Chapters to Go

Essentials of Inventory Management, Second Edition

by Max Muller

Chapter 3: Physical Location and Control of Inventory

Overview

If you can't find an item, you can't count it, fill an order with it, or build a widget with it. If you cannot control the location of your product or raw materials from both physical and recordkeeping standpoints, then your inventory accuracy will suffer.

To sustain inventory accuracy on an ongoing basis you must:

- Formalize the overall locator system used throughout the facility

- Track the storage and movement of product from

  ○ Receipt to storage

  ○ Order filling to shipping, or to staging at a point-of-use

- Maintain timely records of all item storage and movement

The objective of this chapter is to give you guidance in setting up a system that allows you to put items where they will do the most good for your organization. It will provide you with a working knowledge of (1) three key stock locator systems (which relate to the overall organization of SKUs within a facility and their impact on space planning); (2) item placement theories dealing with the specific arrangement of products within an area of the warehouse (should the box be over here or over there?); and (3) some practical methods of attaching addresses to stock items and how to tie an item number to its location address.

Common Locator Systems

The purpose of a material locator system is to create procedures that allow you to track product movement throughout the facility. Although going by many names, the most common "pure" systems are *memory, fixed,* and *random*. A type of fixed system is the zone system. The *combination* approach is a common mixture of the fixed and random systems.

In considering which locator system will work best, you should attempt to maximize:

- Use of space

- Use of equipment

- Use of labor

- Accessibility to all items

- Protection from damage

- Ability to locate an item

- Flexibility

- The reduction of administrative costs

Maximizing all of these considerations at the same time is difficult, if not impossible. Often, each of these concerns creates conflicts with one or more of the others. For example, you may wish to store all cylinders together to utilize the same equipment to handle them or locate them together for ease of reach and retrieval. However, if the chemical nature of the contents of these cylinders prohibits them from being stored in the same area, safety and protection of property concerns take precedence over other considerations. Exhibit 3–1 provides scenarios in which several valid considerations are in conflict.

Exhibit 3-1: Examples of Valid Storage Considerations in Conflict

• Scenario One—*Accessibility versus Space*: Charmax, Inc. wishes to have its entire product as easy to get to as possible for order filling purposes. It therefore attempted to have a "picking face" (a front-line, visible position from which the product can easily be selected) for each item. In order to actually create a picking face for each SKU, Charmax would have to

assign a specific location for every product appearing on all of its pick tickets, with no two items being placed one on top of another, and no item being placed behind another. Charmax quickly realized that it lacked sufficient space in its facility to have a specific position for every item it carried.

• Scenario Two—*Use of Labor versus Protection from Damage*: Alana Banana Enterprises wishes to reduce labor hours by putting into place efficient product handling procedures. Its intent is to develop standard operating procedures so that workers will only handle SKUs four times: once when it is received, once when stored, once when picked, and once when loaded. However, in order to protect SKUs from bruising, items must be placed into protective cartons for storage. SKUs are not picked in full carton quantities so workers have to remove various quantities at different times from the cartons. Empty cartons must then be stacked, cleaned, restacked, and taken back to the receiving area for reuse. These protective measures add a number of labor-intensive steps to the process.

• Scenario Three—*Ability to Locate an Item versus Space Utilization*: Racquetballers America wants to assign a specific home to each of its products for inventory control purposes. However, it has a small stockroom. Racquetballers realizes that if it uses a fixed storage location approach it must assign sufficient space to store the maximum amount of any one of its SKUs that will ever be on hand at one time in that location. If it uses a random location approach where items can be placed one on top of another or behind one another, then it will maximize its use of space. Racquetballers decides using its limited space is more important than putting in the extra labor and administration necessary to keep track of where everything is as it moves around the floor.

The stockkeeper should select a locator system that provides the best solution given the tradeoffs between conflicting objectives. No one system is "right." What is best will depend on considerations such as:

- Space available

- Location system (See the "Impact on Physical Space" sections in this chapter.)

- Dimensions of product or raw materials stored

- Shape of items

- Weight of items

- Product characteristics, such as stackable, toxic, liquid, crushable

- Storage methods, such as floor stacked, racks, carousels, shelving

- Labor availability

- Equipment, including special attachments available

- Information systems support

Every company has a limited amount of space available for stock storage. Some locator systems use space more effectively than do others. When choosing your locator system, think carefully about how much space it will use. The following pages discuss several types of locator systems and evaluate the strengths and weaknesses of each.

Memory Systems

The most fundamental of all locator systems is the "memory" system.

Basic Concept

Memory systems are solely dependent on human recall. Often, they are little more than someone saying, "I think it's over there."

The foundations of this locator system are simplicity, relative freedom from paperwork or data entry, and maximum utilization of all available space. Memory systems depend directly on people and only work if several or all of the conditions listed in Exhibit 3–2 exist at the same time.

Exhibit 3-2: Conditions Under Which Memory Systems Will Work

- Storage locations are limited in number.

- Storage locations are limited in size.

- The variety of items stored in a location is limited.

- The size, shape, or unitization (e.g., palletization, strapping together, banding, etc.) of items allows for easy visual identification and separation of one SKU from another.

- Only one or a very limited number of individuals work within the storage areas.

- Workers within the storage area do not have duties that require them to be away from those locations.

- The basic types of items making up the inventory does not radically change within short time periods.

- There is not a lot of stock movement.

Impact on Physical Space

The most complete space utilization is available through this system. Why? Because no item has a dedicated location that would prevent other SKUs from occupying that same stock location position if it were empty (either side-to-side or up-and-down).

Pros

As with all locator systems, the memory system has a number of strengths and weaknesses. Some of the pros are:

- Simple to understand

- Little or no ongoing paper-based or computer-based tracking required

- Full utilization of space

- No requirement for tying a particular stocking location, identifier, bin, slot, drawer, rack, bay, or spot to a specific SKU

- Requirements of single item facilities (such as a grain silo) can be met

Cons

Some negative aspects of a memory system are:

- The organization's ability to function must strongly rely on the memory, health, availability, and attitude of a single individual (or a small group of people)

- Significant and immediate decreases in accuracy result from changes in the conditions set out in Exhibit 3–2

- Once an item is lost to recall, it is lost to the system

Despite its limitations, a memory system may be as efficient as any other, particularly if there are only a limited number of different SKUs within a small area.

Fixed Location Systems

Memory systems, in which nothing has a home and everything can be put wherever there's room, are at one extreme of locator systems. Fixed locator systems are at the other extreme.

Basic Concept

In pure fixed location systems, every item has a home and nothing else can live there. Some (not pure) fixed systems allow two or more items to be assigned to the same location, with only those items being stored there.

Impact on Physical Space

If quantities of any given SKU are large, then its "home" may consist of two or more storage positions. However, collectively all of these positions are the only places where this item may exist within the facility, and no other items may reside there. Basically, everything has a home and nothing else can live there.

Fixed location systems require large amounts of space for two reasons:

- Honeycombing

- Planning around the largest quantity of an item that will be in the facility at one time

Honeycombing is the warehousing situation where available storage space is not being fully utilized. Honeycombing is unavoidable given location system tradeoffs, product shape, and so on. The goal of a careful layout is to minimize how often and to what extent this happens.

Honeycombing occurs both horizontally (side-to-side) and vertically (up-and-down), robbing us of both square feet and cubic space. See Exhibit 3–3.

Exhibit 3-3: Honeycombing
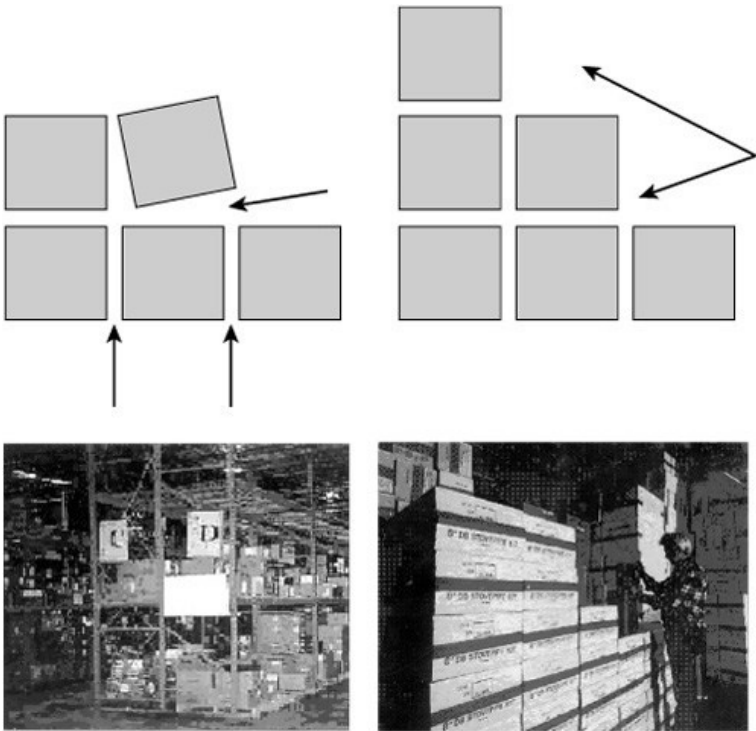
Cause	Description
■ Product shape	Physical characteristics cut down on stackability and prevent use of cubic space or placing one item against another.
■ Product put away	Product not stacked or placed in a uniform manner, causing loss of vertical and horizontal space.
■ Location system rules	A location is empty because no other item may be placed there as it is not the second item's assigned home.
■ Poor housekeeping	Trash, poorly placed desks, etc., force empty space around it.

Two simple methods can determine the level of honeycombing within your own facility. One deals with a simple ratio analysis, the other with cubic space. See Exhibits 3–4 and 3–5.

Exhibit 3-4: Determining Impact of Honeycombing—Ratio Method

Determine the impact of honeycombing on your present facility.

1. Count the number of locations you currently have set up to store items—both horizontally and vertically. Include all locations whether full, partially full, or empty.

2. Count the number of empty positions.

3. Divide the number of empty locations by the total storage positions you have. The result will be your honeycombing ratio.

$$\text{Honeycombing Ratio} = \frac{\text{Empty Storage Locations}}{\text{Total Storage Locations}}$$

$$\text{Example:} \quad \frac{847}{1,200} = .294 \text{ or about } 30\% \text{ Honeycombing Ratio}$$

That ratio represents the percentage of empty space within the storage portion of your stockroom(s). Determining this ratio provides you with a baseline. If you decide to change your storage philosophy, change your storage mechanisms (for example, from racks to floor stacking, or from racks to shelving). You can then determine the new ratio and measure improvement in space utilization.

Exhibit 3-5: Determining Impact of Honeycombing—Square Footage Method

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Globus, Inc. has 16,000 cubic feet (ft^3) of storage space. Globus has a fixed locator system and has divided the storeroom into 490 storage locations with the following sizes (and empty locations):

No. of Locations	Ft^3	Total Cu Ft	Empty Locations
400	20	8,000	65
50	50	2,500	15
25	100	2,500	5
15	200	3,000	8
490		16,000	93

The honeycombing ratio on a location basis is:

$$\frac{\text{Empty Spaces}}{\text{Total Spaces}} = \frac{93}{490} = 19\%$$

The honeycombing ratio on a ft^3 basis is:

$$\frac{\text{Empty Spaces} \times ft^3}{\text{Total } ft^3} = \frac{(65 \times 20 \ ft^3) + (50 \times 15 \ ft^3) + (5 \times 100 \ ft^3) + (8 \times 200 \ ft^3)}{16,000 \ ft^3}$$

$$= \frac{1,300 + 750 + 500 + 1,600}{16,000}$$

$$= \frac{4,150}{16,000}$$

$$= 26\%$$

The ratio method is a relatively simple approach to determining a rough estimate of honeycombing. However, the ratio method doesn't account for the fact that storage spaces within a given facility come in various sizes. A more precise method to determine honeycombing is to calculate the amount of unused cubic feet.

The second reason the fixed system requires significant space is the necessity of planning around the largest quantity of an item that will be in the facility at one time. Each SKU will have an assigned location or locations. This "home" must be large enough to contain the total cubic space the item will fill up at the time that the largest quantity of that item will be in the facility. In other words, if a thousand cases of widgets are in the warehouse at the same time, the home of the widgets has to be large enough to hold them all. Therefore, the total space required for all items in a fixed system will be the total cubic space of one hundred percent of all SKUs, as though the maximum quantity of each of them was in the facility at one time. Space planning for an entire inventory in a dedicated location environment is planned around a one-year time period. Stated differently, all of the space needed for all of the widgets has to be added to all of the space needed for the gidgits and that space has to be added to all of the room needed for the doodads, and so on.

Pros

Fixed locator systems have the following definite advantages:

- Immediate knowledge of where all items are located. (This system feature dramatically reduces confusion as to "where to put it" and "where to find it," which increases efficiency and productivity, while reducing errors in both stocking and order fulfillment.)

- Training time for new hires and temporary workers is reduced.

- Simplifies and expedites both receiving and stock replenishment because predetermined put-away instructions can be generated.

- Allows for controlled routing of order fillers.

- Allows product to be aligned sequentially (for example, SKU001, SKU002, SKU003).

- Allows for strong control of individual lots, facilitating *first in first out* ("FIFO") control, if that is desired. Lot control can also be accomplished under a random location system. However simpler, more definitive control is possible using the dedicated location concept.

- Allows product to be positioned close to its ultimate point-of-use. Product positioning is discussed in the "Item Placement Theories" section of this chapter.

- Allows product to be placed in a location most suitable to an SKU's size, weight, toxic nature, flammability, or other similar characteristics.

Cons

Are there disadvantages to fixed locator systems? Of course. Chief among the cons are:

- Contributes to honeycombing within storage areas.

- Space planning must allow for the total cubic volume of all products likely to be in a facility within a defined period of time.

- Dedicated systems are somewhat inflexible. If you have aligned product by sequential numbering and then add a subpart or delete a numbered SKU, then you must move all products to allow for the add-in or collapse out locations to fill in the gap.

- Basically, fixed or dedicated location systems allow for strong control over items without the need to constantly update location records. That control must be counterbalanced by the amount of physical space required by this system.

Zoning Systems

A variation of pure fixed locator systems are those that place similar items in "zones."
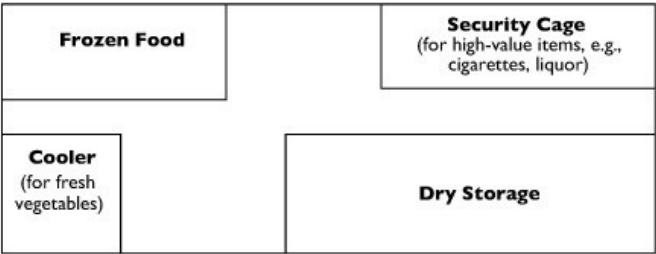
Basic Concept

Zoning is centered around an item's characteristics. Like a fixed system, only items with certain characteristics can live in a particular area. Items with different attributes can't live there.

An SKU's characteristics would cause the item to be placed within a certain area of the stockroom or at a particular level
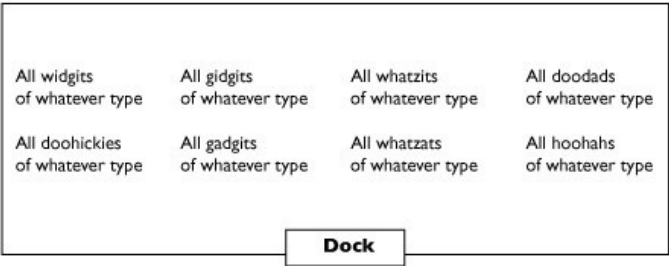
within a section of shelving or rack section. See Exhibit 3–6. For example, irregular-shaped SKUs might be placed in lower levels to ease handling, or all items requiring the use of a forklift for put away or retrieval might be located in a specific area and on pallets.

Exhibit 3-6: Examples of zoning system layouts

1. Natural zones created by the nature of the product

| Frozen Food | Security Cage (for high-value items, e.g., cigarettes, liquor) |
| Cooler (for fresh vegetables) | Dry Storage |

2. Zones created by assigning related types of SKUs to specific areas

| All widgits of whatever type | All gidgits of whatever type | All whatzits of whatever type | All doodads of whatever type |
| All doohickies of whatever type | All gadgits of whatever type | All whatzats of whatever type | All hoohahs of whatever type |

Dock

Impact on Physical Space

As with dedicated systems the more tightly you control where a particular item will be stored, the more you will contribute to honeycombing or to the need to plan around maximum quantities.

Pros

Some of the pros of using zoning systems are:

- Allows for the isolation of SKUs according to such characteristics as size, variety, flammability, toxicity, weight, lot control, private labeling, and so on.

- Allows for flexibility moving items from one zone to another quickly or in creating different zones efficiently.

- Allows for the addition of SKUs within a zone (unlike a fixed system) without having to move significant amounts of product to create room within an assigned location or within a sequentially numbered group of items. It also does not require the collapsing of space if an item is deleted.

- Allows for flexibility in planning: Although items are assigned to a general zone, because they do not have a specific position they must reside in, there is no need to plan around one hundred percent of any given item's cubic requirements.

Cons

As with any locator system, zoning systems also have a number of negative features, including:

- Zoning is not always required for efficient product handling. You may be adding needless administrative complexity by utilizing zoning.

- Zoning may contribute to honeycombing.

- Zoning requires updating of stock movement information.

Basically, zoning allows for control of item placement based on whatever characteristics the stockkeeper feels are important.

Random Locator Systems

Random locator systems allow for good space utilization but require more administration.

Basic Concept

In a random system nothing has a home, but you know where everything is. Pure random locator systems allow for the maximization of space since no item has a fixed home and may be placed wherever there is space. This allows SKUs to be placed above or in front of one another and for multiple items to occupy a single bin/slot/position/rack. The primary characteristic of a random locator system that makes it different from a memory system is that each SKU identifier is tied to whatever location address it is in while it is there. In other words, memory systems tie nothing together, except in the mind of the stockkeeper. Random systems have the flexibility of a memory system coupled with the control of a fixed or zone system. Essentially an item can be placed anywhere so long as its location is accurately noted in a computer database or a manually maintained paper-based card file system. When the item moves, it is deleted from that location. Therefore, an SKU's address is the location it is in while it is there.

Impact on Physical Space

Because items may be placed wherever there is space for them, random locator systems provide us with the best use of space and maximum flexibility while still allowing control over where an item can be found.

Planning space around a random locator system is generally based on the cubic space required for the average number of SKUs on hand at any one time. Therefore, in planning space requirements around a random locator system, you need to discern from our inventory records what our average inventory levels are and what products are generally present within that average. By multiplying the cubic footage of each of those items by the quantity of each usually on hand, you can determine our space required. See Exhibit 3–7.

Exhibit 3-7: Planning a Storage Area Around a Fixed or a Random Locator System

Hammer Company manufactures widgits. It has broken down its bill-of-materials, the listing of all of the pieces and parts required to build a widgit, and has come up with the following list:

SKU #	Description	Container	Dimensions	Total Cubic Ft	Maximum Expected At One Time	Total Cubic Ft Req Fixed System	Total Ft Space Req Random System
12345	Gidgit	Box	2'×3'×1'	6 cu ft	50	300	90
54321	Whazzit	Carton	4'×4'×4'	64 cu ft	100	6,400	1,920
67890	Whozzit	Case	3'×4'×2'	24 cu ft	25	600	180
09876	Doodad	Box	2'×3'×1'	6 cu ft	50	300	90
						7,600	2,280

If Hammer Co was going to store product in fixed positions, it would have to plan around a minimum of 7,600 cubic feet of actual storage space. Although each of these items is required to produce Hammer Company's products, they are not all needed at the same time. On average Hammer only has on hand 30 percent of any of the above items at any one time. If it used a random locator system it would plan for approximately 2,280 cubic feet of actual storage area.

Pros

The major reasons to consider using a random locator system are:

Maximization of space.

Control of where all items are at any given time.

Cons

Major concerns regarding the use of random locator systems are:

Constant updating of information is necessary to track where each item is at any given time. Updating must be accomplished through manual paper-based recording, bar code scanning, or intensive data entry updating.

May be unnecessarily complicated if your organization has a small number of SKUs.

Basically, random locator systems force a tradeoff between maximization of space and minimization of administration.

Combination Systems

A system that blends many of the best features of fixed and random locator systems are combination systems.

Basic Concept

Combination systems enable you to assign specific locations to those items requiring special consideration, while the bulk of the product mix will be randomly located. Very few systems are purely fixed or purely random.

Conceptually, you are trying to enjoy the best features of the fixed and random systems. You achieve this by assigning only selected items to fixed homes—but not all items. Therefore, you only have to plan around the maximum space required by the selected items instead of that required by all items. For the items not in fixed homes, you can plan around the average quantities you expect to have on a daily, ongoing basis. So, the fixed system is used for the selected items and the random system for everything else.

A common application of the combination system approach is where certain items are an organization's primary product or raw materials line and must be placed as close as possible to a packing/shipping area or to a manufacturing workstation. Those items are assigned a fixed position, while the remainder of the product line is randomly positioned elsewhere. See Exhibit 3–8 for typical scenarios for utilizing a combination locator system.

Exhibit 3-8: Typical Scenarios Involving Combination Location Systems

Scenario One: Barash Foods decided to speed up its order filling efforts by changing where product was located in relationship to the shipping dock. First it determined which 15–20 percent of its product lines showed up on 80 percent of its orders. These items would be assigned to fixed positions close to the point-of-use (shipping dock), while those items found in only 20 percent of the orders would be randomly stored.

Barash had to decide if these fixed homes would be large enough to hold 100 percent of the cubic space necessary to house a product if the maximum quantity of it was in the facility at one time during the year. The company decided it could not devote that much space per product in the limited area closest to the point-of-use. It therefore decided to allow for 100 percent of the space needed for one week's worth of product movement for the fixed location SKUs. In other words, while still having to follow the fixed location system rule that space must exist for 100 percent of the cubic space required for the maximum quantity of an item expected during a given time period, it controlled the space and quantity by shortening the timeframe.

Random items were stored in accordance with the general rule that random space is planned around the average quantity expected in an area during a defined time period. In this case the time period was one year.

Scenario Two: Charmax Manufacturing is a "job shop" electronics manufacturer. It manufactures special-order items and often will only produce one, never-to-be-repeated run of an item. Therefore, some specific raw materials inventories required for any given production run may never be needed in the future. However, the company uses many common electronics components such as resisters, transistors, and solder in most of the final assemblies it produces. Its physical plant is very small.

Charmax carefully reviews its master production schedule to determine when various subassemblies and final assemblies will be produced. It then analyzes the bill-of-materials (the recipe of components) for the sub- or final assemblies, and orders as much specific purpose items as possible on a to-be-delivered just-in-time basis. This holds down the quantity of nonstandard inventory it will have in-house at any one time.

Charmax then establishes fixed positions for working stock, both special-order and standard stock items, during a production cycle around the appropriate workstations. Where working stock would consume too much space around a work area, working reserve stock is placed in zone locations close to the workstations. Regular, general-use product, such as resisters and transistors, is stored in random order. This combination location system—which is comprised of fixed,

zone, and random storage for working, working reserve, and general stock—allows Charmax to maximize its use of space at any given time.

Common Item Placement Theories

Locator systems provide a broad overview of where SKUs will be found within a facility. Physical control of inventory is enhanced by narrowing the focus of how product should be laid out within any particular location system. As with locator systems, item placement theories (where should a particular item or category of items be physically positioned) go by many different names in trade literature. By whatever name, most approaches fall into one of three concepts: inventory stratification, family grouping, and special considerations.

Inventory Stratification

Inventory stratification consists of two parts:

1. A-B-C categorization of SKUs

2. Utilizing an SKU's unloading/loading ratio

A-B-C Categorization of SKUs

This item placement approach is based on "Pareto's Law." In 1907, an Italian sociologist and economist by the name of Vilfredo Pareto (1848–1923) expressed his belief that 80 to 85 percent of Italy's money was held by only 15 to 20 percent of the country's population. He called the small, wealthy group the "vital few" and everyone else the "trivial many." This ultimately came to be known as the "80–20 Rule," or Pareto's Law. The concept stands for the proposition that within any given population of things, approximately 20 percent of them have 80 percent of the "value" of all of the items concentrated within them, and that the other 80 percent only have 20 percent of the value concentrated within them. "Value" can be defined in various ways. For example, if the criterion is money, then 20 percent of all items represent 80 percent of the dollar value of all items. If the criterion is usage rate, then 20 percent of all items represent the 80 percent of the items most often used/sold.

Accordingly, for efficient physical inventory control, using popularity (speed of movement into and through the facility) as the criterion, the most productive overall location for an item is a storage position closest to that item's point-of-use. SKUs are separated into A-B-C categories, with "A" representing the most popular, fastest moving items (the "vital few"), "B" representing the next most active, and "C" the slow movers.

Providing product to outside customers is often the chief objective of a distribution environment. Therefore, in a distribution environment, the point-of-use would be the shipping dock. In a manufacturing environment, a workstation would become the point-of-use, with the most active, most often required raw materials positioned in near proximity to it.

To separate an inventory into A-B-C categories, create a sorted matrix that presents all SKUs in descending order of importance and allows for the calculation of those items representing the greatest concentration of value. Exhibit 3–9 represents selected rows of a complete listing of SKUs.

Exhibit 3-9: Categorization for Item Placement by Popularity

A	B	C	D	E	F	G
Line No.	Part No.	Description	Annual Usage	Cumulative Usage	% Total Usage	% Total Items
1	Part 79	Product A	8,673	8,673.00	6.3%	0.3%
2	Part 133	Product B	6,970	15,643.00	11.3%	0.7%
3	Part 290	Product C	5,788	21,431.00	15.5%	1.0%
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.						
.						
17	Part 70	Product Q	1,896	64,915.00	47.0%	5.7%
18	Part 117	Product R	1,888	66,803.00	48.4%	6.0%
19	Part 134	Product S	1,872	68,675.00	49.7%	6.3%

20	Part 170	Product T	1,687	70,362.00	50.9%	6.7%
21	Part 182	Product U	1,666	72,028.00	52.1%	7.0%
22	Part 28	Product V	1,646	73,674.00	53.3%	7.3%
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30	Part 278	Product AD	997	82,919.00	60.0%	10.0%
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93	Part 295	Product CJ	325	123,350.00	89.3%	31.0%
94	Part 30	Product CK	325	123,675.00	89.5%	31.3%
95	Part 11	Product CL	323	123,998.00	89.8%	31.7%
96	Part 192	Product CM	321	124,319.00	90.0%	32.0%
97	Part 96	Product CN	321	124,640.00	90.2%	32.3%
98	Part 40	Product CO	298	124,938.00	90.4%	32.7%
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272	Part 86	Product JG	6	138,053.00	99.9%	90.7%
273	Part 32	Product JH	6	138,059.00	99.9%	91.0%
274	Part 129	Product JI	5	138,064.00	99.9%	91.3%
275	Part 164	Product JJ	5	138,069.00	100.0%	91.7%
276	Part 283	Product JK	5	138,074.00	100.0%	92.0%
277	Part 252	Product JL	5	138,079.00	100.0%	92.3%
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298	Part 151	Product KG	–	138,134.00	100.0%	99.3%
299	Part 61	Product KH	–	138,134.00	100.0%	99.7%
300	Part 165	Product KI	–	138,134.00	100.0%	100.0%

What the Matrix Shows

Before attempting to understand how the matrix is mathematically constructed, you first have to explore what information the matrix is presenting. Unless otherwise stated, all references are to Exhibit 3–9.

- Column A is merely a sequential listing of the number of SKUs in the total population. The example shows 300 items. If an organization had 2,300 SKUs, Column A of its matrix would end with Row 2,300.

- Recall that Pareto's Law has two components. The first refers to the percentage of all items that a certain number of items represent, and the second to the percentage value that the same grouping of items has when compared to the value of all other items combined.

- Column G reflects the first aspect. For example, 30 items represent 10 percent of 300. Therefore, Column G, Row 30 shows 10 percent of all 300 items.

- Column F reflects the second aspect. For example, the first three items (Rows 1, 2, and 3) of Column A have a combined value (usage rate) of 15.5 percent. That 15.5 percent is shown at Row 3 of Column F. (How the 15.5 percent is arrived at is explained below in "Creating the Matrix.")

- After creating the matrix, a review of Column F leads to decisions as to where the cutoff should be for each (A-B-C) category. There is no rule of thumb. The decision is a common sense, intuitive one. In Exhibit 3–9, since 19 of all items represented almost 50 percent of the value of all items (see Row 19, Column F), it seems appropriate to cut off the A category at that number. It would have been just as appropriate to cut it off at Row 20, Column F, which shows 50.9 percent.

Creating the Matrix

Here is how to create the matrix:

- Most application software programs include a report generator module that allows various fields of information, such as SKU identifiers, descriptions, and quantities, to be extracted from the general database and saved in a generically formatted (ASCII) file.[1] This information may then be exported into one of the commonly available spreadsheet software programs such as Excel. Rather than undertaking the data entry required to input the information found in Columns B, C, and D, you should obtain this information from your report generator and then export it into a spreadsheet program.

- Column A—reflects the number of SKUs being analyzed. It is organized in ascending numeric sequence (1, 2, 3 …).

- Column B—SKU number/identifier.

- Column C—SKU description.

- Column D—Annual usage quantity of the SKU.

In a retail/distribution environment, where the inventory is comprised of finished goods, Column D will contain the immediately preceding 12 months' usage quantities. This is based on the rule of thumb that the product lines will remain relatively unchanged during the upcoming 12-month period. The immediately preceding 12 months' usage rates will reflect any product trends and is more timely than using the immediate past calendar year's rates.

In a manufacturing environment, raw materials, components, and subassemblies used during the past 12 months may not be required during the upcoming 12 months. Therefore, the data for Column D must be derived from the master production schedule (the projection of what is to be built and in what quantities). After determining what will be built and in what quantities, examine the bill-of-materials (BOM), the recipe of what pieces and parts will actually go into the items to be manufactured. The data necessary for Column D is ascertained by multiplying the appropriate items in the BOM times the quantity of items to be built.

Column D is sorted in descending order, with the highest use item appearing at the top and the most inactive item at the bottom.

Column D is the sort field. However, if only Column D was sorted, the information in it would become disassociated from the SKUs the data represents, which information is reflected in Columns B and C. Therefore, the sort range includes columns B, C, and D so that all related information is sorted together.

- E—Cumulative total of Column D.

To derive the percentage value that a number of items have compared to the value of all items, it is necessary to establish that overall value as well as the value that any given number of items added together may possess. This is what Column E does.

Note that the first row of Column E is the same as the first row of Column D. Note that adding together the first two rows of Column D results in the second row of Column E. The sum of the first three rows of Column D equals the third row of Column E. The sum of the first 17 rows of Column D results in the data in Row 17 of Column E, and so forth.

The data shown in Row 300 of Column E reflects the usage value of all 300 items added together. The information on any given Row of Column E reflects the value of all of the preceding SKUs added to the value of that specific row's value.

- F—This is the second aspect of Pareto's Law. It reflects the percentage value that a grouping of items has when compared to the value of all other items.

Column F is derived by dividing every row of Column E by the last value of Column E. In other words, the first value in Column F (6.3 percent) results from dividing the first row of Column E (8,673) by the last row of Column E (138,134). The

value found in Row 2 of Column F is derived from dividing the amount shown in Row 2 of Column E (15,643) by the last row of Column E (138,134), and so forth. Using arithmetic terminology, each row of Column E acts as a numerator, the last row of Column E is the denominator, and the quotient is found in Column F.

- G—This is the first aspect of Pareto's Law. It reflects the percentage of all items compared with all other items. In other words, 3 is 1 percent of 300.

- Column G is derived by dividing every row of Column A by the last number in Column A. In other words, the first value in Column G (0.3 percent) results from dividing the first row of Column A (1) by the last row of Column A (300). The value found in Row 2 of Column G is derived from dividing the amount shown in Row 2 of Column A (2) by the last row of Column A (300), and so forth.

- After creating the chart, you look down Columns F and G and decide where you want to place the cutoff for categories A, B, and C. Product would then be arranged according to its category.

- Appendix B sets out the formulae necessary to create the matrix for 300 SKUs in Microsoft Excel®.

Utilizing an SKU's Unloading/Loading Ratio

Even more efficiency in physical inventory control can be achieved through placing items within the A-B-C zones according to that SKU's unloading-to-loading ("unloading/loading") ratio. The unloading/loading ratio reflects the number of trips necessary to bring an item to a storage location compared with the number of trips required to transport it from a storage point to a point-of-use. If one trip was required to bring in and store a case of product, but 10 trips were required to actually take its contents to a point-of-use, the unloading/loading ratio would be 1 to 10 (1:10). Substantial reductions in handling times can be achieved through application of this principle. See Exhibit 3–10.

Exhibit 3-10: Unloading/Loading Ratio Time Savings

Assumptions:

- One case of photocopying machine paper brought in and stored

- Case holds 10 reams

- Only using one ream of paper at a time
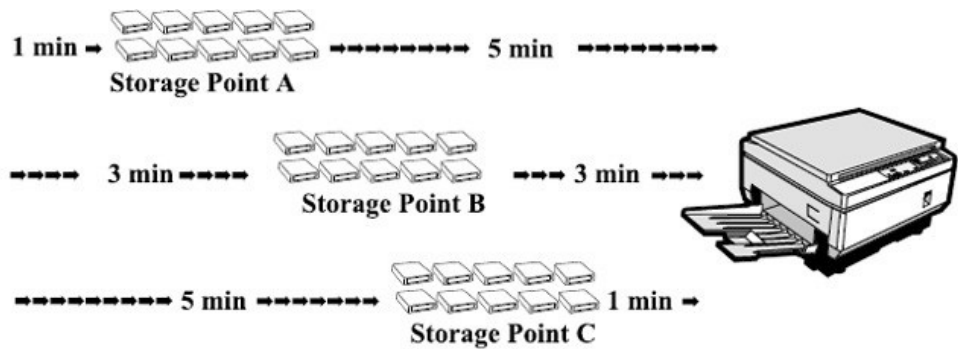
POINT A	POINT B	POINT C
10 items x 1 trip x 1 min = 10 min	10 items x 1 trip x 3 min = 30 min	10 items x 1 trip x 5 min = 50 min
10 items x 10 trips x 5 min = 500 min	10 items x 10 trips x 3 min = 300 min	10 items x 10 trips x 1 min = 100 min
510 min	330 min	150 min
	180 min saved over Point A	360 min saved over Point A
	180/60 = 3 hours saved	360/60 = 6 hours saved

The closer the unloading/loading ratio is to 1:1, the less it matters where an item is stored within an A-B-C zone because the travel time is the same on either side of the storage location. The more the ratio increases, the more critical it is to

place an item closer to its point-of-use. Assuming 7 productive hours of labor within an 8-hour work shift, a reduction of even 30 seconds in travel time every 5 minutes will result in a time savings of 42 minutes. See Exhibit 3–11.

Exhibit 3-11: Practical Effect of Inventory Layout Changes

If a change in procedure, layout, product design, paperwork, or any other factor saved 30 seconds every 5 minutes, how much time would you save each day?

- Assume 7 actual work hours per day

- 60 minutes × 7 hours = 420 minutes

- 420 minutes ÷ 5 minutes = 84 segments

- 84 × 30 seconds = 2,560 seconds

- 2,560 seconds ÷ 60 seconds = 42 minutes

Saving 30 seconds every 5 minutes saves 42 minutes per day!

Family Grouping

An alternative to the A-B-C approach is the family grouping/like product approach. This approach to item placement positions items with similar characteristics together. Theoretically, similar characteristics will lead to a natural grouping of items, which will be received/stored/picked/shipped together.

Groupings can be based on:

- Like characteristics—widgets with widgets, gidgits with gidgits, gadgets with gadgets.

- Items that are regularly sold together—parts needed to tune up a car.

- Items that are regularly used together—strap with sports goggles.

Pros

There are a number of advantages to using family groups, including:

- Ease of storage and retrieval using similar techniques and equipment.

- Ease of recognition of product groupings.

- Ease of using zoning location systems.

Cons

Before using the family grouping approach you should carefully consider some of its negatives, as follows:

- Some items are so similar they become substituted one for the other, such as electronics parts.

- Danger of properly positioning an active item close to its point-of-use, but consuming valuable space close to that area by housing far less active "family member" items with their popular relative.

- Danger of housing an active product with its inactive relatives far from the popular SKU's point-of-use, all for the sake of keeping like items together.

- An item can be used in more than one family.

- Using inventory stratification and family grouping together

Effective item placement can often be achieved through tying both the inventory stratification and family grouping approaches together. For example, assume order-filling personnel travel up and down a main travel aisle, moving into picking aisles to select items, and then back out to the main aisle to proceed further. Further, assume 12 brands of Gidgits are all stored in the same area for purposes of family grouping. Pareto's Law indicates that not all brands of Gidgits will be

equally popular. Consequently, using both the inventory stratification and family grouping concepts together, the most popular Gidgit brands are positioned closer to the main travel aisle and the least popular furthest from it. The end result is a more efficient overall layout.

Special Considerations

A product's characteristics may force us to receive/store/pick/ship it in a particular manner. The product may be extremely heavy or light, toxic or flammable, frozen, odd in shape, and so on.

Even with items requiring special handling or storage, such as frozen food stored in a freezer, the inventory stratification and family grouping concepts can and should be employed to ensure efficient inventory layout.

[1]American Standard Code of Information Interchange (ASCII) is the basic 128-character set understood by all computer systems.

Location Addresses and SKU Identifiers

You simply cannot control what you can't find. Therefore, it is imperative that you create and maintain a system of location addresses and SKU identifiers. Those two elements are essential to tracking an item no matter where it goes.

Significance

Major contributing factors to the success of inventory systems are:

- Adequate, appropriate identification markings on SKUs, including both SKU number and stock keeping unit of measure. These markings allow a worker to quickly and easily identify an item without having to read and translate product descriptions and confusing pack size designations. This ease of recognition reduces errors and the time required for either stock selection or put-away.

- Adequate, appropriate identification markings on bin/slot/floor/rack/drawer/shelf locations. Just like the address on a house, the address of a specific location in the stockroom lets you quickly find the "tenant" or "homeowner" SKU you are looking for.

- Procedures tying any given SKU to the location it is in at any given time. How does the post office know where to send mail to someone who has moved? Obviously, the relocated person fills out a change of address form. In much the same manner, you must set up a procedure that tells your system where a product lives, and if it moves—where to.

- Procedures tying a single SKU to multiple locations in which it is stored. If you have two homes, you let your friends know the addresses. Your friends then put that information together in their address books. You must do the same thing for products residing in two or more locations within the building.

- A system for tracking items, on a timely basis, as they change locations. Whatever form your "change of address" form takes, it has to be filled out and processed quickly.

- Package advertising that does not obscure SKU identifier codes.

- Use of simple marking systems that are easy to read and understand. You should avoid complicated marking systems that are difficult to read, understand, recall, or are conducive to numerical transposition. For example, markings such as "2/24 oz" and "24/12 oz" are quantity-oriented coding employing numbers describing the quantity and size of the inner packages. However, such numbers are easily reversed or transposed, and are not intuitively understood.

If you incorporate these elements into your inventory systems, you can expect:

- Decreased labor costs related to search time for product. These search-time savings manifest themselves not only when you search for an individual item, but most definitely when product is located in multiple unspecified locations.

- Decreased labor costs associated with searching for appropriate storage locations.

- Elimination of the unnecessary purchase of items that are already in the facility but are undiscovered when needed.

- Correct selection of SKUs during order filling.

- Correct selection of pack size(s) during order fulfillment.

All of the above lead to more accurate inventory tracking, less wasted time to correct errors, and an increase in customer satisfaction.

Keys to Effectively Tying Together SKUs and Location Addresses

To keep track of where SKUs are at any given time, it is necessary to:

- Clearly mark items with an SKU identifier.

- Clearly mark items with a unit of measure such as pack size.

- Clearly mark location addresses on bins/slots/shelves/racks/floor locations/drawers/and so on.

- Tie SKU numbers and location addresses together either in a manual card file system or within a computerized database.

- Update product moves on a real-time basis with bar coding coupled with radio frequency scanners (see Chapter 4, "Automatic Identification").

Clearly Mark Items with an SKU Identifier; Clearly Mark Items with a Unit of Measure

Too often, managers believe that workers can read and understand a product's markings and packaging. The end result of this belief is error after error. To eliminate many of these identification miscues, you need to clearly mark items with an identifying number and a unit of measure. Workers will make far fewer errors matching a number on a box to the same number on a piece of paper than they will trying to match words or abbreviated descriptions.

The SKU identifier is generally an organization's own internal identifying code for the item, rather than a manufacturer's or customer's number for that SKU. Although the SKU number itself is often adequate for identification purposes, in manufacturing it may be necessary to also include lot and serial numbers to aid in quality control. Lot and serial numbers make it possible to track manufacturing batch, date, location, and inspector. Exhibit 3–12 reflects various methods of getting items actually labeled or marked.

Exhibit 3-12: Marking SKUs

By manufacturer

• Manufacturer prints or affixes plain, human readable label on the item and/or a bar code label with coding on the items. Manufacturer obtains labels or you provide them.

At vendor site

• Vendor from whom you obtain the product prints or affixes your plain, human readable label on the item and/or a bar code label with coding on the items. Manufacturer obtains labels or you provide them.

At time of receiving

• Everything comes through receiving—it is a natural node. That convergence allows you the opportunity to affix plain, human readable label on the item and/or a bar code label with coding on the items.

• You can have all product that turns even once during the year marked in this manner, with faster moving items (12 turns a year) all marked within a few weeks.

Markings related to unit of measure (such as each/pair/dozen/barrel/ounce/pound/cylinder/barrel/case) also serve to greatly reduce error in picking and shipping.

Clearly Mark Location Addresses on Bins/Slots/Shelves/Racks/Floor Locations/Drawers

Just as you could not find a house in a city if its address was not clearly identified, you cannot find a storage location unless its address is clearly marked or easily discerned in some other manner. The addressing or location system you choose should have an underlying logic that is easy to understand. Addresses should be as short as possible, yet they should convey all needed information.

You should first consider whether the system will be all numeric, all alphabetic (alpha), or alpha-numeric. In deciding which system to adopt, consider the following:

- All numeric systems require sufficient digit positions to allow for future growth. Because each numeric position only allows for 10 variations (0–9), numeric systems sometimes become too lengthy. In other words, since a single numeric position only allows 10 variations, if you required 100 different variations (for 100 different SKUs), you would need two digit positions, representing 00 through 99 (10 × 10). One thousand variations would require three numeric positions, 000 through 999, and so on. See Exhibit 3–13, Alpha-Numeric Variations.

- Systems that are completely alphabetic allow for 26 variations per position, A through Z (assuming only capital letters). Two alphas together, AA through ZZ (26 × 26), allow for 676 variations. Three alphas, AAA through ZZZ, allow for 17,576 variations. See Exhibit 3–13, Alpha-Numeric Variations. Although alphas provide numerous variations in a short address, systems that are completely alphabetic are visually confusing (HFZP).

- Alpha-numeric systems often provide for visual differentiation while allowing sufficient variations in a short address.

- *Caution*: While alpha systems require fewer characters to hold the same number of variations, they are more error prone. For example: Is that the number zero or the letter O? A one or the letter I? A two or the letter Z? A P or an R? A Q or an O? If you are only dealing with a computer system, then characters are "cheap," and you could use only numerics to avoid confusion. However, if part of your system will involve human-readable labels, placards, or markings where a long string of numbers might present a problem or where you are trying to keep a bar code label short, you might have to balance out the merits of shorter alpha-numeric systems against longer pure numeric systems.

## Exhibit 3-13: Alpha-Numeric Variations

$0 \rightarrow 9 = 10$	
$00 \rightarrow 99 = 100$	$10 \times 10 = 100$
$000 \rightarrow 999 = 1{,}000$	$10 \times 10 \times 10 = 1{,}000$
$A \rightarrow Z = 26$	
$AA \rightarrow ZZ = 676$	$26 \times 26 = 676$
$AAA \rightarrow ZZZ = 17{,}576$	$26 \times 26 \times 26 = 17{,}576$

Exhibit 3–14 presents some common location addressing systems for racks or shelving. Exhibit 3–15 presents common location addressing systems for bulk storage.

Exhibit 3-14: Addressing Racks, Drawers, and Shelving

APPROACH	EXPLANATION				
"Street Address" 03A02B02	03 Room (City)	A Aisle (Street)	02 Rack (Building)	B Tier (Floor)	02 Slot (Apt.)
	Although this is a lengthy address if an automated storage and retrieval system (AS/RS) is used, detailed exact spot information is required for the selector arm to find the desired load.				
"Rack-Section-Tier-Bin" 030342	03 Rack	03 Section[*]	4 Tier	2 Bin	
Room/Bldg-Rack-Bin AA001	A Rm/Bldg	A Rack	001 Bin		
Rack-Bin AA001	AA Rack	001 Bin			
	These last two systems are short, simple, and easy to remember, but they do not provide tier information.				
[*]A rack section is that portion of the weight bearing horizontal support between two upright supports.					

Exhibit 3-15: Bulk Storage Grid Addressing System
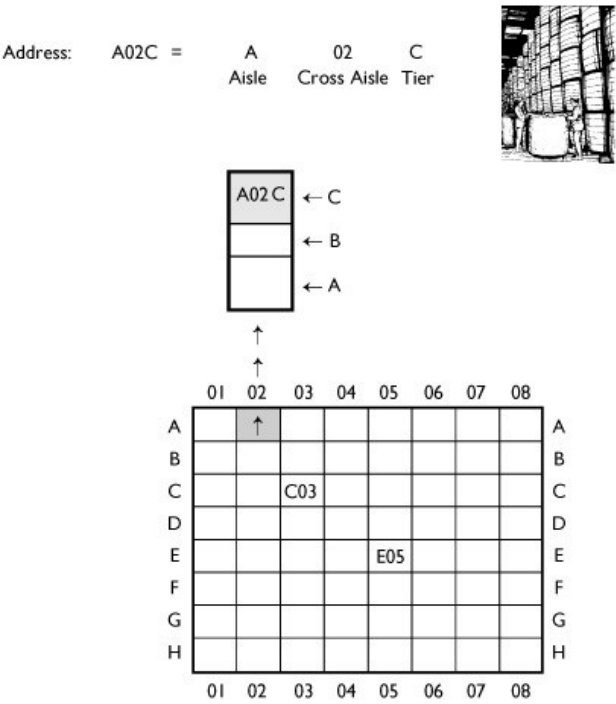
• In bulk storage areas, you can utilize a simple grid denoted with placards on walls or on the building's structural supports to find an address on the floor. This is done through two lines bisecting on a flat plain.

• For vertical addresses, you triangulate three lines.

• The above is applied geometry (Cartesian Coordinates) developed by René Descartes, the famous French mathematician.

Tie SKU Numbers and Location Addresses Together

The placement of identifiers on both product and physical locations creates an infrastructure by which you can track product as it moves. The next step is marrying together an SKU number and the location(s) where that item is located. This can be easily accomplished by using a simple 3 × 5 card file system (which should be computerized as soon as possible). See Exhibit 3–16.

Exhibit 3-16: Simple Card File Tracking System

```
            SKU#    QUANT    LOC
            SKU 3    135    LOC  1

                      87    LOC  2

                     965    LOC  3


        SKU#    QUANT    LOC
        SKU 2    27     LOC  1

                 57     LOC  2


    SKU#    QUANT    LOC
    SKU 1    1235   LOC  1

             187    LOC  2

             187    LOC  3

             543    LOC  4
```

Cards are marked with all SKU numbers. Cards will be indexed in ascending number sequence—lowest SKU number in the front of the file box and the highest SKU number appearing last. All locations and quantities for that specific item are noted. As SKUs are added-to or moved, card file information is updated as often as possible. Updates should occur at least twice daily, for example, during the lunch hour and at the end of the workday.

Update Product Moves

A final step in managing inventory is tracking it as it is added to, deleted, or moved. This challenge exists for any organization whether or not the company uses manual tracking, computerized approaches, or bar coding.

The best generally available approach for real-time tracking of items as they move is using bar coding mobile scanners with radio frequency (RF) capability. See Chapter 4, "Automatic Identification."

If RF-capable bar coding is not available, then updating can be accomplished as follows:

- Portable bar code scanners that capture the information within the scanner mechanism or on a disk in the scanner. The information is then uploaded into the computerized database either through the communications ports on the scanner and computer, or by loading the scanner disk into the computer.

- Manually captured, paper-based information (see Exhibit 3–17) is entered into the database through keying (data entry by a human being).

- Manually captured, paper-based information is manually written onto file cards.

- No matter what method is used, it is imperative that information relative to inventory additions, deletions, or movement be inputted into the system as soon as possible. To the greatest extent possible, the shelf count (what is actually in the facility and where it is) should match the record count (the amount reflected in the main database records). The longer the time lag between inventory movement and information capture and updating of the record count, the greater the chance for error, lost product, and increased costs.

Exhibit 3-17: Bulk Storage Grid Addressing System

STOCK MOVEMENT REPORT

SKU# _____

Date _____   Time _____

Quantity _____

From _____   To _____

Recap

Organizations should carefully consider specific item placement within an overall location system to maximize each SKU's accessibility while being mindful of that item's point-of-use, unloading/loading ratio, relationship to similar items, or characteristics requiring special handling.

Organizations lacking procedures that identify the location of each SKU within the facility suffer from excessive labor costs, "lost" product causing additional items to be purchased to cover for those on-site but unavailable when required, poor customer service, and general confusion. Controlling product location and movement centers around establishing an overall locator system that effectively reflects the organization's basic inventory nature such as finished goods in a retail/distribution environment or raw materials and subassemblies in a manufacturing facility. Often legitimate operational and storage objectives are in conflict with one another, resulting in final location system decisions made on the basis of a series of tradeoffs.

And finally, each item's present location must be identified with that SKU's identifier, with address and quantity changes being updated on an ongoing, timely basis.

Review Questions

1. Honeycombing is best described as: ?
    a. product unevenly stacked.

    b. matrix racking or shelving layout.

    c. empty space in usable storage areas.

    d. the number of items per level and the number of tiers of product on a pallet.

2. Memory location systems: ?
    a. are simple and efficient.

    b. are human dependent.

    c. require updating of location information.

    d. are useful when a large number of different SKUs must be quickly located.

3. Regarding random locator systems: ?
    a. each item has an assigned home in a random zone.

    b. an item's home is the location it is in while it is there.

    c. an SKU's storage location must be planned around the maximum quantity of that item expected to be on-site during a defined time period.

    d. only certain items may be placed in the bulk storage areas of the facility.

4. In relationship to its unloading/loading ratio, an SKU should be placed closer to its point of use if the ratio is: ?
    a. 1:28.

    b. 1:1.

    c. 3:15.

    d. 28:28.

5. Pareto's Law holds that: ?
    a. 80 percent of all items account for 80 percent of the dollar value of 20 percent of those items.

    b. 20 percent of all items account for 20 percent of the usage value of 80 percent of those items.

    c. 80 percent of all items contain 20 percent of the value of those items.

    d. a fixed locator system is operationally efficient 20 percent of the time for 80 percent of all items.

Answers

1. (c)

2. (b)

3. (b)

4. (a)

5. (c)