**VLM SLOTTING HANDBOOK**

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**INTRODUCTION**

***Slotting***is the art of placing warehoused material in planned locations for optimal handling efficiency. While this concept might seem simple and straight-forward, in the *modern warehouse* of automated equipment and mixed storage media, effective slotting is anything but obvious or intuitive.

Effective slotting requires an understanding of many related issues−all specific to the individual customer’s business. It must take into account the:

• Physical parameters of the warehouse

• Material handling equipment

• Ongoing operational procedures

• SKU makeup

• Order profile

• Service levels

• Seasonal inventory changes

• Employee skills/training

• Customer’s marketing and general business plans

• The interactions between all of the above.

After properly considering all the foregoing, the system designer must assign each SKU to a location:

• In proper storage media

• Of the correct cubic volume

• At an appropriate access level

• In the optimum warehouse zone

**The Importance of Slotting**

**Slotting can either make or break a material handling project.** It has a dramatic influence on the throughput and efficiency of a system. It is *the principal means for achieving a high pick rate from essentially slow-moving machines*. Slotting considerations should influence a project from the initial conception, through site implementation, and into the ongoing operation of the system.

**The Necessity of Customer Involvement**

A vitally important aspect of the slotting process is *customer involvement*. The customer must

be involved because no one knows their own business better. Customers must learn, understand, and appreciate the importance of slotting because it is entwined with so many aspects of their

 business and because slotting is an *ongoing maintenance activity*.

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**The Necessity of Customer Involvement (cont.)**

To keep a system “fine-tuned” to its optimal efficiency, slotting must be updated at regular

(monthly, weekly or even daily) intervals.

A high level of customer participation benefits everyone. The customer comes to appreciate the underlying assumptions of slotting, and the educational process prompts early and continued

buy-in to the system design. It follows then, that everyone who is in contact with the customer should understand the importance of slotting and be part of the ongoing educational process.

**About This Handbook**

The principles indicated in this document are applicable to most warehouse storage and retrieval activities.

The handbook roughly divides into two sections that describe slotting theory and practice. The first section, *Basic concepts*, introduces the general reader to slotting’s vocabulary and conceptual assumptions. The second section, *The slotting process*, provides the practitioner with guidelines to follow.

**BASIC CONCEPTS**

Slotting assigns a warehouse location to each Stock Keeping Unit (SKU) in the customer’s inventory. Therefore, the process begins with a thorough analysis of the SKU assortment.

*The customer* provides the data for the analysis, typically in the form of sales history. The more complete the data provided, the more potentially accurate the slotting.

In analyzing the SKU profile, system designers measure each item in terms of two parameters − *cube* and *velocity*. Cube measures the physical space required to store a given SKU in the quantity indicated by the sales history. Velocity is the rate at which a given SKU moves through the warehouse. It measures how often and in what quantities orders request the item. It classifies items as fast or slow movers.

There are two aspects to velocity: *line* velocity and *piece* (item) velocity. While many customers focus on one or the other, both are vital for slotting. Line velocity represents how often a given SKU is picked. (These events are called *picks*, *hits*, *visits* or *bin trips*. SKU is picked. (These events are called *picks*, *hits*, *visits* or *bin trips*.)

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 **BASIC CONCEPTS (cont.)**

It tells how many orders contained that SKU. Piece velocity simply represents the quantity shipped or sold, irrespective of the number of orders involved.

Considered together, velocity and cube let system designers assign SKUs to appropriately sized locations in the proper storage media. Ultimately, it lets engineers specify the size of the system. Following cube/velocity analysis, the slotting process has three distinct phases:

• Media selection

• Cell sizing

• Location assignment.

**Media Selection**

In slotting SKUs in a storage system, one of the first considerations to make is what storage media is appropriate. Every SKU does not belong in a storage system. The goal is to determine what SKUs are “storageable,” and what media is appropriate for the SKUs that are not.

This decision is based partially on SKU velocity. SKUs with a very high velocity are better handled in A-frames or flow racks. The constant need to replenish these items would actually decrease the efficiency and throughput of a carousel system.

On the other end of the velocity scale, the very slow movers are better stored on static shelving. Unwisely placed in a carousel bin, such items lengthen the transit time of the machine. Each time a carousel rotates past that almost-never-accessed bin, it wastes time. Cumulatively, this slows the system.

“Good” carousel stock then is typically a subset of the SKUs that have a *medium velocity*. They are called for often enough to make automatic retrieval sensible, but not demanded so often that the system slows through too-frequent replenishment.

SKU movement−by line or piece rate−may intuitively seem to be a sufficient criteria for SKU selection. However, experience has shown that SKU selection based on *movement alone is not the best way to design the most efficient system*. Rather engineers strive to base designs on *cube efficiency*.

***The Role of Cube (carousel application)***

Cube has the pivotal role to play in media selection. Engineers analyze volume first. They immediately exclude items that are too large or oddly shaped for the typical carousel bin. (Heavy

or otherwise ergonomically difficult to handle items are likewise poor candidates for carousel storage).

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Only when engineers understand the *cube rate* (volume per *n* days), do they factor in movement

(lines or pieces per *n* days). Relating cube to velocity, they arrive at the subset of SKUs that are

appropriate for carousel slotting.

In general, SKUs with high velocity and low volume are good choices for carousel placement.

The ratio of *lines per cubic foot* is known as *pick density* and translates into a measurement of

carousel suitability. For example, if a SKU has a line velocity of 20 lines per week, and this

movement displaces two cubic feet of bin volume, the SKU’s pick density then equals 10. The

higher a SKU’s pick density score, the better suited it is for carousel storage.

***The 20 Day Rule***

The accepted rule of thumb requires that a 20-day supply of the SKU should be able to fit within

10 cubic feet of bin space. The 10 ft3 cut off represents about half of a typical carousel bin.

Filling bins beyond half slows a system by decreasing the number of SKUs that could be

presented by the same number of bins. Adding more bins to compensate, wastes time by

increasing the average distance between successive picks.

The general goal of holding 20 working days of each SKU in the carousel derives from the need

to properly manage replenishment. Fewer than 5 days of stock isn’t practical. It would require

replenishment of 20% of the SKUs each day prior to the pick shift. A 20-day supply only

requires replenishment of a more manageable 5% per day.

Fewer days of inventory may be acceptable if the number of SKU’s in the system is relatively

small, thus the absolute number of replenishments remains low. However, if too few days of

inventory are stored, *short picks* can increase dramatically. Typical variations can cause a single

day’s movement to exceed the minimum storage quantity.

**Cell Sizing**

The ideal system has four basic cell sizes plus multiples of the largest size. For example:

• ¼ shelf x 1 foot

• ½ shelf x 1 foot

• 1 shelf x 1 foot

• 1 shelf x 2 foot

• 1 shelf x 3 foot

No system should exceed six different sizes as larger numbers make the slotting process

cumbersome. Increasing the complexity of the cell scheme buys little (if any) increased storage

density or efficiency. Moreover, as slots are more tightly defined, SKUs will need reslotting

more frequently. Small changes in velocity will shift the optimal cell size.

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**Location Assignment**

At first glance, it might seem logical to place the most frequently requested SKUs in the bins

closest to the workstation end of the carousel. Years of testing and experience, have shown

otherwise. As systems begin to grow in size and complexity, a *random* distribution will increase

efficiency and throughput.

The design goal is to balance the work among the pods so that no individual becomes either

*saturated* with or *starved* for work. The aim is to keep each pod operator engaged in safe and

unhurried, but *continuous activity*. Experience has shown that a random SKU distribution avoids

extremes of overflow and idleness. Over the breadth of the system, and through the length of the

work shift, it pays off in superior throughput and efficiency.

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**ONGOING MAINTENANCE**

To maintain system efficiency, slotting must be updated periodically. Inventories and business

plans inevitably change. As they do, the slotting in place on the day the system went live

becomes increasingly inappropriate. System performance suffers as the distribution of work

across the carousel pods becomes unbalanced and storage media becomes inappropriate for the

SKUs stored in them.

An analysis of system activity over time can indicate appropriate slotting adjustments. This

inquiry should follow two processes:

1. Search the data for indications of imbalance between:

• Media pods

• Individual media machines within a pod

• Bins on an individual carousel.

2. Examine the activity data for each SKU to determine if the original assumptions about its cell

 size are still valid and whether or not it still meets the criteria for carousel storage. Carousel software

 can generate the transactions needed to relocate stock as indicated.

**When to Update Slotting**

Like most aspects of slotting, the exact interval to re-examine the existing scheme *depends on*

*the customer’s business*. As a general rule, the more frequently slotting is updated, the more

fine-tuned and efficient the system will be. However, any of the following criteria might best

match a given customer:

**Program period:** Companies that warehouse supplies for numerous projects are likely to experience changing inventories as one program follows on the heels of another.

**Advertising campaign:** Cosmetics, fashion products, and other consumer goods inventories change rapidly and are often tightly linked to specific, short-term promotions. Slotting probably needs to be updated with each new campaign.

**Season:** Slotting results for an apparel vendor’s winter line would obviously vary greatly with its summer lines. Many categories of goods have a similar *seasonality*. Slotting updates need to reflect seasonal variation.

**Quarter:** It might make sense to couple slotting revision with the fiscal divisions of the year. Often, these intervals mark budget-based inventory changes and a general pause to take stock of the operation.

**Month:** A regular calendar interval could suit a given firm, particularly if thereslotting dovetails with their regular cycle counts. Of course, the intervalcould be weekly, or some number of SKUs could be given a daily review.Again, the more frequently the slotting is adjusted, the better the system works.

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**THE SLOTTING PROCESS**

The slotting process consists of the following activities:

 1. Gather and analyze SKU data

 2. Factor cube/velocity together

 3. Sort SKUs to appropriate storage media

 4. Size the carousel system

 5. Assign SKUs to location types

 6. Assign specific locations (if necessary).

**Gathering and Analyzing Data**

A slotting study requires SKU data. Since the objective of data gathering is to understand the

pick density (lines/cu. ft.), data for both the velocity and cube of each SKU is needed. This

information originates with the customer and is typically provided on disk to system engineers.

Activity data is usually available through some form of sales history or customer order files.

The customer’s MIS group typically provides reports for the following:

• On-hand Inventory (# of days)

• Total # of SKUs

• Lines picked for study period, by SKU

• Orders picked for study period, by SKU

• Order Profile (lines per order, per pick media) picked for the study period, by SKU.

***The Problem of Cube Data***

Package dimensions, used in display space calculations, are sometimes available. However,

SKU dimensions and cube data are commonly missing. When cube data is not readily available,

an inventory survey should be performed. If possible, measure each SKU in the inventory. This

potentially laborious task can be automated and expedited by using volumetric scanners such as

the Cubiscan® by Quantronix, Inc. If such comprehensive data gathering is not practical,

measure a sample of sufficient size that reflects the inventory.

***Special Cube Considerations***

In carousel-based broken case picking, products are not always packaged in neatly squared-off

containers. In deciding what SKUs are appropriate stock for carousels, other attributes can

overrule the simple arithmetic of cube dimensions.

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Consider the following:

• **What are the selling units?** Is the SKU sold in individual pieces (*eaches*) or in standardized

 packages. Depending on what point the warehouse occupies in the distribution channel, a

 typical order might call for one pencil, a box of 10 pencils, a master pack of 10 boxes, or a

 carton of 12 master packs. Each type of unit would imply a very different cube.

• **How does cube relate to actual space consumed?** A glass laboratory funnel might have the

 same cubic dimensions as a plastic funnel for kitchen use. Both SKUs might be sold in a unit

 of eaches. But whereas each single glass funnel would be stored in its own protective

 package, multiples of the plastic version could *nest* safely together. A 20-day supply of both

 SKUs would have radically different space requirements.

• **Is any dimension exaggerated?** An automobile side molding measuring ½” x 1 ½” x 48”

 consumes only 0.02 cubic feet, but requires a slot 48” long. Since 24” is typically considered

 an outer size limit, the item is probably a poor choice for the carousel. Similarly, a wheel

 well molding with an 18” radius, a one-piece fishing rod, or any number of small

 cube/exaggerated dimension SKUs should be excluded from the carousel inventory.

**Factoring Cube/Velocity Together**

Factoring cube and velocity together yields the amount of space the SKU should occupy in the

carousel. Do the following:

 1. From the customer’s activity history, calculate a 20-day supply for each SKU.

 2. Multiply the resulting quantity by the cube of the selling unit.

 3. Round up to a likely cell volume (typically .5 ft3). The product is the total cube to store. The

 next process is to determine if that resulting volume makes sense in a carousel.

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**Sort SKUs to Appropriate Storage Media**

Use the following criteria to further eliminate all SKUs which are not suitable for carousel

storage:

 • Any dimension larger than the largest storage location.

 • Any SKU where the cube to store is larger than the desired cut-off (typically ½ carousel bin).

The SKUs that pass these tests are probably good candidates for carousel storage. The task

remains to assign the non-carousel SKUs to other storage media. While carousel suitability is

determined by cube volume rate, assignment to alternative storage is a more often a function of

piece rate.

It may be appropriate to simply refer to the customer’s ABC report for piece rate data.

Alternatively, the carousel cube analysis and some common sense will work as well. Those

SKUs that exceed half a bin are most likely fast movers that appropriately belong in flow rack.

**Assigning SKU’s to Location Types (horizontal carousel)**

Each SKU chosen for the carousel requires a bin insert (storage *cell*) of the appropriate size. The

cells have defined sizes derived from standard carousel bin/shelf dimensions. The table below

shows some possible choices:

|  |  |  |  |
| --- | --- | --- | --- |
| Type A | 24" dp X 12" w X 7" h | 1.67 cubic feet | shelves on 9" centers |
| Type B | 24" dp X 12" w X 10" h | 1.67 cubic feet | shelves on 12" centers |
| Type C | 24" dp X 24" w X 10" h | 3.33 cubic feet | shelves on 12" centers |
| Type D | 24" dp X 24" w X 22" h | 7.33 cubic feet | shelves on 24" centers |

 (Items larger than a Type D would be put into multiple Type D locations.)

To assign SKUs to these location types, follow the steps outlined below:

1. Having calculated the total cube required for an appropriate stocking supply (typically 20

 days) of each SKU, compare the calculated volume to the cell sizes and choose an

 appropriate type.

2. Divide the SKUs into classes (usually 3) based on velocity. If a file contained about

 2,700 SKUs, they would be divided into the slowest 900 SKUs, the middle 900 SKUs,

 and the fastest 900 SKUs.

3. List the number of SKUs in each combination of location type (e.g. slow & Type A,

 medium and Type C, etc.)

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**SIZING THE SYSTEM WITHOUT CUSTOMER DATA**

When the customer’s MIS department is unable to provide appropriate data, the proposed system

can be sized by performing a physical survey of the warehouse. Follow the procedure below:

1. Focusing on the broken case picking areas of the warehouse, physically measure and count

 the various types of storage media used.

2. In the bin shelving area:

 • Exclude any sections storing parts with any one-dimension exceeding 36 inches.

 • Make note of the percent cube utilization (best guess or sample measurements).

 • Make note of the most common “home sizes/slots” and their percent utilization.

3. Complete this same study for other media containing broken case SKUs, such as flow racks

 and rack area as appropriate.

4. Summarize your findings to yield:

 • Total Media Cube

 • Media % utilization

 • Net Product Cube (SKU Actual Volume)

 • Common slot sizes and % used.

Even when customer data is provided, the method described above is a sound, fast way to double

check your sizing estimates.

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