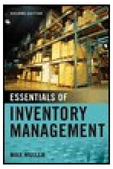


Essentials of Inventory Management, Second Edition

by Max Muller

Chapter 5: Planning and Replenishment Concepts

The objective of this chapter is to provide basic approaches to forecasting inventory levels and to undertaking stock replenishment. With the proper techniques, you will have the right item, in the right quantity, at the right time, and in the right place.

Replenishment Costs

As discussed in Chapter 2, every day that an item remains in your stockroom costs you money in the form of a carrying cost (K Factor). If you take that concept to its extreme, it would make sense to only buy items exactly when you need them. Multiple smaller quantity purchases of the same item certainly hold down your carrying costs. However, it hurts your cost of replenishment—the expenses associated with buying things.

It costs money to buy things. That sounds absurdly simple when you first read it. However, the cost of purchasing product exceeds the actual price paid for it. Expenses related to purchasing include the salaries of the purchasing staff, rent, and other overhead expenses attributable to the purchasing department. See Exhibit 5–1.

Exhibit 5-1: Calculating the R Factor

The cost of replenishment is calculated on a per item, per order basis. This is because it takes the same amount of internal effort to determine how much of each item you desire, from which supplier, at what pricing, terms, and so on, no matter which item is being considered and no matter how many items there are on any given PO. Therefore, if the R Factor is $5.00 per item, per order, and there is a single line item on an order, the replenishment cost is $5.00. If there are two items, it's $10.00. If there are three items, it's $15.00, and so on.[1]

To calculate the cost of replenishment, include:

Annual cost of purchasing department labor	$220,000
Annual cost of purchasing department overhead (rent, utilities, equipment allocation, etc.)	$179,000
Annual cost of expediting stock items	<u>$25,000</u>
Total annual costs	$424,000
Number of purchase orders created per year for stock (assume):	10,000
Average number of different stock items per order (assume):	<u>× 8</u>
Total number of times stock items were ordered:	80,000

$$\frac{\text{Total Annual Costs}}{\text{Total Times Stock Items Were Ordered}} = \text{R Factor} \rightarrow = \frac{\$424{,}000}{80{,}000} = \boxed{\$5.30 = \text{R Factor}}$$

In fact, the more often you buy, the greater your internal costs. For example, if you purchased one million widgets all at the same time, your purchasing or replenishment cost (R Factor) would be the cost per line item per purchase order (PO). See Exhibit 5–1.

- If the per line, per PO cost is $5.00, then your cost to buy all one million widgets at one time would be $5.00.
- If you were to buy the same one million widgets 250,000 at a time, then your R Factor would be $5.00 times four (four POs with one line item each) or $20.00.
- If you purchased the widgets one at a time, the cost would be one million times $5.00 or $5 million.

Order size versus frequency of purchase shifts the cost burden from the K Factor to the R Factor and vice versa. In other words:

- If you buy smaller quantities more often, your purchasing costs go up, which means your R Factor increases.
- If you buy larger quantities less often, you have a higher inventory level for a longer period of time, so your carrying

costs go up, which means your K Factor increases.

- In a perfect world the K Factor and the R Factor would be equal. Although this is difficult to achieve, an organization attempting to have the correct amount of product at the overall lowest cost will strive for that balance.

[1]This method of calculating the R Factor takes a straight average. It implies that every PO requires the same time and effort. Companies that calculate items using activity-based costing would probably develop the R Factor using a blended average.

Types of Inventory Management

In the worlds of distribution, retailing, and replacement parts, an organization deals with finished goods. In the manufacturing world, an organization deals with raw materials and subassemblies. Considerations of what to buy, when to buy it, in what quantities, and so on are dramatically different in these two worlds.

In distribution, you are concerned with having the right item in the right quantity. Issues relating to having the item at the right time and place are often dealt with by simply increasing safety stock on hand. That is not a good solution because it leads to wasted money and space. However, traditional formulae used to compute inventory requirements in a distribution environment focus on item and quantity rather than place and time. In manufacturing, you are concerned with having the right item, in the right quantity, at the right time, in the right place.

Case Study: Balancing Carrying and Replenishment Costs

A dispute has arisen at the Charmax Co. between the purchasing and warehouse managers.

Charmax's receiving ends at 5:00 PM. At 4:45 PM, a 40-foot trailer is backed up to the dock. The doors are opened to reveal three levels of floor-stacked boxes extending from floor to ceiling, back to front.

Joe, the warehouse manager, realizes that it will take four workers at least two hours to hand unload the trailer. Virtually all of that time will be on an overtime basis.

Joe reviews the truck's manifest and determines what items on the trailer are needed for delivery tomorrow morning. He discovers that there are only three boxes on the trailer that are truly required for tomorrow's business. He asks Tracy, the truck driver, if he helped to load the trailer. Tracy replies that he did. Joe asks if Tracy remembers where those three boxes are. With a smile, Tracy replies that they are located in the nose of the trailer.

Joe decides not to incur the overtime. He will have the trailer unloaded in the morning.

Betty, the sales manager, hears that the three items will not be shipped to Acme, a large and important customer. She storms into the warehouse and demands that the trailer be unloaded.

Joe explains the overtime situation. Betty replies that Joe should have scheduled the trailer to arrive earlier in the day. Joe replies that the buyer, Bill, handles traffic management as part of the purchase of the product. Betty angrily says she doesn't much care. Joe had told her that the product would be here today for delivery tomorrow. "You promised me," Betty says, "so that's what I promised the customer. Now unload the trailer." Joe reluctantly does so.

Later, Joe confronts Bill and demands that product be brought in palletized or unitized or in some other manner so it can be unloaded quickly. Joe argues that since internal handling is a major component in computing the cost of carrying inventory, unitization will help cut Charmax's costs.

Bill responds that he has to buy the product as he is buying it now. He argues that to palletize the product would increase the costs per unit of product. He also points out that since the product already extends to the top of the trailer, that the added height of three levels of pallets at approximately four inches each, would force him to buy less per order so that it will all fit on a trailer. Therefore, he will have to buy less and buy it more often, driving up his replenishment costs. Ill-will and stalemate result.

Suggested Solutions:

1. Joe and Bill should coordinate traffic management so that loads match the labor, equipment, time resources, and constraints of the organization. By lowering handling costs the company will reduce overall carrying costs.

2. Both Joe and Bill need to specifically determine their respective costs.

a. Joe can determine the handling portion of the K Factor by:
    1. Determining the average time it takes to hand unload a trailer.
    2. Multiplying the average hand unloading time times the number of trailers during the year.
    3. Multiplying the total hand unloading time times the average hourly labor rate being paid the warehouse personnel.
    4. Determining the average time it would take to unload unitized loads.
    5. Multiplying the average unitized unloading time times the number of trailers during the year.
    6. Multiplying the total unitized unloading time times the average hourly labor rate being paid the warehouse personnel.
    7. Comparing the annual labor costs involved for hand unloading to the annual labor costs of unitized unloading to determine the total dollar savings.

b. Bill can determine his added replenishment costs associated with smaller loads purchased more often.

c. A fair comparison can then be made as to which route is the most advantageous for the overall organization.

3. Alternatives meeting the needs of both parties might be developed. For example, if slip-sheets (thin cardboard or plywood sheets the same length and width as a pallet) were used, Bill might be able to overcome the size of load and volume problem, while Joe could automate the unloading process.

Demand for finished goods and spare parts for replacements are said to be "independent," while demand for items in the manufacturing world are said to be "dependent." Understanding these distinctions will assist you in forecasting your procurement needs.

Independent demand is influenced by market conditions outside the control of your organization's operations. The demand for the widgets your organization sells will be independent of the demand for your gadgets, doodads, and whatchamacallits. Your products are independent of one another. In this environment, you must have the right item in the right quantity.

Dependent demand is related to another item. The demand for products built up or created from raw materials, parts, and assemblies is dependent on the demand for the final product. You would not need one item if you did not also require another, both of which would go into an assembly or finished product. In this environment, you must have the right items in the right quantities at the time to complete a finished product.

A chair can be used as an example. The demand for the number of chairs you need is independent from the number of tables that you need because quantity required is influenced by the demand in the market for each item. The demand for chair legs or seats or rails is mathematically dependent on the demand for finished chairs. Four legs and one seat are required for each chair.

Dependent and independent demands demonstrate very different use and demand patterns.

Independent demand calls for a replenishment approach to inventory management. This approach assumes that market forces will exhibit a somewhat fixed pattern. Therefore, stock is replenished as it is used in order to have items on hand for customers.

Dependent demand calls for a requirements approach. When an assembly or finished item is needed, then the materials needed to create it are ordered. There is no fixed pattern because an assembly created in the past may never be produced again.

The nature of demand, therefore, leads to different concepts, formulae, and methods of inventory management.

Independent Demand Inventory

Since items in an independent demand inventory system "stand alone," the appropriate reorder point for each item must be calculated using *order-point formulae*.

Order-Point Formulae

Order-point formulae are used to determine how much of a given item needs to be ordered where there is independent demand. In these formulae, a reorder point (ROP) is set for each item. The ROP is the lowest amount of an item you will have on hand and on order before you reorder.

A Simple Min-Max Inventory System

Order-point formulae are based on some relatively simple concepts.

Imagine that all of a particular SKU are kept in a single bin. If no reorder point was set, then the entire batch would be used up without any order being placed. The organization would then be unable to sell or use that item during whatever timeframe—was required to order and bring the SKU in the lead time. It would therefore make sense to adopt a two-bin system, with Bin 1 containing working stock and Bin 2 containing working reserve. The amount of product in Bin 2 would be equal to your usage rate during that item's lead time.

In a two-bin system, if all goes as it should, then immediately on using the first item from Bin 2, you would reorder a quantity equal to both Bins 1 and 2. As you use the last item in Bin 2, the order arrives and you refill both bins. This assumes that lead time is exact, there are no vendor stockouts or backorders, and that there are never any defects. That assumption is, of course, often false. Therefore, a true order-point system is a three-bin system, with Bin 3 containing safety stock.

Bin 3, safety stock, relates to Bin 2 since Bin 3 is to make up for uncertainties in lead time and defects. Mathematically safety stock is 50 percent of working reserve. (The average between having nothing in Bin 2 and having it at 100 percent full is 50 percent.) However, companies adjust safety stock levels to coincide with their actual experience.

Bins can be mathematically created or can reflect actual physical separation of items in the stockroom.

A simple formula for determining the ROP reflects the above concepts.

(Usage × Lead Time) + Safety Stock = ROP

In the above formula lead time is shown as a percentage of a month, as follows:

1 week	**=**	**0.25**	**=**	**25%**
2 weeks	**=**	**0.50**	**=**	**50%**
3 weeks	**=**	**0.75**	**=**	**75%**
4 weeks	**=**	**1.00**	**=**	**100%**
5 weeks	**=**	**1.25**	**=**	**125%**
6 weeks	**=**	**1.50**	**=**	**150%**

Example 1

Assumptions:

- Usage rate of 1,200 items per month
- Lead time of 3 weeks

Step-by-Step Calculation:

- Calculate weekly usage. Assume a 4-week month. 1,200 items ÷ 4 weeks = 300 items per week, therefore Bin 1 or working stock should contain at least 300 items
- Calculate working reserve: Given 3 weeks of lead time, working reserve should be 1,200 items × 0.75 = 900 items
- Calculate safety stock, use 50 percent of working reserve as a guideline (900 items × 50% = 450 items)
- Calculate ROP: (1,200 items × 0.75) + 450 items = ROP 1,350 items

Bin 1 Working Stock 300 items	Bin 2 Working Reserve 900 items	Bin 3 Safety Stock 450 items

ROP 1,350 items

Example 2

Assumptions:

- Usage rate of 1,200 items per month
- Lead time of 1 week

Step-by-Step Calculation:

- Calculate weekly usage. Assume a 4-week month. 1,200 items ÷ 4 weeks = 300 items per week, therefore Bin 1 or working stock should contain at least 300 items
- Calculate working reserve: Given 1 week of lead time, working reserve should be 1,200 items × 0.25 = 300 items
- Calculate safety stock, use 50 percent of working reserve as a guideline (300 items × 50% = 150 items)
- Calculate ROP: (1,200 items × 0.25) + 150 items = ROP 450 items

Bin 1 Working Stock 900 items	Bin 2 Working Reserve 300 items	Bin 3 Safety Stock 150 items

ROP 450 items

The ROP is the "minimum" (min) in a "minimum-maximum" (min-max) inventory control system. In these systems there is a minimum below which you will not let your stock level fall, and there is a maximum above which you will not have items on hand or on order.

To compute the maximum in these systems, you must first determine how often you will place orders. This time period is called the review cycle.

The review cycle is the length of time between reviews of when you wish to order product. The formula to determine the review cycle is:

$$\frac{\text{Total Purchases from Vendor for a Year}}{\text{Discount Quantity}} = \text{Review Cycle}$$

The unit of measure reflecting total purchases from a vendor can be dollars, pieces, pounds, units, or whatever your organization uses. The discount quantity is the minimum amount you have to order of that unit of measure in order to be granted a discount.

Review Cycle Example

$$\frac{200{,}000}{5{,}000} = \text{Review Cycle}$$

And, dividing 40 reviews by 52 weeks equals a review roughly every 1.3 weeks. When the review actually occurs will also depend on factors such as seasonality.

The maximum in these systems is also represented by a simple formula.

ROP + Usage During the Review Cycle = Maximum

Maximum Point Example 1: Assume:	Maximum Point Example 2: Assume:
▪ Usage rate of 1,200 items per month ▪ Review cycle every 1.3 weeks ▪ ROP equals 1,350 items $\frac{1{,}200 \text{ items}}{4 \text{ wks}} = 300$ items used per week 300 items × 1.3 weeks = 390 items used during review cycle 1,350 items + 390 items = 1,740 items max	▪ Usage rate of 1,200 items per month ▪ Review cycle every 1.3 weeks ▪ ROP equals 450 items $\frac{1{,}200 \text{ items}}{4 \text{ wks}} = 300$ items used per week 300 items × 1.3 weeks = 390 items used during review cycle 450 items + 390 items = 840 items max

By setting a min-max for each item in your inventory, you can create a simple method of ordering products having independent demand.

Economic Order Quantity Formula

In 1915, F. W. Harris of General Electric developed the Economic Order Quantity (EOQ) formula to help stockkeepers in determining how much product to buy.

To calculate EOQ, assume:

A = Total Value of SKU Per Year

K = Carrying Cost (the K Factor)

R = Replenishment Cost (the R Factor)

P = Price Per Unit

Basic Formula

$$EOQ = \sqrt{\frac{2AR}{P^2K}}$$

This formula and its variations allow you to determine the following:

- Optimal quantity to order
- When it should be ordered
- Total cost
- Average inventory level
- How much should be ordered each time
- Maximum inventory level

The EOQ model is based on several assumptions:

- The demand rate is constant (no variations), recurring, and known.
- The carrying cost and ordering cost are independent of the quantity ordered (no discounts).
- The lead time is constant and known. Therefore, the ordering times given result in new orders arriving exactly when the inventory level reaches zero.
- The formula can handle only one type of item at a time.
- Orders arrive in a single batch (no vendor stockouts or backorders).

A simple example of the basic formula is:

A = $36,000

K = 15%

R = $75

P = $25

$$EOQ = \sqrt{\frac{2AR}{P^2K}} = \sqrt{\frac{2(\$36{,}000)(\$75)}{(\$25)^2(0.15)}} = \sqrt{\frac{5{,}475{,}000}{93.75}} = \sqrt{58{,}400}$$
$$= 242 \text{ units per order}$$

Since the above assumptions do not reflect the real world, mathematicians have developed variations of the basic formula. See Exhibit 5–2.

Exhibit 5-2: Variations of the Basic EOQ Formula

Inventory Variable Formulae and Examples

For the below formulae and examples, assume:

A	=	Total Value of SKU Per Year	=	$36,000
K	=	Carrying Cost (the K Factor)	=	15%
R	=	Replenishment Cost (the R Factor)	=	$75
P	=	Price Per Unit	=	$25

Optimum Number of Orders Per Year =

$$\sqrt{\frac{AK}{2R}} = \sqrt{\frac{(\$36{,}000)(0.15)}{2(\$75)}} = \sqrt{\frac{5{,}475}{150}} = \sqrt{36.5} = 6.4 \cong 6 \text{ per order}$$

Optimum Number of Dollars Per Year =

$$\sqrt{\frac{2AR}{K}} = \sqrt{\frac{2(\$36{,}000)(\$75)}{0.15}} = \sqrt{\frac{5{,}475{,}000}{0.15}} = \sqrt{36{,}500{,}000} \cong \$6{,}041.52$$

How to Set Up an EOQ Worksheet in Microsoft® Excel®

Here's a tip. By setting up a permanent worksheet in Microsoft® Excel® or similar spreadsheet program, you will be able to quickly calculate important EOQ information simply by entering variable values for A, K, R, and P under the "Insert Value" column.

Based on the cell placement as noted below, you can calculate each quantity by entering the following formulae:

Economic Order Quantity → type: = SQRT((2*E4*E8)/((E10 ∧2)*E6))

Optimum Number of Orders Per Year → type: = SQRT((E4*E6)/(2*E8))

Optimum Number of Dollars Per Order → type: = SQRT((2*E4*E8)/E6)

Dependent Demand Inventory

Materials Requirements Planning

Controlling not only what item is purchased and in what quantities, but also the timing of its arrival through computerized systems is called *materials requirements planning* (*MRP*). This concept of the right item, in the right quantity, and at the right time was first introduced by Joseph Orlicky in the early 1960s.

Independent demand inventory management is customer oriented. The objective of ROP rules and formulae is high customer service levels and low operating costs. Dependent demand systems, however, are manufacturing oriented. The objective of dependent demand inventory control is to support the master production schedule. Even if you have a low stock level of an item, it won't be ordered unless and until it is needed to produce something for the master schedule—a true requirements philosophy of inventory control. MRP-dependent demand inventory control is directed inward rather than outward like ROP inventory control. See Exhibit 5–3.

Exhibit 5-3: Contrasting Order Point with MRP Systems

	ORDER POINT	MRP
Demand	Independent	Dependent
Order Philosophy	Replenishment	Requirements
Forecasting	Based on past demand	Based on master schedule
Control Concept	ABC categorization	All items are equally important
Objectives	Meet customer needs	Meet manufacturing needs
Lot Sizing	EOQ	Individual item requirements
Demand Pattern	Consistent	Random but predictable
Inventory Type	Finished goods/spare parts	Work in progress/raw materials

MRP Elements. Key concepts in understanding MRP are the master production schedule and the bill of materials.

The master production schedule sets out what will be built, when, and in what quantities. It can either cover short or long time horizons.

Short horizon—planning of initial requirements sets out:

- Final product requirements
- Schedule for production of components
- Purchase order priorities
- Short-term capacity requirements

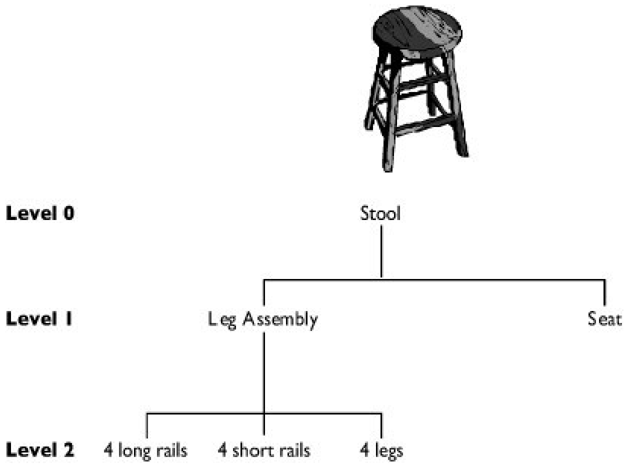
Long horizon—estimating long-term requirements sets out:

- Long-term production capacity required
- Long-term warehouse capacity required
- Long-term staffing required
- Long-term money required

The *bill of materials* (BOM) is the recipe of raw materials, parts, subassemblies, and so on required to build or make something.

Each BOM has levels. See Exhibit 5–4 and Exhibit 6–1 on page 175 for a discussion of how inventory is relieved from stock after each level of the BOM is completed. This is a technique called "backflushing."

Exhibit 5-4: Bill of Materials Levels



MRP's chief advantage over the ROP approach is that it lets you customize your ordering strategy for raw materials, parts, and so on with different demand characteristics, such as lead times. The ROP approach answers the questions of *what* and *how much*:

On Hand	**60**	**or**	**60**
On Order	**100**		**50**
Required	**<u>130</u>**		**<u>130</u>**
Available	**30**		**-20**

ROP does not answer the question of *when:*

On Hand	**60**	**or 60**
On Order	**100 due in on Nov. 15th**	**50 due on Nov. 1st**
Required	**130 needed by Nov. 5th**	**100 needed by Nov. 5th**

30 needed by Nov. 15th

Available	**10 on Nov. 5th**
when needed –70	**–20 on Nov. 15th**

MRP allows purchases to be made as and when needed to ensure that items will arrive when needed. It accomplishes this by setting up time phasing charts within the computer system. See Exhibit 5–5.

Exhibit 5-5: Time Phasing Chart for a Single Item Within a MRP System

Assumptions:

- 12-week production schedule
- 10 units of this item are required each week for production
- Starting balance of 70 units
- One week lead time

As evidenced by the first chart, you do not need to buy and hold any of the items in question until Week 7. Week 7's production will bring our balance of inventory on hand to zero.

Time Phasing Chart Without Release of Purchase Order

0	1	2	3	4	5	6	7	8	9	10	11	12	Week Number

	10	10	10	10	10	10	10	10	10	10	10	10	Gross Requirements
													Scheduled Receipt
70	60	50	40	30	20	10	0	–10	–20	–30	–40	–50	Inventory on Hand
													Planned Order Release

Time Phasing Chart With Release of Purchase Order

0	1	2	3	4	5	6	7	8	9	10	11	12	Week Number
	10	10	10	10	10	10	10	10	10	10	10	10	Gross Requirements
							100						Scheduled Receipt
70	60	50	40	30	20	10	100	90	80	70	60	50	Inventory on Hand
						100							Planned Order Release

In the second chart, a purchase order is released during Week 6. The product arrives during Week 7, and you are ready for production as Week 8 begins.

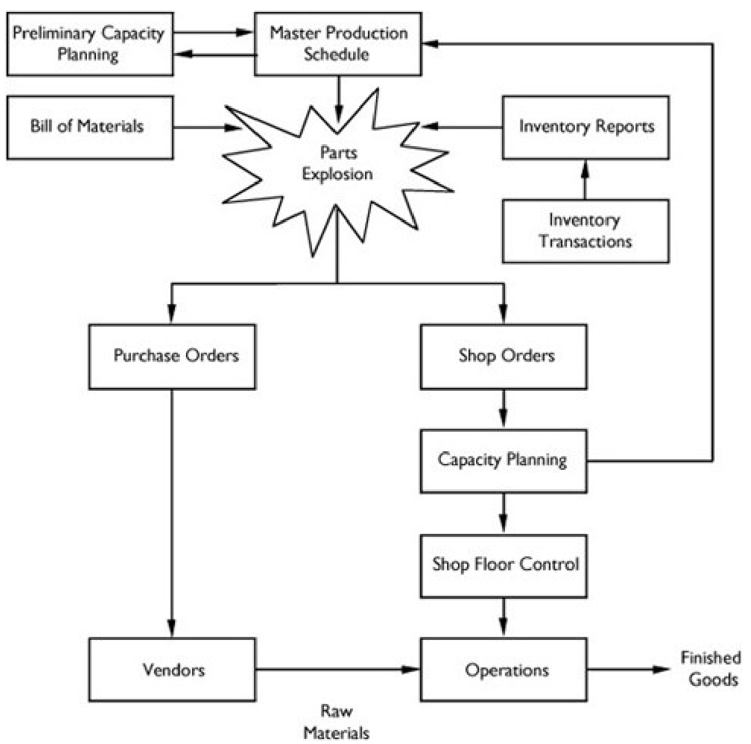
The above charts demonstrate that by timing the release of the PO for a specific item, that item can be brought in only when needed. This holds our inventory levels down.

An example of MRP would be a decision to build one bar stool in your garage on Saturday.

The decision to build a single unit of something on a given day is the master schedule.

Included in your thinking was the fact that if you had all of the pieces, parts, and tools necessary, you could actually accomplish the task. That is rough-cut capacity planning. See Exhibit 5–6.

Exhibit 5-6: MRP—The Closed Loop



You then draw-up and define what parts are required for the task. See Exhibit 5–4. This is your bill of materials.

The next step is a parts explosion, during which you review your on-hand inventory levels to initially determine if any POs must be prepared and released.

You then engage in detailed capacity planning to decide if you can proceed or if the master schedule, capacity, or the planned release of POs must be changed.

Ultimately, all parts, equipment, and so on come together and the stool is built.

MRP works well because it is a forward-looking system. The predictability of events allows for careful planning and a reduction in unnecessary inventory.

A major drawback of MRP and JIT systems is that they are highly data dependent. Not only do you have to have all of the data easily available on an ongoing basis, but, in addition, the information must be accurate and timely. Organizations lacking a strong software/hardware infrastructure will have difficulty in fully implementing an MRP system.

Just-in-Time (JIT) Inventory Systems

JIT was first developed within Toyota’s manufacturing operations by Taiichi Ohno in the 1970s as a means of meeting customer demands with minimum delay. In its original form, it referred to the production of goods, assemblies, and subassemblies to meet exactly the customer’s demand in terms of time, quality, and quantity. With a JIT system, the “buyer” can be the actual end user or another process along the production line.

JIT goes further than MRP, because you control not only the right item, in the right quantity, at the right time, but you also bring that SKU to the right place. Under this time-based concept, an item appears exactly when it is needed—not before, not after.

The American Production and Inventory Control Society (APICS) has the following definition of JIT:

> … a philosophy of manufacturing based on planned elimination of all waste and continuous improvement of productivity. It encompasses the successful execution of all manufacturing activities required to produce a final product, from design engineering to delivery and including all stages of conversion from raw material onward. The primary elements include having only the required inventory when needed; to improve quality to zero defects; to reduce lead time by reducing setup times, queue lengths and lot sizes; to incrementally revise the operations themselves; and to accomplish these things at minimum cost.

The many benefits of a JIT system include:

- Reduction of stockouts
- Reduction of inventory levels
- Reduction of need for material handling equipment
- Reduction of timeframes between delivery and production
- Significant quality improvement
- Employee inclusion in continuous quality improvement

JIT is a management philosophy rather than a technique.

The fact that certain words and acronyms have come to be used somewhat interchangeably can be confusing to anyone not in the manufacturing world. Do those terms/acronyms have individual, stand-alone characteristics differentiating one from the other? Most certainly they do, but grappling with the details of what separates one particular type of manufacturing philosophy from another closely related theory won’t further your understanding of the basic concepts of inventory management and control.

The terms/acronyms MRP III, Computer-Integrated Manufacturing, Lean Manufacturing, Short-Cycle Manufacturing, Just-in-Time, JIT, Enterprise Resource Planning, ERP, and so on all relate to the fundamental notions that:

- Manufacturing activities should be integrated.
- The actions and decisions of each department should complement all other departments.
- Information should flow both internally throughout the organization and externally to/from suppliers/customers electronically rather than through:

  - The movement of hard paper copies, or
  - Individual software (accounting) modules whose data do not flow into one another both automatically and in real time.
- Suppliers are reliable and raw materials are without defect.
- All employees follow the philosophy of continuous quality improvement in all aspects of the operation.

Let's concentrate on how these concepts—by whatever name—relate to inventory. They all regard inventory as *waste*.

Today JIT has come to mean producing with a minimum of waste. "Waste" is used in the broadest sense and includes any non-value-adding activities. For example, storing, inspecting, and counting materials doesn't change the items; therefore, those actions add no value. There are seven types of waste JIT systems strive to eliminate:

1. Overproduction—producing more than needed. Wasted money, effort, space, etc.
2. Waiting time—decreases productivity and efficiency.
3. Transportation-double and even triple handling of an item from one storage position to another.
4. Processing—what are the interfaces between parties, departments, you, and your suppliers? The fewer and faster the better.
5. Inventory—stock simply sitting around does no one any good.
6. Motion—reduce motions such as those involved in looking for materials.
7. Defects—defective goods not only cost money directly, but they also cause stops and delays.

Implementing JIT. Take the following steps to introduce a JIT-type system into your manufacturing facility:

1. *Stabilize and level the production schedule.*
   - All work centers should have a uniform load through constant daily production.
   - Prevent changes in the production plan for some period of time.
   - Produce roughly the same mix of products each day, using a repeating sequence if several products are produced on the same line. This is often called "mixed model assembly."
   - Change the quantity of end-item inventory to meet demand fluctuations rather than through fluctuations in production levels.
2. *Reduce or eliminate setup times.*
   - Strive to create single-digit setup times (less than 10 minutes).
3. *Reduce lot sizes (manufacturing and purchase).*
   - Reducing setup times allows economical production of smaller lots.
   - Close cooperation with suppliers is necessary to achieve reductions in order lot sizes since more frequent deliveries will be called for. In JIT systems, the old, adversarial methods of purchasing will not work. In traditional approaches, buyers buy an item here and another item there through a series of disconnected negotiations over price, delivery quality, and terms. In JIT systems, larger quantities and types of items are purchased from fewer vendors. The larger purchases give the buyer more economic leverage while providing the supplier with enough financial incentive to become the buyer's business partner. Both parties recognize the critical needs, costing, pricing, quality concerns, and so on of the other.
4. *Reduce lead times (production and delivery).*
   - Production lead times can be reduced by:

     – Moving workstations closer together.

– Applying group technology and cellular manufacturing concepts.

– Reducing the number of jobs waiting to be processed at a given machine ("queue" length).

– Improving the coordination and cooperation between successive processes, such as reducing delivery times by inducing suppliers to have distribution centers/warehouses closer to your operation.

5. *Engage in strong preventive maintenance.*

    - Machine and worker idle time should be used to maintain equipment and prevent breakdowns.

6. *Cross-train to create a flexible workforce.*

    - Workers should be trained to:

    – Operate several machines.

    – Perform maintenance tasks.

    – Perform quality inspections.

7. *Require supplier quality assurance and implement a zero-defects quality program.*

    - Since there are no buffers of safety stock, errors leading to defective items must be eliminated.

8. *Use a control system such as a kanban (card) system to convey parts between workstations in small quantities (ideally, one unit at a time).*

Inventory Objectives

Inventory in and of itself is not waste. *Unnecessary* inventory is waste. A key question is: What is unnecessary in the context of your organization?

In manufacturing operations, inventory in excess of that needed to support current operations or research and development efforts would certainly be waste. However, is the inventory of a distributor that uses immediate availability of a large cross-section of items as an effective, profitable marketing tool "unnecessary?"

Your company should have a "zero-tolerance" inventory policy. That is, it will not accept any inventory over a stated target. But what is the target? Is it zero-tolerance from a days' supply of inventory on hand? Is it a zero-tolerance from a dollars-invested standpoint (turns per year)? Is it zero-tolerance from an order fill rate of 97 percent?

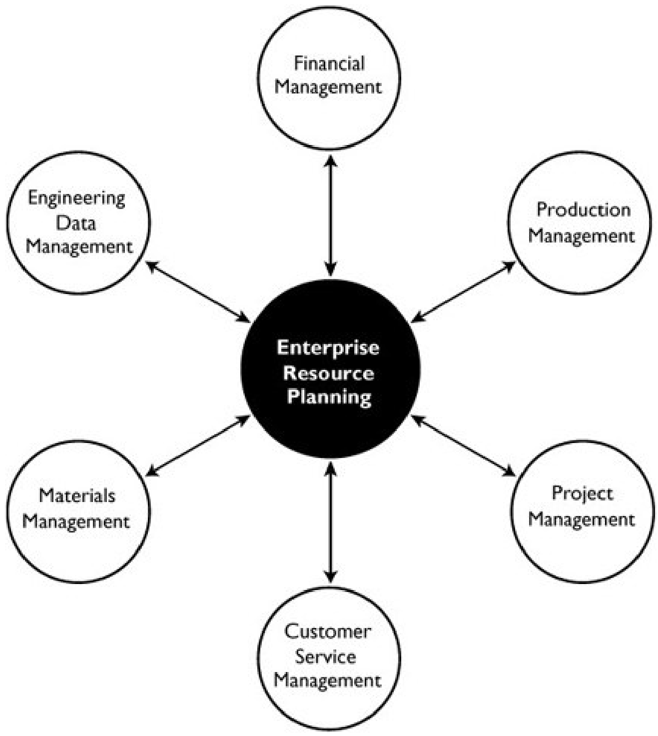
For an organization to actually have useful inventory, it must understand its own objectives for the product it will have on hand, on-order, or in-transit at any one time. What inventory level is required for your organization to profitably and effectively operate?

Until the answers to these questions are determined, it will be difficult to get everyone within the organization to work toward the common, shared goal of eliminating inventory waste.

Enterprise Resource Planning

A significant way for any organization to pull together all of the diverse elements of information it needs to more effectively acquire and control inventory is to use enterprise resource planning. *Enterprise resource planning* (ERP) is an integrated computer-based information system that is used to manage both internal and external resources serving all departments within an enterprise, as shown in Exhibit 5–7.

Exhibit 5-7: Enterprise Resource Planning



Because different departments within a company have different functions and needs—for instance, the particular interests and needs of a company's finance department are certainly different than those of its human resources, production planning and operations, warehousing, sales, and other departments—it's typical for each department to have software systems, information flows, and operations optimized for the ways that department works.

In addition, because information generally moves through the system at different speeds than the physical movement of inventory, there are often significant disconnects in who knows what, when they know it, and what they do with it. (See Chapter 1 for a discussion of inventory as both a tangible and intangible item.)

ERP involves the use of packaged software rather than proprietary software written by or for one customer. With this software, which integrates all departments and functions of a company into a single, integrated computer system that runs off a single database, one department is able to "see" the information contained in another department. This allows all departments within a company to share information more easily and to communicate with each other more effectively.

Integrated ERP software is divided into software modules that roughly approximate the old stand-alone systems, such as manufacturing, order entry, accounts receivable and payable, general ledger, purchasing, warehousing, transportation, and human resources. Departments get the equivalent of their former standalone system, however, now the modules are linked so that someone in accounting can see if an order has been shipped, and the sales department can determine when an item will be available for sale or use.

Most ERP vendors' systems are flexible enough to allow, with varying degrees of effort, modules to interface with an organization's own software and, depending on the software, ERP modules may be alterable by the enterprise itself. Many companies only install one or two ERP modules at a time rather than trying to install everything at once.

The benefits of installing ERP can be tremendous. Imagine the efficiencies gained if a salesperson can immediately know the credit limits of a customer from the finance module as well as if the warehouse has in stock the items that customer wants from the warehouse module, and so on.

The five main reasons organizations implement ERP are:

1. Integration of financial information—all business units use the same set of metrics.
2. Integration of customer order information—customer information is available to all business units on a real-time basis.
3. Standardization of manufacturing processes—standardization of processes leads to operating efficiencies.
4. Reduction of inventory—excess inventory is held to a minimum.

5. Standardization of human resources information—uniformity of information and access leads to better administration.

Actually implementing an ERP system can be expensive, time consuming, and difficult.

One of the greatest challenges to ERP implementation isn't so much the installation of the software itself, it's getting employees to actually change the way they perform their jobs in order to conform to standardized procedures. Unless you are willing to undertake a focused training program together with sustained managerial vigilance, you may not want to attempt the effort at all.

Unless your organization is relatively small, you should count on the installation and implementation of an ERP program to involve at least one year of effort. This minimum timeframe reflects the reality of factors such as installation, data conversion, data analysis, training, integration and testing, customization, add-ons, etc.

Recap

Organizations establish techniques for forecasting their product-level needs based on the nature of the demand characteristics of those items.

Formulae for ensuring that you have the right item, in the right quantity, in the right place, at the right time can range from relatively simple min-max models to highly sophisticated computer-dependent systems.

For individuals not directly involved in purchasing, successful inventory control doesn't so much flow from actually using the various formulae, but rather from understanding what outcomes are supposed to result from their use.

ERP systems allow more efficient and effective operations throughout an enterprise by allowing all departments to have access to one another's data and information on a real-time basis.

Review Questions

1. Independent demand is best described as: ?

a. erratic purchasing of inventory.

b. one item is needed because of its relationship to another item.

c. items are impacted by market conditions outside the control of your organization's operations, and they are therefore independent of operations.

d. demand for items outside of their normal review cycle.

2. Just-in-time manufacturing results in: ?

a. right item, right quantity, right place, right time.

b. right item, right quantity, right place.

c. right item, right quantity.

d. larger inventory levels.

3. Independent demand calls for a(n) ___________ approach to inventory management. ?

4. Dependent demand calls for a(n) ___________ approach to inventory management. ?

5. The reorder point is the ?

a. point in time when a product review is undertaken.

b. largest quantity of an item you will have on hand or on order.

c. lowest quantity of an item you will have on hand or on order before you reorder.

d. lowest quantity at which you can obtain a discount from a vendor.

6. The bill of materials is: ?

a. another name for a purchase order.

b. the recipe of raw materials and subassemblies that make up a finished product.

c. the schedule of what will be built, when, and in what quantities.

d. an accounts payable concept.

7. JIT systems regard inventory in excess of current production and R & D needs to be: ?

a. safety stock.

b. FIFO inventory.

c. waste.

d. part of the kanban system.

8. True or False. ?

Enterprise Resource Planning software is developed for a single user's requirements.

a. True

b. False

Answers

1. (c)

2. (a)

3. replenishment

4. requirements

5. (c)

6. (b)

7. (c)

8. (b)