SSI SCHAEFER
BEST PRACTICE GUIDE

HOW TO GO FROM MANUAL TO SEMI- OR FULLY AUTOMATED COLD CHAIN DISTRIBUTION

A best practice guide to gain higher throughputs with less labor while increasing profits, and what to know before specifying a system.

ssi-schaefer.com

SSI SCHÄFER

INTRODUCTION

Current Market Status
To say that cold chain storage is becoming a hot market is an understatement. Even before COVID-19, the trend was escalating upwards from $15 billion, in 2015 to a now projected $387 billion according to Brandessence Market Research. There are several factors that drive this growth, but mostly, it's a shift in consumer behavior. Plus, it's not just happening in one region—it's a global shift, which has the Americas, Europe, and Asia all working towards increasing storage capacity and implementing either semi- or fully automated systems to offset labor shortages.

Pre- and Post-COVID-19
While the pandemic has changed how the industry thinks about cold storage, it was still in high demand before stay-at-home orders were put in place. However, just a few years back, just-in-time inventory methodologies were very much hailed as the way to run a profitable supply chain. Everyone is now racing to ensure that there is ample space for the skyrocketing product demand and there is little room left in cold storage facilities.

Between food manufacturers and processors, grocery, restaurants, and pharmaceuticals, the demand for cold chain warehouse space isn't subsiding anytime soon. Add in the fact that e-commerce is driving the need for fast deliveries, and localization becomes a strategic need for greenfield builds or expansions to existing facilities.

Working to Implement a Cold Chain Distribution Strategy
With the increase demand in cold storage space, everyone is rethinking their strategy. In fact, the U.S. Department of Homeland security classified cold storage facilities and their employees as an essential infrastructure. And with faster inventory turns, making a sound cold storage strategy for your business makes good sense. Although security is a key factor in any strategy, it's not the only factor that cold chain distributors, manufacturers, and retailers need to include. There are lots of other factors that come into play with cold chain. Rising energy costs, workplace safety, track and trace requirements, labor shortages, growing consumer demand for e-commerce, and future expansion

to meet growing business are all factors that play a role when thinking about cold chain distribution. Other strategy elements include greenfield vs. a retrofit and of course, current and future demographics for location.

Cost & Energy Savings

As with any cold chain distribution, rising energy costs play a key role in an initial design, a retrofit, or an expansion. After labor, energy costs are the highest operation line item. According to Industry Dive, over $30 billion of power is consumed on a yearly basis. And, with the U.S. alone having over 2,200 frozen food warehouses, each facility faces a shortage in net profit if upgrades aren't implemented. While most cold storage facilities are investing capital to lower energy costs, it's best to understand which upgrades can make the most difference.

While new technologies in refrigeration are more energy efficient, a high-density storage facility helps lower overall costs—including labor. Greater storage heights and storage density enable less energy consumption and require less real estate. High-density storage reduces space by up to 60% as compared to a manual facility based on facility heights of 30 to 40' (9m to 12m) vs. 90 to 120' (27m to 37m). Furthermore, modern ASRS equipment manufacturers provide the latest in energy saving technology that works with 25% less energy by harnessing the movement of the equipment.

Meeting Sustainability Goals

While many cold chain facilities are working towards lowering energy cost, several are now faced with a growing demand to implement sustainability, too. Many consumer packaged goods manufacturers are working towards a more sustainable future. It's not only good for the brand image, but for everyone involved. Incorporating sustainable processes into workflows meet some of the demands, but when working towards a more economical business, one must look at every facet—including location and equipment manufacturers. While many companies can say they offer energy savings, others create additional savings in technology, software, and design.

CHALLENGES

New Greenfield Facilities vs. Retrofitting an Existing One

Location, location, location is always the key when looking at real estate. When dealing with commercial properties, it's often the same. However, other business factors play a role. In cold chain, the market is changing and the need to be closer to urban areas is becoming increasingly important. Thus, sometimes that means retrofitting an existing facility vs. having a nice new greenfield facility located just outside city limits.

With COVID-19, consumers' preferences have changed, and e-commerce drives a lot of the purchase requirements for food and beverage. This may indicate a business strategy of going for a smaller facility but closer to consumers, which make the last mile delivery or local brick and mortar replenishment a lot easier and more cost effective. Although, other costs are associated with tackling a cold chain retrofit vs. a greenfield project.

Greenfield:
With a greenfield project, it's easier to get exactly what you need with an automation project. There is enough room to plan effectively and to think about future growth and scalability. Furthermore, it provides a straightforward construction approach.

BENEFITS

- Flexibly design for meeting present and future business requirements
- Future expansions
- Lease or own options
- Optimal integration of automation equipment
- Usually more energy efficient

DISADVANTAGES

- Further away from urban areas with more transit time
- Harder to find skilled labor
- Perceived as negative impact to environment

Retrofitting:
When working with a brownfield site, usually some upfitting must occur before installation can begin. Also, retrofitting a site may limit what you can do in cold chain automation since some technologies aren't as feasible to implement with a shorter building height. Although, there are some advantages.

BENEFITS

- Reduces environmental impact
- Helps revitalize urban areas
- Grants are sometimes available for improvements
- Labor is typically easier to find

DISADVANTAGES

- Longer construction and installation time
- Higher labor requirements
- Upfitting to meet building codes
- Space constraints may limit throughput
- Usually higher energy costs
- Possible issues with slab usability

While each option has pros and cons, it's part of the strategy companies need to think about when planning a facility. As mentioned earlier, location is key for one's strategy. However, other factors must be considered, which include amount of storage needed, throughput for inventory turns, energy costs, transportation, and skilled labor.

Small Facilities
Even before the onset of COVID-19, e-commerce adoption drove consumer shift towards click and ship or click and pick models. Fulfilling those orders have prompted a review of cold chain strategies that include smaller facilities that are more local. These facilities work much like the hub and spoke system of the airlines. With automation, smaller facilities can create a lot of value with higher throughput, faster replenishment for brick and mortar stores, and even the fulfillment of e-commerce orders. Furthermore, when planned correctly, these facilities can scale as business grows.

Medium Facilities
With growing populations, medium facilities are ensuring that imports and exports keep food and pharmaceuticals fresh and safe. Medium sized facilities are large enough to implement complex fulfillment needs or meet requirements for specific workflows or processes—like the ones that pharmaceutical or food track and trace protocols can bring. Controlled room temperatures for pharmaceuticals are a prime example of this. While the main facility is set-up for a typical freezer for food quality, a secure pharmaceutical area may need 1 to 8 degree Celsus (35 to 46 degree Fahrenheit) chilled storage. These changes in protocols work more efficiently with medium to larger facilities.

Large Facilities
Capacity constraints, food processing, and greater regulatory scrutiny lend itself to larger facilities. When it comes to automation, larger facilities have the advantage of energy savings and incorporating advanced workflows. Furthermore, having the ability to scale as more SKUs are added is paramount with any storage facility. In addition to added storage space, the additional square footage lends itself to safer work environments—especially when social distancing. Even though a fully automated facility requires less labor, it's important to think about daily temperature readings, flexible break room space, contactless environments. Work areas must be ergonomic and require enough space to minimize physical interaction.

THE DIFFERENCE BETWEEN MANUAL, SEMI-, OR FULLY AUTOMATED

Manual

While manual cold chain facilities may sound more economical, they aren't. Problems emerge long-term and that's not good when you consider food and pharmaceutical safety must be paramount. With manual distribution facilities, there are four common areas that continually see challenges.

Condensation
When employees go in and out of an area, condensation finds its way into operations. This is especially true where there are both freezer and ambient operations. Moisture leaks in and starts to accumulate on surfaces creating slick areas—that creates a liability for employers. Not to mention potential damage to product.

Microbial Growth in Freezer
Within a manual facility, human errors are made. This can equate to forklifts damaging product resulting in spills in some cases. This common occurrence can lead to mold growth. Keeping manual facilities clean is a challenge but extremely necessary for product integrity.

High-Touch Handling
In a manual setting, pallets can easily be moved without very little processes in place. This can lead to moving product between temperature zones and picked product that doesn't always abide by FIFO method. This method is usually required with both food and pharmaceuticals due to expiry dates. Not having a firm process in place only generates a lot of wasted product.

Labor Costs
Labor is an essential ingredient inside manual facilities. However, with cold chain, labor is quite expensive and has a higher liability than a typical dry warehouse. According to the Global Cold Chain Alliance, labor accounts for 46% of cold chain operating costs. Even as more cold chain facilities are being built, labor remains a constant issue. In today's labor market, skilled labor is hard to attract and retain. Working conditions in manual cold chain facilities are less desirable and typically have a higher turnover rate. Furthermore, labor remains at a higher liability due to cold exposure. Safety programs need to be paramount and health costs can skyrocket.

There are some benefits that manual distribution centers do provide. Basically, processes can easily be changed in a manual facility. This can be a benefit for 3PLs who work with client contracts. Even though it's more expensive long-term to operate a manual facility, it may be cheaper to build depending on the location. Plus, there are warehouse management software systems that work with manual facilities to provide track and trace along with order verification with use of barcode labeling and scanning. However, it's still a manual component that can be easily manipulated—an added risk when dealing with food or pharmaceuticals.

Semi-Automated

Cold chain facilities with semi-automation typically include some flavor of an automated storage element that can include automated guided vehicles (AGVs) or storage unit and are controlled with a warehouse management software. Going from a manual to a semi-automated process is often a logical step when making the leap to automation for many, especially when retrofitting an existing building. Be aware that when moving to semi-automated first, it can be more difficult to justify higher automation later.

Going from manual to fully automated is not only a strategic decision, but one that is also made with capital justification. Therefore, many cold chain facilities go from manual to semi-automated to reduce labor and reap at least some of the benefits that automation brings to a process. This strategy is one that many 3PLs take due to short term contracts with clients. Also, it's typical for existing cold storage facilities to implement a semi-automated approach before a facility expansion of a new greenfield facility. This strategy typically builds out the maximum amount of an existing space.

Most semi-automated "retrofit" facilities incorporate high density channel storage with a pallet shuttle or mobile racking. While deep channel storage is usually incorporated with greenfield builds, it can also be installed in existing facilities too. Most systems can be installed by increasing the temperature within a few degrees.

This saves time and money on installation. High-density channel storage works great with lower SKU counts and higher storage requirements.

Mobile racking can also be implemented to create additional storage space by reducing aisles. This too is a great option for 3PLs as clients grow or change product SKUs. AGVs can be combined with mobile racking to create a very efficient cold storage solution. However, if you're just looking to automate some processes, then an AGV might serve the purpose. Although there are still some challenges using AGVs in frozen environments, many sensors, batteries, and other parts do not work well in frozen environments.

Moving to a semi-automated process still requires good planning and an engineering design team to review current processes and workflows. Understanding the amount of labor access that is available with both short and long-term strategies provides guidance to create the best plan moving forward while creating value on an investment.

SSI SCHÄFER

Fully Automated

For companies that have a long-term strategy plan and capital to invest, a fully automated solution makes sense. A fully automated cold chain storage system can cost as little as half the price as a conventional building for the same amount of pallet storage due to the much smaller footprint. Both labor and energy cost within manual facilities are primary drivers for fully automated cold chain storage solutions. However, there are other benefits too.

Energy Savings
Building up versus out not only saves on energy costs by having a smaller footprint, but also requires less land and space to cool. This usually translates into a smaller tax bill, but also is more environmentally friendly. Plus, fully automated systems are equipped with perfectly isolated double door airlocks for pallet access. This design keeps the cold in while keeping warm air and moisture out. This too lends itself to energy costs, but it also improves product integrity. A fully automated system only enters a cold storage area when needed. This lowers energy consumption and keeps costs lower. Furthermore, more storage space is achievable within a given footprint when implementing a fully automated system.

Labor Savings
Fully automated systems require less labor, which translates into big cost savings. However, there are other benefits with labor. With fully automated systems, labor is typically easier to attract. It is a different skillset, but usually you'll find a higher retention rate as well. A fully automated cold storage facility limits the amount of exposure to employees and thus, liability is reduced and workers are happier.

High-Density Space Utilization
With a fully automated cold chain facility, you get more storage per cubic meter / foot, which gives a better ROI cost per square meter / foot than either manual or semi-automated. Highly automated systems require narrow aisles but do not require forklifts or AGVs. Again, less equipment for maintenance and more space for product. Furthermore, fully automated solutions require a robust WMS solution that can drive greater throughput per facility. This also has a higher payback as more product distribution can happen within a given timeframe.

Safety
With fully automated ASRS cold chain solutions, one can expect a more scrutiny from a safety perspective. However, fully automated systems are engineered to work at the desired temperature. This keeps product integrity intact and limits liability with food safety. It also keeps your employees away from any potential danger way by restricting access to potential problem areas

Staging
With an ASRS or fully automated system, staging for route sequence and temperature-controlled transport saves time and labor. A well designed and highly automated facility should include a temperature control staging area. Orders that have a product mix of both ambient and cold storage not only need to be loaded correctly for transport but should include route sequencing. Fully automated facilities typically leverage a warehouse management software solution to facilitate this step in the process.

With automated facilities, you can easily create more storage capacity, which provides better production efficiencies by producing larger production batches (less down times of production lines for process changeover). This has greater impact as the variety of products tend to grow in packaging size, in special diet ingredients or special food like Kosher or organics. Savings by increased production efficiency to cope with market demands can justify automation easily if you consider all aspects of handling more complexity caused by higher product variety. And, let's not forget an increase in demand for order picking processes.

Overall, a fully automated system will give the best ROI. While many operations do not have the capital to invest in a larger solution, for those that do can expect to see an ROI within three to five years.

Future Proof Design

As with any distribution or warehouse project, it's best to plan for business growth in the early stages. While most business cases only call for a specific timeframe and/or space requirements, the engineering design phase is better suited to account for future business growth. This pre-planning helps lower cost for expansions and retrofits as the business grows. Similarly, equipment choices need to be considered carefully for this same reason. It's always best to pick a solution that can be easily retrofitted or expanded from the currently planned solution. Equipment and software that provides scalability is often the key to a well-managed long-term facility. This enables an easier transition to gain more space and throughput in the future.

COLD CHAIN FULFILLMENT SOLUTIONS

As with any distribution facility, one can break down various warehouse sections into several key functions. While some of these may differ from facility to facility, almost all have some type of function depending on the application.

These functions are receiving, storage, picking, conveying, software, and goods-out. Given the expertise of SSI SCHAEFER, a deeper look into storage, picking, conveying, and software are outlined here.

Storage

While cold chain distribution centers encompass a variety of products and services, each have different storage needs. Based on the number of SKUs, product types, temperature requirements, throughput needs, and economical feasibility, this criterion may dictate what types of storage work best for your facility. There are essentially different solutions for storage that work best within manual, semi-, or fully automated systems. Below, you will find different solutions for each type of distribution facility. Each section contains a brief overview on the type of product, the pros and cons for each product, and what you should know before scoping this type of product for a cold chain application.

Manual

Most manual facilities rely on very limited storage components. A forklift vehicle and some type of storage racking system is most common. Although, the racking system may differ depending on the application and the number of SKUs.

RACKING SYSTEMS
While there are several different types of racking systems for manual applications, cold storage distribution facilities have specific requirements that one must consider.

Structural vs. Roll-formed
There are various pros and cons when it comes to both roll-formed and structural rack systems. Each point should be considered when evaluating for a specific application. Structural frames provide the best performance against forklift impact, especially in frequent high inventory turnover applications like the food industry. However, structural frames may not be the best for highly seismic locations due to the welded bracing, where the flexibility of bolted connections could help improve the design and reduce the cost. Furthermore, a roll-formed frame can be provided with either a weld or bolt bracing. Bolted drastically reduces transportation costs, as the frames shipped collapsed but increases installation cost and timeline. Bolted also allows for much easier replacement of damaged components. Finally, welded frames pose a significant challenge when performing annual inspections: if a welded connection seems affected, the quality of a weld cannot be truly determined unless the welded area is sectioned. However, the torque of a bolted connection can be tested and verified easily.

The best approach is to discuss your application and needs in detailed with your rack supplier so they can review the pros and cons of each solution and find the best design for your needs.

> Single Deep Selective Pallet Racking

While selective pallet racking is the most common type of racking system used in a cold storage facility, it doesn't have the capacity or density of other types of racking systems. However, it is the most economical so if you're truly need a quick solution for pallet storage with very limited pallet counts, then this may be a good option for you.

INVENTORY METHODOLOGY:

FIFO (First In First Out)

Pros:
- Economical
- Highest selectivity for fast moving
- Fast installation

Cons:
- Lowest storage density
- High storage cost as business grows
- Limited storage height

> Drive-In Or Drive Through Pallet Racking

While not as economical as a selective pallet rack system, a drive-in pallet racking solution can be just as cost effect within manual applications. Drive-in pallet rack systems are designed to store between 2 and 10 pallets deep per pallet position. These systems can be closed at one end of an aisle, hence the name "drive-in." This gives more storage capability. However, drive-in pallet storage isn't optimal for cold chain applications. This has to do with inventory management methodologies of FILO, which doesn't lend itself to perishable goods that expire quickly. While FIFO is supported here, when storing more than two-deep, this solution is harder to maintain inventory turns with expiry dates. There are also safety and financial risks involved with drive in rack due to the "drive in" feature, where the rack can easily be damaged by forklift interaction.

INVENTORY METHODOLOGY:

FILO (First In Last Out) and FIFO (First In First Out)

Pros:
- Virtually unlimited depth
- Cost effective
- Can integrate with other pallet racking systems
- Higher density of pallet storage within manual pallet rack systems

Cons:
- Limits inventory applications
- Poor accessibility to pallets 2nd row or further back
- Can be tough to maneuver and more maintenance requires

> Pallet Flow Rack

Pallet flow racks utilize a gravity flow system and provide a FIFO rotation to manage food and beverage along with pharmaceutical supplies. Racks are placed with aisle in between, which allow forklifts to input inventory on one side, while picking inventory from the other aisle. This design ensures inventory rotation. Plus, the roller action of the racking enables easy and quick replenishment once a unit is picked.

INVENTORY METHODOLOGY:

FIFO (First In First Out)

Pros:

- More capacity vs. conventional pallet rack storage
- Less travel time between aisles
- Good manual system for expiry goods

Cons:

- Installation needs to be compact in cold storage
- Lubricants may lock-up at low temperatures
- Plastic and/or rubber wheels may crack in low temperatures
- Pallets can get stuck within the channel

> Pushback Racking

Pushback racking is a pallet storage system that uses a cart on inclined rails–similar to a C channel design. Depending on the installation, each rack can have either two to six pallets deep. Once loaded with pallets, the first pallet is pushed back by the second pallet. It continues until all pallet positions are full. Once a pallet is picked and the remaining pallets move forward on the rail. This type of racking system uses the LIFO (Last in First Out) methodology and does offer density storage.

INVENTORY METHODOLOGY:

FILO (First In Last Out)

Pros:
- High density storage capability
- Good for fast moving SKUs
- Great for low SKU counts

Cons:
- Not ideal for items with expiration dates
- Product damage can occur

> Double Deep

Double deep racking systems are just as they sound—meaning that they store pallets two rows deep instead of one. These are also known as deep reach pallet rack as well. They are designed to consolidate aisle space and allow more storage per storage space.

However, these racks require the use of a deep-reach fork truck. These systems can also go three-deep too depending on your needs.

INVENTORY METHODOLOGY:

LIFO (Last In First Out)

Pros:
- High density storage capability for manual applications
- Good for fast moving SKUs
- Great for low SKU counts

Cons:
- Not ideal for items with expiration dates
- Need special fork truck
- Three deep positioning depends on pallet weight

Semi-Automated Systems

Semi-automated systems are typically ideal for facilities that are currently manual but need to boost throughput or gain additional space. Also, these solutions tend to thrive where SKU count is minimal, but where FIFO methodologies are needed for expiration of goods such as food and pharmaceutical goods—perfect for cold chain applications.

These systems utilize warehouse management systems to increase throughput and reduce picking errors. Furthermore, semi-automated solutions also decrease exposure to labor and thus, reduces liability. Within this category, there are two main types of storage solutions—channel storage and mobile racking.

> Channel Storage

Channel storage systems provide compact storage within a defined area. Several storage locations are included one after the other in what are known as channels. Channel vehicles or pallet shuttles move up and down the channel performing storage and retrieval tasks. Only the load unit at the very front of each channel is accessible for both safety and security reasons. This design is what makes a channel storage system so dense. This type of system is well suited for large volumes of minimum SKUs. It can also be used to stage inventory in front of the shipping dock for efficient trailer loading.

Another benefit to a channel storage system is the ability to practice both FIFO and FILO storage methodologies within the same warehouse. Channel vehicles can also be used with remote controls. This is a huge benefit to a cold storage facility in that it limits exposure to employees. However, it's always best to find a solution that provides end-to-end accessibility—especially in cold or freezer applications. This access gives the ability to clean and perform maintenance within the channel when needed, which is a must for both food and pharmaceutical applications.

INVENTORY METHODOLOGY:

FIFO (First In First Out)
FILO (First In Last Out)
FIFO & FILO Combined
(can be created when an aisle is located at the lower level for manual access)

Pros:
- High density storage capability
- Great for low SKU counts
- A good option for stepping up from manual operations
- Can be installed in retrofit applications
- Can integrate with other automation components
- Efficient trailer loading and dock management

Cons:
- More expensive than manual solutions
- Requires adequate training
- Not suitable for a large variety of SKU counts

> Mobile Racking System

When it comes to cold storage, easy, fast, and quick picking is always needed. Mobile racking for freezers enables quick visibility and storage capacity. Since freezer space is more expensive than ambient, it makes sense to go with a technology that creates additional storage by limiting the requirement for aisle space. Rails are installed in the flooring, which act as the guide for the rack, which has wheels, to move along when access is needed. Employees have easy access through a warehouse management system. When an item needs to be picked, the system locates the item and the appropriate aisle opens for access. Employees can pick the item safely since safety sensors are in place to stop any movement when a person or obstacle is detected.

Other than easy access to inventory, there are additional reasons to go with mobile racking. Load units of varying sizes are easily accommodated. Throughput increases with the introduction of warehouse management software. Items are easily batched together to pick within certain areas and times. Plus, mobile racking is a good choice for facilities housing products with low SKU count but needing medium to low rotation of inventory. These applications also tend to lend themselves to smaller to mid-size facilities.

INVENTORY METHODOLOGY:

FIFO (First in First Out)
FILO (First in Last Out)

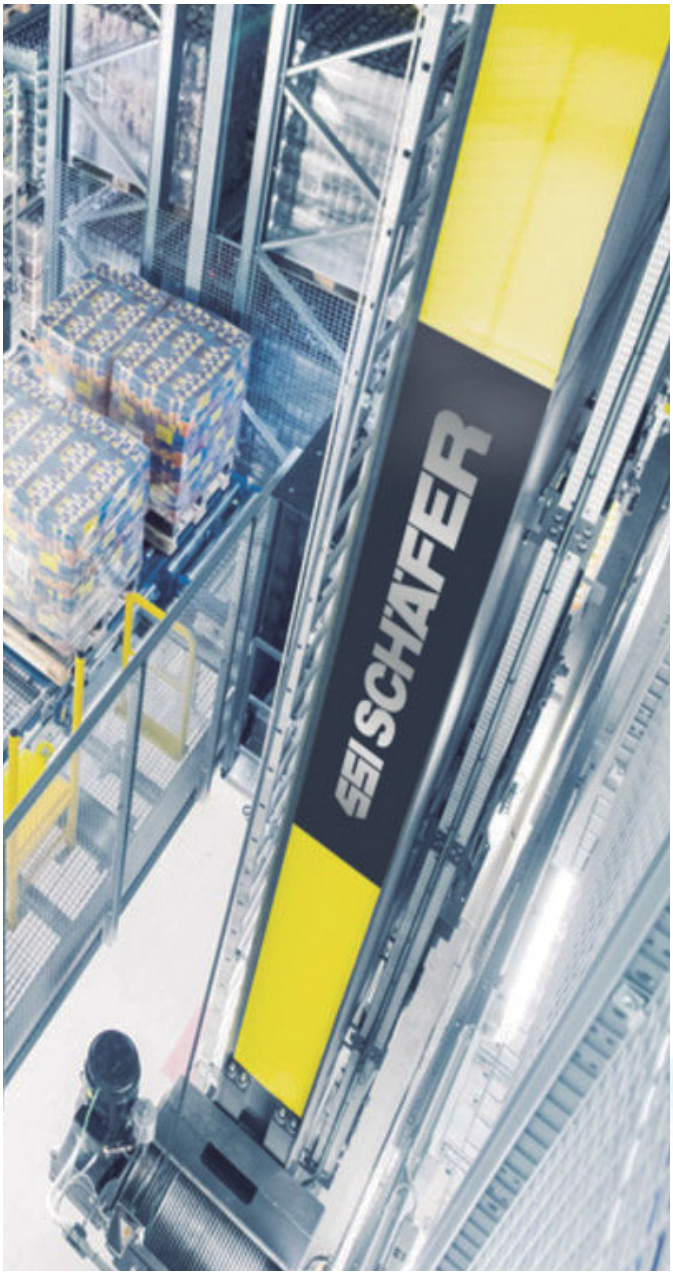
Pros:
- Works with small to medium sized areas
- Works with a warehouse management system
- Manual access is available
- Provides high density storage
- Can work with a remote control
- Can integrate with lighting solutions for additional energy savings

Cons:
- Best suited for Greenfield projects due to floor leveling requirements
- Typically used when throughput requirements are lower

Fully Automated Systems

Fully automated systems provide more benefits than manual or semi-automated solutions. However, they also require the highest investment. Depending on your application, a fully automated system may be the best fit if you need a high throughput, have a high SKU count, or have the need for highly dense storage. Other motives for a fully automated solution are to offset labor or reduce product waste—which are large operating costs. Another thing to mention about fully automated systems is that there is full visibility with product tracking.

This includes lot numbers, expiration dates, and put and pull dates. This type of track and trace features are a must for certain products such as food and pharmaceuticals and this type of tracking is mandated in certain countries by regulatory government agencies like the U.S. FDA through the Food Safety Modernization Act (FSMA), the European EMA, or the Chinese NMPA. This also enables easy access to pull and destroy products that are recalled.



AN ENERGY EFFICIENT HIGH BAY WAREHOUSE

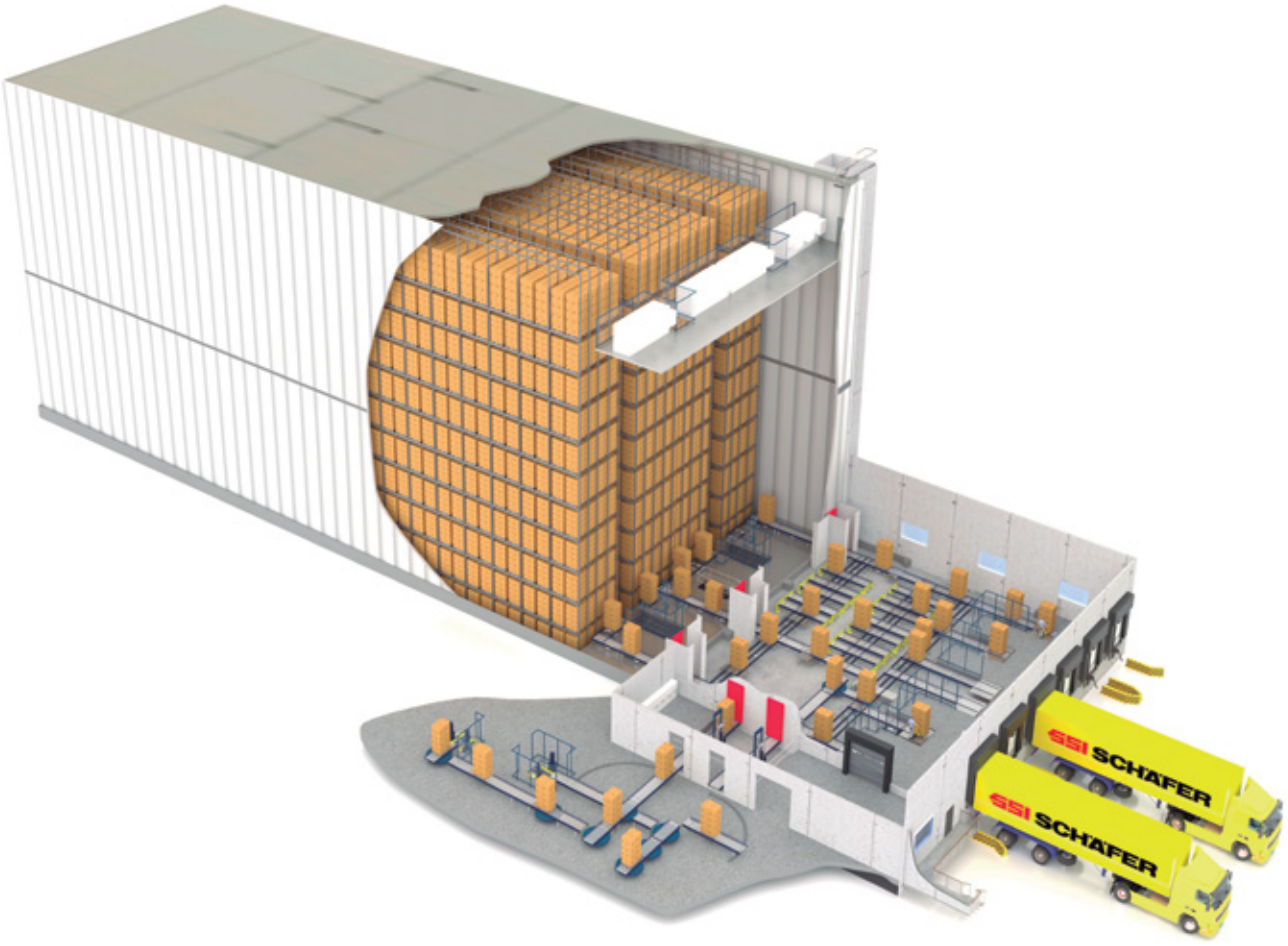
Designed for the utmost energy efficiency, the high bay warehouse (HBW) is a fully automated racking system combined with Storage and Retrieval Machines (SRMs) that provides the densest storage of all automated pallet solutions and are often the cornerstone of a cold storage solution. These buildings can either be conventional or rack supported structures and typically vary in height from 12 meters (39') and reach up to 50 meters (164').

A high bay warehouse (HBW) is a racking system combined with storage and retrieval machines (SRMs), designed to create incredibly dense storage within a relatively small footprint. This is especially important in cold chain as every cubic meter/inch within the warehouse has to be conditioned regardless of it is holding product or not.

These towering structures range from12 meters (40') up to 45 meters (148') in height and can hold from thousands to hundreds of thousands of pallets depending on the requirement. They can also be built in two main ways:

- Free standing construction where the racking is built inside of a completed, self-supported warehouse.

- Rack supported construction where the racking is built onto a completed building slab and it supports the roof and wall that is used to skin the racking system, which forms it into a building. Typically, this type of construction is used above 18 meters (60') due to the cost required for building a conventional building at similar heights.



The racking systems used for a HBW are customized to each application and are designed to store loads in three ways:

Single Deep

Single deep has a single pallet location on either side of the aisle. This storage concept is utilized in low storage, but high throughput applications.

Double Deep

Double deep has two pallets on either side of the aisle. This storage concept features the use of a telescopic fork and is utilized in most applications due to its balance of storage density, throughput and relatively lower cost per location as when compared to multi-deep or shuttle systems.

Multi-Deep

Multi-deep, also known as channel storage, uses a pallet shuttle to access pallets that are stored up to 10 to 15 pallets deep or deeper on either side of the aisle. This storage concept requires a higher investment, but typically has a lower cost per location. However, they work very well in applications with low SKU counts and medium throughput requirements.

With temperatures that can dip as low as -28 Celsius (-4 degrees Fahrenheit), fully automated systems employed in cold chain require the use of equipment designed to handle such harsh conditions.

There are several types of freezer-ready SRMs within the industry, but typically, you'll find the following:

Storage Retrieval Machines for Heavy Loads

An SRM is an automated pallet storage machine. These pallet handling devices automatically pick, or place pallets within a racking system based on software algorithms. These sturdy machines can be equipped with one or two load handling devices for single-, double-, or multi-deep storage (via pallet shuttle described below) and retrieval.

In existing buildings, some low profile SRMs can be used that are designed specifically for low clear heights of under 12 meters (40'). These systems can also be fitted with energy saving devices that limit consumption and also heat output.

FEATURES

Pros:

- Works with large number of SKUs
- Extremely dense storage through use of vertical space
- Works with a warehouse management system
- Limits human exposure
- Can work in a completely dark scenario for additional energy savings
- Easy maintenance with service from the ground
- Sustainable energy savings for cold chain applications

Cons:

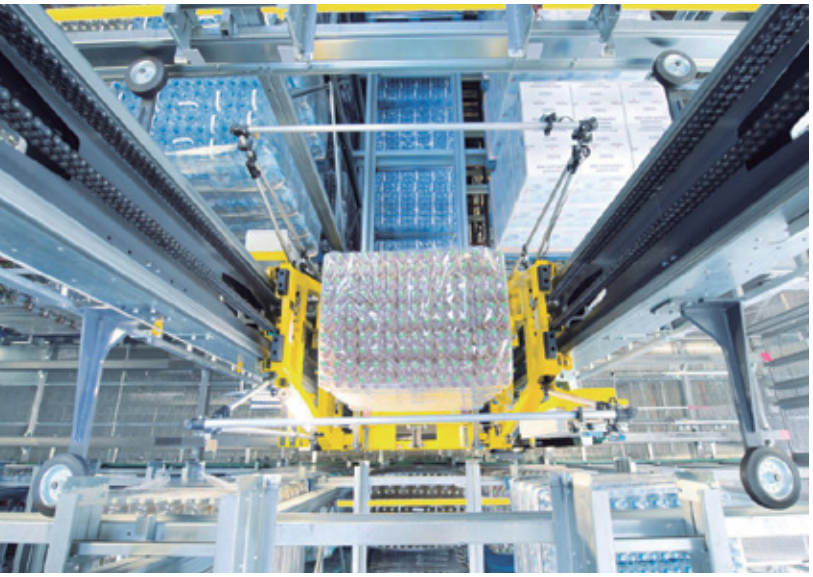
- IT system required
- Best suited for greenfield projects, but can be used in retrofit when load bearing requirements and floor leveling has taken place
- May have a longer ROI depending on the application
- Requires larger investment

Shuttle Systems for Heavy Loads

As with any application, there are restraints. When it comes to cold chain, many facilities are already existing. The prospect of incorporating a fully automated solution is sometimes limited to height restrictions. This may also be the case for when a facility is in an urban area since zoning may require height restrictions. When these types of restrictions occur, one will need to seek out a solution that can work within the confinements of the building. Pallet handling storage solutions are available for facilities that measure up to 8 meters (26') and can serve two to four rack levels per aisle.

This type of solution encompasses a load handling device that runs on a bottom railing since loads on the floor are not as high as when using standard ASRS machines.

For applications needing high throughput and without height restrictions, these units can be designed to work with multiple devices one above the other. This creates a higher throughput rate without the HBW. This type of application works extremely well with beverages. The high density and quick demand for product is a perfect combination with these types of units.



FEATURES

Pros:

- Works with medium to large number of SKUs
- Extremely high dense storage
- High throughput
- Limits human exposure
- Potentially lower cost than standard ASRS machines
- Can be used in brownfield projects
- Can work in a completely dark scenario for additional energy savings

Cons:

- Requires larger investment

For applications requiring high throughputs like those found in the fresh food and beverage industry, pallet shuttles are also a way to combine dense storage with high dynamics. This is achieved by adding additional load handling devices (LHDs) within an aisle, usually connected to the ground floor conveyor system via front end lifts.

Some pallet shuttles are designed to service a single level and others can handle multiple levels (between 2 and 4 depending on pallet height), but all of them are used in multi-deep storage concepts. This type of equipment is also especially useful in existing buildings due to their low profile.

Shuttle Systems for Compact or Case Loads

For applications that require storage for cases, bins, or cartons, there are storage retrieval machines that are built for more compact loads. This is especially valuable for cold storage facilities that perform mixed case storage and picking for various retail or other businesses. When it comes to case picking and planning for automation, it's best to look for a solution that will grow with your business. There are basically two differences to look for when vetting a solution. First, there are shuttles that are built to perform greater throughputs. A single level shuttle can often perform at higher capacity speeds. Second, certain types of shuttles are capable of handling mixed cases with varying widths and lengths. This feature along with the ability to handle multiple deep storage units make these shuttles an excellent choice for deep freeze environments.

A flexible single-level shuttle is such a unit and handles load units up to 50 kg (110 lbs.). The adjustable storage location size allows for flexible and maximum storage density. It's a great choice for those with businesses that are still in growth mode and need to scale later.

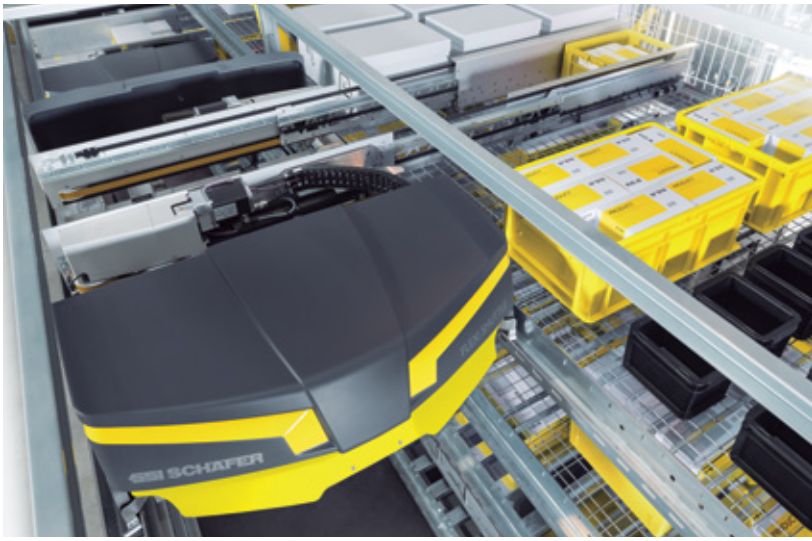
FEATURES

Pros:

- Scalable shuttle system
- Capable of handling loads of varying dimensions
- Performs at high-capacity speeds even in deep-freezer environments
- Multiple deep storage capability, which maximizes storage density

Cons:

- Maximum case load is usually lower 50 kg (110 lbs.)
- One shuttle is needed for each level



Containers, Bins, and Trays for Cold Storage

Since most automated cold storage applications are mainly pallet applications, the use of reusable containers, bins, and trays represents only a small percentage. Although, one must understand what to look for in a vendor when it comes to supplying these much-needed storage components. First, plastic can become brittle in cold temperatures. The impact strength is much reduced, which makes it suspectable to cracking when under pressure.

While polypropylene (PP) totes are recommended in automation systems due to dampened noise levels, regular PP does not perform well in low temperatures. It's best to look for a vendor who can use a copolymer PP blend for applications down to freezing temperatures. This copolymer blend is generally good down to -23 C / -10 F.

PICKING SOLUTIONS FOR COLD CHAIN ENVIRONMENTS

The act of picking within a cold chain environment is one that must be taken with labor in mind. With a global consumer shift purchasing frozen ready prepared meals, throughput needs have become much higher. Thus, it's best to automate as much as possible. This saves on labor cost, but it also helps deter any liability for human exposure. Furthermore, cold chain products are typically products that need the utmost of care when it comes to picking—meaning that error-free picking is a must. Expiration date and lot number tracking within the automated system guarantees that each order is picked correctly. This is a mainstay for both food and beverage and pharmaceutical applications. The key is to harmonize the picking technology with order fulfillment.

Case Picking

Case picking is when an individual or an automated robotic solution picks cases to create a pallet to ship to a retailer or a processing facility. There are some applications where case picking is picked and shipped as a standalone shipment. Although, those applications are in the minority, it is gaining in popularity. When designing for a fully automated solution, there are two ways to design the process. It is recommended that the system bring the pallet to another area for picking. This way, the employee can pick for longer periods of time. Although, it will always depend on the type of product. However, there are warehouses where employees pick within the freezer area. This type of design is more expensive since the process takes longer due to the limited amount of time an employee can stay within the chilled or freezer areas.

In both applications, most picking is done by software and fed back to an individual via voice or to an automated robotic picking solution. The software application optimizes picking and limits the number of minutes an employee is in the facility.

In most manual to semi-automated applications, case picking within cold chain is performed with voice picking. This enables the employee to utilize their hands for picking cases and uses acoustic feedback to confirm the correct item picking and that the quantity is correct. A wireless Bluetooth headset is used to incorporate the order picking process. There are two main methodologies used for case picking:

Person to Goods
Person to goods is somewhat self-explanatory, the picker will travel pick aisles or zones to pick inventory at the case level for order fulfillment. An operator can pick cases directly to a pallet (Pick to Pallet) or they can pick and place them on to a conveyor system (Pick to Belt) to be routed to a downstream pallet building or truck loading location. Replenishment can either be done manually or by an ASRS machine if reserve inventory is kept in an automated system. Most often the pick face for this type of picking is either a full pallet location (static or pallet flow) or case flow rack. It's also very flexible from a throughput perspective as you can add labor as needed to cover peaks. A typical pick rate is 150 cases / hour up to 250 cases / hour.

Goods to person
Goods to person picking is also fairly self-explanatory as the product to needs picking will be pulled from an ASRS system and brought to the employee or robot for picking. This type of picking increases employee productivity by eliminating unnecessary travel time, but obviously requires a higher investment due to the automation used to deliver the product to the picker. It's a great way to add case picking functionality to an ASRS system, but keep in mind that the capacity is limited by the number of picking stations in the design.

With labor being in demand and sometimes hard to find, operators are often substituted with robots with an increase in investment to achieve the highest level of automation, which also moves employees out of harsh frozen conditions. Typical pick rates are 350 cases / hour up to 650 cases / hour between a person or picking robot.

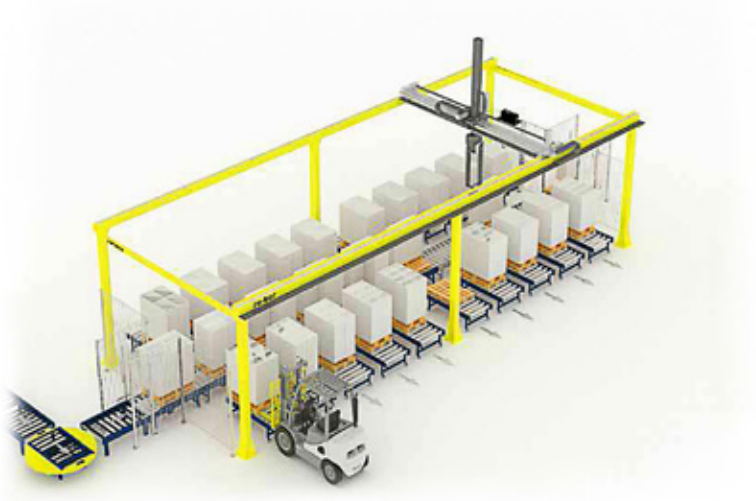
Layer Picking

Layer picking is used when an order needs less than a full pallet, but more than a couple loose cases of product. The outcome is a mixed layer pallet or often what is called a rainbow pallet, which is picked with either a robot or forklift attachment.

Automated layer picking is easily integrated with an ASRS and can drastically reduce picking labor within the warehouse.

Pallet Picking

Pallet picking happens when a full pallet is pulled from an ASRS or conventional pallet rack and sent directly to the staging area for route sequencing for shipping or loaded directly onto a truck.



Robotic Picking

Robotic picking is the most efficient picking solution within a cold chain facility. Either by layers or case picking, robotic picking can offer 24/7 operation and work within a cold environment. This type of technology can pick either in layers or cases to either create a pallet or depalletize.

CONVEYING

When planning a cold chain facility, it's best to keep conveying to a minimum. This is where experience counts. Design engineers need to take into consideration the cost of operations for energy. Every inch or cooled area is best suited for storage.

However, it is recommended to have a conveying system from the freezer or chilled areas to an ambient area for picking. As mentioned earlier, this will lower the cost of picking since throughput is much higher and liability goes down.

PROS AROUND COVEYING VS. MANUAL TRANSPORT

- Less space needed
- Less damages
- No people in cold areas
- No trouble with batteries for fork lifts

SOFTWARE SOLUTIONS FOR COLD CHAIN

Cold chain automation has unique requirements, which indicates that one should look for a warehouse management software (WMS) or warehouse control system (WCS) that was programed with these challenges in mind. Storage optimization for cold food and beverage items are indicative of several things. First, a WMS/WCS will enable storage optimization for different methodologies. This typically starts before a shipment is even accepted. Look for a WMS/WCS that can integrate into an ERP and understand the logic of what is arriving that day. This will allow for the system to shift inventory and optimize based on goods in.

Once a shipment arrives, goods are scanned, validated, and expiry dates, batch numbers, and even GTIN information can be captured. This is especially useful for food and beverage companies because it allows these fields to be leveraged for order processing and also track and trace regulations or processes.

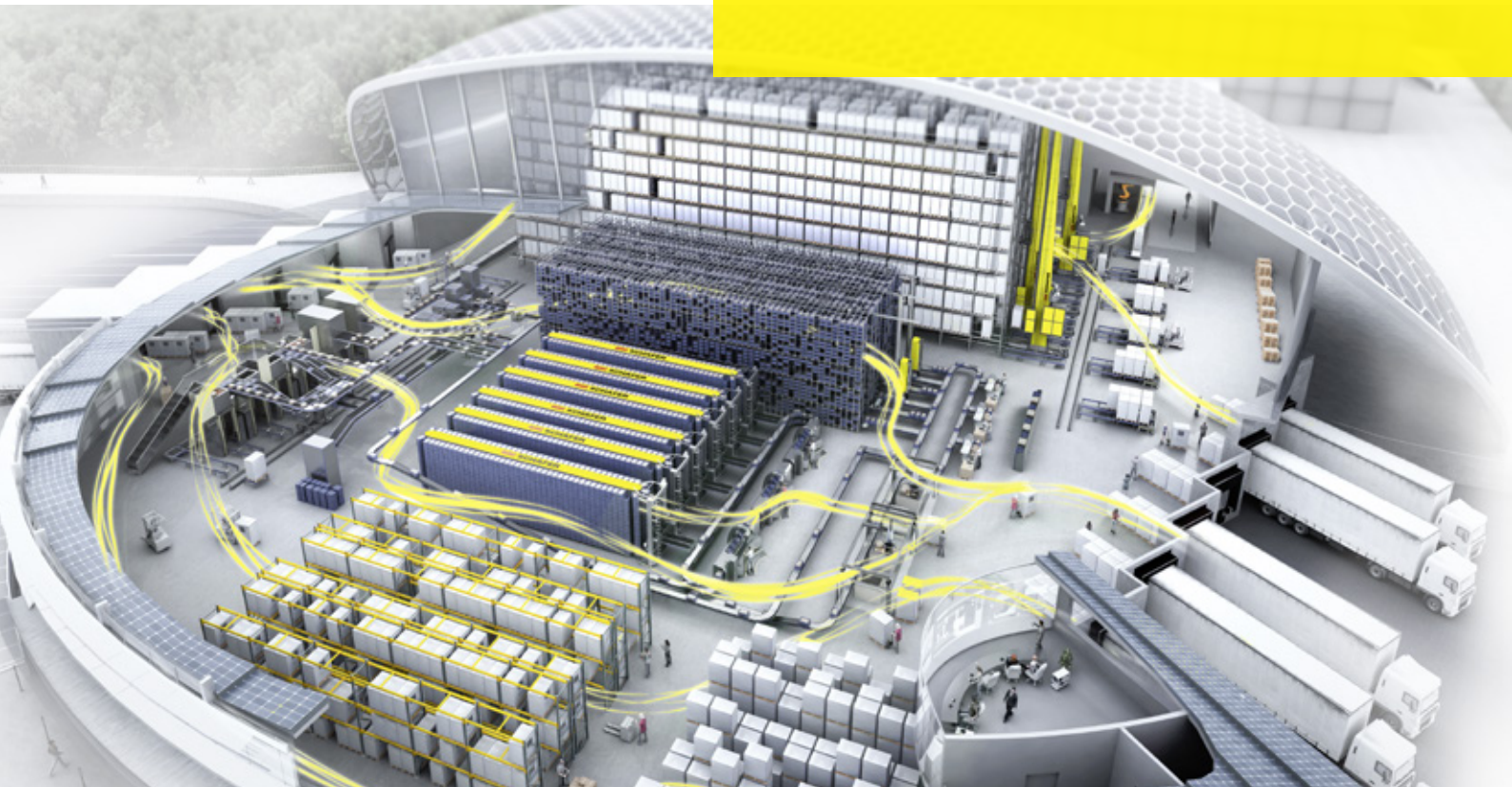
For fast moving SKUs, the first one in still goes out first, but these items should be stored near the picking area as close as possible. An intelligent WMS/WCS will handle this for you by slotting inventory based on velocity. This methodology increases output speeds and saves valuable time and when picking in frigid conditions. Slow movers may tend to be placed in a static rack in another area if available.

The facility configuration will determine the best placement based on current inventory levels and history profiles.

Furthermore, a good WMS/WCS will help facilitate adherence to the safety requirements that are needed for cold chain storage. Indicators for maximum picking time when an employee is picking in a freezer or chilled area. It can also keep track of individuals for maximum daily exposure. The same is true for monitoring time that inventory is outside of its designated temperature zone so food doesn't spoil. Also, a good WMS/WCS system will also coordinate route sequenced truck loading.

Since cold chain distribution facilities fall under the most expensive to operate, a good WMS/WCS can help indicate when a sensor is indicating replacement or maintenance. These types of features will keep operating cost low and maintenance repairs at a minimum.

Real time data is also key when it comes to cold chain WMS reporting. If there are multiple facilities, one should choose an WMS that enables multi-tenancy and gives real time updates based on key performance indicators. Also look for a software solution that is mobile friendly.



SAFETY / LABOR

While safety is the utmost requirement for both labor and product, it also should be top of mind when deciding on whether to retrofit or expand into a new greenfield facility. The more one can automate a facility, the lower the risk for both food spoilage and labor liability issues. Training goes a long way, but humans aren't error-free. While automation equipment can lower the risks, high-touch handling can result in food spoilage.

Cold chain has the highest cost per labor given the throughput and time limit on exposure requirements. Safety is a must for employees, but technology does make cold chain processes safer. Mapping out each process can help offset the slightest risk, which goes a long way in both human safety and throughput.

Fire Safety

While industrial fires are rare, they can and do happen. It's always best to plan but there are several alternatives. First, cold chain facilities are densely packed large-scale buildings, which leaves little room for sprinkler systems to perform well. If there is a fire, sprinklers can damage product and cause costly downtimes. Most facilities are running 24/7 and cannot afford disruptions. Furthermore, installing a sprinkler system can be costly—even if it's a retrofit situation. Constant air movement between racks can create hazard for firefighters in a dark area surrounded by ice.

This is not a scenario that manufacturers nor 3PLs want. Newer applications are now being designed to reduce or displace the oxygen level to prevent fires from even starting. These systems keep damages at a minimum and help protect employees, firefighters, as well as product. A well-designed facility should leverage the right amount of oxygen levels to help prevent fires from happening in the first place. Oxygen levels are typically reduced from a normal of 20.9% down to 13.8 and 17.0% depending on the products and environment according to Wagner, a global industrial fire prevention company.

LIFE CYCLE / CUSTOMER SERVICE

The life cycle of a cold storage facility is typically around 34 years, but has more to do with the actual facility than the solution. Most material handling solutions last longer and can be retrofitted as business grows. While a new facility may not need customer service initially, it's always best to plan. Look to find a reputable customer service team that can provide residence maintenance or dial in service.

A reputable customer service team can offer long-term service contracts and maintenance hotlines when or if needed. With cold chain facilities, downtime is not an option and condensation can happen at any time on a sensor or around a door, etc. It's always best to have a team of experts ready to manage, diagnose, repair as needed.

CONCLUSION

The return on investment will be heavily dependent on the individual application requirements and equipment selected. Since energy consumption is such a huge cost driver within the cold storage industry, it will always be better to maximize building efficiencies and limit footprint whenever possible. Look for equipment that harnesses its movement for energy. This will not only help save on energy costs but also create less heat, which allows your HVAC system to work more efficiently.

The type of facility will generate very different returns. If a project is a new greenfield facility, one can expect a high degree of labor and footprint savings if the building is highly automated. However, before you start calculating the savings, establish a baseline labor cost.

Typically, a new facility can generate a positive ROI within three years. Again, this is based on a highly automated facility. For a retrofit within an existing facility, ROI can be a bit longer—usually around four to five years. Considering all aspects of the project including the building, equipment, and lowering production costs by producing larger batches, there is a greater return over manual due to less product damages and waste, greater production volume, labor savings, and greater fulfillment throughput, etc.

Labor and energy are the biggest items to take into consideration. The labor shortage within multiple countries along with using labor to pick is the most expensive picking you can do within any distribution center. Energy consumption across all seasons should be examined. Peak holiday season will have equipment running more frequently due to demand, but summer months may have higher HVAC power consumption.

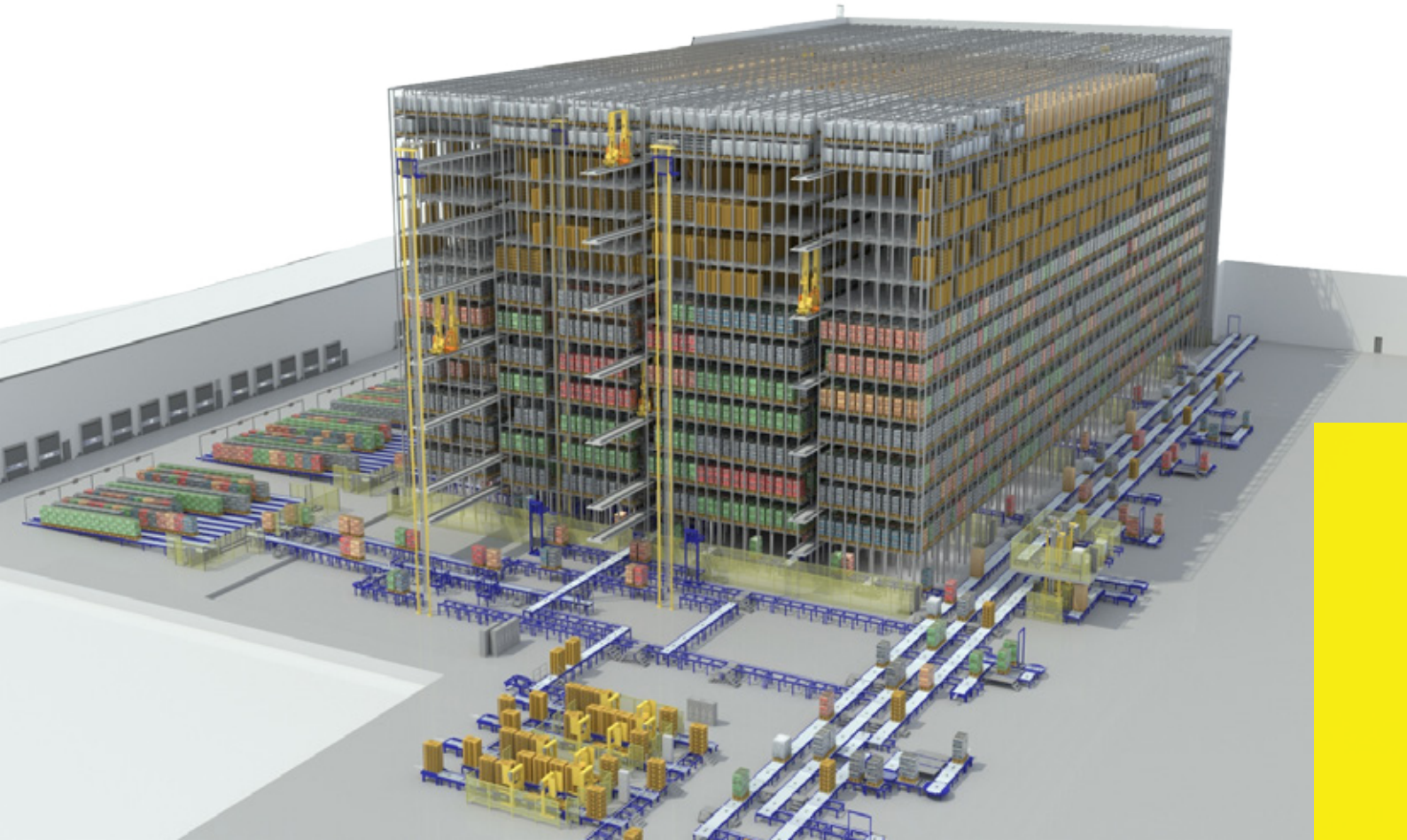
PLANNING AND GETTING STARTED

Regardless of whether you plan on building a new greenfield facility, erecting an expansion, or a retrofit, it's always best to call in the experts. Cold chain consultant experts can work with specific requirements and design a solution to fit your needs. Furthermore, it will save time and money. A well-designed facility with proven cold chain processes saves on energy and in labor. Before you call a vendor, have the following data ready as it will speed up the process:

- Number of SKUs,
- Throughput demands,
- What type of items,
- How items are picked (full-pallet, layer, case, etc.),
- What type of data needs to be captured,
- Current software solution if any—will there need to be an integration,
- Number of current employees and shifts if it is a retrofit or expansion.

SSI SCHAEFER can help guide you through the process. Our team of cold chain experts have years of experience with some of the largest cold chain facilities worldwide.

And, we have designed numerous smaller manual and mid-size semi-automated solutions too. However, it goes without saying to check references and get a few bids, but make sure you choose an expert with experience.



WHAT TO LOOK FOR IN A VENDOR

Reliability, experience, and longevity are key when choosing an automation and technology partner. In addition, it's not just about cost savings. Look for a vendor who has multiple installations in similar applications and who have a robust customer service program. Furthermore, there are other items to consider:

Integrity
While most companies do business under the premise of integrity, look for a vendor that has professionals that you can trust. Steadfast engineers who take the time to listen to your particular needs and business challenges. A good company culture needs to be one that fosters innovation and transparency. Ask about application processes for installation and operation. These processes and procedures should be well documented and available for review.

Flexibility Now and Later
Distribution centers are usually built with the mindset of having to scale, retrofit, or additional locations as business grows. Different applications vary and so should software and systems technology. Choose a vendor who can work with you to implement a process for strategic business goals. In addition, when processes change, and they will, choose a vendor who has the ability to update your software and equipment.

History and Experience
Some of the best technologies have come from start-up ventures. However, when it comes to distribution, choose an expert. Industry professionals agree, the barrier to entry into software isn't high, but manufacturing automation equipment and understanding distribution and warehouse operations is an extremely specialized skillset. Look for a vendor who has decades of experience when it comes to your application. Of course, higher expertise is needed for large complex projects. However, even the most simplistic application benefits from a background with decades of installation experience and best practices.

Long-term Viability
Pick a vendor who is financially stable and has long-term staying power. Technology companies come and go, so it's best to pick an automation technology company that has a long-term track record and viable business model moving forward. Review references; look at the number of employees, and locations to determine future success of an automation technology partner. Also, review the client list. If larger corporations are utilizing a specific vendor, changes are that the company has long-term viability.

Compare Equally
As with any application, it's always best to get multiple quotes. However, make certain that they are equal. Both equipment manufacturers and software providers can vary in features and technology. Knowing what is missing from one provider from another may determine a successful bid. So, make certain to compare apples to apples. In addition, a last-ditch effort to include a technology feature to make a bid quote may not be the best scenario for a business. Proven technology has scheduled roadmaps and beta testing before releasing new features.

Adaptable
Each distribution application is different, so each installation will also be different. Software and automation technology should match each requirement when it comes to system design and installation. While smaller manual applications may be able to handle a one-size-fits-all approach, scalability for future should be mandatory. Also, think about availability. Does the vendor have a local presence? How accessible are they?.

References and Reviews
As with any large purchase, make certain to check references. Since it's a large investment, ask for at least two to three. Check to see if they are similar in size and contain similar processes. The reference check will give peace-of-mind and eliminate any concerns about a vendor being able to perform certain process functions. A reputable vendor will not hesitate to show examples of previous work or take you to a
site visit.

As for review sites, please take a bit of caution.
Many review sites for automation and/or warehouse technology sites are a pay-to-play business model. These sites bid for search engine optimization and then sell auction placements on their sites. In fact, many of these sites are owned by the same organization. Furthermore, large-scale WMS software does not warrant the same type of reviews that a personal software program would have. Users from a corporation aren't going to spend time reviewing a particular piece of custom software that is used for work. Therefore, you're better off skipping the review sites and asking for references.

Works cited

- **Brand Essence Research.** (2019, December). Retrieved from Brand Essenence Research: https://brandessenceresearch.com/food-beverage/refrigerated-transport-market?add-autocomplete=cold+chain

- **Global Cold Chain Alliance**. (2020, July). Global Cold Chain Alliance. Retrieved from Global Cold Chain Alliance: https://www.gcca.org/resources/2020-covid-19-cold-chain-business-impact-survey-summary

- **Utility Dive**. (2018, April 12). Utility Dive. Retrieved from Unitility Dive: https://www.utilitydive.com/spons/alternative-energy-now-has-alternative-storage/520802/

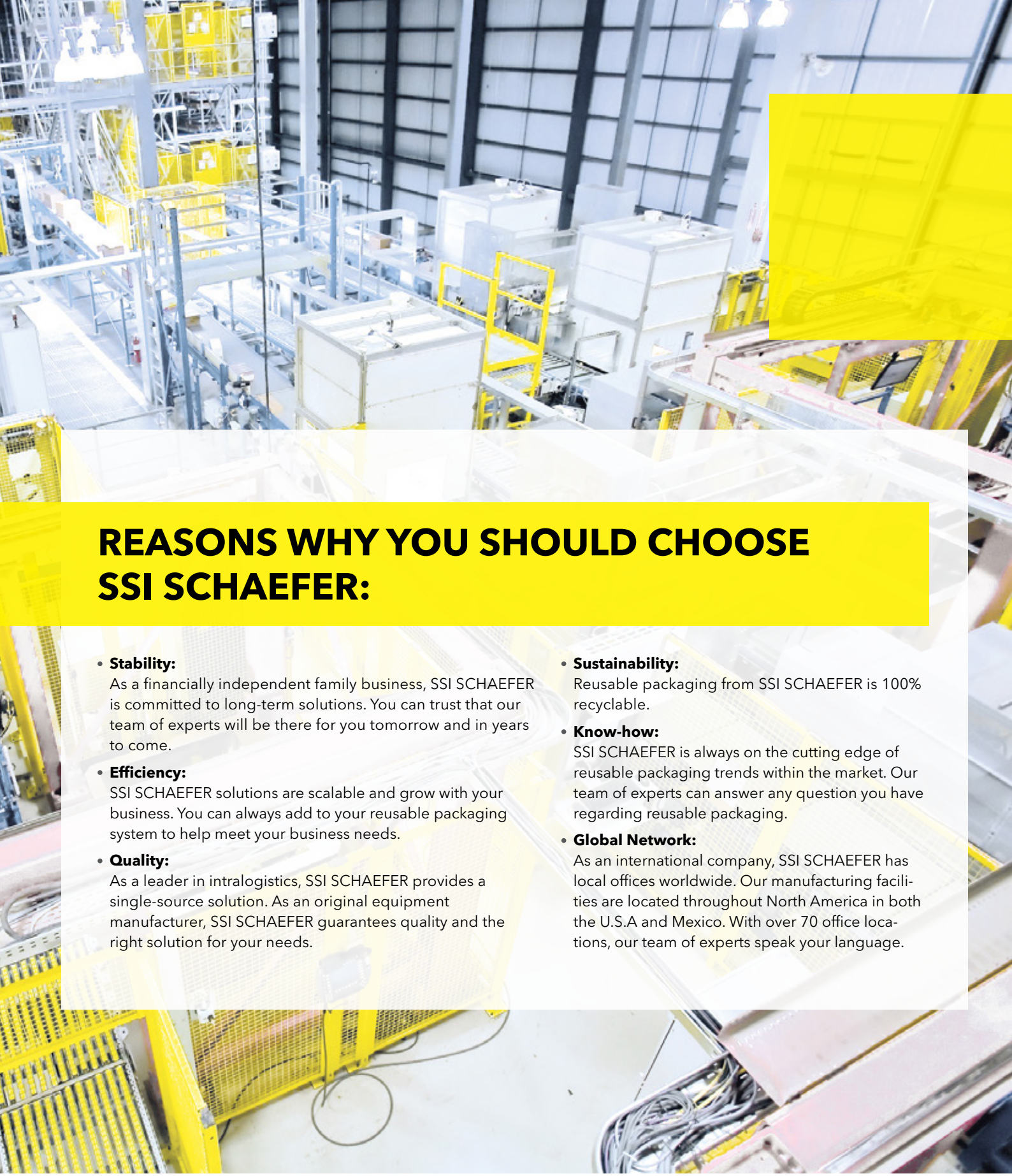
ABOUT THE AUTHOR

ABOUT SSI SCHAEFER

SSI SCHAEFER is a leading supplier of innovative automation systems, integrated warehouse management technology, and storage solutions for various industries. SSI SCHAEFER provides end-to-end solutions for manual, semi-, and fully automated distribution and warehouse operation facilities including picking solutions, vertical lift storage, automated guided vehicles, and warehouse management software.

SSI SCHAEFER is part of the SSI SCHAEFER Group, a global leader in material handling solutions and waste technology. Schäfer Werke and Schäfer Shop are also part of the SSI SCHAEFER Group. Founded in 1937, SSI SCHAEFER is a privately owned family company, with over 70 office locations, 8 manufacturing facilities, and 10,500 associates worldwide.

ssi-schaefer.com



REASONS WHY YOU SHOULD CHOOSE SSI SCHAEFER:

- **Stability:**
  As a financially independent family business, SSI SCHAEFER is committed to long-term solutions. You can trust that our team of experts will be there for you tomorrow and in years to come.
- **Efficiency:**
  SSI SCHAEFER solutions are scalable and grow with your business. You can always add to your reusable packaging system to help meet your business needs.
- **Quality:**
  As a leader in intralogistics, SSI SCHAEFER provides a single-source solution. As an original equipment manufacturer, SSI SCHAEFER guarantees quality and the right solution for your needs.
- **Sustainability:**
  Reusable packaging from SSI SCHAEFER is 100% recyclable.
- **Know-how:**
  SSI SCHAEFER is always on the cutting edge of reusable packaging trends within the market. Our team of experts can answer any question you have regarding reusable packaging.
- **Global Network:**
  As an international company, SSI SCHAEFER has local offices worldwide. Our manufacturing facilities are located throughout North America in both the U.S.A and Mexico. With over 70 office locations, our team of experts speak your language.

ssi-schaefer.com

SSI SCHÄFER