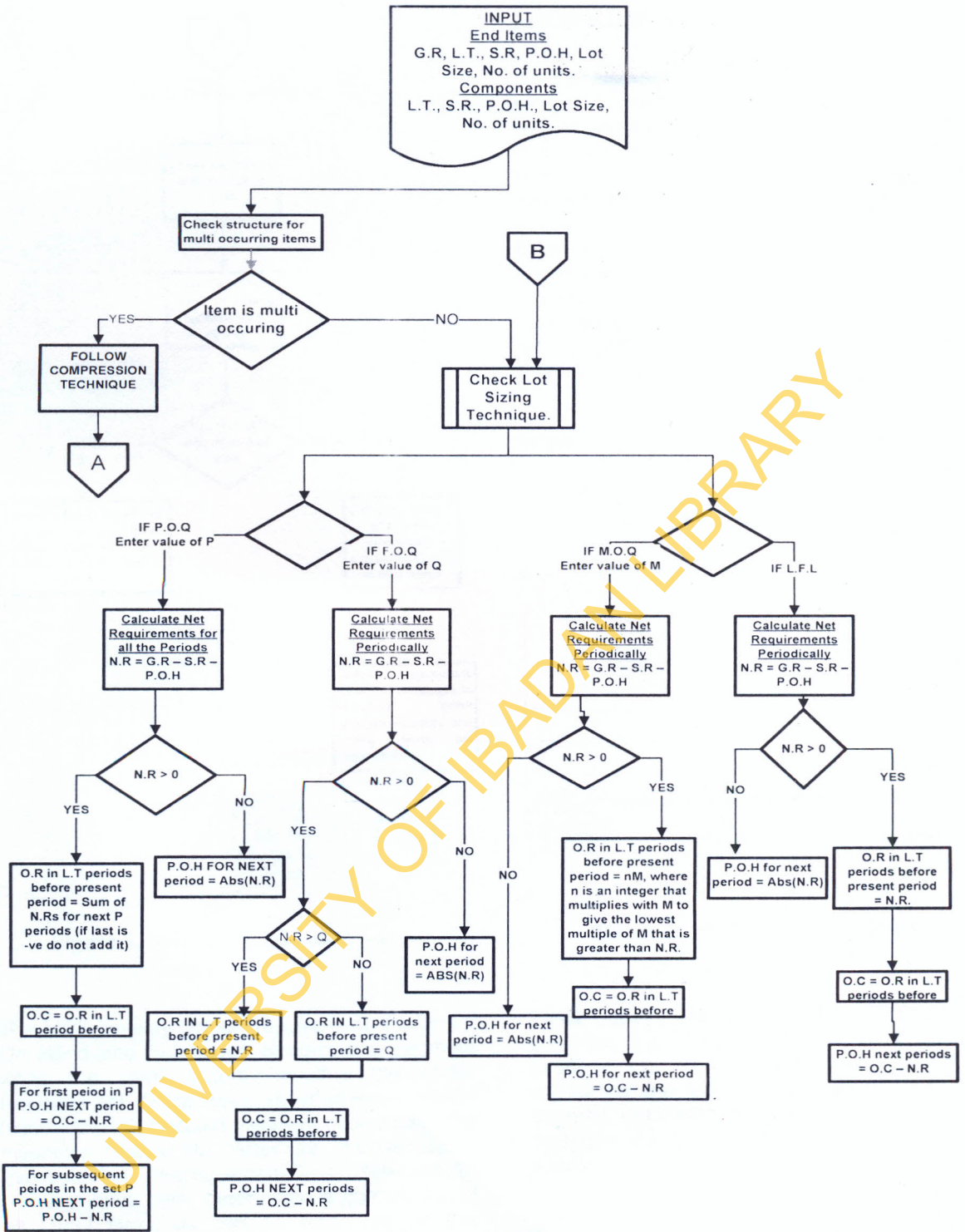


Figure 2: MRP Processing Logic.

Systems Testing and Results

A critical step in the system development process, system testing and debugging, revolves around ascertaining the integrity of the system output. System testing and debugging of software was done to identify errors and possible areas of improvements in the software. The software accuracy was tested using MRP computations for three product types; namely a bicycle structure, a lawn mower, and a set of garments. The software outputs were compared with results of manual calculations to verify its accuracy in handling simple, complex one and multiple items under the four lot sizing techniques.

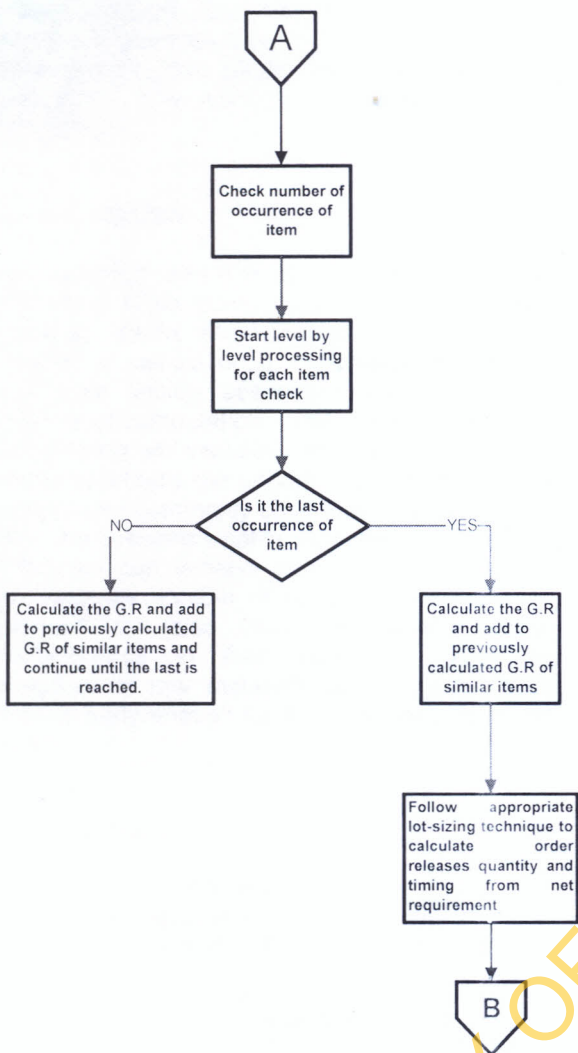


Figure 3: MRP Compression Process.

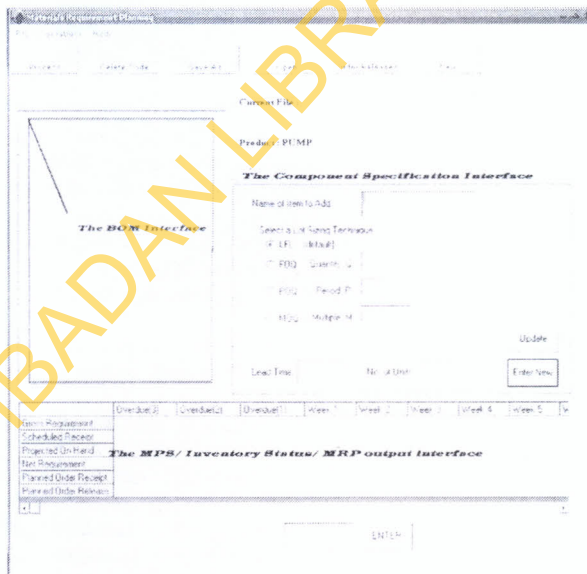


Figure 4: Interface for the Software.

The MPS, weekly Gross Requirement, Projected On Hand and Scheduled Receipt are the input while the MRP output includes the Order Releases and Order Receipts while Projected On Hand and Scheduled Receipt constitute the Inventory Status file. After all the necessary Explosion and Netting when Order Releases for all items have been determined a compilation of all Order Releases can be displayed on this Interface. It also shows the overdue orders which may need to be expedited.

Three issues were considered in determining the computational accuracy of the MRP software. Firstly, it was verified that the software correctly carries out the level-by-level computation of the material requirements and how Planned Order Releases at one level affects the requirements at successive lower levels.

Secondly it was confirmed that the time phased Order Releases are correctly determined based on the recorded Lead Time and finally, it was verified that the MRP processor has correctly aggregated the Gross Requirements obtained from the various parents into a single Net Requirement for component common to several

parent products. Four Lot sizing technique built into the system were used. Specifically accuracy of explosion from parent to children was also tested. The software was tested for user friendliness.

CONCLUSIONS

The software, which is user friendly, was tested with small scale locally made products and gave accurate results when verified with the manual method of calculation. It eradicates the difficulty and error liability associated with the manual method of computation. The software allows for the drawing and visualization of product structure. Most importantly the underlining algorithm is built around four commonly used lot-sizing techniques. With the software local small scale manufacturing industries can achieve reduction in inventories, increase the number of variety of products they produce and also make and satisfy delivery commitments to their customers. Also the suppliers of raw materials can be given order notices early enough for them to make up for the supply.

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SUGGESTED CITATION

Oladokun, V.O. and O.A. Olaitan. 2012. "Development of a Materials Requirements Planning (MRP) Software". *Pacific Journal of Science and Technology*. 13(1):351-357.



Pacific Journal of Science and Technology

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