Are very narrow aisles appropriate for your operation?

by Robert B. Footlik, P.E.

Materials handling and warehouse layout involves balancing and trading time, manpower, capital and aggravation. For a plastics distributor with limited resources in any of these areas, designing an efficient operation will always involve compromises.

Conventional fork trucks require aisles of 12 to 15 feet, depending on wheel configuration, driver position and capacity. Any aisle width under 9 feet 6 inches is regarded by the lift truck industry as a "narrow aisle." Reducing the rack storage spacing to less than 8 feet is considered a "very narrow aisle" (VNA) layout. Analyzed strictly on the basis of minimizing space, VNA will always optimize the utilization of space. In the real world, however, cramming the maximum inventory into the tightest configuration can be inefficient, especially for a specialties distributor where frontal positions are more important than pallet loads.

Unlike plumbing distributors, electrical wholesalers or office supplies dealers, plastics specialties warehouses live by the number of stock keeping units (SKUs) in inventory. It is not unusual for a multiline distributor to store over 50,000 SKUs to meet customer demand. Each and every item must be available for immediate picking. There is usually plenty of time to stock the materials, but shipment must be made on a timely basis, or for immediate "will call" pick up. There are many ways to meet these varying needs, using mezzanines, horizontal or vertical carousels, or with narrow aisles. Analyzed solely on the basis of available fronts, versus the square footage required for the storage unit and aisle, VNA is a viable alternative.

Analyzing the square footage

In a modern building, with at least 24 feet of available storage height, easily pickable storage extends from the floor to about 7 feet high. Overstock, or slow-moving items, can then be stored on top of shelving with a maximum usable height of 8 to 10 feet. Typically, if this is in a steel shelving area, with 18" deep x 36" wide shelving and 36" aisles, there is a ratio of storage to aisle of 50 percent. Factoring in cross aisles and a wider perimeter aisle provides a realistic 40 percent factor. For every 100 square feet of storage, 40 square feet will be covered by shelving and 60 percent will be open. At a typical rental cost of $5 per square foot, this space costs $500 per year. Adding a mezzanine over this space will cost around $15 per square foot ($900 for the 60-square-foot area), but provides for twice the storage. By requiring less floor space, this saves $200 per year, and seemingly would result in a 4-1/2 year payback. Triple decking the space would cost around $1,080 and take the area down to 36 square feet, with a net saving of $320 per year. Dividing this into the cost of the mezzanine ($1,080/$320), results in a 3.4 year payback.

These same ratios also apply to pallet rack storage, provided the upper portion of the rack is used for "pickable fronts." The big difference is that racks are intended for larger quantities and/or heavier materials. Top storage positions are less expensive because the picking positions at the bottom of the racks are supported by steel columns. The tops of these columns are essentially a sunk cost, included in the initial purchase.

The incremental cost of utilizing the height is based on the cost of pairs of beams required for creating "shelves" for storage, and the equipment to reach a picking position. Under these conditions, the incremental added cost of the storage positions is the same in any analysis.

A similar comparison can be made with steel shelving used for small items. When comparing a mezzanine to a VNA order picker operation, the cost of the shelving is essentially the same, and does not factor into a straight comparison. Whether the shelving supports a mezzanine floor or is free standing, the same posts are required. These supports must be heavier than the posts of 8 feet high free standing units, but if a mezzanine is planned for the future, heavy duty posts are a sunk cost of the initial purchase.

Starting with a counterbalanced, sit down rider forklift as the base for analysis, aisle spacing for 3,000 pound loads is 12 feet, with an overall rack depth of 8 feet and 6 inches (4 feet 3 inches per side of aisle). This represents a rack to aisle ratio of 30 percent, based solely on the storage area, or 25 percent for the real world. Reducing the aisle to 8 feet by using a reach forklift saves 4 feet in every aisle, and raises the practical utilization factor to 40 percent or more. In actual practice, this will save about 20 percent of the floor space for the same lineal footage of pallet racks. Incrementally, the cost difference between comparable capacity electric vehicles, counterbalanced versus reach forklifts, is $4,000 or less.

At the same $5 occupancy cost per square foot, a facility with 200 lineal feet of aisles can easily achieve a one-year payback of the investment. This addresses the utilization of floor space, but does not factor in cube utilization. Working from the floor level, the same length of storage is still required for man reachable picking positions.

To gain picking fronts, by storing higher, there are several pieces of equipment that will do the job. Maintaining the same 8 feet wide aisles will not require a guidance system or fancy

FACTORS TO CONSIDER

- Have you analyzed the square footage of your facility?
- What type of forklift do you use?
- Is your inventory efficiently stocked for quick picking?
- What kind of lighting is in your facility?
- Does your facility have a sprinkler system?
- What is the temperature gradient from the floor to the ceiling?
- Do you have a good warehouse management system in place?
- Have you also taken into account the width of the cross aisles?
- What would the downtime be to switch to very narrow aisles?

electronics. Utilizing twice the height reduces the overall warehouse space and can delay moving to another, larger building. In a 10,000 square foot storage area, the savings can amount to around 4,000 square feet, with a one-year payback. Equipment such as the Raymond "Gofer," Crown "Wave" or Atlet "Ergopicker" can be used to a comfortable 12 to 14 feet picking height. Storing pickable items into the full height means even more savings, but will require an "order picker" type of forklift, at an initial cost of $10,000 for reconditioned, used equipment, to $26,000 for a new truck.

If narrow aisles are good, is VNA better?

The answer to this question is more complicated. Space gain can be analyzed using the same techniques, but there are far more factors to consider.

With any change to an existing layout, the lighting must be modified to conform with the aisle center lines. Individual high bay or low bay metal halide or sodium vapor fixtures are often mounted with flexible cords. Changing locations is merely a matter of moving the hangers. Fluorescent strip lights will require far more work and expense to relocate. This can also add time if the lights and rack realignment cannot be accomplished concurrently. If the existing fixtures are more than 20 years old, replacement is probably cost effective, and should be performed at this time.

In a sprinklered facility, with pallet rack storage, the applicable fire code is National Fire Protection Association (NFPA) 231-C. This is the standard by which most building departments, fire departments and insurance companies evaluate fire risk. The code is written for two aisle widths: 8 feet and greater, or aisle spacing of 4 feet. By the NFPA definition, any aisle less than 8 feet is 4 feet and must be protected by in-rack sprinklers, which are costly and carry a risk of water damage. Alternatively, an early suppression, fast response (ESFR) sprinkler system can be utilized. The sprinkler code also factors in a risk factor for the materials. With "Group 4 Plastics," ESFR is far superior because it can extinguish the fire, not just wet down the surrounding area. ESFR systems need lots of water at high pressure, and many municipal water systems can't provide either prerequisite. This means it will be necessary to install a fire pump, and, possibly, water holding tank or reservoir. Costs for this can range from $25,000 to a half million dollars or more. Improving fire protection is an excellent idea, and typically this has a five to seven year payback in fire insurance savings. In a facility that is owned, upgrading the sprinkler makes sense. In a rental property, it may not.

Another environmental concern is the temperature gradient from the floor to the ceiling. Climb a ladder to the highest point that a man on a fork truck will reach. If the temperature varies significantly, a new ventilation system, ceiling fans or an air rotation heating system should be added. Poorly insulated buildings, with "unit heaters" at the ceiling will be very hot at the top in both summer and winter. Hot air rises, and efficiency will decrease dramatically when people are working in a 120°F (48°C) environment. Narrowing the aisles and picking from a higher level also has a claustrophobic effect. Unless there is good air movement, the aisle will feel "stifling," and productivity will suffer dramatically. Adding new air handling equipment is another good idea, but the cost may be too high for a rental warehouse.

The next concern is productivity. This breaks into a horizontal and a vertical component. Concentrating the inventory into

a tighter configuration means less horizontal movement will be required. Narrowing the aisles, however, makes it impossible for two pallet loads or fork lifts to pass in a picking aisle. This implies that only one truck at a time can work in this aisle or a very sophisticated warehouse management system (WMS) must be in place. If there is only one picker/vehicle working in the warehouse, this is not a problem. Adding fork lifts with aisles of less than 8 feet will require strategy for splitting the orders, then mating the pieces together prior to shipping. A good WMS can handle this. A poor system will fail. Travel times will decrease, but unless procedures and training are updated, the overall order processing time will increase dramatically. Spending money on sophisticated systems that add cost is not good for the company or your career.

"When all of the appropriate elements are considered, VNA (very narrow aisle) systems are often the best choice for improving space utilization and productivity."

Vertically, the additional frontal positions for storage must be carefully arranged to maximize the throughput. According to accepted practices of industrial engineering, the fastest moving items should be stored closest to the front of the warehouse, with slow-moving materials at the back of the storage area. This may be true, but only of product families. Most products have an affinity for other items or families. For example, nuts and washers for nylon fasteners move far faster than any individual bolt because they are used with many different SKUs. Profiling a narrow aisle warehouse must take into consideration both the vertical and horizontal travel speeds of the equipment. Every narrow aisle fork lift moves slower when the forks are elevated. This design maintains stability and safety. It is, therefore, far faster to store slow moving, related items vertically, rather than spreading them throughout the warehouse. Misprofiling the pallet racks can reduce productivity and throughput. Placing items randomly, or by rules that ignore product affinity, guarantees that there will never be a payback for the new equipment.

Aisles that are 4 to 6 feet wide are too narrow for an operator to traverse without hitting the racks or pallets. Electronic guidance systems, or steel angle iron guide rails are an absolute necessity. With the forklift contained in the aisle, and self steering, the operator can focus on the task of moving to the right bin and picking the right materials. These systems are expensive to install, and in a rental facility the cost of installation may not be recoverable over the period of the lease. While the electronic controls and steel can be reutilized, the cost of moving these components to a new building can negate the space savings.

Another important layout consideration is the width of the cross aisles. A counterbalanced, or reach, forklift can turn from an 8-foot aisle into an 8-foot aisle. VNA equipment may require clearances of 12 to 16 feet to turn from one aisle and enter an adjacent aisle. If the picking aisles are short, space that is saved in the narrow aisle will be squandered in the cross aisle. Some vendors have suggested that this condition can be alleviated by eliminating one or more of the cross aisles. On paper this looks good, but in the real world, the savings in space is traded for reduced throughput. An operator who needs to go from the rear of aisle one, to the rear of aisle two must backtrack to the cross aisle. This could result in over 200 feet of travel to move 12 feet sideways.

At this point, VNA may make economic sense, but the "aggravation factor" is starting to dominate the discussion. Putting in a very narrow aisle system is not just a matter of shoving the racks together. Every aspect must be planned to maximize performance. Investing in a $100,000 fork lift is only the down payment. Each additional cost factor contributes to the savings, or expenses, of the system.

One must also examine the throughput. Will only one vehicle and system be required, or are additional units needed? There are computer simulation programs available for quantizing these numbers. Most vendors can arrange for a dynamic test of their equipment. This might be performed in an installed system, in another industry, by utilizing a deck of cards to simulate product picks. With 52 cards, arranged in four families (spades, hearts, diamonds and clubs) one can set up a storage and pick pattern that optimizes the equipment usage and provides a fair evaluation of the throughput. This "poor man's" system planning cannot cover every contingency, but will provide an initial starting point.

The last factor to take into consideration is downtime. The more complicated the equipment, the greater the opportunity for mechanical or system failure. When the complex equipment is out of commission, will everything come to a halt? A relatively inexpensive "order picker" type of forklift can do many of the functions of a "swing reach," with some loss of productivity. This may be an acceptable way to cover these contingencies, and it should be factored into the system justification.

Are there any other choices?

When all these elements are considered, VNA systems are often the best choice for improving space utilization and productivity. Payback periods of three to five years are legitimate criteria, but this may not optimize your situation. An acceptable alternative is not to try solving all problems with the same solution. Given the different requirements of picking "hits," it may be possible to use a variety of equipment and aisle spacing. Fast moving, high pick families can be handled at floor level with wider aisles and a reach type of forklift. The slower moving, affinity items within this family can be located directly above the "quick picks," and the slower moving families, or stand-alone items stored in a VNA area established in only a limited number of aisles.

Mixing and matching the materials handling equipment to the needs of the operation allows one to develop optimization techniques and expand these improvements on a "pay as you go" basis. The savings generated by each productivity enhancement can be accrued to prepay the next level on efficiency.

Every plastics distributor has a unique operation. Even two branches, of the same company in the same city, may not have identical needs, and should not utilize duplicated layouts, equipment or systems. Very narrow aisles have their place in the layout specialist's "bag of tricks." Knowing that sophisticated equipment exists, and evaluating its potential in your operation requires a long range perspective. Now is the time to initiate a "master plan" for adding sophistication to the operation. Devote as much time to planning and improving the warehouse as you do to increasing sales. The profitability may be greater, and at the very least, the warehouse can continue to support the promises that sales generate. ■

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