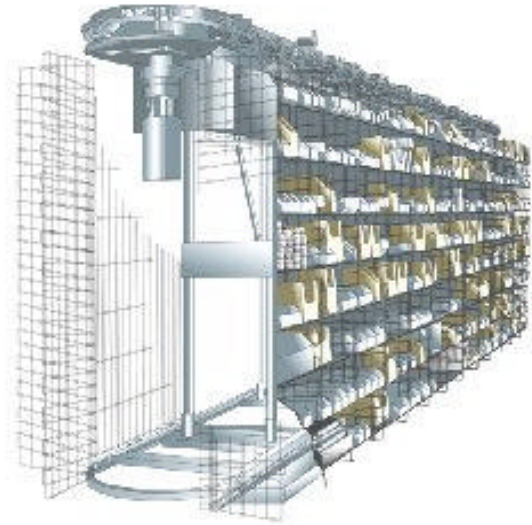


## **What are Industrial Carousels?**

Industrial carousels are a type of “moving shelving unit” that brings a stored item to the order selector rather than having the order selector travel to the item. The product stored on a carousel may be a retail product, manufacturing part, or a customer order. Carousels are a variety of automated storage and retrieval system (AS/RS).



**Cutaway of Horizontal – Courtesy Remstar International**



**Horizontal Carousel – Courtesy Diamond Phoenix**

Carousels have been around in some form for a long time. Just about everyone has seen the dry cleaning carousel, which is really just a suspended track those serpentine around the store. The track has brackets attached to it, hung on small wheels and the garment hangers are placed at locations on the brackets. Industrial carousels follow the same in concept – in fact rumor has it that the first industrial carousel came about from a visit to the cleaners by a warehouse man.

Instead of hanging a simple bracket from the track, industrial carousels instead attach a carrier to the track. The carrier is sometimes called a “bin”, probably named after the bins used in bin-shelving units. Alternately, the carrier could support the stored product from underneath as would be the case when storing a full pallet of material. In either case, the function of the carousel is similar to the function you see at the dry cleaner – to bring the item to the selector rather than have the selector travel to the item.



**Horizontal Picking Area – Courtesy of White Systems**

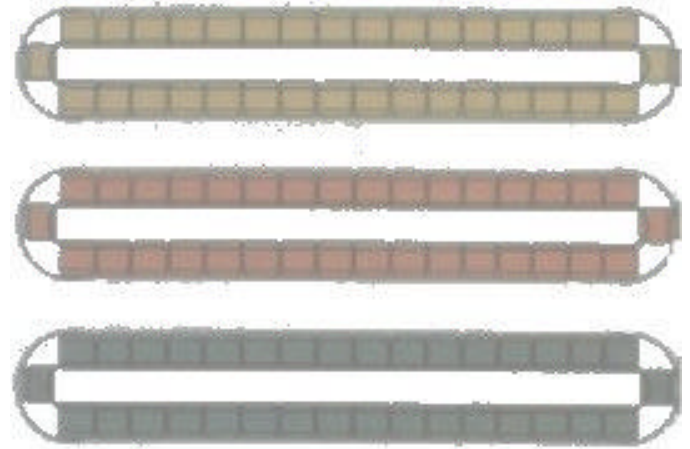
A vertical carousel appears to the naked eye to be a rectangular storage unit where material is presented on moving shelves through a window conveniently located at an ergonomic height. In fact, the inside of the unit is actually a series of shelves attached to a “horse track” shaped guide track on the right and left sides of the machine. The track is oriented so that the long runs of the loop extend vertically (hence the name “vertical”), and the track bends are located on the top and bottom of the unit.



**Cutaway of Vertical – Courtesy of Remstar International**

The shelves in this unit are quite wide (usually from 6 to 12 feet wide) and can hold a substantial amount of material. The shelves pivot on mechanical arms, which are similar to the fastening mechanism you might find on a Ferris wheel. Unlike a Ferris wheel seats, industrial vertical carousel shelves have dampening mechanisms that prohibits excessive rocking back and forth.

A horizontal carousel like a vertical carousel travels in a “horse track” shaped path. The difference is that the entire path is in contact with the ground (in a horizontal orientation) rather than being oriented vertically.



**The “Horse Tracks” – Courtesy White Systems**

Rather than long shelves, horizontal carousels (or “horizontals” as they are commonly called) usually have wire or solid bins. The bins range from relatively small in width of 12” to as wide as 40”. Bins may extend up to 12’ tall. Shelves are attached within the bins on adjustable centers, which permits several different adjustable storage surfaces within each moving bin unit.

In general, it is possible to store more material per cubic foot of space occupied by a horizontal carousel than in a vertical carousel. The primary reason for this is that horizontal carousels are supported by ladder frames that are contained completely within the center of the horse track loop.

Verticals have the supporting structure and the enclosing metal case outside of the storage shelves. Verticals make up for this inefficiency in that they can store product up to 30+’ in the air. As we will see later, horizontals can do this too, but only if they are stacked one atop the other.

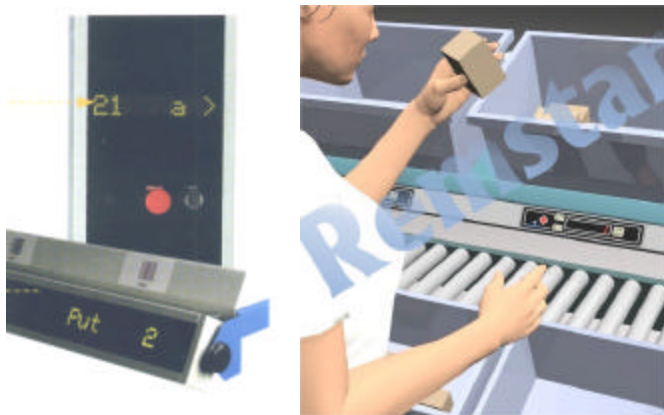
In addition to holding storage bins, horizontal carousels may be used to transport pallets. Think of this as a kind of a carousel-like a train on which “pallet cars” ride around in the horse-track shaped loop.



**Pallet Carousel – Courtesy of Remstar International**

### Use of Pick-to-Light with Carousels

You will often hear the term “Pick-to-Light” used when discussing carousels. This is because most modern carousel systems have a light selection system available to assist with the pick out of the storage location, and in some cases, the put into an order location.



**Diamond (left) and Remstar (right) Pick/Put to Light – Courtesy Diamond Phoenix and Remstar International**

Unlike Pick-to-Light systems found on flow rack, the unique feature of carousels is that selection and put lights are only needed at the selection end of the moving carousel units. Storage bins, which have pick requirements, are then moved around the track, and are positioned as needed in front of the lights. For this reason, there only need be as many pick lights as there are selection levels on a single carousel bin, even though there could be 100 or more moving bins that could be selected from on a single carousel.

The other unique feature of carousels, is that put lights can be set up to direct the placement of product into particular orders after an item is selected out of the storage location.

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Put lights can be on either a conveyor or on a cart. Normally the put lights are set up at a location opposite where the picking takes place. As we will find later, this ability to batch put to one of several locations is crucial in creating an efficient carousel picking application.

### Why Use Carousels for Order Selection?

Carousels can significantly improve an order selector’s efficiency if they are properly applied. At first blush, you might think that this is counter-intuitive since most carousels travel at a rate of only 50-80 feet per minute (a little less than 1 MPH). Since an order selector walks at a rate of 3 MPH it would appear that carousels are just too slow to help (the order selector could walk to the location on the carousel and back faster than the carousel could move the product to the order selector).

In a traditional distribution application (one where many items are being selected on a particular selection run) the order selector normally does a substantial amount of walking between locations. We’ll explain why our normal intuition does not apply next.

### Coordination of Multiple Carousel Units

Carousels can actually select orders faster when they are coordinated together. While the picker selects from one of the carousel units, software allows 1 or more other units to move the next item into place. This coordination helps equalize carousel speed with the selector’s travel speed, but even with 4 carousels working together, the carousels are only working effectively as fast as an order selector can walk.

### Using Software to Increase Order Pick Density

This is where the second feature of software driven carousels is applied – order batching. In a traditional picking environment, order selectors pick one or maybe two orders at a time.

With carousels, using light directed order placement, as many as 40 orders can be picked with one rotation of the carousels. Given this enhancement, the slow moving carousels are able to gain a significant advantage over the traditional order selector. As more orders are picked together, the distance between pick locations on the carousel becomes smaller, and thus the carousel travel becomes smaller. Smaller travel equates to faster positioning of the next pick

In very dense situations, carousels can position the next pick (on average) in just a matter of a few seconds, and by using more than one carousel, the picker has a negligible wait time between picks.

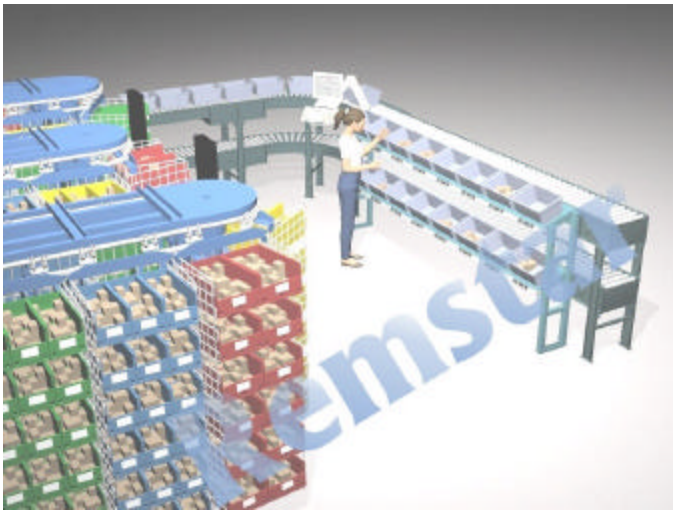
<http://www.2wmc.com>

Effectively the order selector has a virtual selection face which always has the next product to be picked positioned in front of him. He need only reach, grab the product, and then place it into the proper order location.

Note that the same batching method could be used on a traditional walking order selection run. The problem is that an order selector would have a hard time moving 40 orders around the floor as he fills them. Carousels permit the orders to remain fixed in a convenient location while picking occurs.

### **Effective Picking Rates of 300 to 600 Lines Per Hour**

Using the software technology just described, an order selector can achieve sustained rates as fast as 300-600 lines per hour (a line is one visit to one stock location, picking a quantity of one or more units). This rate is about 3-5 times as fast as traditional picking, and often faster than technologies such as



**The “picking area” – Courtesy Remstar International**

Note that the more orders there are to put in a batch, the more efficient the carousel system becomes. This is because as the number of orders in a batch increases, the average distance between picks decreases.

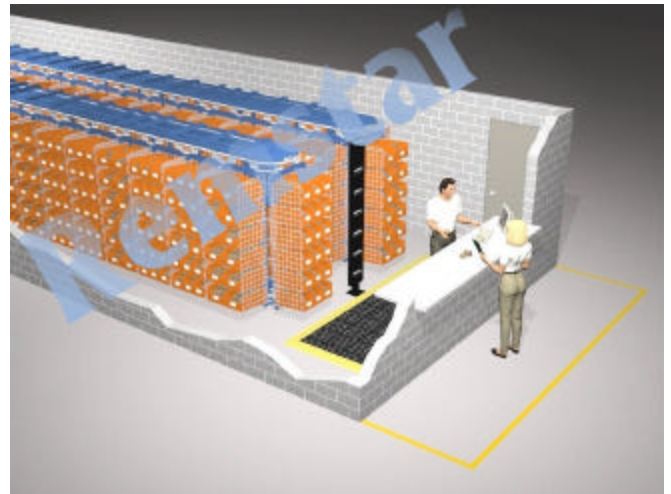
Systems such as carousel pick to cart (discussed later) permit very large batch sizes, and therefore extremely efficient picking.

### **Proper Data Analysis is Crucial to Carousel Planning**

Proper data analysis of your customer orders is crucial in order to determine how many orders should be in a batch, and how many carousels should be used to maintain an optimal picking environment.

### **Convenience Carousels for Service Window / Parts Desk Applications**

On the other extreme are very small (pick on demand) orders (such as a 1 line order at an auto parts store). For these orders, the order selector might have to walk a substantial distance through a shelving area to find the part, and then return to the counter.



**Service Window Application –  
Courtesy Remstar International**

An alternative would be to have a bank of vertical or horizontal carousels near the customer service area. The selector would then need to determine which carousel the item was in and then walk to that machine to select the part.

Although verticals are slower than horizontals, this type of application can work with verticals as well, because the selector often needs to perform other tasks while waiting for the carousel to spin.

### **Can Carousels be Used to Accumulate Order Materials?**

Until now, we’ve talked about selecting orders by moving product into position, and then distributing that product to one or more receiving order containers. It is possible to turn that process around by making the locations on the carousel “order containers” and instead bring product to the carousel (usually by flow rack, cart, or conveyor).

In this application, again the operator stays within a fixed area. Instead of transferring product from the carousel to the order, he is doing the reverse – transferring product from an inbound SKU vendor carton to the carousel.

For reasons just explained in the previous section, it is important to have enough inbound products so that the distance the carousel must spin between put locations is small. For this reason, it is common to have several different SKUs on the inbound batch. The inbound items are identified to the system by scanning or some other type of product input identification.

The carousel system identifies the orders, which require one of those inbound items, and sequentially rotates order locations into place. The operator is then instructed to select particular items and place them into selected order locations on the machine.

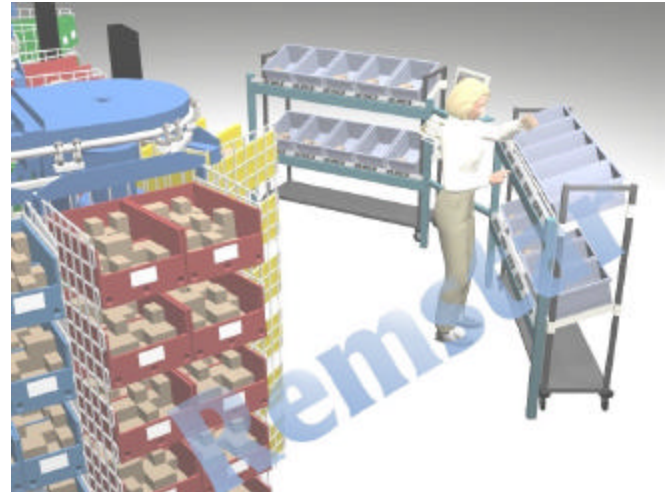
Note that this process is no different in theory than normal carousel replenishment. It is more efficient to replenish from several inbound items rather than replenishing a single item at a time, since the rotation speed of the carousels are slow. The primary difference in a put carousel is that there will generally be a one to many mapping of product to store orders, so the put system will tend to be more efficient.

In a retail “distribution” environment where a particular SKU is distributed to every store, only the single inbound SKU and two carousels are needed, since while the operator is putting to the store location on the left, the store location on the right can index forward one location.

### **Can Batch Pick Carts be Used with Carousels (Catalogue, E-Commerce)**

An application, which is superb for low line order environments (such as those found in e-commerce or catalogue orders), is that of the batch pick cart. In this type of picking environment, a cart is used to replace a fixed table or conveyor.

The cart is wheeled in to a fixed location, which has pick-to-light in front of fixed positions on the cart shelves. The primary advantage of the cart is that it uses the third (height) dimension to hold customer orders. In a conveyor or table environment, only one or two levels would be possible.



**Batch Pick Cart – Courtesy Remstar International**

With a cart environment, 5 or more levels are possible with many put locations being available on each level. Two or more carts can be combined to further increase the number of orders in the batch.

Large batches are particularly important when the application has only 1 or 2 items per customer order. The larger the batch that can be handled at one time, the more efficient the system will become, due to the decrease in average wait time between picks. By batching a large number of orders together, the carousel system can be transformed from a relatively slow system to a very fast, high pick rate system.

### **What types of Products are Well Suited for Carousel Each Picking (traditional distribution)?**

#### **Analysis of Cubic Velocity of the Item**

Carousels are traditionally used to select items which are either small each pick items or which have low movement velocity. The trick is that if the daily cubic requirements are too high, the carousel storage location will need to be replenished frequently, and replenishment is the most time consuming component of carousel operation. Also, carousel real estate is considerably more expensive than static storage, like shelving or decked pallet rack. For this reason, items with low relative “cubic velocity” are normally stored in a carousel.

“Cubic velocity” refers to the cubic measure of the amount of material moving in a period of time. For example, I might pick 1,000 tiny 1/16” ball bearings a day, but the cubic velocity of this item would only be a little under 4/100 of a cubic foot. On the other hand, I might pick only 20 toasters each day, but the cubic velocity of this item would be much much larger (over 10 cubic feet).

Carousels are best used for either fast moving tiny items (like a resistor), slow moving small items (like a spark plug), or extremely slow moving large items (like toasters) – and slow moving toasters might be better off on shelving if we are tight on carousel space.

One way to profile products for the carousel is to translate all movement into cubic velocity. To do this, take the number of units moved per day and multiply it times the size of a single unit. This permits an equalization to be made between faster moving small items and slower moving large ones.

Generally speaking, items with less than 1 to 2 cubic feet of movement per week are ideal carousel candidates, while items as much as 10 cubic feet per week can be considered for carousels.

## **What Advantages do Carousels Have in an Each Pick Environment?**

### **Very High Pick Rates**

As already mentioned, carousels can increase picking efficiency dramatically (as much as 2-5 times as fast as picking from a traditional rack and shelving environment). The key to fast pick rates is to have enough order lines in a batch to make the distance between picks on the carousel small, which permits the next pick to be positioned in the time it takes the picker to complete transferring the current pick.

### **Reduction in Storage Footprint**

A side effect of switching to carousels is that products are often stored much more efficiently in carousels than they were in shelving. One reason for this is that since carousel storage is more expensive than shelving, folks tend to pay much closer attention to efficient slotting and elimination of wasted space.

Totes are commonly used to replace loose stock or half empty vendor cartons. Often product is removed from vendor cases and placed into a storage location on the carousel, which is a good (tight) fit for the receipt. Totes also permit very low clear heights between shelves since most totes have a handhold cut out for reaching in under the shelf above.

Part of the space gained with carousels comes from smarter storage of material, and part from the fact that adjacent carousel units require only a 6-12" between them to operate. Shelving would require at least a 30-40" aisle between shelving rows. When applying good storage methods, carousels can save as much as 70% over the original storage layout.

### **Lower Overhead Costs – limited picker comfort zone**

Carousels can reduce overhead costs, since lighting and heating do not have to be applied uniformly to all product storage locations on the carousels, but rather only to the area where picking actually takes place.

Carousels can provide a substantial advantage in a refrigerated or freezer environment since the pick area can be heated to a higher temperature, making the picker more comfortable. When the carousel is not in use, designated empty bins can be rotated to the heated zone.

Only the order selector's area need be lit, except when maintenance or special operations are being performed on the carousel units.

### **Better Supervision and Visibility of Work Processes -**

Since picking only occurs at one nose end of the carousel units, different work areas can be lined up so that all work areas are visible to a supervisor from a single location.



**Supervisor's View – Courtesy Diamond Phoenix**

This permits much easier supervision of pickers than could occur in a rack or shelving environment. Furthermore, carousel software can keep track of picker productivity on an individual basis.

### **Improved Ergonomics –**

Carousels bring the product to the picker, and heavy items can be profiled to the most optimal reach locations. This permits better control over the physical pick. In addition, vertical carousels, by their design, present all products at an ideal ergonomic height.

Going beyond the optimal reach or golden zone, processes and systems can be put into place to assist the picker with heavy or awkward products. For example, a vacuum lift or other manipulator can be used to select products from the carousel. Since the carousel brings all products to one place, this equipment can be installed in a fixed location.

In addition, a device called lift table can be used to select from very tall horizontal carousels, or even stacked horizontal carousels. The lift table can be moved up and down with the order selector so that all of his picks are made with an easy reach. Carousel software can be applied so as to band picks (low picks, middle picks, then high picks).



**Lift Table – Photo Courtesy White Systems**

Ergonomics may be a reason to use carousels for even large items, where they would not otherwise be considered. In these cases, the slower replenishment and retrieval is compensated for by the fact that order selectors are protected from injury.

#### **Application of Special Systems and Equipment in a Fixed Location -**

Ergonomics is not the only advantage of having a defined fixed location where all order selection occurs. Auxiliary processes such as selecting, weighing, counting, labeling, and bagging, are ideal candidates for use with a carousel system. Specialized printers, scanners, scales, and other devices can be placed at the order selector's work area and tied into your host system without the need for portable RF links or mobility.

#### **Product Security or Controlled Access**

Both horizontals and verticals can provide security for your products. Verticals through their design are secure since the only way to access the product in them is through the pick window, and this pick window can be locked. Horizontals can be made secure by putting a fence around them and limiting access to the front pick area. A particular type of carousel known as a "twin-bin" carousel provides automatic security, because when bins are not being picked from, they turn sideways, preventing access to the product contained on them.

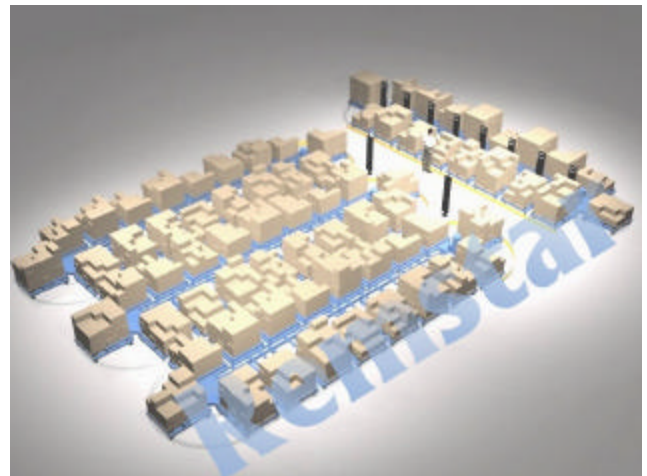
#### **Are Carousels ever Used in a Case or Fast Moving Environment?**

Recently, both horizontal and vertical carousels have begun to be used in fast moving case environments. This at first blush, appears to be contrary to the information presented earlier regarding cubic velocity. The answer lies in the fact that the carousels are used in a completely different manner than they are in an each pick environment.

#### **Pallet Carousel Order Picking**

In the simplest form, pallets of product can be loaded on transport platforms, which travel around a horse track loop. Such a system might be used in a situation where ergonomic picking is a primary consideration.

A fork truck can load the pallets without any danger of injury to an individual just as they would a rack location. The individual pallets can then be moved into position at a location where the selector has an ergonomic manipulation device such as a vacuum lift. The appropriate pallet is moved into position in front of the lift device, and then the operator can take one or more cases, and move them to a different put location or pallet.



**Pallet Carousel "Pod" – Courtesy Remstar International**

If the other location happens to be on an outbound pallet carousel, it is possible to build full case orders by selecting specific products from a set of inbound pallet carousels and then placing them onto a set of outbound pallets. Each inbound pallet would represent a particular SKU and each outbound pallet would represent a particular customer order.

By having many put locations on the outbound carousel, we realize the same advantages discussed in the each pick section concerning order batching reducing waiting periods.

### **Buffer Storage of Cases**

Carousels (either pallet or other continuous motion horizontals) can be used to store cases temporarily, awaiting their demand for a shipping operation. These carousels effectively become “3 dimensional conveyor storage and sorting systems”, permitting many cases to be stored in a very small space at a much lower cost than if a multi-level conveyor or sorter were used.

Normally, a robot device is used to insert and extract cases from the carousels. Various methods exist with some carousels running in continuous motion, and others positioning for each automated insertion/extraction.

The main drawback to this type of a system is the speed with which cases can be removed from the system. There have to be enough opportunities to select cases so as to keep a shipping line busy. The trick, like any other carousel operation is to keep the travel time between hits low, so that there is not a lot of waiting going on. New systems are in development now that will help to address this speed issue.

## **Are Carousels ever Used in Manufacturing?**

### **Supply of Tools and Materials to the Shop Floor**

Carousels are often used in manufacturing for tool or part delivery. Vertical carousels are particularly attractive to manufacturing facilities because they have a very compact footprint, and they take advantage of tall ceilings available in many manufacturing facilities. They also provide good security.

Horizontal carousels can also be used in a “stock room” application. A collection of 2 or more horizontal carousels can be set up in a factory stock room to permit rapid on demand access to supplies.

Tool supply machines are available that can supply and track the dispensing of tools to individual employees. These employees access the tools by using an identification badge. This can also be used for other high value items such as computer memory.

### **Work in Process Buffer**

Verticals are sometimes used to hold work in process materials. Verticals can also provide complete protection for stored products and, if necessary, climate and humidity control.

Both horizontal and vertical carousels can be used in manufacturing as a buffer storage system. Materials from one work process can be placed into a tote and then stored in a “buffer carousel” awaiting use in a second work processes.

The carousel can be used to even out differences in process steps and labor can be moved from one process to the other with additional flexibility due to the built-in buffer.

Robots are sometimes combined with horizontal carousels to permit automatic storage and retrieval of material from the buffer storage system.

### **Progressive Assembly Buffer**

Progressive Assembly is another application of a WIP process. Here a group of workstations will be performing various stages of assembly. An assembly is started at one workstation and then placed onto a specific shelf level of the carousel. Next, an operator performing the second assembly step takes the item from the specific shelf and performs a second operation. Once the second operation is complete, the item is moved down to the next shelf and the process is repeated by a third step workstation. The process continues until the piece is complete.



**Progressive Assembly Carousels –  
Courtesy of Remstar International**

Normally, the progressive assembly carousel rotates at a constant slow rate of speed, and each operator looks for his next component on an occupied level and places his finished component on an empty level.

Multiple workstations for each step can be positioned around the carousel and more than one shelf level can be made available to a particular process step. Finally, people can move from one process step to another to keep the manufacturing process balanced.

The carousel provides a 3 dimensional storage area for pieces being assembled. It can replace carts completely, perhaps with the exception of initial inbound material, and outbound components.

### **Burn-In Carousel**

A final application similar to the progressive assembly application is for burn-in or testing of equipment. It is possible to wire individual shelves of a carousel so that all shelves have power.

Sub-assemblies or finished components can then be placed onto the shelves, and plugged in. They are then turned on and tested for a period of time.

The carousel is set to turn so that one revolution completes the burn-in time period. Alternately a computer can be used to alert an operator to retrieve the completed “burned-in” units”

## **Horizontals – The Nitty Gritty Details:**

### **The Distribution Picking Application**

#### **Physical Details**

The most common horizontal configuration consists of multiple vertical stacks or bins, which rotate under motor control around a horse track shaped path. Each bin has shelves that vary from 12” to 36” wide and 8” to 26” deep. Individual shelves can be easily added to a bin and adjusted to provide various storage clear heights on the bin.

A carousel used for order selection commonly has 5-7 shelves spaced vertically at 8” to 20” apart on a bin, which is between 6’ and 12’ high. Shelves can hold from 75 to 200 pounds. Bins can hold from 500 to 2,500 pounds depending upon construction.

Due to the slow rotation speed of all carousels, most horizontal systems consist of at least a pair of carousels, and can have as many as 6 carousels to a work area.

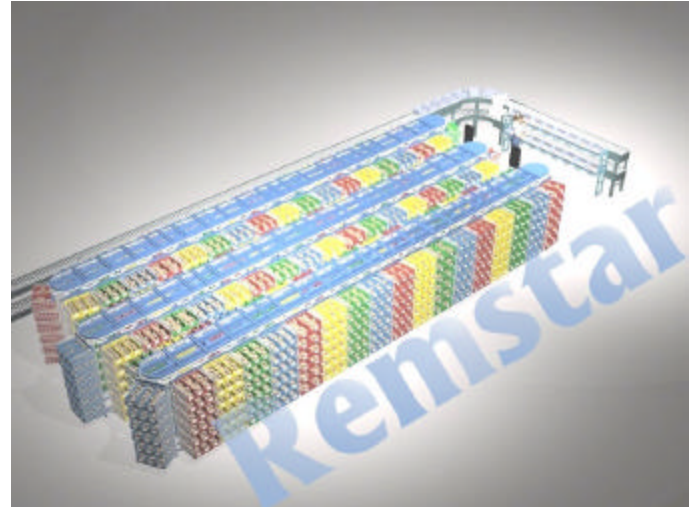
In general, the taller the bin, the lower the cost per cubic foot of storage in a horizontal carousel. Bins can be constructed up to 12’ tall. Due to the construction of the bin supports, bins, which are about 24” wide and 24” deep, tend to be the most cost effective from a cubic storage point of view.

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### **The Picking “Pod”**

The work area (known as a “picking pod”) is composed of a set of 2 or more carousels, a place for staging orders (usually more than one) to be picked, and always a single picker.



**A Carousel “Pod” – Courtesy Remstar International**

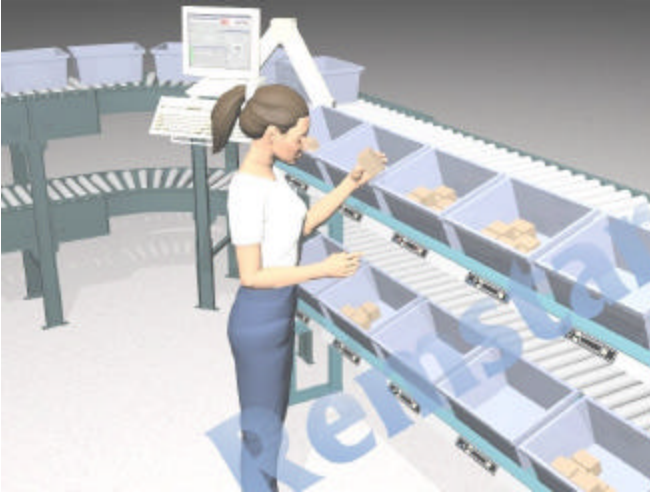
Pick-to-light technology frequently accompanies horizontal systems in order to improve operator productivity. On the carousel side, the pick to light “tower” or “tree” is used to show where an item is to be selected.



**Pick from Carousel Bin Using Light Tower –  
Courtesy Remstar International**

Once an item is selected from the carousel, another set of lights may be used to indicate where the product should be placed. A product may be placed into more than one order location (allowing a pick of multiple units from the carousel being distributed among several orders). Lights can be placed under totes, in front of pick carts, on a table or a conveyor.

<http://www.2wmc.com>



**Put to one of multiple orders using pick-to-light –  
Courtesy Remstar International**

### **Configuration and Sizing of the “Pod”**

In general, the longer the carousel or taller the bin, the lower the cost per cubic foot of storage. The number of carousels and length of the carousels is selected based on the anticipated density of picks within the carousel. This pick density can be manipulated by increasing order batch size (the more orders in a batch, the more hits, on average will occur on any set of storage locations).

The objective is to keep the pick density high enough so that the next pick can be rotated into position on one carousel while picking occurs on a different carousel in the same pod. If picks are too sparse, the relatively slow carousel rotation time will cause the picker to wait for the next bin to rotate into position.

The more carousels in a pod, the longer one can wait for a single carousel to position – since the other carousels will keep the picker busy picking longer. There can be up to 6 carousels in a pod, but most commonly there are 3 or 4. Since each carousel unit is about 78 feet wide with clearance, putting more than 4 carousels together creates a substantial amount of walking back and forth.

### **Plan for Peak Activity when Designing a Carousel System**

It is very important that you consider your periods of peak activity when planning a carousel system. Although carousels are among the fastest of human controlled picking systems, they can only operate at a fixed rate of speed, albeit very high.

Furthermore, carousels operate most efficiently with a single order selector in each “pod”. This is a substantial point of difference from other picking mediums like paper, RF scanners, and pick-to-light on flow rack. With all the other technologies, it is possible to add labor to speed up order processing.

With carousels, you either need to add equipment to take care of the peak, or have enough working hours to extend order selection periods during the peak. You cannot add labor in the pod since the light system is designed for only one picker to work at a single time.

The moral of the story is to plan and design for peak activity, not the average activity in your facility. The same principle applies, by the way, to other systems including conveyors and other AS/RS equipment.

### **Variety of Configurations and Uses**

Horizontal carousel bins can be constructed as high as 12’, but require a ladder, robot, mezzanine, or lift device for access. Carousels can be stacked one atop the other as high as 60’, providing tremendous storage density.

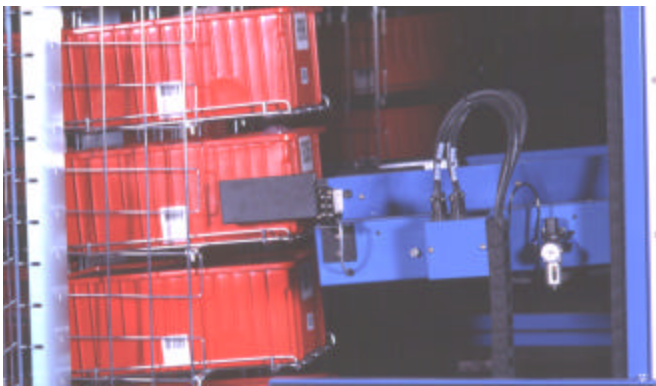


**Robotic Extraction Delivery System –  
Courtesy Diamond Phoenix**

For stacked horizontal carousels, usually a lift table, robotic inserter/extractor or a mezzanine is used to facilitate picks from each level. Carousel frames themselves can support walkways and mezzanine construction at each level, if they are designed with that purpose in mind.

Carousels can be placed in a wide variety of environments from clean rooms to refrigerators to freezers. Shelves can be painted metal, galvanized steel or stainless depending on requirements.

Automated insertion/extraction can be accomplished by in several different ways. Cases, totes, trays, and other similar sized cartons can be stored and retrieved in this manner. Automation can facilitate 24-hour “lights-out” operation of equipment.



**Robot Grabbing a Container from a Carousel Shelf –  
Courtesy Diamond Phoenix**

## **Verticals – The Nitty Gritty Details**

Vertical carousels share the fact that they have a horse track shaped loop in common with horizontals. They differ in that the shelves are much wider and the product of a vertical is completely enclosed in a “tall metal box” with an ergonomically positioned pick window.

The individual shelves in a vertical carousel are fastened to “carriers”. Think of the shelves as the “seats” and the carriers as the individual ride units on a Ferris wheel.

The carriers are rotated by motors in a horse track shaped loop just like horizontals, but they are rotated in an up and down direction. The pick window will normally permit reaching for product stored on one more or shelves at a time. Totes or containers normally divide the shelves up.

Vertical carousels range from as short as 8’ to as tall as 40’. Carousels can have carriers as little as 3’ wide to as much as 12’ wide. Shelves can be between 12” and 24” deep. The shelf to shelf clear height is generally less than 24”, and can be as little as 3”.



**Vertical Carousels – Photo Courtesy White Systems**

A single carrier can carry a single shelf or as many as three shelves. Carriers can support 300 lbs. To 1,200 lbs. Shelves can be designed to hold certain types of materials such as specialized equipment or tools. They can be perforated for ventilation or be finished in special materials such as stainless steel.

The frame of a vertical carousel has a capacity limit in addition to the individual shelf weight limits. Generally, a carousel can support no more than 30,000 pounds without expensive reinforcement.

In general, taller machines are less costly per cubic foot of storage up to the point where structural reinforcements are required. Extra wide shelf machines (>120”) are little more expensive than standard machines per cubic foot. Generally speaking a machine, which is 30’ tall and 120” wide, is the most cost effective from a cubic storage point of view.

## What are the Primary Differences Between Horizontal and Vertical Carousels?

### Specific Advantages of Horizontals

#### Better Product Storage Density

Horizontal carousels can hold more cubic feet of product per square foot of floor space in situations where the clear height is 12' high or lower. This is because horizontal bins are commonly manufactured to be as tall as 12' high. Note that if bins over 7' tall are used, a ladder or other access device (such as a lift table) must be used.

#### Better Density Even in High Ceiling Environments (with lift table or mezzanine)

Horizontal carousels, because their weight is evenly distributed over a large floor area can physically pack more product more densely. Even in situations with tall ceilings (as much as 40' high or more) horizontal carousels can be easily stacked on atop the other to use the available height.

Stacked Horizontals – Photo Courtesy White Systems



If the carousels are stacked, it is then necessary to build a platform to access the higher levels. This is done in one of three ways. First, a mechanical device called a lift table can be used to raise the operator (and orders) up and down. Lift tables can reach product up to about 20' high. Second a fixed mezzanine platform can be built. The platforms only need be built at the pick face of the carousels, although service walkways can be constructed using the carousel frame itself on upper levels. Third, when an automated inserter extractor device is used, there is no practical limit on how high the carousels can be built (up to the height of available buildings).

#### Faster Effective Positioning

Horizontals turn about twice as fast as verticals, this is because product tends to be less stable going over the top loop of a vertical than round the nose end of a horizontal. In both cases, the units can only spin so fast before making the product stored on the shelves unstable. Horizontals can turn at speeds from 60 to 80 feet per minute, where verticals are limited to about 30 feet per minute.

What this means in a fast distribution environment is that horizontal order batch sizes can be smaller, and still keep the picker busy. Note, however, that even with verticals, if the order batch size is large enough, little or no waiting will be experienced while picking.

#### Ability to Carry More Weight per Carousel

Since all weight in a horizontal is either directly supported on the floor or through “ladders” equally positioned along the floor track, horizontals have the ability to carry very heavy total weights and weights per carrier. The only limiting factor is the size of the wheels, frame, and brackets supporting the bins or pallets.

Verticals, on the other hand, are limited by three additional factors. First, the supporting hardware for each shelf is more expensive and becomes prohibitively expensive for very heavy weights. Second, since vertical shelves tend to be wide, they must be “beefed up” substantially if heavy weights are placed on them. Third, the structural frame of a vertical is a single frame rather than a series of frames spread out over a wide area, so both the floor and the frame have weight limits.

The vertical frame must be constructed out of much thicker steel to handle heavy weights, where a horizontal only needs frames big enough to handle the load, which is being locally supported.

### **Horizontals Experience No Problems with Loading Imbalance**

Horizontals do not become imbalanced (from a physical weight point of view) even if only ½ of the carousel is loaded with material. This would be similar to loading only the first 50 freight cars of a 100-car train. The train still travels just fine since the individual loads are supported by the wheels of each car, not by the locomotive. Note that with horizontals you can fill up just half of the machine, and software will rotate the machine back and forth only between the bins which are loaded.

With a vertical carousel, trying to load up ½ the shelves in sequence would be impossible. This is because, vertical carousels work in a manner similar to elevators. With an elevator, a counterbalanced weight is attached by cables opposite the passenger car. As the passenger car goes up, the counterbalance goes down. By using the counterweight, a much smaller motor can be used to move the passenger car than would be needed if a counterbalance were not used; the motor only need be big enough to handle the largest weight differential between the passenger car and the counterbalance. This is why elevators have specific weight limits.

Verticals are similar in that the weight going up must be reasonably matched with the weight going down. If the weight isn't balanced the motor won't be able to lift the load. For this reason, operators must use care to balance product as they load a vertical carousel, and all manufacturers provide software or hardware to detect imbalanced conditions.

### **Lower Cost**

Horizontals are less expensive per pound of product stored and also per storage location, in general. There are exceptions, but generally speaking, horizontals are roughly ½ the cost of verticals for the same amount of storage.

### **Advantages in a Power Failure**

With both verticals and horizontals, product access is much more cumbersome when the power fails. With horizontals, it is possible to make narrow aisles between units, permitting emergency access by an order selector.

With a vertical carousel, such access is more difficult. Since product is stored "in the air", the order selector must manually rotate carriers into position at the pick window.

This process is very labor intensive and slow since these units use relatively large reducers and many turns of a manual crank (or battery powered drill) are needed to rotate the carriers into position. Such a method of vertical carousel order selection would only make sense for dire emergency situations, and would not be practical for routine daily selection.

### **Specific Advantages of Vertical Carousels**

#### **I Want a Refrigerator Appearance in my Facility**

Vertical carousels are very sleek in appearance. The product stored inside them is completely covered by metal "skins" and this provides a very neat and tidy appearance. Horizontals are generally not enclosed, although they can be made to look neater by using totes or containers for product storage. In general, verticals will always provide a more attractive appearance where looks are important.



**Vertical Carousel – Courtesy Remstar International**

#### **Better Environmental Control**

Vertical carousels, since they are enclosed, provide better control over the environment. For example, product inside a vertical carousel will be protected from dust or other contaminants in the facility.

Verticals can also be set up to be air conditioned, humidified, or dehumidified. Since the product is contained in a closed box, it is much easier to apply HVAC technology to what is inside. Finally, vertical carousels are a much better candidate for clean room applications since they permit air to be contained and controlled within the unit.

### **Excellent for Manufacturing Supply**

Often floor space is at an extreme premium in a manufacturing operation. Vertical carousels can be strategically positioned at various locations, taking up only a footprint of about 10 or 12 feet by 8 feet. This is substantially smaller than even the smallest horizontal carousel, and a vertical carousel can be as much as 40 feet high.

The combination of the small foot print, good vertical storage capacity, neat appearance, and product protection for materials stored inside make verticals a favorite for manufacturing operations.

### **Designed for Ergonomics**

Vertical carousels always present product at an ergonomically correct height. They are normally fitted with convenient counters and good lighting. An access counter is positioned at an optimal (and sometimes adjustable level) to provide the operator the best height for accessing product.

### **Automatic Security**

Verticals, unlike horizontals are fully enclosed with access possible only through the pick window (unless skins are removed). Most manufactures supply a locking handle and door, which prohibits access to the material inside the unit when desired.

### **Conclusion**

Carousels have a rather unique niche in the world of distribution. As far as AS/RS systems go, carousels are among the least expensive. As far as pick rates go, carousels can outperform most other order picking technologies when applied properly, yielding pick rates of 300 to 600 lines per hour.

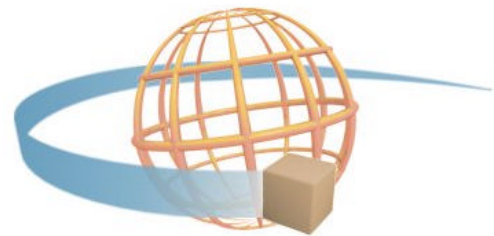
Proper data analysis of historical order data is crucial to finding the optimum order batch size and product slotting. A carousel that does not have a “dense” enough picking batch will not be nearly as efficient. Planning for peak activity is crucial when adding carousels to your operation.

In addition to picking, carousels can also be used to accumulate materials for orders stored on the carousel units. In addition, carousels can be used to support manufacturing operations, ether as work in process buffers, or to hold tools or burn-in equipment. Carousels can even be used to store and retrieve clean room supplies.

These versatile devices, when properly applied, can be a tremendous asset to your distribution or manufacturing operation.

### **About the Author:**

Sam Flanders is President of **Warehouse Management Consultants**. In the past Mr. Flanders has worked for Kingway Material Handling (Pick-to-Light), White Systems (Carousels AS/RS) and St Onge Company (Consulting). He is a national authority in the area of broken case or “each pick” order selection. Mr. Flanders has 15 years of experience in distribution. He also has a degree in Computer Science and is an expert at applying computer driven systems in the warehouse.



**Warehouse Management Consultants** is a firm that provides simple, practical, cost-saving solutions to our clients. We deliver high quality results quickly. We focus on distribution operations, in particular, on order picking both in traditional distribution environments and manufacturing operations. Our methodology is designed to provide immediate money-saving recommendations and avoid spending time on areas that are not of interest to a client. We stress team participation and education in our efforts, so that your key people can be involved in the creation of a new vision for your company. Find out more about how WMC can help your business:

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