

BEYOND THE BASICS OF MRP: IS YOUR SYSTEM DRIVING EXCESSIVE ORDER QUANTITIES?

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INTRODUCTION

MRP (Material Requirements Planning) has long been a popular software tool for manufacturing environments. In spite of this, it has come under fire for being an “enabler” of large lot sizes, poor yields and long lead times by creating planned orders (PO’s) that allow for those conditions. This is in contrast to JIT or Lean methodology that aspires to Lot-for-Lot (L4L) quantities, 100% yield and short lead times. While this may be the utopian scenario, the fact is that many manufacturers exist in a reality that requires planning for lot sizes and less than 100% yield. This paper will focus on maximizing the effectiveness of MRP planning by carefully analyzing the processing sequence of yield and lot sizing. It is worth noting that the author is not advocating MRP versus JIT/Lean; rather, he is suggesting that companies that have MRP systems should use them correctly.

The objectives are as follows:

- To illustrate the effect of applying lot size or yield inappropriately
- To distinguish where lot sizing should be applied (PO receipt or PO release)
- To demonstrate how to use a computer algorithm to optimize MRP processing

BACKGROUND

The author has witnessed many environments in which the shop floor must make frequent miscellaneous issues from (or miscellaneous receipts to) the stockroom. These activities result from over- or under-issues from the stockroom, even if the stockroom issued the correct quantity given on the pick lists. How is this possible? The reason is that the MRP-generated quantities reflect the theoretical requirements, which are often different from the practical need. One popular cause is that the MRP parameters are not in sync with the “real world” conditions with respect to lot sizing.

For example, MRP may suggest a PO release of 900 feet of cable that is issued on 1,000 ft. spools. In reality, the stockroom practice will be to issue an entire spool, thus requiring 100 feet to be returned after the job. In other cases, the operators may decide to “use up” the entire quantity as a means of being efficient. This would likely require the stockroom to issue an additional quantity of the other components. Note that the popular default would be for the floor personnel to request an additional 10% of each item ($100\text{ ft}/1000\text{ ft} = 10\%$), but this would be incorrect. The additional cable was 11.1% extra material ($100/900 = 11.1\%$). The result would be many small issues back and forth between the stockroom and shop floor to have enough material, or in some cases leftover would be tossed out, without the proper inventory adjustment. It should be obvious that the correct procedure would be to adjust the MRP parameters such that the resulting PO quantities model the manufacturing environment. This is not often the case, as floor personnel cannot be bothered with working with a computer system or planners who “don’t understand how operations work.” They will adapt by using the miscellaneous issue system, or worse yet, by helping themselves to any needed material and/or returning extra without an accompanying system transaction. It is thus the responsibility of MRP users, or the system gurus, to ensure that lot sizing parameters are consistent with the physical environment.

STANDARD MRP PROCESSING

The first item of consideration is to understand how MRP calculates lot sizes and yields. The process described within the APICS BOK (Body of Knowledge) is consistent with most textbooks on the subject. Starting with the Net Requirements, MRP will adjust for the lot size by rounding up to it or a multiple thereof. In this fashion, MRP is applying the lot size to the PO receipt. MRP will then consider yield to adjust for scrap loss, resulting in a PO release of some larger quantity. Thus, the sequence is to apply lot sizing and then yield (see Figure 1). [Note: for simplification all examples in this study use the following assumptions: on hand = 0, no scheduled receipts, no overdue orders, safety stock = 0, lead time = 1 period, round up to integer values on yields, lot size = 100 and yield = 90%]

PERIOD		<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>5</u>
GROSS REQUIREMENTS		0	0	99	0	0
SCHEDULED RECEIPTS		0	0	0	0	0
PROJECTED BALANCE	OHB = 0	0	0	1	1	1
NET REQUIREMENTS		0	0	99	-1	-1
PLANNED ORDER RECEIPT	Lot Size = 100	0	0	100	0	0
PLANNED ORDER RELEASE	Yield = 0.90	0	112	0	0	0

(Figure 1)

In this example, the order start quantity is 112 so that the ending quantity will satisfy the lot size rule of 100. Calculations of this manner are based on the underlying assumption that completed product (or perhaps a subassembly) will be “lot sized.” Some examples of this case are:

- Finished goods packed into a carton or other handling container (boxes, crates, palletized, etc.)
- WIP transferred in standard containers (Kanbans, pallets, drums, etc.)
- Justification for setup cost (note: this should then be a minimum, not a lot size multiple).

In the first two examples it makes perfect sense to apply the lot size rule to the PO receipt. The third case is a common misuse of lot sizing. Given the fact that most MRP systems allow for setting minimums, there is no excuse for applying a lot size rule here. Note the dramatic effect that can result from this practice (assuming the parameters used in Figure 1): an order for 101 pieces will cause MRP to calculate a PO receipt for 200, and generate a PO release of 223 (see Figure 2). The next step is to consider what environments justify alternative processing.

PERIOD		<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>5</u>
GROSS REQUIREMENTS		0	0	101	0	0
SCHEDULED RECEIPTS		0	0	0	0	0
PROJECTED BALANCE	OHB = 0	0	0	99	99	99
NET REQUIREMENTS		0	0	101	-99	-99
PLANNED ORDER RECEIPT	Lot Size = 100	0	0	200	0	0
PLANNED ORDER RELEASE	Yield = 0.90	0	223	0	0	0

(Figure 2)

APPLYING LOT SIZE TO THE PLANNED ORDER RECEIPT

There are many examples for which material issued to a job is transferred in a lot size, and thus the standard MRP processing is not ideal. In these cases it would be preferable to have the start quantities relate to a multiple. One common scenario is the gateway work center, which may be fed by vendor lot sizes as follows:

- Reels of taped or spooled components
- Rolls of paper or film
- Tanks or drums of chemicals
- Lengths of lumber or bar stock
- Pounds (or Kg) of plastic molding compound
- Pounds (or Kg) of paint pigment
- Any item for which the quantity is “used up.”

Another case where the lot size should be applied to the start quantity is when the prior job “batches” materials, such as:

- Ovens – baked goods, PCB’s, ceramics
- Acid bath or plating operation
- Standard containers on incoming material
- Any circumstance in which the incoming material was batched to “fill something up.”

As described in the introduction, these situations tend to create miscellaneous material transfers or “ghost” transactions that are never reflected in the system. The resulting effect on inventory balances results in more shortages (or overages) until the entire formal planning process has been replaced by a “damn the pick list, take what you need” substitute. This can be avoided if the MRP processing applied the yield rate first, then lot sized to a multiple (see Figure 3). Using the same numbers as with Figure 1, we note that the PO release is now 200, satisfying the lot size requirement. Of particular interest is the fact that in this scenario there is a “recalculated PO receipt” of 180 pieces based on the inflated start quantity, then adjusted for scrap loss. The casual observer could easily make the mistaken assumption that this processing sequence generates excess inventory. In reality, the MRP system has been fine-tuned to reflect what is actually happening in practice on the shop floor. The added knowledge would be a benefit to planning, particularly in terms of improved capacity requirements planning based on MRP output.

PERIOD		<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>5</u>
GROSS REQUIREMENTS		0	0	99	0	0
SCHEDULED RECEIPTS		0	0	0	0	0
PROJECTED BALANCE	OHB = 0	0	0	81	81	81
NET REQUIREMENTS		0	0	99	-81	-81
PLANNED ORDER RECEIPT	Yield = 0.90	0	0	110	0	0
PLANNED ORDER RELEASE	Lot Size = 100	0	200	0	0	0
RECALCULATED PO RCPT.		0	0	180	0	0

(Figure 3)

PROVIDING FLEXIBILITY IN LOT SIZING

We have established that our preferred MRP system would provide for the option of applying the lot size on either the receipt or the release. As given by the example cases, we would judge where the lot size is best applied and set the system parameters accordingly. For example, a woodworking company manufacturing wooden “widgets” could apply a lot size rule on the start quantity that is consistent with the incoming lengths of lumber (purchase lot size) to avoid remainder quantities. There is an opportunity to extend this logic to a higher level. What if we preferred to set the processing sequence based upon the net requirements, such that the resulting projected balance was always minimized? This case would exist when the lot size is a “soft rule” with flexibility, such as minimum quantities for setups that might allow for adjustment based on a trade-off with the resulting inventory cost, or any time where a conscious decision can be made to override the lot size rule.

Consider the following examples that highlight the effect of processing sequence. Let us assume there are two customer orders (CO), one for 25 pieces and another for 99. The following cases demonstrate the resulting PO’s and remaining inventory balance (after filling the CO) for each using both methods.

Case 1 (CO for 25 pc., standard MRP processing)

PO Release of 112; scrap 10% and thus receive 100; ship 25 and inventory 75 pc.

Case 2 (CO for 25 pc., apply lot size to release)

PO Release of 100; scrap 10% and thus receive 90; ship 25 and inventory 65 pc.

Given these two cases for the 25 pc. order, we would prefer to apply the lot size to the PO release.

Case 3 (CO for 99 pc., standard MRP processing)

PO Release of 112; scrap 10% and thus receive 100; ship 99 and inventory 1 pc.

Case 4 (CO for 99 pc., apply lot size to release)

PO Release of 200; scrap 10% and thus receive 180; ship 99 and inventory 81 pc.

Given these two cases for the 99 pc. order, we would prefer standard MRP processing. This suggests that we would like MRP to consider net requirements before deciding on which processing sequence to use. This can be accomplished by utilizing the following computer algorithm to calculate the PO's based upon which technique will produce the minimum release quantity (and resulting minimum balance).

[Note: The expression "CEILING (X, 1)" will round up the value of X to the next integer value (i.e. 7.3 rounds up to 8)]

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IF NR <= 0, REL = 0; RETURN REL
REL1 = CEILING (CEILING (NR/LS, 1)*LS/YR, 1)
REL2 = CEILING (CEILING (NR/YR, 1)/LS, 1)*LS
REL = MIN (REL1, REL2); RETURN REL
RCPT = REL*YR; RETURN RCPT

```

Where the variables are as follows:

- NR = Net Requirements
- LS = Lot Size
- YR = Yield Rate
- REL = Planned Order Release
- RCPT = Planned Order Receipt

This algorithm was used to produce the MRP report given in Figure 4, which matches the optimum results from Cases 2 and 3 above.

PERIOD		<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>5</u>
GROSS REQUIREMENTS		0	0	99	0	25
SCHEDULED RECEIPTS		0	0	0	0	0
PROJECTED BALANCE	OHB = 0	0	0	1	1	66
NET REQUIREMENTS		0	0	99	-1	24
PLANNED ORDER RECEIPT	Lot Size = 100			100		90
PLANNED ORDER RELEASE	Yield = 0.90		112		100	

(Figure 4)

OTHER CONSIDERATIONS

There are many other factors that can influence the desired goal of optimum MRP processing. For example, there may be multiple items incoming to a work center with various lot sizes. For the purposes of this analysis, it is assumed that there is a prevailing material that dominates the process (such as the lengths of lumber in making wooden widgets), but this may not always be the case. Further, there may be different effects depending on whether a scrap loss is per assembly or per component. Generally speaking, MRP yield rates consider the scrapping of the total assembly. If only a particular component is subject to scrap loss, this should be handled by inflating the "quantity per" on the bill of material (BOM). It may also be useful to consider the effects of safety stock, lead time and CRP. These considerations will be the basis of further analysis of the MRP processing model.

SUMMARY

The following options have been presented as methods of calculating planned orders:

- Standard MRP processing
- Applying the lot size to the PO release
- Using a computer algorithm based on net requirements

The examples given clearly illustrate that standard MRP processing is not always ideal. When the system fails to reflect the realities of the shop floor, substitute processes prevail. Worse, the users may continue to put blind faith in computer-generated numbers that ultimately increase inventories. As with most situations, the fault lies not within the MRP system, but in the designers who failed to optimize parameters or processes for a given situation. Systems analysts should look for the opportunities to improve the performance of their system and make it work for their environment.

ABOUT THE AUTHOR

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His work history includes twenty years of materials management experience in retail, distribution, manufacturing, consulting and training. He has instructed community education classes for several colleges as well as providing corporate training to private businesses. His consulting projects have included software implementation, warehouse layout, cycle counting, work documentation and needs analysis. Ford specializes in providing customer delight via “outside the box” solutions. Contact info: michaelford@earthlink.net or 607.624.4853.