Warehouse Picking Productivity increases by Slotting inventory in the Golden Zone

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ABSTRACT

Most companies strive to save money in their distribution and warehousing operations. The two areas where money can be saved are from minimizing obsolete inventory and increasing employee's productivity. By planning where fast moving inventory is stocked and designing how employee's work, the goal of minimizing cost and maximizing productivity can be achieved. In this research we will provide a real world example of best practices used for slotting inventory to get optimal picking performance while minimizing picking labor.

INTRODUCTION

Order picking is considered by most warehouse professionals as one of the more critical functions in distribution operations. It is one of the most customer-sensitive, labor-intensive, and more complex of warehouse functions. Because this function is labor intensive and crucial to warehousing operations, it is important that we make this function as cost effective as possible. This study describes how to stock products with respect to ergonomics so that manual order picking can be performed productively.

Traditionally, stocking of product for optimal material handling movements, or slotting, only takes into account the products movement velocity for product storage. Product movement velocity refers to how fast a product is stocked and then picked for orders over a period of time, commonly called turns. In order to attain higher productivity, stocking products by taking the order selector's human factors, or ergonomics, into account is important. Stocking products that are picked, or selected, more often than others at the most common reach heights for the worker population is believed to increase worker picking productivity. There may be other tangible benefits for this type of storage method like the reduction of worker compensation claims.

PURPOSE:

The purpose of this report is to define and demonstrate the efficiency of the basic rule of assigning and stocking fast moving products, or high velocity items, to better selecting locations in the order picking system. A "better location" is a selecting location which provides faster and more ergonomic access to the product stored. For example, in a pallet flow rack, an angled gravity rack that holds pallets, the pick-face, or product location that order selectors pick product from which corresponds to the direct front of the order-picker, also called the golden-zone, is a better position than a pick-face which the order-picker has to bend down to reach.

BACKGROUND:

It is important that we give some warehousing and distribution background so that we can further describe the impact of this study. We will define storage, picking, material handling techniques, and warehouse controls strategies. Then we will discuss a how stocking with respect to ergonomics so that we can pick in the "golden zone" can impact warehouse operations. We will show the results of the research that proves this phenomena, and discus conclusions.

SLOTTING OR STORAGE

Slotting or storage layout planning of the warehouse is crucial to warehouse cost efficiency. The relationship of slotting to order picking is often overlooked, but warehousing best practices emphasize the relationship. Because order picking is time sensitive, it is important that clients get orders within promised lead times, warehouses should stock products so that order picking can be optimal. It may be a time tradeoff to take more time to stock inventory in an optimal picking location rather than minimize stocking time. But stocking efficiency at the cost of sacrificing customer lead times when making order selection less efficient is not a wise choice.

Optimal slotting usually takes into account five principles of popularity, similarity, size, characteristics, and space utilization. (Tompkins 2003) Typically, most warehouse managers only focus on popularity or the inventory turns of the product. Popularity means stocking the most popular material such that travel distance is minimized. Often the Pareto's law is taken into account. Vilfredo Pareto, an Italian economist, discovered the relationship between wealth and individuals. His law states that 85% of the wealth in the world is held by 15% of the people. Applied to stocking 85% of the inventory selected (picked) will be a result of 15% of the materials stored. (Tompkins 2003) Most warehouses utilize this philosophy and stock the fast movers close to the outbound location, but often overlook the possible ergonomics of stocking in the "golden zone"

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ORDER PICKING

In warehousing we can broadly define order picking as the retrieval of goods from storage. There are usually five levels of order picking based on the size of the unit that is being picked. They are listed below:

1. Pallet picking: Retrieval of full pallet quantities
2. Layer picking : Retrieval of full layers of cartons from pallets
3. Case picking: Retrieval of full cartons from storage
4. Split case picking: Retrieval of inner packs from cartons in storage
5. Broken case picking: Retrieval of individual items from storage

The focus on this research is on picking of smaller units. The challenge of stocking , separating, selecting, clasping, and packaging of smaller items drives make it higher than the traditional picking of a unit load, like a carton or a full pallet. Because of the trend of internet customers buying in units of one, this may be where the distribution industry is headed in order to meet customer demand.

In this research the operation studied utilized modern material handling techniques and advanced warehouse control systems.. This operation used the material handling techniques of pick and pass order selection, and pick-to-belt material handling on a three-level pick pod racking system. These techniques allowed for increased labor productivity and higher facility utilization. The distribution center used the warehouse control technologies of a warehouse management system, and a pick-to-light system. The warehouse control systems were used to ensure inventory accuracy, and minimize labor. There is a brief description of the material handling techniques and warehouse control technologies.

MATERIAL HANDLING TECHNIQUES

Material handling techniques are utilized to make warehouse and distribution operation more efficient. When used effectively, they can improve storage capacity, minimize equipment travel, and improve order selection productivity. Some of the techniques used in advanced operation are pick-and-pass, pick-to-belt, and pick pods.

PICK-AND-PASS

The order selecting procedure that is utilized is called Pick-and-Pass. In this procedure each picker is assigned a zone, and picks all of the lines for an orders stocked in the assigned zone, then the order is sent forward via material handling to the next picker in the next zone, and repeated until the order is finished.

PICK-TO- BELT

In this traditional type of pick-to-belt (roller) man-to-part operation the picker walks to a location and picks the product. Usually the picker is assigned a zone along a conveyor, to which he selects picked items. This is commonly used with a material handling storage system like carton or pallet flow rack type of system. The conveyor system configuration usually consists of two gravity roller conveyors and one powered-belt takeaway conveyor. There is one gravity roller belt on each side of the powered belt so that workers can work on each side. The selector takes product from the rack adjacent to the conveyor and then places the product into the carton which is on the roller conveyor. Then, he pushes the carton on the gravity conveyor to the location where he picks the next product and places that item into the carton. After all the products for the workers zone are placed in the carton, or the carton becomes full, he pushes the carton on the middle takeaway conveyor which transports it to the next zone, where the process repeats.

THREE-LEVEL PICK POD

The modern material handling storage system called a Pick Pod, is a combination of pallet flow rack and carton flow system. The system is stocked from the outside and items are picked from the inside. The inside of the storage system is supported by the pick-to-belt material handling configuration. In order to save space and better utilize the facility, it uses mezzanine support structure to repeat the rack configuration on multiple levels, 3 levels in this operation.

PICTURE

WAREHOUSE CONTROL TECHNIQUES

Warehouse control techniques are most effective in large distribution operations. Because of the cost associated with implementing a control system, the return on investment (ROI) should be justified. The business case for control systems are that they direct personnel to move product and update information which leads to up 20% labor reduction and inventory accuracy levels of up to 99%. Two of the most effective warehouse control systems are the warehouse management system and pick-to-light control system.

WAREHOUSE MANAGEMENT SYSTEM

A warehouse management system utilizes computer based algorithms for directed receiving, stocking, picking, consolidating, and shipping operations in a warehouse. It also tracks all inventory and labor moves for the operations. By defining procedures of where to move inventory, the warehouse operations can be automated. Also, when partnered with other control systems it can send orders to specific devices like a pick-to-light control system or an Automatic Storage and Retrieval Devices (AS/RS)

PICK-TO-LIGHT

This control strategy uses a visual display to lead the picker to the product that needs to be picked and the amount that needs to be picked. A display is located in each rack bay to indicate the correct pick quantity. A pick confirmation pad and indicator light is located at each stock location. Its benefit is that it allows for very accurate and efficient inventory accuracy.

ERGONOMICS IN WAREHOUSE PICKING

Human factors and ergonomics can improve our picking labor efficiency. By designing an operation in which personnel can perform standard routines safely and efficiently, operations usually become safer, more efficient, and more cost effective. By stocking in the "Golden Zone" we can realize the benefits of ergonomics in warehouse picking.

Human Factors and Ergonomics in Warehousing

It is important that we talk about the human factors/ergonomic content for lifting loads. Ticchauer (43) studied methods of lifting weights off the floor as measured by electromyography recordings of muscles and activities. He found less muscle activity involved when the load was close to the body while squatting and lifting with the legs. Davies (14) reports research by Frederick (20) dealing with the efficient methods of lifting boxes with two hands to various heights as measured by energy extended per foot pound. In general, lifting weights from 40 to 60 in requires less energy than lifting them from the floor to 20 in, form 20 in to 40 in, or overhead, 60 to 80 in. In work situations where workers must lift a number of heavy boxes, they should be located within this range of 40 to 60 in. In following table there is a chart with provides the maximum acceptable weights that can be lifted by male and female industrial workers in various height ranges.

Table 1A. Distribution of the Maximum Acceptable Weights
That Can be Lifted by Male and Female Industrial Workers

Lifts	Percent of Population 90	75	50	25	10
Floor to knuckle height					
Males	37	42	53	65	76
Females	19	21	33	39	46
Knuckle to shoulder height					
Males	40	47	55	62	69
Females	23	25	27	30	31
Shoulder to reach height					
Males	36	42	42	56	49
Females	18	22	27	31	35

(Hutchinson 1981 pp.214)

Ergonomic Factors influencing Manual Material Handling

Chaffin and Ayoub (9) have discussed manual materials handling as comprising four components: the characteristics of the worker, the material container, the task, and the work practices. Worker characteristics include age, sex, body build, sensory motor skills, training and health. Material container characteristics include dimensions, location of the center of gravity with respect to the worker, grasping aids (handles), and stability of the load, for example, liquids. Task characteristics include the movement distance, frequency, duration and pace of movement, foot traction, and work environment. Work practices include posture and lifting technique, administration and organization of safety/hygiene function. Usually all of these character should go be taken into account when setting a work standard for warehouse personnel.

Awkward Lifting

Deep containers tend to increase the horizontal distance between the person and the center of gravity(c.g.) between the person and the center of gravity of the object being lifted. Figure 1 provides a formula by Tichauer (42) for the calculating the bending moments on a person's back (sacrolumbar joint) as a function of the object's weight and the distance tot the box's c.g. Workers often stoop over to pick large cardboard boxes stacked in columns some distance from the worker's c.g. If the weight is over 35lbs, excessive stress is placed on the lower back. When lifting, a worker's hands should be no lower than 20 in from the floor nor should they be higher than the shoulders (also, the decreases the possibility of dropping the load). Lifting loads asymmetrically from one side of the body should always be avoided. Two people should carry a load (with handles) if it is over 20 in (51cm) in breadth or requires a single worker's hands to be extended more than 16in (41cm) in front of the hips.

Other Considerations

When picking or constant lifting and asymmetrical lifting other ergonomic consideration include the impact of quick lifting, sustained muscular exertion and performance, shoulder abduction angle, hand positions and head tilt should be considered.

Understanding the golden zone

A measure of "goodness" of an item is the frequency that it is requested. If an item is requested frequently, it is logical to keep that item in an easily-accessible location. But if the item is too heavy, it may be too time consuming to replenish that item to the favored location. A best practice for order picking is to assign the most popular items to the most easily accessed locations in the warehouse. (Tompkins 2003)

A good strategy is once items have been assigned to storage modes, like reserve locations and primary locations, the assignment of forward pick locations can be approached. Because 15% of the items produce the majority of picking activity we can minimize the order picking travel time and bending moves. By focusing on popularity storage at this point we can reduce the amount of stooping and bending and possibly reduce fatigue and improve picking accuracy.

The most popular items should be assigned to the picking locations at or near waist height. A goal may be to stock as much as 70% of fast moving picks at waist height. We must be careful to make sure that the product has characteristics that will allow for ergonomically safe selecting per NIOSH standards.

Another basic rule in assigning products to selection locations is taking into consideration the dimensions. Cube matching of the items with the selection locations is essential to eliminate space inefficiencies. Shelf dimensions should be spacious enough to allow easy picking, but tight enough to avoid excessive unused space. We can see from figure 1 how the row indicated would be a more efficient reach and selection location than the others because of the reaching dimensions.

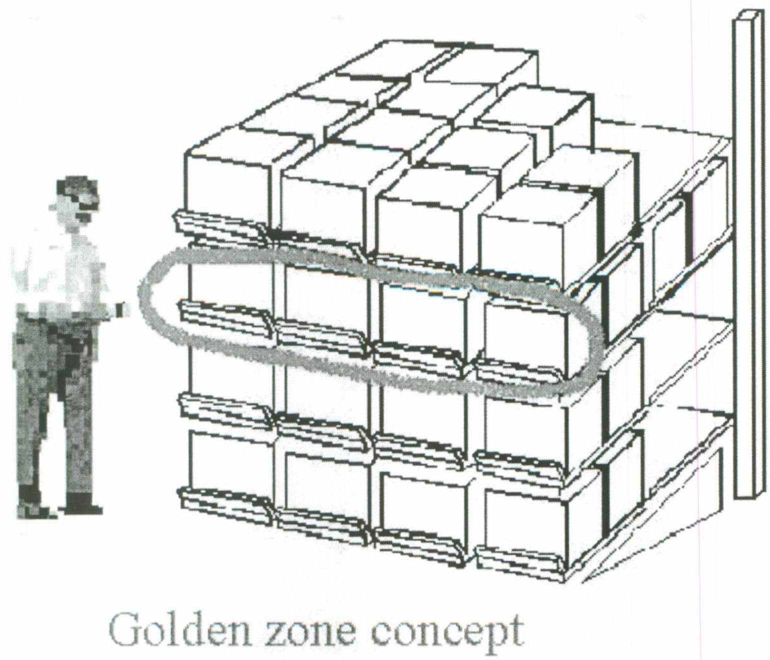

Figure 1 : Pick height for the Golden Zone

SCOPE OF THIS STUDY

The scope of this study is to test whether high velocity items stocked in the golden zone is will take less time to pick for an order selector in comparison to not stocking high velocity items in the golden zone. Specifically we will test if the picking mean time has a significance variance. It is believed that there could be up to a 20% difference in labor time.

HOW THE STUDY WILL BE CONDUCTED

The study will be conducted by collecting data from selectors picking items from both the golden zone pick faces as well as pick faces outside of the golden zones. The selection area will consist of a 20 ft aisle with 10 pick faces (5 select locations residing in the golden zone and 5 outside of the golden zone). The Locations will consist of 4 level high flow-rack (72 inches high) with 16 inch pick faces on each level.

Outlay of pick area and locations:

1) 20 ft aisle / 6 ft. wide

2) 4 level high pick faces (2^{nd} and 3^{rd} level = golden zone)
   - 1^{st} level = 7 inches high (from bottom of pick-face to floor)
   - 2^{nd} level = 28 inches high (from bottom of pick-face to floor)
   - 3^{rd} level = 49 inches high (from bottom of pick-face to floor)
   - 4^{th} level = 70 inches high (from bottom of pick-face to floor)

3) 10 items used for study | 5 items in golden zone / 5 outside of golden zone

4) Pick Method will be Pick -to- Tote

Test Population

The test population will consist of case-pickers from the Home Interiors and Gifts, Inc Distribution Center.

Data from pickers:

Average Height of HIG case picker = 5'6"

Average Age of HIG case picker = 27

PICKING RESULTS

Order Selection Observation Statistical Comparison
We will utilize statistics to measure the variance in the observations of picking in the golden zone vs. picking outside of the golden zone. Utilizing hypothesis testing that will allow us to have a 95% confidence that there is a statistical difference in the two methods. This is important so that the inference in the amount of savings this kind of stocking can save a company money and can be considered valid. Below is a description of the statistics used.

Test for Normality

We will create a scatter plot of the difference of the two observations. If the probability plot has a straight pattern, this may indicate that the assumption of a normal difference distribution is plausible. An alternate approach would be to take a large sample size m greater than 100 observations.

Paired T Test
When there is an experimental situation in which there is only one set of n individuals and two observations are made on the individual, we can utilize statistics to analyze paired data. By assuming that the different pairs (observations) are independent we can use what is called in statistics the paired t-test to analyze the difference between the observations. The paired test is valid even if variances are not equal, since the differences are still normally distributed and observation sample variance differences estimates actual observation variance difference. (Davore 345).

Null hypothesis: H_0: u_D - Δ_0(Where D = X-Y is the difference between the first and second observation within a pair ($u_D = u_1 - u_2$)

Test Statistic value: $t_{paired} = \bar{d} - \Delta_0 / \sigma^2 / \sqrt{n}$ square n (Where d bar and sD are the sample mean and standard deviation, respectively, of the di's)

Alternate hypothesis: $H_a: u_D \neq \Delta_0$

Rejection Region: $t_{paired} \geq t_{\frac{\alpha}{2}}, n-1$

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