PACKAGING AND AUTOMATED WAREHOUSING: HOW ARE THEY CONNECTED?

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Discusses the extent of the change needed in package design to facilitate use in automated warehouses.

The importance of packaging in warehousing and distribution has always been recognized in the need to protect the product all the way from the end of the production line to the ultimate consumer and to facilitate its efficient movement every step of the way. This task remains constant, but the specific ways that packaging fulfills its function must change with the evolution of the environment in which it must operate.

The milieu that a package moves in today is quite different from 15 or even 10 years ago. One of the big changes is automation of materials handling and warehousing, and one of the important questions is to what extent, if any, does an automated system make different demands on packaging. Closely related to that is the question of what effect packaging has had on the justification and successful introduction of automation itself.

Automated warehousing first appeared in the late 1950's when some of the early soft goods systems were developed for order selection, staging and shipping. A degree of mechanization was brought to these labor-intensive operations by using special purpose computers tied in with advanced systems planning to run some of the warehouse activities.

By the early 1960's, automation spread to other merchandise areas and industries while technical advances integrated the information system with selection and sortation in the warehouse. Card readers were developed for automatic routing of products to their predetermined locations in the warehouse and the shipping dock, and the stacker crane came into use as an automatic method for the put-away and retrieval of unit loads.

Applications of this automated equipment crossed industry lines. Metal fabricating companies, for instance, used stacker cranes for handling tools and dyes and similar materials. In the consumer product field, Johnson & Johnson was one of the first companies to automate case goods handling.

This was the "first generation" of automatic warehouse equipment, and it had its share of problems. But at the time, the outlook was quite bright for the spread of automation. In 1960, a prestigious West Coast university carried out extensive research for a group of private sponsors and came up with this prediction: that by 1980, 80% of the merchandise in the United States would be moved through automatic warehouses. Labor content would be greatly reduced, bringing warehousing closer to the level of the technological advances and productivity found in manufacturing.

Unfortunately, this has not been the case. There have been some new developments since the early 1960's, but they were mostly refinements of existing technology. Part of the problem goes back to what was basically an unfavorable situation when the early systems were introduced. Several factors contributed to it:

1. Equipment and related software were extremely expensive so that cost justification became very difficult.

2. Systems were often unreliable in operation or too inflexible to meet the changing needs of many companies. A West Coast frozen food wholesaler, for example, developed a fine system for a limited number of products but had to scrap it when the line expanded with the proliferation of products in this industry.

3. Rapidly expanding computer technology provided attractive alternatives for upgrading existing non-automated systems with a greater return on investment.

Today, we have a better understanding of what automation can and cannot do and how it can be most efficient. But we still find most managements reluctant to take the kind of financial and business planning risks required by large scale automation. There are no hard statistics to go on, but from our position in the mainstream of the warehousing and distribution field in North America we would estimate that perhaps 10 percent of the facilities now being planned will be designed with a level of mechanization high enough to be considered automation.

Here the nagging question remains whether packaging shares some of the responsibility for the slow acceptance of automated warehousing. How, after all, is packaging affected by automated operation? And what should the package designer and engineer know in order to include packaging as part of a totally integrated system for the efficient and economical functioning of automated warehousing?

To answer these questions, we have to remain aware of the variety of automated systems for handling different types of products. To make the discussion more meaningful, we will concentrate on packaged consumer goods that are sold in supermarkets, drug stores and other general merchandise outlets. Even here, automation has a variety of applications, and the product is handled in three basic ways: as a unit load, with or without a pallet, as a shipping container and as the individual consumer package.

Automation can be applied to the unit load in several ways:

1. Palletizers or unitizers create the unit load at the manufacturer level, with all the related sortation and accumulation requirements to facilitate this step.

2. Pallet conveyors move the unit load horizontally, with various devices to route merchandise to a storage area, including interfacing with pallet lifts for vertical movement.

3. A tow-line or tractor-trailer system is also used for horizontal movement, with or without automatic dispatching.

4. Stacker cranes are used for vertical movement in storage and retrieval of unit loads.

5. Live storage of pallet loads is automated; this can be performed in combination with stacker cranes.

In these systems involving the unit load, automatic routing does not involve sensing information on the unit load itself. Instead, it is provided by an IBM card, magnetic tape or some other form of external input. Package requirements for these unit loads are mainly dimensional, aiming at the best cube utilization and stability of the load. If the cases interlock well, there is no danger of toppling. Stability is increased by anti-skid coatings on the package. It should be noted that there are no greater requirements here than in conventional warehousing with a fork lift truck. And structural requirements in stacking are the same.

The forms of automated unit load handling we discussed are predominant in manufacturing which deals in large quantities of relatively few products (numbered in the tens or hundreds) and which uses the unit load as the basic form of storage.

The unit load is significant to the retailer or wholesaler mainly in receiving and for a cube-intensive storage system. Since they ship relatively small quantities of thousands of items, the basic handling unit is the shipping case or the individual consumer package. This is reinforced

by the trend toward greater frequency of replenishment as food chains prefer to stock less merchandise in the store and make deliveries from the warehouse more often. The ultimate goal is virtually to eliminate the backroom and ship direct to the store shelf on delivery carts. Only a few products such as flour, sugar, soft drinks and promotional items can be shipped to large stores in pallet loads.

In such non-foods as health-and-beauty aids and general merchandise, the trend is to replenish many items in less than case quantities in order to save on inventory carrying costs and get greater exposure in a limited amount of display space.

The result is that selection on order picking is very labor intensive, accounting for one-half to two-thirds of total warehouse labor costs, and represents a logical area for advanced mechanization or automation. Present automated case handling systems are designed essentially for selection and the subsequent flow of merchandise to the shipping dock.

One automated order picking machine, aptly called Ordermatic, consists of numerous lanes that are gravity fed and an intelligence system which discharges specific order amounts, merges them and conveys them to the output point. Lanes may be replenished manually or by automatically depalletizing layers of a unit load and feeding cases through a semi-automatic land loader which requires manning. Because this is a million dollar machine, its use may be limited to operations large enough to justify it economically.

Several batch picking systems that fill a number of orders simultaneously seem much easier to justify. One semi-automatic operation features manual picking onto a conveyor from a pallet load. The cases may be identified visually or read automatically before diversion to the correct store order accumulation spur. For food chains, this system is expected to become more popular, especially because the Universal Product Code, if standardized on the shipping carton, will make sortation automatic,and, hopefully, reliable. This system is less capital intensive, but it is also less efficient than the Ordermatic.

A combination batch picking system could handle active items by automatic layer depalletizing onto a conveyor and automatic sortation by store. Inactive items would be batch picked manually, automatically sorted and then merged with the active items. This system is not yet in use but shows promise for the future since it calls for moderate capital outlays. It has the advantage of eliminating the intermediate steps of gravity accumulation, but it must have tight scheduling and control in merging the automated and manual elements

Another variation of batch picking is the FMC Pickmaster machine. The manned unit travels to the correct pallet slot, and cases are picked manually onto a conveyor for automatic sortation. The unit then attaches a machine-readable label for sortation. There are a few of these systems operating now, but no trend has emerged for the future.

Further automation could be achieved with a robot arm, now just in the prototype stage, which could pick merchandise off pallets or shelves or out of bins.

In all these batch picking systems, there is some question about the reliability of sortation. The problem arises when a label or the Universal Product Code is in some way removed or destroyed or proves unreadable because of dirt or package damage.

There are a number of packaging considerations in case handling. If a package were designed for use in the Ordermatic, it would be particularly desirable to have a modular size or at least a fixed size for a given item in order to simplify chute or lane allocation and maintenance. The gravity feed system requires just the right amount of friction so that sliding speed is constant. Adjustment for the specific friction of the package is provided with the equipment. Cases must also be able to ride on various types of conveyors and withstand the impacts and compression forces of diversion accumulation and drops. Bags, bundles and some shrink film packages are therefore not suitable. Nor would such fragile items as weak glass bottles be able to withstand

the severe impacts at several points in the system. Package size is a further consideration for the Ordermatic because oversize items must either be eliminated from the machine or the machine must be designed for oversize use, which is very expensive.

Batch picking systems don't have the friction requirements of gravity feeding, but all the dimension, impact and conveyorability considerations apply. Package configuration also becomes important in vacuum-operated depalletizing. Open space pallet patterns might dissipate the vacuum, so the load should be as tight as possible.

The consumer package poses the fewest problems in current materials handling, partly because the individual item is not often handled in the warehouse. When loose merchandise is picked, it is a manual function, and tote boxes are used for conveying and sortation. But there may be some surprises on the horizon. Current developments, for instance, may lead to automated picking, conveying and sorting of such standard items as cigarette cartons. In the case of many other popular items, the fragility and/or odd shape of existing packaging could be a serious problem for such techniques.

Mail order systems have already put some demands on the consumer package. In those operations, loose merchandise is batch picked manually and then conveyed for manual or automatic sortation. So each package must be conveyorable and able to withstand the impacts of sortation and discharge or must be overpacked.

Further demands on the consumer package are hard to envision, and we don't foresee any large scale automated picking of loose merchandise.

What emerges from this detailed look at the current state of the art in automated materials handling is that only moderate change is required in packaging. With the unit load, the shipping carton and the consumer package, there are few requirements greater than those we already encounter in conventional materials handling and warehousing.

Essentially, the package engineer should be concerned with dimension and structure, and he learned most of what had to be done when the first package was created. Unit loads must be compact and stable. In a gravity or powered flow system involving automatic depalletizing, lane charging, escapement, sortation or accumulation, size is the main factor. The wider the range of sizes or the more frequently they are changed, the harder it is to design a system with good cost justification. Structurally, the stresses imposed on the package by automated equipment should be no greater than those of the normal distribution cycle from the manufacturer all the way to the consumer.

Even when new machinery dictates special requirements, the burden should not automatically fall on the package. After all, the machine is only a one-time expense, while the package is a continuous expense. And the package must be designed for both conventional and automated handling. When the package can meet new conditions without significant extra cost, it should. Otherwise, it might well be cheaper to satisfy the new demands in the design of the machine itself.

One of the few special circumstances of automation is the need for machine readability of a package. In the grocery field, identification will come in the form of the Universal Product Code, and other industries will no doubt learn from the experience here. But the specific code or identification doesn't matter as long as a machine can read it on the package.

Given the many different systems that are now available for automated warehousing and the likely developments ahead, what are the prospects for their widespread use?

The greatest application would seem to be with the manufacturer who produces a limited number of products and has direct control over shipping and consumer packages. But economics get in the way of appearances here. After all, it is hard to justify spending $100 per unit load storage cubicle in a stacker crane system

when it would cost only $10 per cubicle for a conventional pallet rack system. Even without advanced mechanization, we know the manufacturer can attain a high degree of efficiency in handling unit loads.

Of course, other considerations may force the manufacturer to turn to automation. If, for instance, his building is land-locked without sufficient space around it for expansion, he may have to go high-rise in order to get more volume without resorting to a shuttle operation or a completely new building. Take the case of a frozen food manufacturer also. For a special temperature building, he pays three times the normal warehouse construction costs, and he may find it cheaper to get more capacity and productivity out of his expensive investment. With a below zero working environment, there is the added incentive to rely on machines that don't shiver rather than on most men who don't take kindly to arctic weather.

The push toward automation is not much stronger for the wholesaler or retailer whose materials handling operation is so labor intensive. Package standardization would be a little help here--but only a little. For the quantities per order are so small and the number of different items so large that we would need a system totaling thousands of operating elements--even if every package were the same size.

So it turns out to be economics and the special nature of each company's operation that pose the greatest obstacles to automation. At this point, only the large operators can justify such installations as the Ordermatic or batch picking systems. For some, automation may even be economically feasible, but management is reluctant or unable to commit itself to large capital expenditures. What's more, the growing emphasis on electronic checkouts and awareness of their potential savings at the store level may give that a higher priority than warehousing for investment of capital that is hard to come by.

This is not to say that new development and new technologies won't make automation very attractive in the future. As labor costs continue to rise and profit margins are squeezed, there is bound to be more effort to improve technology. And as use spreads, both the cost and reliability of hardware and software will improve. But whatever happens, the package designer should keep abreast of the changes in the larger environment in order to integrate packaging with the new forms and uses of automation.