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THRIVING IN THE COLD: INTEGRATING BUILDING DESIGN, AUTOMATION AND MANAGEMENT TO IMPROVE COLD STORAGE EFFICIENCY

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INTRODUCTION

The demand for cold chain storage continues to grow. According to Grand View Research, the North American market for cold chain storage, driven by improvements in packaging and processing as well as shifts in the retail landscape, is expected to more than double between 2019 and 2025.

This growth is occurring within an uncertain labor market. Warehouses in general are struggling to attract and retain talent. In 2018, industrial real estate firm CBRE analyzed the warehouse and fulfillment labor market and concluded that the industry would have to add an additional 452,000 workers in 2018-19 — more than double the industry's actual average job growth since 2013 of 180,300 new positions per year. It's not unreasonable to conclude that this situation will be worse in cold storage facilities where working conditions can be harsh.

Cold storage facilities are also under more pressure to manage energy costs than other types of warehouses. Energy is the number two expense in the cold chain warehouse, behind only labor.

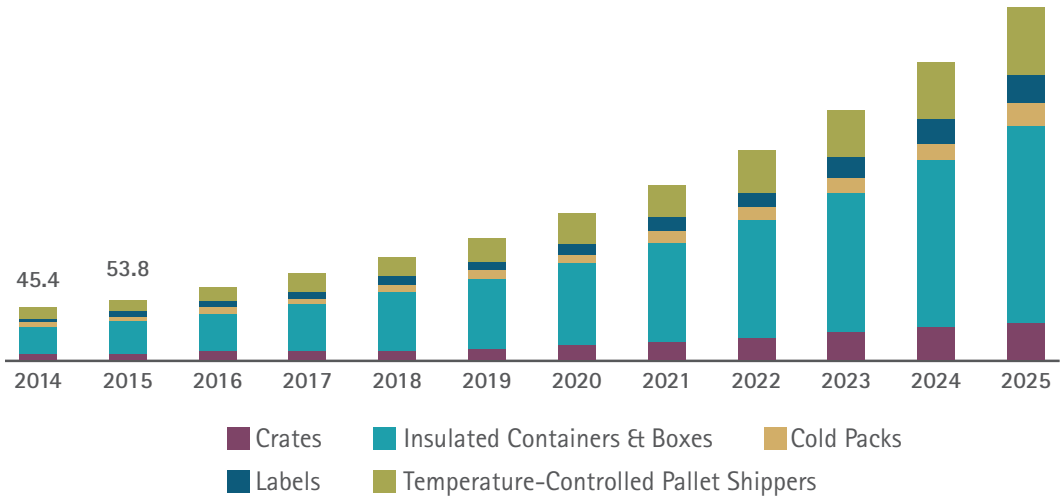
Finally, the nature of cold chain storage is changing as well. Long-term storage, once dominant, now represents a fraction of total warehouse income in many facilities. Today's cold chain facilities must accommodate higher-turn velocity inventory.

Automation is playing a key role in addressing the labor, efficiency and throughput requirements of cold storage facilities. However, unlike other facilities where flexible automation systems can be adapted to virtually any environment, achieving the true benefits of automation in a cold chain warehouse requires tight integration between the building design and automation system.

Energy is the number two expense in the cold chain warehouse, behind only labor.

This paper describes a collaborative approach to cold storage facility development in which the building designer, automation vendor and operator work collaboratively to ensure the resulting facility can meet the demands of today's market in the most efficient way possible.

Global cold chain market size, by product, 2014-2025 (USD Billion)



Source: Grand View Research

DESIGNING FOR EFFICIENCY

Traditional warehouses with 40-foot ceiling heights are not conducive to efficient refrigeration because the square footage of the roof introduces heat from solar energy, increasing the load on the refrigeration system. If the facility is a deep-freeze warehouse it will also have a heated floor, so a large square footage floor also adds to the heat load.

> Designing the building to fully leverage the space-saving capabilities of the automation system can result in a reduction of building energy consumption of 20%.

These issues can be minimized by a building design that reduces roof and floor square footage without compromising storage capacity. That requires building taller warehouses, enabled by automation systems that support vertical storage. Relying on these automation technologies allows the building designer to achieve a footprint approximately one-third that of a conventional facility.

These high-bay warehouses typically have ceiling heights of 100-120 feet and, in addition to reducing refrigeration costs, increase inventory density by reducing aisle widths, further increasing cooling efficiency.

Designing the building to fully leverage the space-saving capabilities of the automation system can result in a reduction of building energy consumption of 20%. That equates to a 10% to 15% decrease in electrical power draw in the refrigeration system, reducing both the initial cost of the system as well as ongoing operating costs.

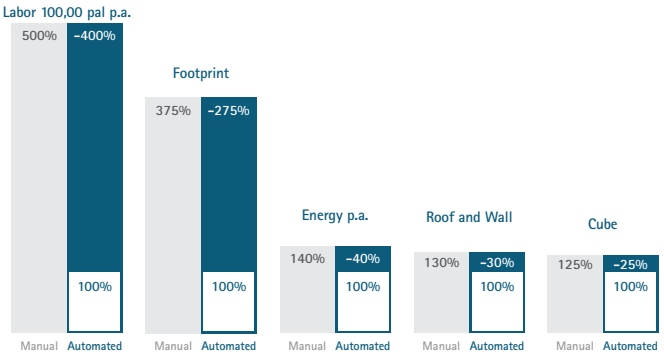
Getting the automation vendor involved in the design process as early as possible helps ensure labor and energy savings are maximized through the integration of the automation system and building design.

AUTOMATING THE COLD CHAIN WAREHOUSE

Automation technology that is integrated into the design of today's cold storage facilities generates savings in building costs as well as labor and energy.

The Value of Automation

Example: deep-freeze warehouse with 17,000 pallets



When it comes to cold storage automation there is no single solution that meets the requirements of every facility. Automation should be tailored to product type, throughput and desired density.

It's also important to consider the automation control platform offered by the automation vendor. Stand-alone automation control systems can create data silos while forcing operators to adapt to different interfaces for each system. A modular automation platform that integrates automation control into the WMS platform, such as Swisslog's SynQ, is preferred. This approach enables increased use of data for system optimization and business intelligence and supports a universal operator interface across the warehouse. The system should also include standard APIs to integrate with the ERP system for enhanced inventory management.

The primary solutions used in deep-freeze or temperature-controlled warehouses include ***pallet cranes***, ***pallet shuttles,*** ***pallet conveyors*** and ***automated carton handling*** systems.

ASRS Pallet Cranes

Stacker crane systems are a cost-effective and reliable approach to enabling high-bay warehouse designs where the highest density and throughput are not required. In addition to enabling vertical storage up to 140 feet, by eliminating the need for forklifts they allow aisle widths to be reduced from 12 feet to five feet, freeing up additional space for storage. This has the added benefit of eliminating product damage caused by forklifts.

AUTOMATING THE COLD CHAIN WAREHOUSE

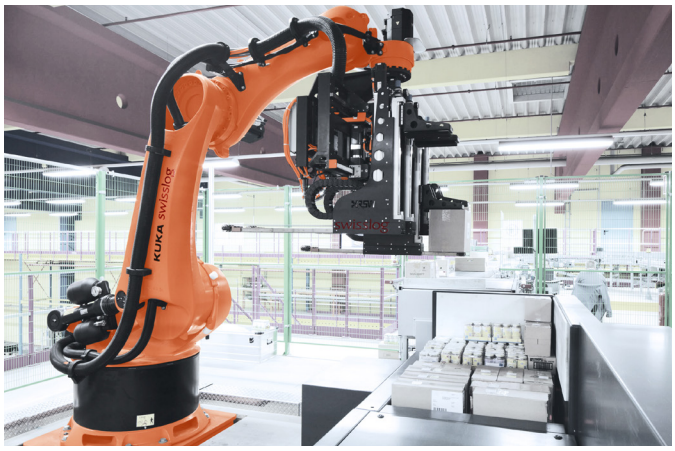
Pallet Shuttle Systems
Robotic pallet shuttles for high-bay storage in deep-freeze and chilled temperature warehouses are capable of storing pallet loads in the highest density configurations at heights up to 110 feet.

The best example of these systems is the Swisslog PowerStore system, which employs low-footprint pallet lifts in place of aisles to enable storage 20 pallets deep. PowerStore provides the industry's most dense automated pallet storage, further improving cold retention. As each storage level is serviced by individual shuttle vehicles, system redundancy or operating "uptime" is high. It also supports the high throughput requirements of today's high-turn cold storage facilities and delivers outstanding reliability to minimize service technician exposure to deep freeze environments.

Pallet Conveyors
Multifunctional conveyor systems provide energy efficient transportation of pallets for both light and heavy loads. With its flexible design, the Swisslog ProMove pallet conveyor can be configured to meet a wide range of requirements for automated pallet transportation and can be used in temperatures from -30°C to 50°C.

Automated Carton Handling
Downstream operations within the cold chain warehouse can be automated through the use of robotic case picking systems, such as the Swisslog ACPaQ system.

This system automates the task of building store-friendly pallets by combining light-goods shuttle systems, conveyors and high-performance de-palletizing and palletizing robotic technology from KUKA, a global leader in robotics. The system can be configured for small, mid-size and large distribution centers handling up to 500,000 cases a day.



Adapting to the Cold

Automation systems require some special adaptations to perform reliably in low temperature environments, including:

- **Remote visibility:** Look for the ability to monitor I/O status remotely through software as well as 3D visualization. Cameras on racks enable remote visibility into equipment operation.
- **Cold-resistant lubrication:** Components and lubrications should be rated for deep-freeze environments to ensure reliable operation.
- **Service-friendly control cabinets:** Cabinets and motors should be placed close to the ground wherever possible to facilitate access. Cabinets may be heated to create a better environment when service is required.
- **Quick-disconnect couplings:** Quick-disconnect couplings reduce MTTR — and service technician exposure to harsh environments.

MANAGING FOR EFFICIENCY

The building design and choice of automation system can significantly reduce the costs of building and operating a cold storage warehouse. However, innovative operators are also employing supplemental technology to reduce energy costs.

Energy costs on a per kilowatt hour basis are based on demand. Reducing energy costs during high-demand periods can drive down average overall energy costs. This is challenging because surge pricing is often triggered by high ambient temperatures, which increase the thermal load on the refrigeration system.

In a standard industrial controls system, systems are turned on and off without consideration for peak energy costs. However, by tuning the operation of the control system using advanced control algorithms that factor in internal and external temperature, the environment can be effectively overcooled during non-peak hours, significantly reducing energy consumption during peak hours.

Monitoring is key to this approach. Sensors installed across the warehouse enable visibility into the thermal envelope across the warehouse and support the algorithms that manage temperature control automatically.

Collaboration in Action

Primus Builders, Swisslog and Lineage Logistics collaborated on a new distribution center in Texas serving the retail market. The 100-foot tall, 75,000-square-foot high-bay warehouse uses Swisslog's PowerStore solution to support storage of 24,000 pallets with a throughput of 400 pallets per hour. Designed with just 11 dock doors to minimize energy loss and incorporating advanced energy management, the facility represents the state-of-the-art in cold storage.

CONCLUSION

Meeting the energy efficiency, low labor and high throughput requirements in today's cold storage warehouse can best be accomplished by collaboration across the building designer, automation provider and operator. This collaborative approach ensures the building designer can fully leverage the space and energy-saving capabilities of the automation system, while significantly reducing exposure to cold environments by warehouse staff. When supported by advanced energy management strategies that minimize the power draw during peak periods, these facilities can achieve new levels of energy and labor efficiency.

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