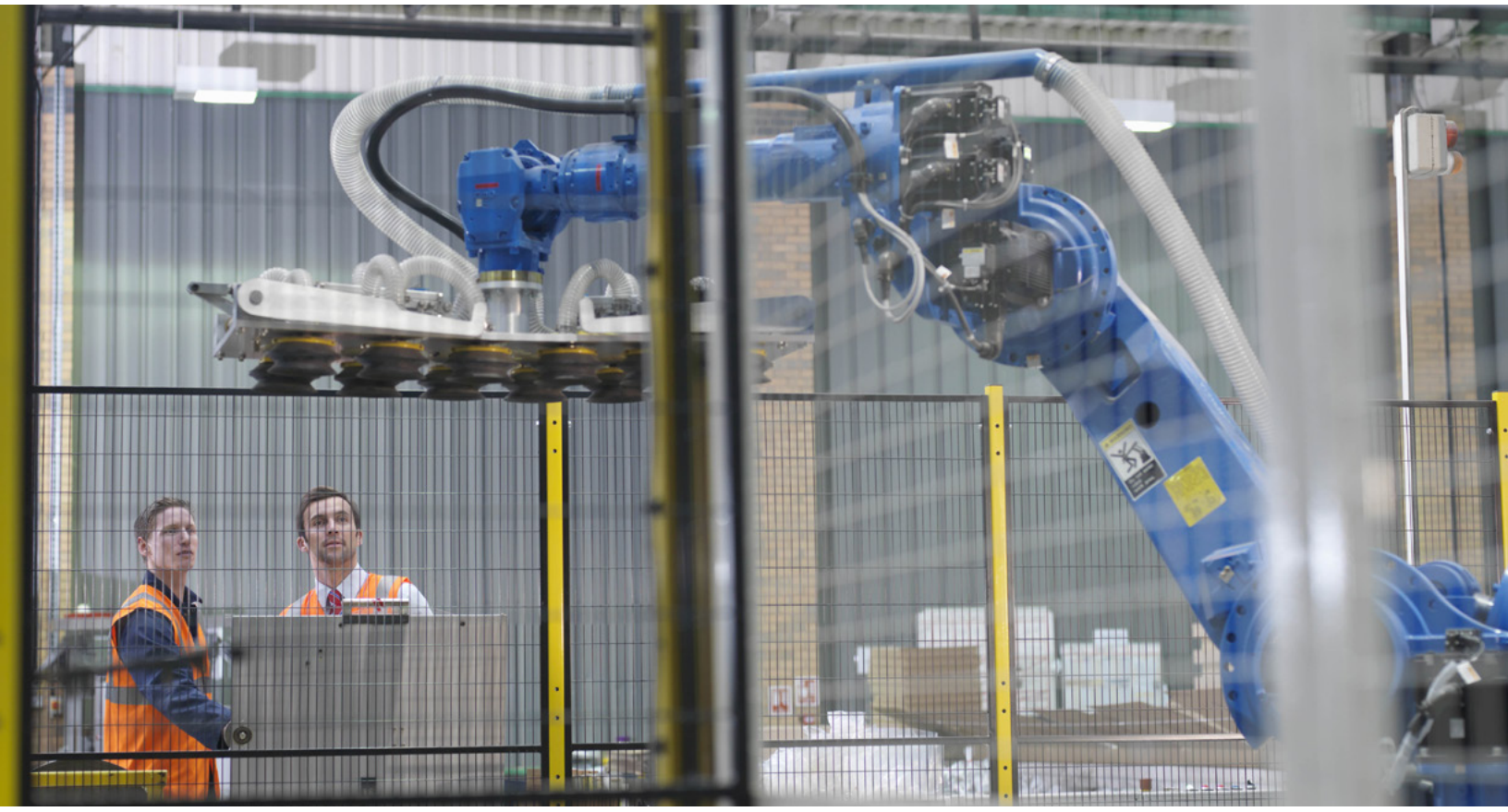
McKinsey & Company

Operations Practice

Improving warehouse operations—digitally

A digital twin lets companies design, simulate, and test new warehouse operations and product movements virtually, before starting up new sites or making changes within existing sites.

by Felipe Bustamante, Ashutosh Dekhne, Jörn Herrmann, and Vedang Singh



February 2020

Warehouse operations are increasing in complexity with time. The growth of e-commerce has led to a proliferation of SKUs, and there's an ever-growing need to delight customers by offering super-fast fulfillment. Technology is a factor as well: as new automation systems come onto the market, operations leaders must face the challenge of keeping pace and understanding which technologies apply and what kind of impact they can generate.

Worldwide, companies spend an estimated $350 billion a year on warehousing, and that number grows each year as pick sizes shrink and costs balloon, raising pressure not just on margins but also on service levels.

The need to improve both sides of the equation may be obvious, but the question is how. Trial-and-error is not an option: companies cannot simply shut down a warehouse so they can tinker with new layouts and workflows to see what works best.

But the better news is that they don't have to. A few companies are already able to design and visualize their warehouse operations virtually via "digital twin" simulations. The simulations allow companies to create virtual models of their existing facilities, and then test different scenarios—no shutdowns required.

This digital warehouse-design approach lets companies experiment with different floor plans, workflows, and other variables to assess the overall impact virtually. Operations leaders can see the impact of changes in a wide range of factors, including the SKU mix, order and shipment profiles, seasonal demand spikes, productivity initiatives, automation options, and a host of other issues that impact warehouse performance. This level of detail allows warehouse designs to be optimized in advance, before anyone starts moving physical assets.

The process typically takes six to ten weeks. The revamped warehouse designs that result can help companies improve efficiency by 20 to 25 percent, before spending the money to test or pilot the changes (exhibit).

Exhibit

Digital warehouse design lets companies test-and-learn using a digital twin, which can improve efficiency by 20% to 25%.

The power of digital simulations

Digital warehouse design has a wide range of applications, from productivity initiatives at existing facilities to mergers, warehouse consolidations, and new warehouse construction. Across all applications, however, the benefits are reasonably consistent: sizable savings in operating expenses from productivity improvement, as well as in capital expenses from optimizing the deployment of material-handling equipment, storage assets, and targeted, right-sized automation systems.

The approach removes bottlenecks to improve efficiency and effectiveness, and enables optimal slotting and product flows to meet service requirements at the lowest possible cost. Most important, digital warehouse design identifies the full potential of a given facility, rather than forcing companies to settle for incremental improvements to the as-is layout.

Critically, the process also enables companies to gauge the potential impact of mechanization and automation options across the entire spectrum of vendors and products on the market. These technologies can be powerful tools to reduce space and increase efficiency. But in some cases, incorrect or inappropriate automation can actually create more problems than it solves. Digital modeling lets companies see what is possible from a range of technologies and applications, before they make any investment decisions.

Transcending traditional improvements

Of course, most companies know they need to improve their warehouse operations. But they struggle to identify and make the needed upgrades, due to limited data and internal expertise. Quite simply, many companies lack the full set of capabilities needed to assess various warehouse improvement options and create a business case that incorporates capex investments and running costs.

Some rely on third-party logistics providers, but even those vendors often lack the breadth of expertise to see what is truly possible with alternative warehouse designs and operations. A related problem is that most traditional methods to design or revamp warehouses use computer-aided design software (CAD)—which is resource-heavy and time-consuming, and doesn't allow companies to calculate the impact of new changes or anticipate second-order effects. Digital warehouse design, by contrast, offers a low-risk way to visualize and optimize layouts, allowing companies to rapidly identify real, feasible solutions that deliver quick impact.

For example, a North American manufacturer decided to consolidate several regional manufacturing and warehouse locations into a single campus, with separate buildings dedicated to manufacturing and warehousing. However, it faced several challenges, including capital constraints, insufficient warehouse space, and a need to move fast.

Instead of relying on traditional tools, the company used a digital warehouse-design approach to simulate various options across warehousing, kitting (assembly of related items into a single "kit" for shipment), and value-added operations. The digital tools allowed the company to develop detailed OPEX and CAPEX estimates for both manual and automated solutions, making it far easier to evaluate various business cases. In all, the company reduced planned capex by approximately 10 percent and operating expenses by more than 30 percent.

Digital warehouse design can also help companies rethink existing facilities. For example, another company deployed digital warehouse-design and simulation tools to optimize and revamp its operations in a warehouse currently in operation. It built models to test various layouts, material-handling-flow scenarios, picking methods, and targeted automation solutions.

Starting from an optimized slotting design, the digital twin analyzed historical orders to estimate the exact labor and equipment requirements by day of the week and by hour of the day. With accurate labor-staffing models, the company was able to choose the most optimal, modular design to implement during the transition. In addition, the company could define precise, engineered standards for each operation of the warehouse,

and it could monitor daily labor and equipment performance once the new system was in place. This enabled the company to reduce annual operating expenses by 18 percent.

Similarly, one business had a central regional warehouse in Eastern Europe, with annual costs of several million dollars. By constructing a digital twin, the company analyzed the potential improvements from a proposed layout change (specifically, a picking zone that enabled one-step picking). Looking at both high-season and low-season volume, the company determined that it could reduce input costs by more than 25 percent.

Foundational capabilities

As with most technology, digital warehouse design is not a turnkey solution. To capture its full potential, companies must understand their strategy not only for today and tomorrow, but also well into the future—in terms of product portfolio, customer-order profiles, and other factors. Leadership teams must assess the implications of design changes on the supply-chain network as well. And success requires new capabilities in warehouse design—typically engineers who understand the range of variations and permutations for a space. Most organizations do not yet have internal people ready for these roles, and thus need to source that expertise externally.

As a practical matter, the simulation process must involve operations and warehouse managers—those with the deep day-to-day knowledge and real-world insights that can only come from direct experience. Because these experts will be tasked with implementing any changes to the warehouse after the simulation ends, their buy-in will be essential. The more they contribute during the early stages of the process, the more willing they are likely to be to forego old habits and work in new ways.

Last, companies need to plan for repeated changes over time. Optimizing warehouse performance is a process without a finish line—it must happen again and again, as market forces, technology, and consumer preferences continue to evolve. In fact, digital warehouse-simulation tools could become a new way of setting performance expectations, with the tools embedded as part of the day-to-day management of each distribution center. Estimating daily performance targets based on daily volume, mix, and staffing can help warehouse managers manage the shift's performance more precisely than any other traditional, static approach to setting goals.

Companies face a growing need to improve their warehouse operations. Digital warehouse design is one clear means to help them do so. The process may be virtual, but the results generate a real impact on performance, providing an edge in an ever-more-complex warehousing landscape.

Felipe Bustamante is a consultant in McKinsey's Miami office, **Ashutosh Dekhne** is a partner in the Dallas office, **Jörn Herrmann** is a senior expert in the Zürich office, and **Vedang Singh** is a consultant in the New Jersey office.

The authors would like to thank Aditi Brodie for her contributions to this article.