

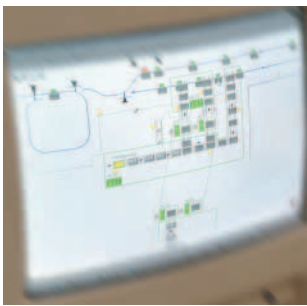
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Automatic Storage
Retrieval Systems
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systems WAREHOUSING EFFICIENCY
THROUGH AUTOMATION

Automatic Storage Retrieval Systems



Typical "conventional" warehouses using lift trucks operated by people are usually characterized as being extremely flexible, especially with unpredictable workloads. However, they are normally confronted with higher operating expenses through additional personnel costs, which make up a large portion of the overall operating expenditure. Given an evenly high requirement for efficiency, an Automated Storage/Retrieval System (AS/RS) provides many potential benefits that should be considered.

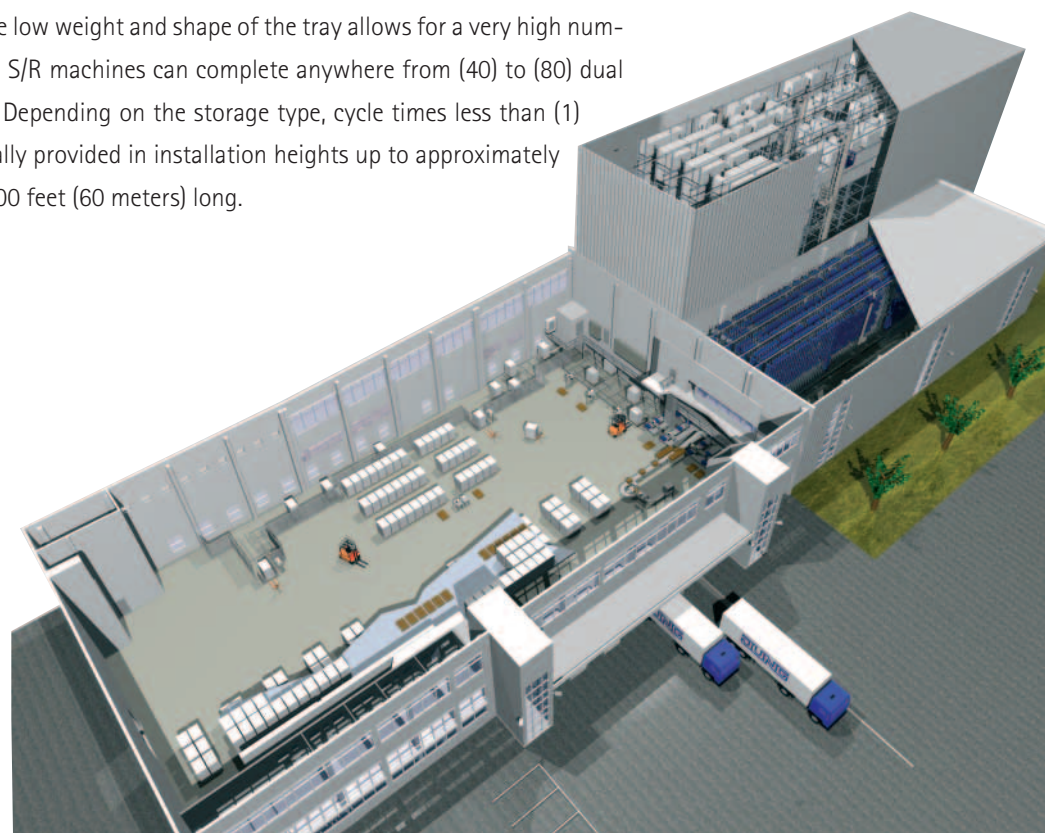
In an AS/RS, the entire warehouse can be controlled and monitored through the use of software. Lift truck drivers can be directed through the best possible route from order to order through the use of radio frequency (RF) terminals mounted on the vehicles; computer controlled picking takes place independently from the chosen picking process; or the inventory can be put in storage and then later retrieved by Storage/Retrieval (S/R) machines. In automatic warehouses that are equipped with S/R machines, there are basically three (3) different types for consideration: unit-load, mini-load tray and mini-load container systems.

Unit-load pallet AS/RS are typically built up to a maximum height of 130 feet (40 meters) or so, with the most common building heights being between 50 and 80 feet (15 and 25 meters). Currently, warehouses are used for two (2) basic functions: First, they can be used for the storage of inventory with the storage and retrieval of entire unit-load pallets and secondly, they are able to combine the storage of product with order picking. By applying the "goods-to-man" principle, the pallets are automatically conveyed to the order picker, who then only has to remove the respective goods. Therefore routing time is eliminated and an optimization of the warehouse organization is achieved providing a high picking efficiency as well.

**For the sizing of a unit-load AS/RS,
two practical formulas apply:**

The first is with regard to the ratio of the building height to the length of the rack, which is dependent on the building size and on the expected throughput efficiency. Second, the efficiency of a single S/R machine depends on the rack configuration and provides approximately (20) to (40) storage and retrieval cycles per hour. As a general rule, a unit-load AS/RS is typically constructed as a rack supported building. With this construction the roof deck and wall siding are supported by the rack construction, meaning that the racks must now carry external loads such as wind and snow. Typically, one (1) S/R machine is used in each aisle, however, in systems with a high number of storage locations and a relatively low throughput, the S/R machines can also serve several aisles through the use of a transfer car that is a machine capable of transporting S/R machines between several adjacent aisles. Unit-load warehouses can be installed to heights of up to 130 feet (40 meters), and the S/R machines provide the automatic storage and retrieval of the inventory. Mini-load systems can be compared to unit-load warehouses, but provide less capacity and handle smaller loads. With this type of storage, a tray is used as the load carrier instead of a pallet.

These trays may remain captive to the system and are re-filled by a person with parts or containers, before being restored. Trays can be loaded with different parts, packing units and container sizes, resulting in a high degree of flexibility. At the same time, the low weight and shape of the tray allows for a very high number of storage and retrieval operations; mini-load S/R machines can complete anywhere from (40) to (80) dual cycles (storage and retrievals) or more per hour. Depending on the storage type, cycle times less than (1) minute are possible. Mini-load systems are typically provided in installation heights up to approximately 50 feet (15 meters) and with aisle lengths up to 200 feet (60 meters) long.



Simply Faster

Storage/Retrieval Machines

The high throughput and efficiency of automatic storage systems can be attributed, for the most part, to the modern S/R machines. Because a floor rail and top guide beam steer each S/R machine at both the top and bottom, very high acceleration rates and driving speeds can be achieved. At the same time, these S/R machines can be used safely to reach heights up to 130 feet (40 meters) high. S/R machines are manufactured in both single (one) and dual (two) mast designs according to the system height, dimensions and weight of the products to be stored. The cycle time (the average time for a storage or retrieval cycle of the S/R machine) is the essential parameter for determining throughput efficiency. In a small mini-load AS/RS, it is not uncommon to obtain in excess of (120) dual cycles per hour, and in a unit-load warehouse up to (40) dual cycles per hour.

For the actual process of storing and retrieving, an S/R machine is equipped with a load-handling device that is mounted to a carriage that moves vertically up and down the mast. This load-handling device can take on many different shapes and forms, which are chosen according to the load being stored and are adapted to each specific respective application. In order to increase the handling efficiency even more, a number of load handling devices can be mounted on one S/R machine; in this way, many storage and retrieval steps can be performed simultaneously, resulting in a considerably higher throughput and efficiency. In the following paragraphs different systems and S/R machines are introduced with a list of their respective advantages and disadvantages.



Automatic AS/RS with picking stations

The product is stored on pallets or in wire baskets, and a telescopic shuttle fork is used for the load-handling device. Picking takes place according to the "goods to man" principle. With viastore systems' "viapal" S/R machine, up to (40) dual cycles can be provided per S/R machine, per hour and (20) to (60) storage locations can be processed by one (1) order picker per hour. The advantage of this solution is the optimum design of the pick station, which is provided at the end of the aisle. The employee remains at his picking station and walking time is eliminated.

The application criteria for an automatic AS/RS of this type are:

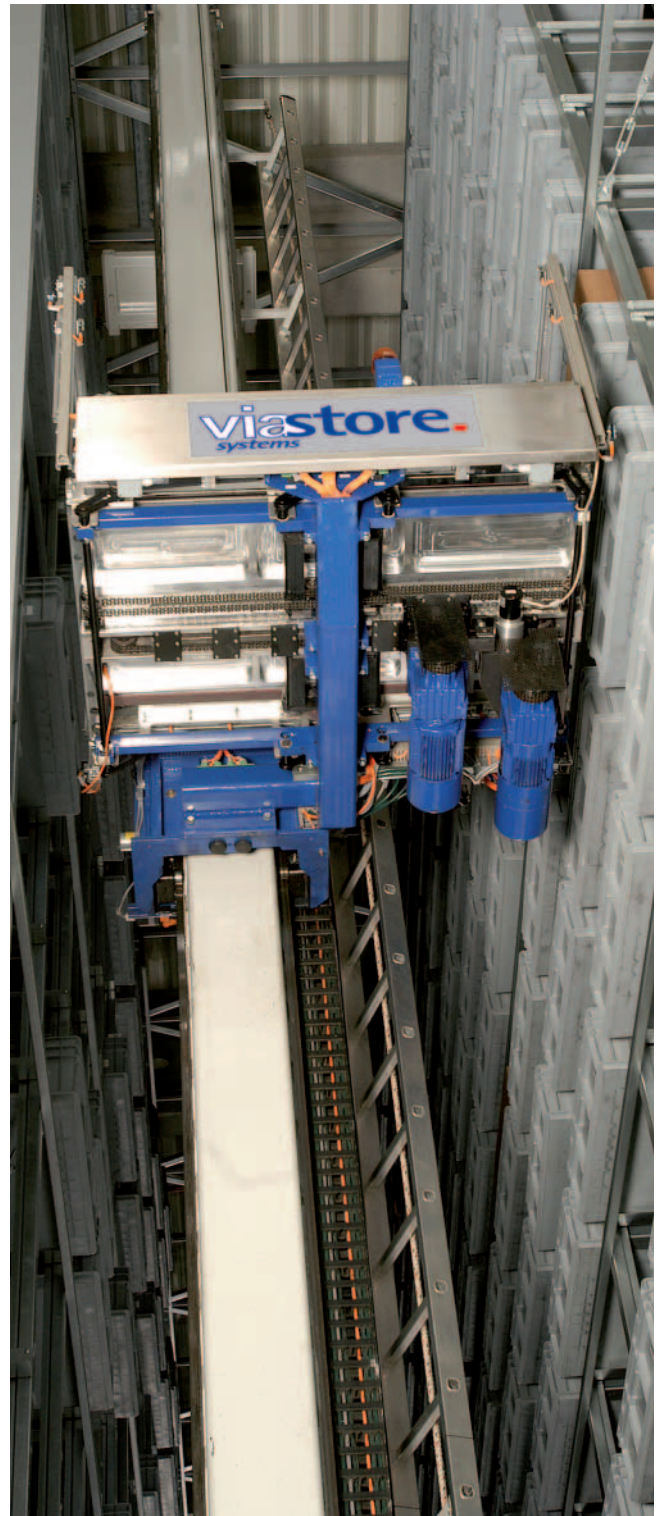
- Few different load units
- A steady, high utilization
- Large withdrawal quantities/volume per part

Automatic mini-load container AS/RS

In an automatic mini-load container AS/RS, the product is stored in plastic containers or cartons. Here again, the picking takes place according to the "goods to man" principle, where the picking efficiency can reach up to (150) dual cycles per S/R machine per hour (for example viaspeed by viastore systems). The same advantages and disadvantages apply as with the automatic unit-load AS/RS. The economic use of an automatic mini-load AS/RS depends on an evenly high utilization. The space utilization within a unit-load AS/RS as well as with a mini-load container AS/RS can be improved by storing two pallets or containers behind each other in one storage location (double-deep storage).

Automatic mini-load tray AS/RS

Plastic containers, cartons or individual pieces are stored on captive trays and the products are brought to the operator by the S/R machine. With one (1) S/R machine, up to (80) dual cycles per hour are possible. The advantage of the mini-load tray system is the ability to store product of different types, sizes and qualities. The efficiency in comparison to a mini-load container AS/RS is lower. Mini-load systems are typically used if the products to be stored are not suitable for direct handling by the S/R machine due to varying sizes and volumes.





Automatic or Manual?

Here are 12 basic questions that will help establish the framework for the planning of a new warehouse, supplemented by considerations with regard to whether or not the automation of the warehouse makes sense.

1. What functions does the planned warehouse have to fulfill (i.e. buffer warehouse, supply warehouse, distribution or picking warehouse)?

2. Is the storage area to be installed in an existing building, or is a new building planned? (If the maximum clear height in the existing building is less than 10 feet (3 meters), automation probably makes little sense.

If the maximum height in an existing building is less than 20 feet (5 meters), automation in the unit-load area is probably not justifiable. With a planned building height of more than 50 feet (15 meters), is a rack-supported building construction the most economical solution?

3. What type of load units are currently in operation, or are planned for the future (pallets, wire baskets, etc.)?

4. What are the dimensions (including overhang) of the load units, their weight and quantity in the warehouse? (A large number of different load units might go against automation of the warehouse).

5. How many SKU's are to be kept in the warehouse?

6. What types of packaging units (cartons etc.) are utilized and what are their dimensions?

7. How many load units per SKU are stored on average?

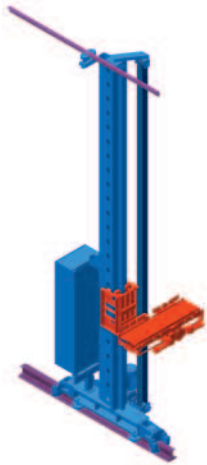
8. How many orders/lines are processed per day or will be processed in the future?

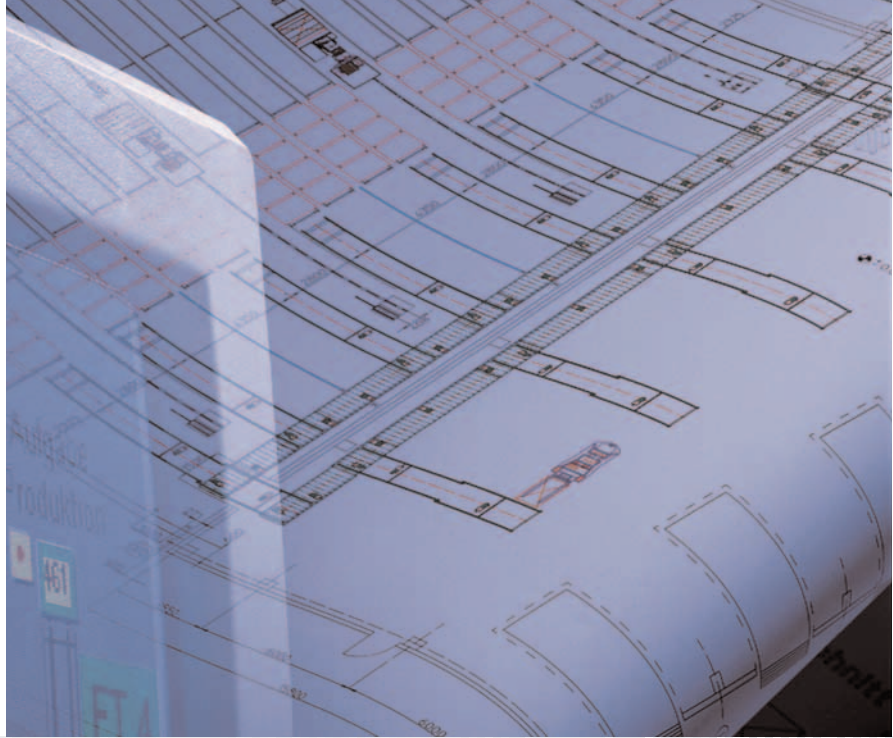
9. Do rush (priority) orders need to be considered?

10. Are there fluctuations in the number of orders to be processed? If yes, how large are they? With large fluctuations automatic warehouses often are not economical.

11. How large is the pick quantity per storage location (number of accesses per position)?

12. What growth forecast or goals regarding article variety and product group variety, order structure and sales quantity can be made?





High requirement - the slab

For long term, problem free operation in an AS/RS, some building characteristics must be taken into consideration. S/R machines put high demands on the slab of the warehouse; the general criteria with regard to difference settings and elastic or permanent deformation are not sufficient. The prerequisite for trouble-free operation of the S/R machine is the exact perpendicular position of the unit. Possible settlement differences of the foundation, as well as elastic deformation, which could effect a separation of the crane rail from the slab, must be limited. In addition, comparably large and constantly changing loads from the rack structure columns have an effect on the slab.

For the evenness of the slab in lengthwise and transverse direction in reference to an ideal horizontal plane, the following manufacturing tolerances are recommended; FEM 9.831 unloaded condition of the slab at the start of installation:

- Up to 160 feet (50 meters) = 0.40 inches (10 mm)
- Up to 500 feet (150 meters) = 0.60 inches (15 mm)
- Over 500 feet (150 meters) = 0.80 inches (20 mm)

The rack columns are fastened to the floor with epoxy anchor bolts. With higher tensile load (for example with rack supported buildings) special dovetail-shaped recesses may be incorporated into the slab. The floor reinforcement engineering must take these recesses and the anchor boltholes under consideration (reinforcement free zone). In the area of the crane rails of the S/R machines, no reinforcement larger than 0.25-inch (6 mm) diameter is allowed up to a depth of 6 inches (150 mm). Reinforcement mats with closely spaced iron reinforcement bars are also not permitted.

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