Jones Lang LaSalle

Real value in a changing world

Perspectives on distribution center design

New demands drive distribution center design

Wide-ranging changes in the supply chain and logistics field are prompting modifications in the way distribution centers and warehouses are designed.

As retail sales escalate and just-in-time deliveries grow increasingly important, the supply chain and logistics industries rise in significance to the U.S. and world economies. The backbone of the industry is the distribution center, where products are stored and shipped to businesses or individual customers. Distribution centers not only need to be strategically located to move product quickly to the most people possible, but they now must be designed in a way that improves productivity and meets corporate strategies. The largest drivers of distribution center design change include energy and maintenance cost reductions, taller ceiling heights, labor shortages and evolving building codes.

Corporate bottom lines push energy efficiency

Distribution of product doesn't come cheaply, and that is having an effect on distribution center design. The cost of total logistics in 2011 rose 6.6 percent to $1.28 trillion, according to the *2012 State of Logistics Report,* compared to the previous year. Logistics costs as a percent of Gross Domestic Product also rose 2.6 percent to 8.5 percent last year.[1] As fuel costs and wages continue to rise, companies must find ways to compensate for transportation costs. One way of recouping these costs is to build more cost-effective distribution centers. Energy efficient design changes have been a key to meeting these goals, including:

- Prismatic skylights and daylight harvesting
- LED lighting for cold storage facilities
- Solar systems

Prismatic skylights and daylight harvesting

The basic design for warehouse and distribution facilities make them a natural fit for daylight harvesting and skylights. Large open structures with a relatively small number of employees provide an environment well-suited for energy efficiency through the use of natural light versus manufactured lighting.

Skylights allow natural sunlight to filter into a distribution center from the roof. The prismatic lens skylight is a new product that scatters the light rather than projecting a concentrated hot spot of light. In addition, the prisms of the skylight diffuse sunlight to provide optimum lighting for the work environment, reducing the need for electric lighting.

These skylights can provide illuminance levels of 50 foot candles or more. Standard lighting in a distribution center ranges from 20 foot candles to 30 foot candles.

Daylight harvesting can further reduce energy costs, especially when combined with prismatic skylights. Photo sensors are similar to the more commonly used motion sensors that turn off lights when there is no activity in a portion of the facility. The photo sensors turn off lights when skylights produce sufficient natural light in the facility. These adjustable photo sensors can be set to allow for adequate lighting on cloudy days or any low light conditions. Incremental controls only turn on the required number of fluorescent tubes in each fixture to meet the desired light levels.

> *As fuel costs and wages continue to rise, companies must find ways to compensate for transportation costs ... Energy efficient design changes have been key to meeting these goals.*

Together prismatic lens and daylight harvesting may produce a short payback on the investment, typically within one to three years.

LED lighting for cold storage

It is not surprising that one of the primary costs of operating a cold storage distribution center is the cost associated with temperature control. According to *Sustainable Facility Magazine*, a refrigerated distribution center can see energy costs comprising more than 25 percent of a cold storage facility's overall operating costs.[2] Generally speaking, lighting systems and refrigeration systems work against one another with lights generating heat while refrigeration reduces temperatures by removing heat from the facility.

LED lighting offers a solution to this problem. The Federal Energy Management Program (FEMP) reported in a study that LED lights helped reduce energy usage and energy costs at the Defense Commissary Agency's worldwide chain of commissaries, which include cold storage facilities. The report shows that LED light output improves in colder climates. At -15 degrees Fahrenheit, lumen output of the LED light is about 18 percent greater than at room temperature.

In addition, FEMP reported that lighting power in the freezer storage rooms was reduced 85 percent from 3,600 watts to 540 watts. Overall,

[1] Council of Supply Chain Management Professionals and Penske, *2012 State of Logistics Report®*, June 2012

[2] Sustainable Facility Magazine, *LED Luminares Help Cool Costs*, April 2010

Dock injuries cost distribution centers money and good employees. As a result, more effort is going into designing safer work environments for dock employees. Included in these changes are installing pneumatic or hydraulic levelers, vehicle restraints, and LED lights.

the move to LED from incandescent lights in the cold storage rooms saved the agency $4,561 per year in energy costs and reduced usage by 26,659 kWh. The cost to install came in at $14,400, meaning the payback of the upgrade was realized within 3.2 years.

Also, maintenance of the LED lights was much improved over the previously used incandescent lamps. FEMP explained that the LED lights will provide five years of useful service, while the incandescent lamps previously used required replacement more than eight times a year.[3]

Solar systems

The return on investment for solar panel installations has kept this trend on the back burner to some degree. Many company's developing new distribution centers, however, are extremely interested in solar. So, as the cost per watt of solar equipment reduces with increased demand, the trend of including solar installations will likely grow. On average, it takes about six to 10 years to see payback on investments, with prices averaging $2.50 to $2.75 per DC watt for multi-crystalline cell solar panels.

Low maintenance design reduces long-term costs

In addition to energy savings, companies are lowering long-term costs in distribution centers by including low-maintenance design elements. Two of the newest solutions are northern climate roofs and low-shrink floors.

Use of white roofs is relatively commonplace for distribution centers. These "cool roofs" use solar-reflective surfaces to maintain lower roof temperatures, decrease air-conditioning needs, improve indoor thermal comfort for spaces, and extend roof life by decreasing the operating temperature.

With distribution and logistics demands on the rise, some companies also are opting to improve productivity within their warehouse facilities. Many are doing so through better utilization of space.

Northern climate roofs

Recently, a condensation problem has emerged with cool roofs in northern climates. Because cool roofs do not generate the heat to dry out the condensation, the water builds up between the roofing membrane and the rigid insulation. This condensation buildup leads to premature rust and ultimate failure of roof decking.

Several solutions have proven effective such as:

- Adding a vapor barrier to deflect condensation
- Staggering two layers of roof insulation
- Adhering the roofing membrane directly to the deck

Low-shrink floors

Low-shrink floors also help reduce maintenance costs in the long term. Low-shrinkage concrete minimizes the likelihood of uncontrolled cracking and curling, or warping, of the floor over time. Low-shrink floors enable saw cut control joints to be spaced farther apart, resulting in less maintenance. The lower number of joints in a warehouse floor also result in lower equipment replacement costs. Tires that typically wear from driving over more floor cracks and joints last longer and require fewer replacements.

Distribution centers focus on new clear heights

With distribution and logistic demands on the rise, some companies also are looking to improve productivity within their warehouse facilities. Many are doing so through better utilization of space by going "higher." For many years, 32-foot clear height has been the standard for warehouse structures. However, with increased demands, higher logistics costs, and a need for efficiency, 36-foot clear heights or higher are now taking center stage in distribution center design.

According to a recent study by HPA Architects, there is opportunity to increase pallet capacity of a building footprint by 12 percent to 25 percent by utilizing a 36-foot clear height versus the old 32-foot standard. For example, in a 32-foot clear building, the study shows that an occupant can stack 64-inch pallet loads five high—64-inch pallet loads make up approximately 50 percent of the market. With a 36-foot clear

[3] Federal Energy Management Program, Spotlight on Design

[4] HPA Inc., *Supersized Distribution Facilities (Want fries with that?)*

building, that number can increase to six high for a 20 percent increase in pallet positions. In addition, for e-commerce-style buildings, 36-foot clear heights provide additional space for mezzanine, conveyors and various pick modules that small package consumer deliveries require.

There are a few trade-offs for increasing clear heights to 36-feet, however, including increased fire protection standards and the need for smooth, flat floors. In terms of fire protection, the National Fire Protection Association approved two early suppression, fast response (ESFR) sprinkler configurations for 36-foot clear height buildings storing class I-IV and cartoned, unexpanded plastics. Those configurations include in-ceiling K-22.4 or K-25.3 heads at 40 pounds per square inch that allow maximum storage heights of 40 feet under a maximum deck height of 45 feet. No in-rack sprinklers are required, except in storing exposed, uncartoned and unexpanded plastics.[4]

Also, floors need to be level and flat in order to maintain rack stability and safe operation of equipment in higher storage zones.

Labor shortages promote employee-friendly design

Another growing development in the supply chain and logistics industry is the decreasing number of qualified employees. According to the World Economic Forum's (WEF) *Logistics & Supply Chain Industry 2012* report, it is estimated that 25 percent of all industry costs are staff related, making it essential to attract high-caliber employees at all levels. However, one WEF council member, the editor and CEO of *Transport Intelligence*, conducted an international survey of logistics executives that showed two-thirds, or 68 percent, of respondents had trouble finding qualified staff.[5]

With the rapid increase in e-commerce and logistics software development, warehouses and distribution centers will need to attract more technologically adept employees. As a result, many companies are improving the basic design of their distribution centers and warehouses to attract high-caliber employees and be the employee of choice in their markets.

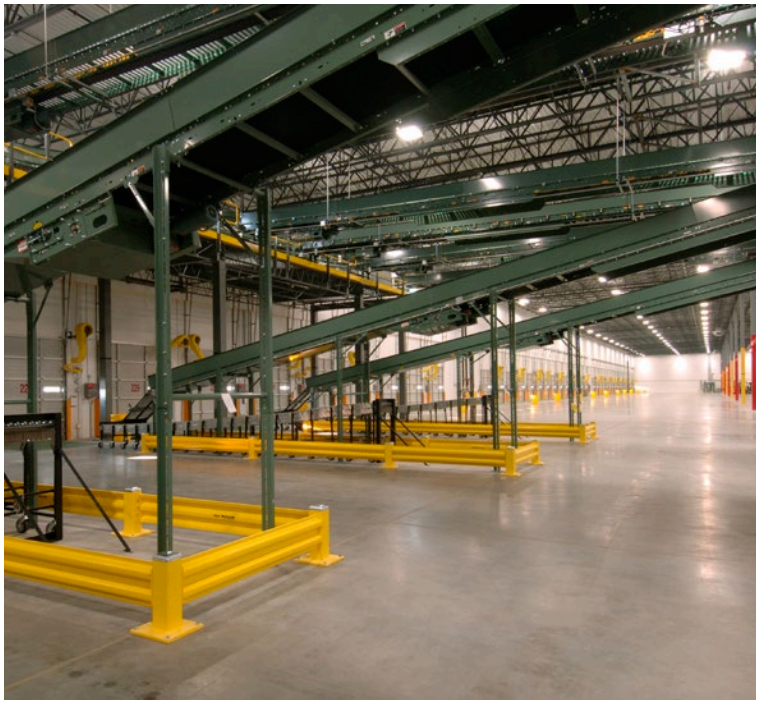
To do so, companies are incorporating safety and comfort elements such as:

- Heating, ventilation and air-conditioning (HVAC) systems
- High-volume, low-speed (HVLS) fans
- Night purge ventilation
- Automatic dock levelers
- Vehicle restraints
- LED lighting at dock doors

HVAC, HVLS and night flushing offer cooler environments

One highly appreciated solution, especially in southern climates, has been to include HVAC in distribution center design. HVAC offers a more comfortable work environment for warehouse employees, especially in locations that experience extreme weather conditions. Employers can balance the cost and benefit of the HVAC system through selection of the design temperatures. HVAC systems also vary greatly in design and performance efficiency. Care should be exercised in the programming phase to evaluate the options along with any potential energy rebates.

Many companies are improving the basic design of their distribution centers and warehouses to attract high-caliber employees and be the employee of choice in their markets.



As companies struggle to reduce costs, more warehouses are incorporating energy efficient design elements to cut operating costs.

As an alternative to HVAC, in some climates, companies are improving the workspace through better air circulation with the use of high-volume, low-speed (HVLS) fans. These large blade fans typically range from eight feet to 32 feet in diameter. HVLS fans operate at a low rotational speed to provide cooling without the noise and air velocity nuisance of high velocity fans.

For another economical solution, some companies are including night purge ventilation in their distribution center design. Generally speaking, night purge ventilation, or night flushing, simply requires ventilation openings be closed during the daytime hours and open at night to flush out the warm air. From a climatic perspective, night flushing is suitable for climates with a relatively high temperature range from day to night—with nighttime temperatures below 70 degrees Fahrenheit.[6]

For best results, the system should be automated. If controlled manually, staff or maintenance may miss opening and closing windows at optimal times. Mechanized windows or ventilation louvers that are set on a timer or a thermostat-driven control system provide the best solution.

Dock safety improves appeal to workers

Dock safety has also become a focus for distribution design. Installation of pneumatic or hydraulic levelers, which typically cost more than manual levelers, is on the rise. But these are safer and more ergonomic for the user. These systems use a control panel to operate the leveler, reducing the risk of injury by keeping personnel off of the leveler to manually position the equipment. The push button operation also means personnel are not required to bend or pull to deploy the leveler, reducing opportunity for injuries.

Vehicle restraints further enhance the safety of a modern loading dock. These restraints lock trailers into position at the dock, reducing the risk of early departure or trailer

[5] World Economic Forum, *Outlook on the Logistics & Supply Chain Industry 2012*, June 2012
[6] AutoDesk® Sustainability Workshop

The code for 250-feet egress distances will revert back to 400 feet in 2015. The change came about as a result of several California organizations and the National Association of Industrial and Office Properties Association lobbying the International Code Council.

creep that lead to hazardous conditions and dock accidents. More companies are opting to incorporate this feature.

LED lights at the dock offer a two-fold benefit. First, LED lights reduce energy consumption by approximately 80 percent versus incandescent or halogen bulbs. But, more importantly, LEDs provide longer-lasting use and less maintenance. This means that dock workers are less likely to work in unlit conditions when a light bulb fails, and maintenance staff will not have to replace the lights as often. LED lights are typically brighter than traditional incandescent lights.

Building standard changes alter distribution center design

In 2009, the International Code Council reduced the egress distance for warehouse structures from 400 feet to 250 feet. As a result, new building designs had to increase the number of doors on the building perimeter to compensate for the shorter egress distances.

However, the building code standard is set to change again. After a lobbying campaign by the National Association of Industrial and Office Properties, the California Business Properties Association, the California Fire Marshall and others, the code will revert back to the 400-foot standard in 2015.

Until that time, however, the current code requiring a 250-foot standard has been revised, allowing for a 400-foot exit distance for large industrial properties that meet the following criteria:

- The portion of the building is limited to one story in height
- The minimum height from the finished floor to the bottom of the ceiling, roof slab or deck is 24 feet
- The building is equipped throughout with an automatic fire sprinkler system

Conclusion

The supply chain and logistics industry continues to see rapid growth, and it is playing an increasingly important role in the world economy. The pressure on companies to "work smarter" extends to all areas of their operations—including the design of distribution facilities. The focus of each company varies with their unique mission and financial abilities. This ever-changing focus impacts the way distribution facilities are designed and operated.

For some companies, the first priority is on sustainability, or LEED certification. These companies will pursue design advances in energy savings, water reduction, and other design enhancements.

For others, the first priority is on quality and stability of the workforce. They strive to be the employer of choice by creating a convenient, comfortable work environment.

Other design choices include low first cost to minimize capital investment, or, low operating and maintenance cost by investing in a higher grade of building design.

In practice, the design of a distribution facility is a balance of all these design components. Careful consideration should be given to these recent design changes, as well as the more established design practices during the early programming stages of design.

One thing is certain, design changes to distribution centers will continue to evolve to help industries meet growth demands and corporate objectives.

Jones Lang LaSalle

Real value in a changing world

For more information on Industrial Project and Development Services, contact:

Tripp Eskridge
Senior Vice President
+1 404 995 2466
tripp.eskridge@am.jll.com

Rick Steger
Senior Vice President
+1 773 458 1383
rick.steger@am.jll.com

www.us.jll.com/pds