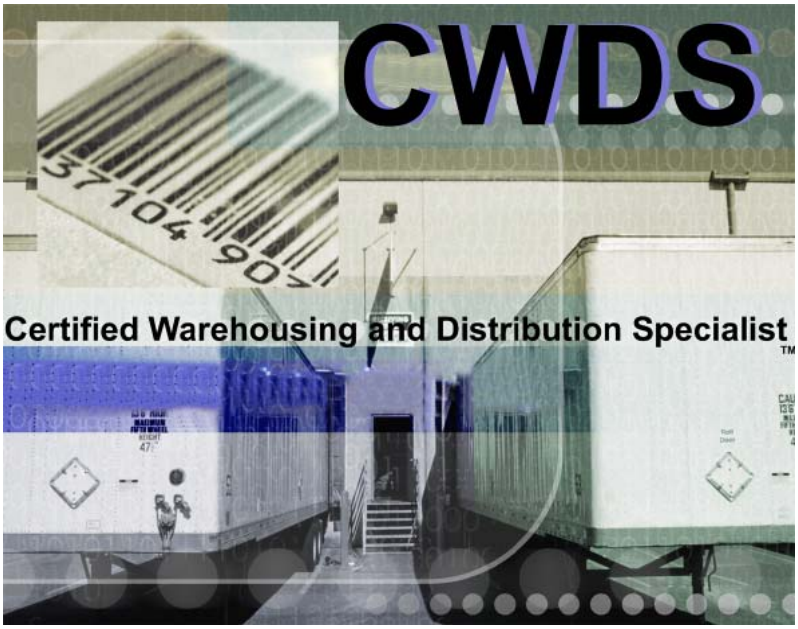

Methods of Inventory Management

QUICKSTART®
TECHNICAL COLLEGE SYSTEM OF GEORGIA

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Introduction

Overview

Inventory management is critical to the success of any company. In today's world, a company must manage its entire supply chain. This means that inventory managers must understand (and manage) their own inventory as well as that of their suppliers. The often-changing demands of production means that manufacturers and suppliers must be strategically linked. In this unit we will discuss the types of inventory control systems, including MRP, the Just-in-Time philosophy and the Kanban process.

Objectives

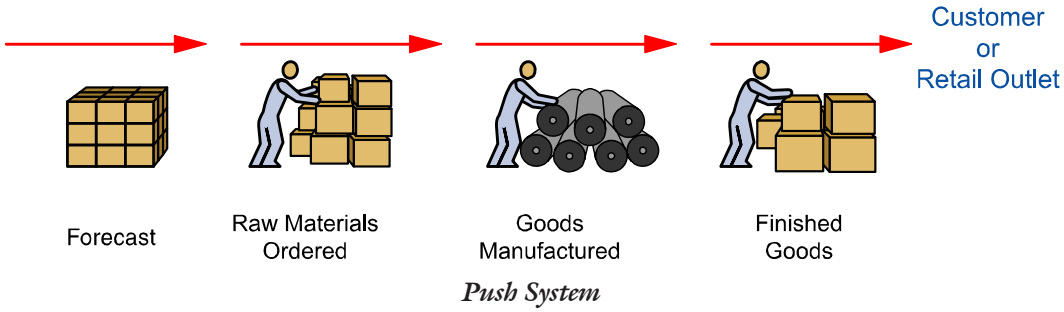
The information, activities and practice provided in this unit will enable the participant to:

1. List the two classifications of inventory control systems.
2. State the advantages and disadvantages of a "push" system.
3. State the advantages and disadvantages of a "pull" system.
4. Explain the purpose of MRP.
5. List the three key inputs to MRP.
6. State whether MRP is a "push" or a "pull" system.
7. Explain the JIT philosophy.
8. List the seven goals of JIT.
9. State which ABC classification requires the most, less, or the least management attention.
10. List the two basic options businesses have when reordering raw material.
11. Explain how vendor-managed inventory can benefit both the supplier and the customer.
12. Explain the Kanban process.
13. State the two key factors involved with the Kanban process.

There are two basic classifications of Inventory Control Systems. There are "Pull" systems and "Push" systems. Each has its own advantages and disadvantages.

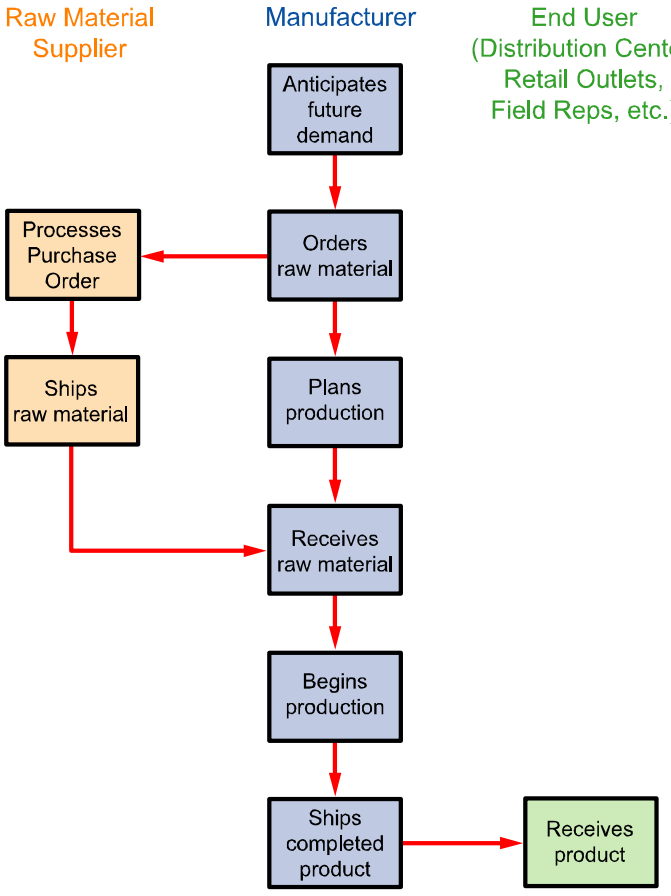
Push Systems

In a Push Distribution System, the manufacturer makes the ordering decisions. This system is generally used when the same company owns the distribution system and the manufacturer. The manufacturer determines the customers' needs by reviewing previous orders, adjusting for seasonal demand and anticipating new trends. Once this "forecast" is developed, the manufacturer orders the necessary raw material and begins production. The end items are shipped to the retail outlets or distribution centers.



Push System

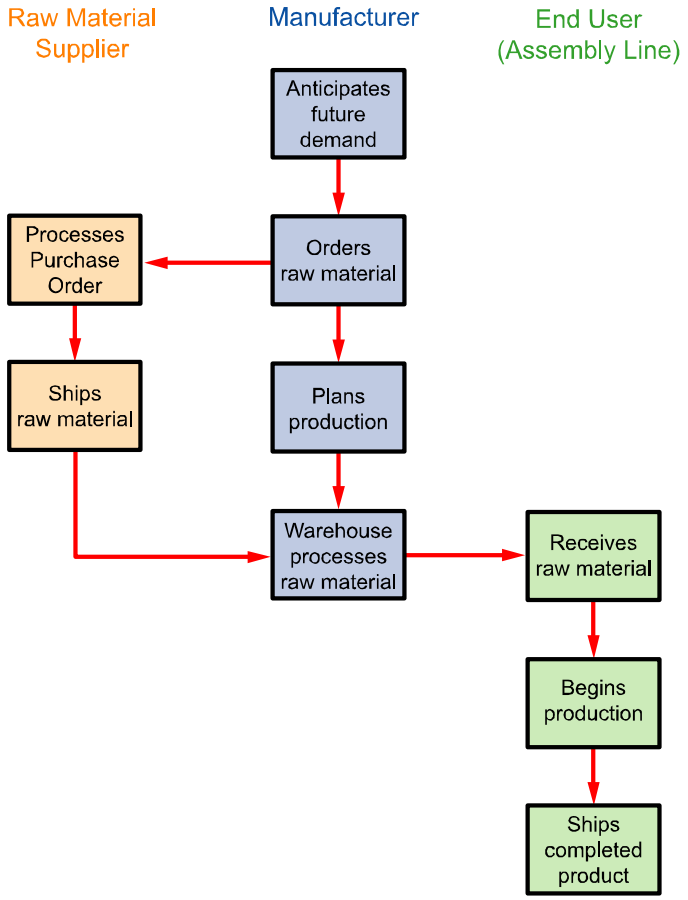
The advantage of this system is that the manufacturer can utilize "economies of scale", that is, save money due to many factors relating to the size of the operation (i.e. larger order sizes, improved efficiency of equipment and employees, shipment consolidation.) The disadvantage of this "push" system is that the forecast could be incorrect. This could result in excess inventory.



Push Distribution System

In manufacturing, a "push" system is where the raw material ordering decisions are made by a central source in manufacturing based on a forecast which anticipates the needs of the customers. The forecast instructs manufacturing to order the raw material and schedule the production to begin on a specific date. A "push" system "force feeds" material to manufacturing and does not take into account machine downtimes, personnel availability, etc. Because we are obtaining material and beginning production for product that has not been ordered, we are said to be "pushing" the product.

The advantage is, again, "economies of scale." And, as before, inventories can grow if the forecast is incorrect. In addition, inventories can grow if manufacturing encounters production problems (machines down, personnel unavailable, quality issues, etc.).



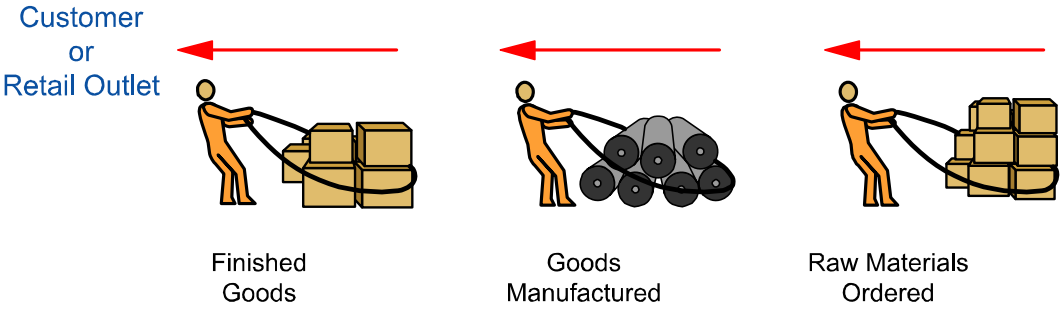
Push System in Manufacturing

Notes:

Pull Systems

A "pull" system is where orders for an end item are "pulled" through the distribution system to satisfy demand for the end items. This kind of system can be used in manufacturing or throughout the distribution process.

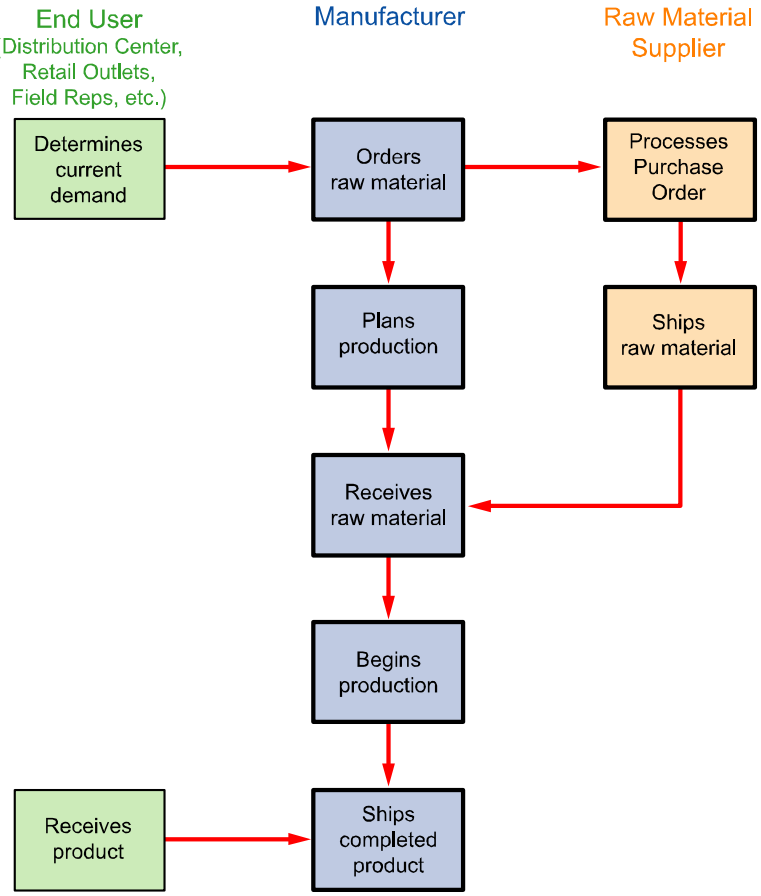
In a Distribution Pull System, the ordering decisions are made in the field. A retail outlet or distribution center may be experiencing an unexpected surge in sales on a particular item. They can quickly order more from the supplier to maintain their inventory levels and satisfy customer demand.



Pull System

The advantage of this system is that those doing the ordering are close to the customer and, presumably, better understand the customers' needs. The

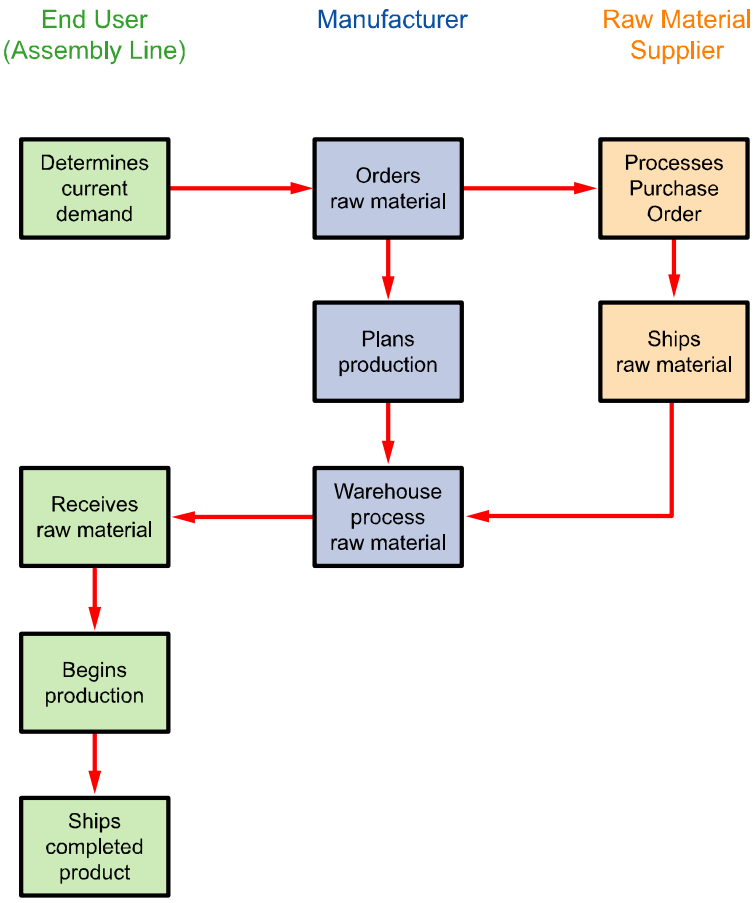
disadvantage of a "pull" system is that there is a potential lack of visibility between the field warehouses. One field warehouse may have excess quantities sitting unused on their shelves while another field warehouse is placing new orders with the supplier. This could result in excess inventory.



Pull System Distribution

In manufacturing, a "pull" system is where the raw material ordering decisions are made on the assembly line. The assembly line workers receive the production orders and review their on-hand inventory of raw material. They then order only what they need when they need it.

The advantage of this system is that it minimizes inventories throughout the supply chain because those doing the ordering are in the production area and better understand their raw material requirements. If machines are down for extended periods or there are quality or personnel issues, material flow can be halted until the problems are resolved. The disadvantage is that line workers may overcompensate for unknown supply-chain lead times by ordering too much raw material. This could result in excess inventory.



Pull System in Manufacturing

Progress Check #1

1. List the two classifications of inventory control systems.

2. Which of the following is an advantage of a "push" system?

   a. Increased inventory

   b. Increased safety stock

   c. Increased cost

   d. Economies of scale

3. Which of the following is a disadvantage of a "push" system?

   a. The forecast could be wrong

   b. Decreased inventory

   c. Economies of scale

   d. Larger order sizes

4. Which of the following is an advantage of a "pull" system?

   a. Lack of visibility between field warehouses

   b. Better understand of customers' needs

   c. Maximum inventory

   d. Workers can order anything they want

5. Which of the following is a disadvantage of a "pull" system?

   a. Line workers may order too much inventory

   b. Machines may break down

   c. Minimizes inventory

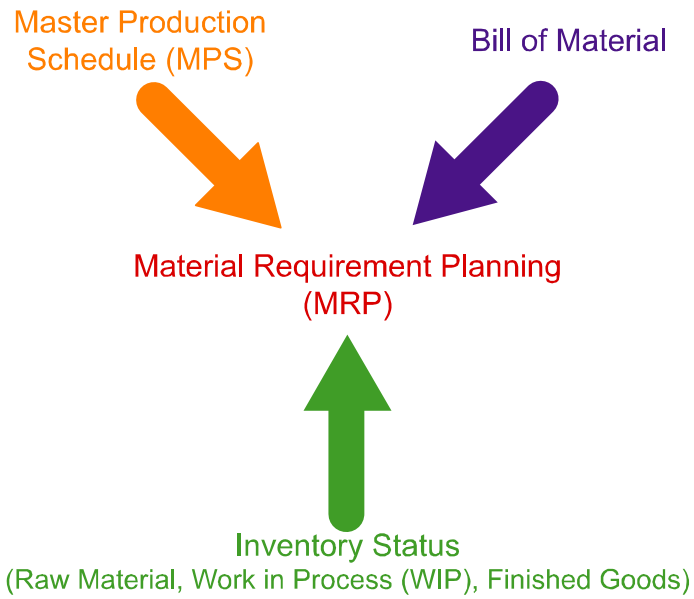
   d. Those doing the ordering are closer to the customer

Material Requirement Planning

Material Requirement Planning (MRP) is a computer-based system that supports manufacturing organizations by controlling the release of production and purchase orders. It uses the production plan for end-items to determine the materials and time required to make the product. Customer orders are phased in over time to ensure the flow of raw materials matches the production schedule for the product.

The three key inputs to MRP are:

- The Master Production Schedule
- Inventory Status
- Product Bills of Material



Material Requirement Planning Inputs

Master Production Schedule

The Master Production Schedule includes customer orders and the dates the customers expect the product. It also takes into account the production lead time.

Production lead time is the time it takes the manufacturer to produce an end-item after the customer order is received until the item is available for packing. Production lead-time may include setting-up machines, assembling, curing and testing the product.

Inventory Status

Another key input is the inventory status of all material needed to manufacture the items. This includes raw material, Work-in-Process (WIP), and finished goods in the warehouse.

Information concerning raw material lead times is critical to MRP. Raw material lead time is the time between the decision to purchase an item of raw material and its actual addition to manufacturing's stock.

WIP is the total amount of work currently in processing between production stages.

Finished Goods are completed end-items available for distribution.

Bill of Material

The product Bill of Material (BOM) is a listing of components, parts, or other items needed to manufacture a product. It shows the quantity of each item required to produce each end-item. A Bill of Material is similar to a parts list except it usually shows how the product is fabricated and assembled. A BOM is sometimes referred to as product structure record, formula or recipe. It may also be called an ingredients list.

MRP: A Pull System

By taking the customer's required delivery date and production lead-times into account, MRP can calculate precisely when the production order should begin. By taking the raw material lead times into account, MRP plans the raw material to arrive just as the production is scheduled to start.

Because we are only ordering what is needed, as it is needed and we are only manufacturing items ordered by customers, MRP is considered a "pull" system.

State-of-the-art MRP systems (MRP II) can provide the user with simulation capabilities. This enables the user to explore a series of "What if…?" situations.

Progress Check #2

1. What is the purpose of MRP?

2. What are the three key inputs to MRP?

3. MRP includes

   a. Customer lead-times

   b. Production lead-times

   c. Machine downtime

   d. Employee absenteeism rates

4. Raw material, WIP and finished goods are included in the:

   a. Production lead-time

   b. Supplier lead-time

   c. Bill of Material

   d. Inventory status

5. A listing of all components, parts, or other items needed to manufacture a product is:

   a. A BOM

   b. A WIP

   c. An MRP

   d. An Inventory Control System

6. MRP is a _____ (push/pull) system.

Just–in–Time Philosophy

Just-in-Time (JIT) is an inventory control philosophy which views production as a system in which all operations, including the delivery of materials needed for production, occur just at the time they are needed. JIT strives for a level of zero inventories by producing end-items at the rate required by the customer.

Many companies have made a commitment to JIT production. Many other are doing so. It is generally recognized that effective implementation of JIT will result in significant reductions of inventories. As a matter of fact, inventory levels are a key indicator for measuring JIT performance.

The Goals of Just-in-Time

The JIT inventory control philosophy is simple. The goals of JIT are:

1. **Eliminate all unnecessary lead times.**

   This includes production lead times as well as raw material lead times.

2. **Reduce setup costs.**

   The goal is to the smallest economical lot size, ideally, a quantity of one.

3. **Optimize material flow.**

   This will minimize inventories from suppliers through production to the point of sale of the end-item.

4. **Ensure high quality from suppliers.**

   This reduces the need for receiving inspections. It also minimizes quality issues during production.

5. **Ensure dependable just-in-time deliveries from suppliers.**

   Holding suppliers accountable for late (or early) deliveries provides an incentive for them to deliver when the material is needed.

6. **Implement a strong Quality Control program.**

   This will minimize rework and scrap. It also reduces the resultant time delays in production. Working with suppliers minimizes quality issues with raw materials.

7. **Minimize safety stocks.**

   Safety stocks are materials held to protect against the difference between forecast and actual demand. They are also held to account for other factors such as service levels and variations in lead-time.

Implementing Just-in-Time

While the JIT philosophy is simple, JIT implementation is not. To implement the JIT philosophy we must:

1. **Determine the types of inventory.**

   Typically, these are classified by inventory segments: raw materials, purchased components, manufactured subassemblies, work in process, packaging materials and finished goods.

2. **Determine how many different items there are in each segment.**

   This lets us know how complex the effort will be.

3. **Determine the unit cost of each item.**

   The cost of inventory is a major consideration regarding order quantities and safety stock.

4. **Determine the anticipated annual demand.**

   This is accomplished by reviewing previous customer orders, current orders and estimating future orders.

5. **Run an ABC Analysis for each inventory segment.**

   This enables us to apply selective inventory management controls. The inventory value of each item is obtained by multiplying the unit cost by the annual demand. The values are then ranked from most costly to least costly.

6. **Classify the items.**

Using the ABC Analysis, place each inventory item into one of three basic groups.

Classification	Percentage of Inventory	Percentage of Inventory Value
"A"	20%*	80%*
"B"	30%*	15%*
"C"	50%*	5%*

* Approximately

ABC Analysis

"A" Items: The 80/20 Rule is often used: 20% of the inventory items account for 80% of the inventory value. "A" items are a small group of items with high inventory value. These items may also have strategic importance to the business. The greatest management attention is paid to "A" items.

"B" Items: Approximately 30% of the inventory items will account for about 15% of the inventory value. "B" items require less management attention.

"C" Items: Approximately 50% of the inventory items will account for about 5% of the inventory value. The least management attention is paid to "C" items.

7. **Establish inventory and reporting policies for each item based on the method of inventory control.**

"A" items will require strict controls while "B" and "C" items will require less strict controls.

8. **Establish blanket purchase orders for selected items with qualified vendors.**

   Authorize individuals in production to release vendor deliveries against the blanket purchase orders.

9. **Establish Economical Order Quantities (EOQ).**

   EOQ is the size of an order that minimizes the inventory cost. It is based on a trade-off between the cost of placing an order and the cost of holding stock.

10. **Establish minimum Safety Stocks.**

11. **Continually measure inventory performance.**

    To determine the effectiveness of JIT production and inventory control, inventory levels and inventory turns are monitored.

Progress Check #3

1. Explain the JIT philosophy.

2. Circle the goals of JIT:

   a. Increased inventory

   b. Reduce setup costs

   c. Ensure high quality from customers

   d. More WIP

   e. Optimize material flow

   f. Eliminate lead-times

   g. Strong QC program

   h. Minimize safety stock

   i. No MRP

   j. A "push" system

   k. Maximizing safety stock

   l. Ensure JIT deliveries from suppliers

   m. Increased incoming inspection

   n. Increase lead times

3. Match the "ABC" classification to the amount of management attention it requires:

___	"A" Items	a.	The least management attention
___	"B" Items	b.	The most management attention
___	"C" Items	c.	Neither the least nor the most management attention

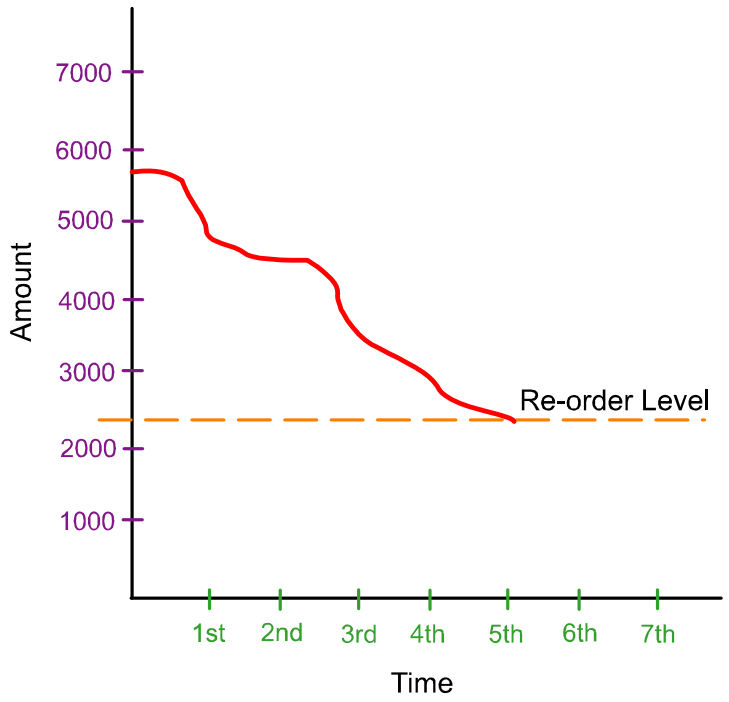
Reordering Systems

Since demand and lead-times are variable, businesses have two basic options:

- Order fixed quantities of stock and variable times, or
- Order variable quantities of stock and fixed times.

Fixed Quantities System (Re-Order Levels)

Whenever an inventory item falls below a predetermined level, a replenishment order is initiated. This is a method that is easy to manage and adjusts well to changes in demand. If production slows, they will order fewer times. If production increases, the fixed quantities will be ordered more often. Even if demand increases dramatically, the only concern is the supplier lead time. And, if there is an outstanding order, it has the opportunity of being expedited. Because it is so adaptable, it also keeps inventory low. Orders can also be grouped together to obtain supplier discounts.



Fixed Quantity System

Two-Bin Replenishment System

A variation of the Fixed Quantity System is the Two-Bin Replenishment System. This system uses two equally sized bins of the same item. Items are used from the first bin until it is empty. The empty bin is then sent to the warehouse (or supplier) to be refilled. Meanwhile, the items from the second bin are being used. The newly-filled bin is returned and placed behind the bin in use. The process is repeated when the in-use bin empties.

Using this method, the reorder level is visual. The people using the items do not have to keep track of them. They simply wait until the first bin is emptied.

This method is well suited for items that require large quantities and where bin size can be checked easily.

With proper rotation the two-bin replenishment system is very efficient and requires little paperwork. In a computerized environment the bins can be bar-coded and their movement/location and batch numbers can be traced.

Computerized Inventory Systems

With many stock items, the two-bin system is inappropriate. Some items (high value, important items) require more detailed control so a stock record showing precise receipts/issues and on-hand balances is required. This is especially true for high dollar-value items or items susceptible to damage. It is also true when dealing with large inventories where there are often differences between the book stock (what the computer says is in stock) and the actual on-hand quantities. With large inventories, you will often hear, "The system says we have five in stock. I can only find three and one of those is damaged!"

Computerized systems enable replenishment orders to be raised as soon as an item falls below its predetermined reorder level.

Fixed Time (Order Cycle System)

Some low value, low bulk items can be estimated and ordered on a routine order cycle. This may be annually, monthly, or weekly. A maximum stock level is set (Average usage + Safety Stock). At the routine order time, current stock is counted. The amount of current stock is subtracted from the maximum stock level to give the reorder quantity.

If production slows, they will order fewer items. If production increases, the safety stock will be used. When using the fixed-time method, it is critical that the safety stock is able to accommodate unexpected increases in demand. This is even more critical if the order cycle is monthly or yearly. This forces a business to maintain high levels of safety stocks.

If demand increases dramatically, there is a serious concern of stock outages. In a fixed-time method the concern is not only supplier lead time but also reorder cycle lead time.

January						
S	M	T	W	T	F	S
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	(31)			

February						
S	M	T	W	T	F	S
				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	(28)			

March						
S	M	T	W	T	F	S
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	(30)		

April						
S	M	T	W	T	F	S
					1	2
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10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	(29)	30

May						
S	M	T	W	T	F	S
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8	9	10	11	12	13	14
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22	23	24	25	26	27	28
29	30	(31)				

June						
S	M	T	W	T	F	S
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5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	(30)		

July						
S	M	T	W	T	F	S
					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	(29)	30
30						

August						
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14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	(31)			

September						
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18	19	20	21	22	23	24
25	26	27	28	29	(30)	

October						
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						1
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9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30	(31)					

November						
S	M	T	W	T	F	S
		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	(30)			

December						
S	M	T	W	T	F	S
				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	(30)	31

◯ Order Cycle

Fixed Time System

Reorder Level or Order Cycle…Which is better?

Example #1: A business has a dramatic increase in orders on the 1st of the month (Monday) and the supplier lead-time for material is 14 days. Using a fixed-quantity system, the business' material falls below its reorder level on Tuesday (2nd). It orders a fixed quantity from its supplier. It runs out of material on Thursday (4th) before the delivery arrives. It must wait 10 days for the delivery to arrive.

Example #2: A business has a dramatic increase in orders on the 1st of the month (Monday) and the supplier lead-time for material is 14 days. Using a fixed-time system, the business only orders material on Monday mornings. It runs out of material on Thursday (4th). It orders the material on Monday (8th), four days after it ran out of stock. It has to wait those four days plus the supplier's lead-time of 14 days. It may have to wait a total of 18 days for the delivery to arrive.

As you can see, the fixed-time method works well with low usage items and when demand is stable and predictable. The fixed-quantity works well with high usage items, is easy to manage and is more suited to sudden changes in demand.

Vendor Managed Inventory (VMI)

Vendor managed inventory is a process by which the supplier controls the flow of inventory into a customer's production area based on inventory, demand and/or a forecast provided by the customer.

Case Study: A manufacturer of paint had difficulty maintaining paint cans for its production line. Fluctuations in its production schedule caused the manufacturer to be overstocked or not have enough. Because of this, it had several vendors supplying cans. Each vendor had different lead-times and different prices for its cans. After an analysis of the problem, the manufacturer decided to select one vendor as its sole-source supplier and have it provide on-site management of its can inventory. The manufacturer set aside an area in its warehouse for the vendor-managed inventory. The vendor assigned one employee to provide on-site support. Because of the sole-source agreement, the vendor agreed not to increase its prices. The manufacturer only pays for the cans it uses, not the ones in inventory. Since the agreement was signed, the manufacturer has reduced its inventory costs and has never run out of cans.

Progress Check #4

1. What are the two basic options relating to reordering systems?

   a. MRP & WIP

   b. Fixed-time & Fixed-quantity

   c. Safety Stock or Raw Material

   d. One-bin or Two-bin

2. When might a two-bin system be inappropriate?

3. What is the advantage of a fixed-time system?

4. What is the advantage of a fixed-quantity system?

5. Explain how vendor-managed inventory can benefit both the supplier and the customer.

Kanban

Kanban is a Japanese term for "visual record." "Kan" means card. "Ban" means signal.

Kanban is a simple inventory control system developed by Toyota Corporation for coordinating the movement of material to feed the production line. The method uses standard containers or lot sizes with a single card attached to each. It is a "pull" system in which work centers signal with a card that they wish to withdraw parts from suppliers.

Kanban is a chain operation that is used to "pull" raw material, as well as manufactured parts, through the production process. The supplier may be a vendor, a stockroom or a preceding operation. The vendor or the stockroom fill the container and reissue it to production. In the case of preceding operations, the supplying work centers produce enough material to fill the container, then stop.

Advantages of Kanban

The advantages of Kanban over traditional "push" systems are:

- It is a simple and understandable process.
- It provides a quick response to changes.
- It avoids overproduction.
- It minimizes waste.
- It is low-cost and easy to maintain.
- It delegates responsibility to the line workers.

Kanban – More than Inventory Control

Kanban is much more than a simple inventory control system. The entire Japanese Kanban process takes form on the production floor, in close interaction between the work force and management. More importantly, it involves both internal and external customers.

The Kanban process involves industrial re-engineering as well as the human factors of production.

Industrial Re-engineering

Modular/cell production.

Organizing machinery so related products can be manufactured continuously.

Layouts of processes and machines that are oriented around the product.

Product flows smoothly from start to finish.

No items waiting to be worked on.

U-shaped production lines.

Increases focus on both ends of the production line.

Increases supply accessibility to the lines.

Total preventative maintenance.

Prevents machines from breaking down during production time.

Mass production of mixed models.

This is possible if processes are fully integrated with the product.

Human Factors of Production

Breaking down administrative barriers.

Workers have greater input.

Teamwork.

Companies practicing Kanban believe that productivity and quality come from people rather than systems.

Quality Circles.

Quality Control provides the framework where employees are able to discuss and find solutions to production problems.

Increased worker authority.

Workers have the authority to shut down production.

Cross-training and job-rotation are encouraged.

Continuous improvement.

Companies practicing Kanban believe quality leads to lower costs and that systems cause most defects.

Housekeeping.

Workplace cleanliness leads to improved morale and better quality.

Kanban is an organizational change that decentralizes responsibility. Simply stated, advocates of the Kanban process believe that "It's organizations that need to be changed. Not hardware."

Progress Check #5

1. Kanban uses standard containers or lot sizes with a single _____ attached to each.

2. Kanban is a _____ (push/pull) system.

3. List three advantages of the Kanban process.

4. What are the two key factors that Kanban addresses?

5. Those who advocate the Kanban process believe in:

   a. Centralized responsibility

   b. Breaking down administrative barriers

   c. Straight production lines

   d. U-shaped Quality groups

Glossary

"ABC" Analysis	A form of analysis applied to a group of items in order to apply selective inventory management controls.
Bill of Material	A listing of components, parts, or other items needed to manufacture a product.
BOM	Bill of Material
Economical Order Quantities	The size of an order that minimizes the inventory cost. It is based on a trade-off between the cost of placing an order and the cost of holding stock.
Economies of Scale	The ability to save money due to many factors relating to the size of the operation.
EOQ	Economical Order Quantities
Forecast	The estimation of expected demand over a specified time period in the future.
JIT	Just-in-Time
Just-in-Time	An inventory control philosophy which views production as a system in which all operations, including the delivery of materials needed for production, occur just at the time they are needed.

Kanban	A simple inventory control system developed by Toyota Corporation for coordinating the movement of material to feed the production line. The method uses standard containers or lot sizes with a single card attached to each. It is a "pull" system in which work centers signal with a card that they wish to withdraw parts from suppliers.
Lead Time	The cycle time needed for raw-material-to-market cycle.
Master Production Schedule	A listing of all the production orders required to fill all outstanding customer orders.
Material Requirement Planning	A system that supports manufacturing organizations by controlling the release of production and purchase orders.
MRP	Material Requirement Planning
MRP II	A method for the effective planning of all resources of a manufacturing company.
Order Cycle	A method of reordering material at a fixed-time. See Reorder Levels.
"Pull" System	A system where orders for an end item are pulled through the facility to satisfy demand for the end item.

"Push" System	A system where orders are issued for completion by specified due dates, based on estimated lead-times or forecast.
Raw Material	Items purchased from suppliers, to be input to a production process and modified into finished goods.
Reorder Levels	A method of reordering material at fixed quantities whenever an inventory item falls below a predetermined level. See Order Cycle.
Safety Stock	Inventory that is used to guard against fluctuations in supply or demand.
Vendor Managed Inventory	A process by which the supplier controls the flow of inventory into a customer's distribution network based on inventory, demand and other relevant product movement data provided by the customer to the supplier.
VMI	Vendor Managed Inventory
WIP	Work in Process
Work in Process	The total amount of work in processing between production stages or subject to waiting time.