

Optimizing safety and efficiency – Leveraging simulation technology for risk mitigation



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Introduction

The warehouse automation industry has matured rapidly, with most players now recognizing its necessity. Moving out of the COVID-era's "innovation-first" strategy, today, the pivotal challenge lies in enhancing the reliability and efficiency of automated systems while keeping costs in check, especially for brown-field implementations. As warehouses and technology providers push for more advanced solutions, they face the complex task of balancing cutting-edge capabilities with operational stability and financial viability.

At the heart of this revolution is the need to validate complex warehouse designs ahead of implementation, ensuring they meet the demands for reliability, efficiency, and cost-effectiveness. Traditional methods of building and evaluating solutions, like on-site assessment by consultants and integrators, remain an important step in the process. But this critical validation process is now enabled by powerful tools that are reshaping warehouse design, implementation, and optimization: digital twin, simulation, and emulation technologies. These advancements offer unprecedented opportunities to streamline operations, mitigate risks, and future-proof automation systems in an industry where long-term investments demand careful planning and foresight.



Present and future considerations

Warehouse automation systems represent investments spanning multi-year operations. This long lifecycle creates unique challenges, as systems must meet current operational demands while adapting to future technological advancements and market changes. The traditional approach of implementing automation solutions without considering future scalability is no longer viable.

Simulation technologies for large automated systems, conveyors and sorters, and robotic fleets offer a groundbreaking solution to this challenge. They create detailed digital representations of warehouse systems, enabling businesses to:

- Test and validate automation concepts before physical implementation
- Anticipate future bottlenecks and capacity issues
- Experiment with various "what-if" scenarios without disrupting ongoing operations
- Optimize system performance and throughput over the entire system lifecycle





Shift-left for validation

Historically, testing and validation of warehouse automation systems occurred on-site, often just before the system go-live. This approach carried significant risks, including unforeseen issues, costly delays, and potential operational disruptions. The advent of simulated control systems and software emulation techniques, coupled with digital twins, has fundamentally altered this paradigm.

Creating a virtual replica of the warehouse environment, complete with automated systems and processes, allows for a "shift left" on the project timeline. This means:

- Early identification and resolution of potential issues. A down-trending bug-release report
- Reduced on-site testing time and associated costs
- Minimized disruption to existing operations during implementation
- Increased confidence in system performance before the 'go-live'



Flexibility and integration— a technology agnostic approach

Choosing simulation software for warehouse solutions needs to be use case specific because warehouses vary significantly in size, layout, operations, and the type of automation implemented. A one-size-fits-all approach may overlook critical nuances, leading to suboptimal performance or inaccurate results. By selecting software tailored to the particular use-case, businesses can model scenarios more effectively.

This flexibility enables:

- Selection of the most appropriate tools for business-critical use cases
- Integration of simulation models from different tools and with existing warehouse management systems (WMS) and other enterprise software
- Accurate emulation of software services for quick unit-level validation
- Interoperability between different automation components and systems
- Tailored solutions that align with long-term strategic goals



Futureproof hardware and software

The rapid pace of technological advancement in warehouse automation necessitates a forward-thinking approach to both hardware and software design. Simulation and emulation play a crucial role in future-proofing automation systems by:

- Allowing virtual testing of new hardware configurations without physical modifications
- Facilitating software updates and upgrades in a risk-free virtual environment
- Enabling the evaluation of new algorithms and control strategies before deployment
- Supporting the integration of emerging technologies such as AI and machine learning into existing systems



Enhance efficiency and accessibility through remote capabilities

One of the most significant advantages of simulation and digital twins is the ability to perform complex testing and troubleshooting remotely. This capability:

- Reduces the need for on-site presence, saving time and travel costs
- Enables a smaller team of specialized engineers to support multiple sites effectively
- Facilitates rapid response to issues and continuous optimization
- Supports global collaboration and knowledge sharing



The role of an engineering partnership

As warehouse automation continues to evolve, the role of simulation and emulation in driving innovation and efficiency will only grow. These technologies offer unprecedented opportunities for optimization, risk mitigation, and futureproofing in an industry where long-term investments demand careful planning and foresight.

Harnessing the full potential of these advanced technologies often requires expertise that goes beyond the primary skills and focus areas of many logistics and warehouse automation companies. Partnering with a specialized engineering firm may be crucial, as well as a key engineering strategy to reduce risk and manage costs. The right strategic partner, with a combination of deep industry knowledge and core engineering expertise, a technology-agnostic approach, and global reach, can enable businesses to leverage digital twins, simulation, and emulation solutions to their full extent.

Quest Global stands out as that partner, offering a unique blend of industry expertise and technological prowess. Quest Global's deep understanding of warehouse operations and cutting-edge engineering capabilities enables clients to leverage simulation and emulation effectively for maximum ROI.

Quest Global's unique approach is particularly valuable for:

Optimize investments with a simulation roadmap:

Adopting a new technology takes time and effort. Building a roadmap aligns technology goals with business objectives, ensuring targeted investments. Quest Global helps establish a simulation roadmap which could begin with simulating individual warehouse components to understand behavior and performance. This could then evolve into integrated system simulation and dynamic digital twins.

Leverage centers of excellence for industry and technology:

Building simulation models for warehouses requires deep industrial experience and an understanding of automation systems, conveyors, AS/RS, robotics, and enterprise systems. Additionally, there is a need for expertise in cutting-edge and legacy technologies. Quest Global's end-to-end engineering pedigree and industrial experience help build centers of competencies for customers with the right resources globally.

Technology-agnostic teams and solutions:

A few simulation tools, like Unity, FlexSim, Rockwell Emulate 3D, and Nvidia Omniverse, are commercially available in the market and offer a wide range of generic components suitable for logistics and material handling simulation. Utilizing these tools, or a combination of tools, as the base framework to enable the simulation roadmap is the right idea. Irrespective of the underlying technology, Quest Global helps build teams that can enhance the tools with customer-specific components and integrate multiple techs to produce models for warehouse implementation.

Focus on continuous improvement: Maintenance and support of ongoing operations are key focus areas on the simulation roadmap. If existing models are well maintained, any changes in design, controls, or material workflow algorithms can be implemented and tested. A global partner with dedicated teams can ensure ongoing support and optimization services.

As the warehouse automation industry moves towards more intelligent, data-driven operations, partnering with an experienced engineering solutions provider like Quest Global becomes crucial. Quest Global's expertise in simulation and emulation technologies helps warehouse owners and 3PLs navigate the complexities of modern automation and achieve better ROI on their investments. With Quest Global as a partner, businesses can turn the potential of simulation and emulation into tangible, long-lasting benefits, setting new standards in warehouse automation and supply chain management.



For further information or queries, please reach out to us at info@quest-global.com