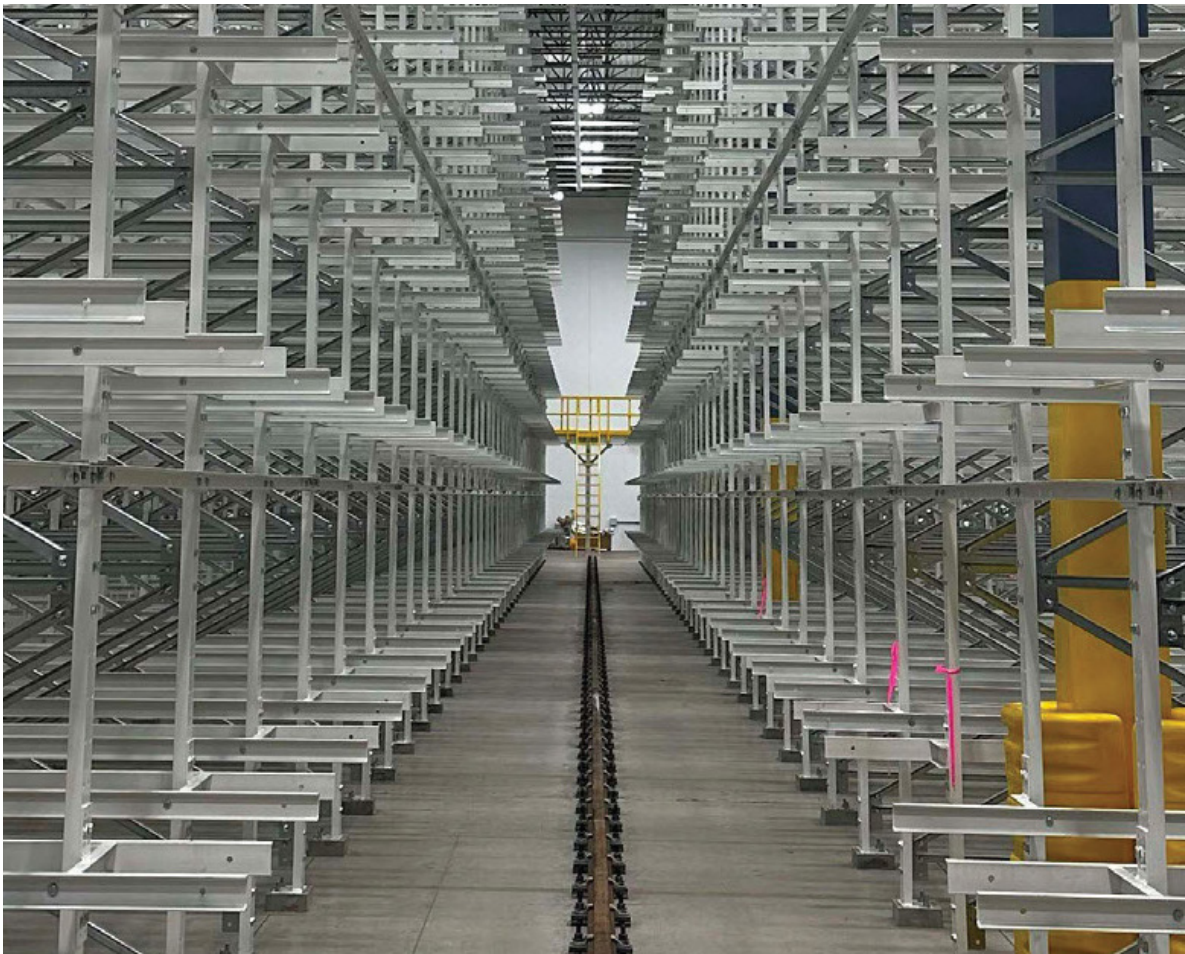


MODERN MATERIALS HANDLING

THE RACK BEHIND THE ROBOTS: How structural design impacts automation performance and uptime



High-performance automation starts with racking that can handle dynamic loads, integration demands and ongoing change.



Companies around the world are investing heavily in warehouse automation, and the pace isn't expected to slow anytime soon. The global warehouse automation market will reach nearly \$116 billion by 2034, up from just \$26.5 billion in 2024. That investment reflects what's happening inside warehouses and DCs, where companies are using more automation, robotics and artificial intelligence (AI) to improve efficiency, accelerate throughput and maximize available space.

The demand is coming from multiple directions. E-commerce and omnichannel fulfillment keep raising the bar on speed and accuracy, for example, and more companies are automating cold chain and perishable handling to protect product integrity and cut waste. At the same time, pharmaceutical and healthcare facilities are stepping up storage and compliance requirements while grocery retailers tighten supplier delivery and order accuracy requirements.



In the race to automate, core equipment like racking tends to either be taken for granted or treated as an afterthought. People assume it'll be there when called upon and that it will magically flex to meet the demands of the automated operation.

Amit Kutumbale, director of engineering at Steel King, sees this all the time in the fulfillment setting, where automation is placing intense structural demands on racking. Once cranes, shuttles and other high-throughput systems are in play, the rack is supporting the operation itself. Minor deflections or misalignments that rarely mattered before can have a significant impact on automated storage and retrieval (AS/RS) uptime and throughput.

Put simply, the automation itself only performs as well as the structure supporting it. "Before automation, rack was an independent product that wasn't really tied to the rest of the operation," Kutumbale explains. "There were forklifts, conveyors and other systems, but rack could be specified, installed and left alone. Now everything is tied together."

Conveyance is attached to the racking, for example, cranes are interacting with the racking structure and the entire system is planned around the rack (or, at least it should be). "We're at a point where rack is front and center in a way it wasn't before," Kutumbale says. "Yet many companies still relate racking to storage without factoring in its impact on overall system and operational performance."

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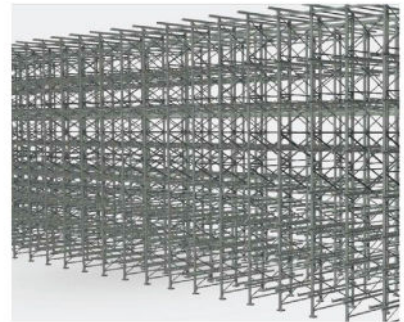
DESIGNING FOR DYNAMIC LOADS & WORKFLOWS

In a manual operation, loads are mostly static. A forklift puts a pallet away, pulls it back out and the rack holds weight. Automation shifts that dynamic by introducing constant movement inside the structure, with shuttles moving product in and out, cranes traveling up and down quickly and conveyors tying directly into the rack to keep product flowing through it. That introduces dynamic loads, with more impact and repetition and less room for error.

That shift puts new pressure on the structure itself. “With automation, the crane is programmed to hit a specific position every time. Then, the rack has to match that exactly,” Kutumbale says. “With a manual system, a forklift operator can adjust if something is slightly off, but automation doesn’t have that flexibility.”

When the system depends on that level of precision, small deflections or inconsistencies don’t get absorbed. They show up in missed picks, slower cycle times and in some cases, costly site realignment and measurement work to bring the rack to meet the required tolerances.

This is where structural rack comes into play. Built to handle heavier loads and repeated impact, it holds its shape under stress, keeps storage locations where they’re supposed to be and ensures equipment runs as intended. Steel King’s SK ADVANTX system builds on that approach with a modular, structural design. Instead of working around fixed, welded components, the rack can be configured to fit conveyors, lifts and shuttle systems without compromising strength.



The system is well suited for automated environments, where equipment must integrate directly with the rack and where space has to be carved out for movement inside the structure.

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That flexibility matters once the system is up and running, too. “With racking in an automated environment, any repairs or changes are much more expensive and time consuming,” Kutumbale says. “The system is much less forgiving, so you have to get it right up front and make sure everything works together from the start.”

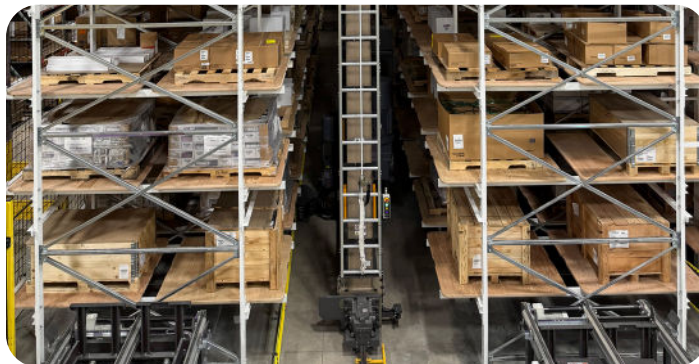
CONFIGURABILITY WITHOUT COMPROMISE

With product mixes changing, volumes swinging and workflows shifting faster than ever, designing a system around today's requirements won't hold up for long.

"It gets much harder to make changes once automation is in place," Kutumbale says. "Aisles are occupied by cranes and rails, so you don't have the same access you would in a manual system, and you can't just bring in lifts and start moving things around. You have to be able to adjust individual components without tearing into the entire structure."

As SKUs proliferate, volumes shift and new technologies get introduced, the rack has to keep up by supporting new and/or upgraded conveyors, shuttles and safety systems. The underlying infrastructure has to adapt over time, not lock the operation into a fixed layout because:

- ➔ **Layouts don't stay fixed.** Product profiles and throughput requirements change, which means storage locations, flow paths and system design have to adjust with them.
- ➔ **Rack sits at the center of it.** Conveyors, shuttles and safety systems all tie back into the structure that must support those connections as they evolve.
- ➔ **Repairs and Design Changes have to be manageable.** Systems that allow sections to be reworked, expanded or repaired without tearing everything apart give operators a way to respond without major disruption.
- ➔ **Flexibility protects the operation.** When the rack can adapt, companies avoid getting locked into layouts that no longer fit and don't have to work around their own infrastructure.
- ➔ **Downtime is expensive.** Systems that require full shutdowns to make adjustments slow the operation and add unnecessary expense.
- ➔ **Expansion should be built in.** The ability to extend the system or add capacity without starting over helps companies grow without rebuilding the entire structure.



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If these points aren't factored in early, any of them can become major problems as the company grows and adds even more automation, AI and robotics to the mix. Unfortunately, this doesn't always happen.

“We've seen projects where the rack is specified before anyone really looks at the engineering behind it,” says Kutumbale. “They might design around a certain upright size, but once we get into it, that size doesn't have the capacity they need. At that point, changing it affects the entire layout.”

This also happens at the floor level, where a concrete slab that wasn't designed to support the right loads can become a major expense after the fact. Getting those details right up front keeps the system on track and avoids costly adjustments later. By making the rack part of early automation conversations, organizations can avoid rework and ensure the structure is built to support the system from day one.

FUTURE-PROOF YOUR AUTOMATION INVESTMENT

Global organizations will be spending at least \$116 billion a year on warehouse automation by 2034, yet many of them still treat racking as a secondary decision instead of part of the system itself. The issues tend to surface quickly when the structure limits how the automation runs and how far the operation can push it.

The dynamic fulfillment environment also comes into play here. Volumes are higher, SKU counts keep growing and everything has to be able to move faster with fewer mistakes. Automation helps companies keep up with that, but it also changes the economics of the building itself.

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HERE'S THE BOTTOM LINE

Automation doesn't stand on its own, nor does it perform in isolation. The underlying infrastructure has to carry loads, flex when needed and keep everything running smoothly. Get that part right, and the systems will keep delivering value long after the initial investment is made.

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