White Paper on

WAREHOUSE AUTOMATION IN 2021

Navigating The Journey of Technology Adoption

April 2021

Executive Summary

Warehouses, distribution centers, and other core components of the supply chain industry are not new to technology-led automation. Yet, stakeholders at these facilities discover that the automation journey can be daunting – especially when it comes to the adoption of relatively new technologies such as IoT, blockchain, or fully autonomous drones. Thankfully, the core principles involved in building and evaluating the business case for adoption of automation remain the same. What has changed (exponentially!) is in the availability of data, the pace of innovation, and the role of software – factors that can help or hinder warehouse automation depending on how skillfully they are leveraged by decision-makers. The so-called digital transformation of the warehousing industry has made possible the notion of 'digital twins' – electronic equivalents of the physical world that can help executives boost revenue, margins, safety, and growth. This white paper sheds light on the considerations involved in warehouse automation – starting with labor-related challenges faced by the industry and the need for operational flexibility and proposing the use of a model inspired by the agile approach to effective change management.

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The Warehouse Automation Context

If you are a single warehouse owner/operator or if you are responsible for 300 warehouses or even 30, you are probably thinking, "How could there possibly be a solution that's made just for me?" Well, you would be right. There is not a one-size-fits-all solution to warehouse planning, optimization, or automation.

Every warehouse is different. You exist in a different industry, a different playing field, you have different products, different suppliers, and you serve different customers than 99% of the other people reading this. So then, why are you reading this? Because even if you arrive at a unique automation solution for your warehouses, the journey to get there will have been the exact same as it was for everybody else.

More importantly, it has become critical to begin this journey – if you haven't already – towards a greater degree of autonomy across your warehouse operations.

The Need for Automation

According to the latest data from the U.S. Bureau of Labor Statistics, the average turnover in the transportation, warehousing, and utility industry has been hovering around 4 to 5 percent per month! This number is corroborated by IARW findings, which reported an average 32.6% turnover rate in North American cold storage warehouses in 2019.

According to Kane Logistics, estimates for replacing warehouse workers run from $7,000 in direct, traceable costs up to $42,000 if you aggressively factor in productivity losses, informal training, and reduced efficiency of new workers. Add in your seasonal variability in labor needs, health benefits, taxes, and insurance, and you might be spending twice as much you think you are per employee, based on their paycheck.

F. Curtis Barry & Company estimates that labor generally accounts for over 60% of warehouse fulfillment costs. Given these factors, warehouse operators would be well advised to improve working conditions, smooth their seasonal variations in demand for labor, and streamline operations to reduce overall staffing needs.

Combine these labor issues with tight supply chains, the exponential growth of e-commerce, and sudden disruptions due to pandemics – the result is an urgent need for warehouse automation.

Step 1: Plan for the Future, Not the Present

Before we dive into the nuances of warehouse automation, let us first consider the main goal. Capital investments in automation technologies are driven by long-term returns, so it is of the utmost importance that the solutions you adopt ensure lower operational costs and drive revenue growth in a sustainable manner.

> ***" What is going to be expected of my warehouse to be profitable, even thriving, in the next ten years? That's the main question. You have to list everything out carefully, and ask yourself, can I do this? "***
>
> - Professor Benoit Montreuil, Coca-Cola Faculty Chair in Material Handling and Distribution; Director, Supply Chain & Logistics Institute; Director, Physical Internet Center at Georgia Institute of Technology

Your first instinct when reading this might be to look to your industry for answers. Say, for instance, you are a distributor in the MRO market. Some of your biggest competitors might offer 2-day shipping in an attempt to keep Amazon from stealing their market share.

But do your customers really care about 2-day shipping? Are you pursuing a service-oriented strategy or a cost-leadership strategy? Just because something makes sense for a competitor does not mean it is going to make sense for your business. That said, you must factor in overarching themes that span across industry sectors and market segments.

> ***" Warehouses need to deliver on their promises. You'll need to be much greener, you'll need to treat your employees better, and you will be digitally connected to suppliers and customers better than you are now. "***
>
> - Professor Benoit Montreuil, Coca-Cola Faculty Chair in Material Handling and Distribution; Director, Supply Chain & Logistics Institute; Director, Physical Internet Center at Georgia Institute of Technology

Thus, your automation decision must be driven by your individual, long-term business strategy. The technological capabilities that you need are based on what you wish to promise your customers. If they desire fulfillment accuracy over speed, that is what you need to prioritize going forward, when it comes to warehouse automation investments.

Now that you have a strategy, it is time to think about how much to invest – using sound, data-driven financial analysis. If you haven't already, start by collecting data for your average cost of labor, costs incurred due to labor unavailability, and compounding in costs due to the seasonal variability in labor. Add training costs and also factor in the reduced productivity of newer employees.

> ***" We started 2020 looking at a labor shortage due to the low unemployment rates. Many of the challenges in distribution were due to the shortage of labor. Then the pandemic hit, and there were more people that needed jobs, but there was also hesitancy due to safety concerns. Whether you have low or high unemployment, automation is always important to mitigate unpredictability in the supply and demand for labor. "***
>
> - Dr. Dima Nazzal, Director of Professional Practice, Stewart School of Industrial and Systems Engineering; Research Director, Center for Health and Humanitarian Systems at Georgia Institute of Technology

Consider the effective number of working days per year, the number of shifts per day that you operate, and – most importantly – the impact of labor-related downtime on your warehouse operations. If you adopt automation technologies that can operate 24x7 or during the warehouse downtime, the net business benefits may become multiplicative and directly shorten the payback period on your investment.

Understand your order profile at unit economics. The number of orders filled per day, number of lines on each order, size of SKUs, and the types of customers receiving the order are all relevant information when evaluating the business case for warehouse automation. What proportion of your customers are retail, wholesale, or through e-commerce? What proportion of your orders are picked as items, cartons, spools, or pallets?

Common wisdom states that most of the non-value-added (NVA) activity in a warehouse comes from employees traveling from one location to another within the warehouse. The order profile, combined with your warehouse layout, will determine the time spent traveling and feed into the overall cost savings. Even if you are properly leveraging a forward-pick area, there is still time spent traveling when storing and replenishing goods.

A similar inefficiency is introduced due to the travel involved in cycle counts and wall-to-wall counts of warehouse inventory. Other inefficiencies in inventory management include location inaccuracy, redundant counting processes, and the lack of picking optimization. Human errors, incomplete inventory inspections, improper barcode labeling, and improper product picking further worsen the operational metrics for many warehouses. Imagine the savings from automation if the entire inventory counting process could be fully automated – and the human resources deployed on higher-value-added activities!

Once you have these inputs ready for the financial model, conduct a breakeven analysis. Pick an automation technology relevant to your warehouse operations, make educated guesses about how much it will save you in labor costs, how much it will increase data quantity/quality, the extent to which it will improve safety and reliability, the degree of adaptability, and scalability – and other consideration relevant to long-term business goals.

Typically, the greater the level of standardization across SKUs and orders, the greater the return on investment when automating warehouse processes using technology. Additionally, note that the flexibility of your warehouse management system (WMS) will also determine the value of benefits derived – since it consumes the newly available data and can be used to generate novel insights.

The financial model can also be subjected to sensitivity analysis to get a better sense of how long it will take for the automation investment to pay for itself, whether it will generate the target rate of return, and which factors are the most critical when it comes to return on investment. It turns out that this model can also serve as a valuable tool when negotiating the pricing structure and amounts with vendors of automation technologies.

Step 2: Position for Success

It may seem counterintuitive, but the greatest benefits from automation are likely to come to warehouses that are already well optimized for their specific business. Once the low-hanging fruit has been squeezed, you can use automation technology to re-optimize the warehouse dynamically, based on changing conditions.

As you proceed on the automation journey, explore areas for improvement when it comes to the profitability of your warehouse operations. Consider the following factors:

- Order profile
- Inventory levels
- Size of warehouse(s)
- Speed/accuracy requirements
- Average cost of inventory
- Industry trends
- Service level agreements
- Special conditions – e.g., captive retail, network inventory planning
- Special considerations – e.g., temperature, shelf-life, regulations

Take time to consider the above factors and their degree of variability. Consider hiring supply chain experts to analyze and make suggestions for improvement in your day-to-day operations. It is possible that the most financially efficient route forward involves reconfiguring the warehouse layout or modifying the storage strategy before adopting automation technology.

Going forward, data accuracy will become critical for warehouses and distribution centers – after all, a database is only as smart as the inventory and operational data that you populate it with.

> ***" The better you are at managing inventory, essentially the less inventory you need for the same level of sales. When you have more precise information, you can add more intelligence. You can get things at the right time to the right place. "***
>
> - Professor Benoit Montreuil, Coca-Cola Faculty Chair in Material Handling and Distribution; Director, Supply Chain & Logistics Institute; Director, Physical Internet Center at Georgia Institute of Technology

Not only will keeping real-time track of your inventory improve your operational insights and material flow, but it will also immediately lower your overall inventory costs and time spent doing rework due to outdated inventory data.

Step 3: Focus on Flexibility

Supply chain executives have sought to make investments in warehouse automation based on their forecasts of the growth in new SKUs and the growth in inventory levels of existing SKUs. The accuracy of these assumptions notwithstanding, warehouses have installed state-of-the-art automated storage and retrieval systems (AS/RS) - in the attempt to cut costs and streamline inventory operations.

> ***" [Richway] had a distribution center in Jonesboro, Georgia that had all kinds of technology...It had automated storage and retrieval systems for pallets; it had mini loads; it had a little of everything. Well, the chain stopped operating, and a lot of their retail stores became Targets, furniture stores, and antiques stores. The [retail] buildings have all been reused, but the distribution center is no longer there. Nobody wanted it because it was so complicated and specialized for the sole purpose of distribution to their discount chain. If the distribution center was more adaptable, then there still would have been a use for it. The thing about automated systems is business models change. "***
>
> - Professor Gunter Sharp, Professor Emeritus, Stewart School of Industrial and Systems Engineering at Georgia Institute of Technology

What warehouse executives sometimes fail to consider are the risks of disruptive changes in their markets. Economic, technological, demographic, regulatory, or other changes can require warehouses to drastically lower costs, accept completely different types of inventory, or implement technology solutions just to stay competitive – let alone grow!

Locking yourself into an expensive automation solution assumes that you may not need to change in the short or intermediate-term to stay competitive, which is rarely the case. Imagine supply chain companies that set up large, fully automated distribution centers in rural areas that were cost-effective from a real estate point of view – only to find the end-user demand shift to large urban areas thanks to 'same day delivery' expectations set by e-commerce companies.

A powerful enabler of operational flexibility is software – specifically a Warehouse Management System (WMS) in the inventory context. Modern WMS features allow you to respond to changing conditions both internally and externally, in near real-time. They enable support for several picking styles, order types, and linkages to suppliers, customers, and internal stakeholders. Going forward, the WMS will evolve into a 'digital twin' - so-called because it accurately reflects the real-time state of the warehouse inventory, thereby allowing decision-makers to maximize operational efficiencies. For example, the digital twin can accommodate batch picking, zone picking, voice picking, replenishment of a forward-pick area, partial orders and split orders. It can also interface with marketing systems so that customers can be incentivized to order carton-sized quantities.

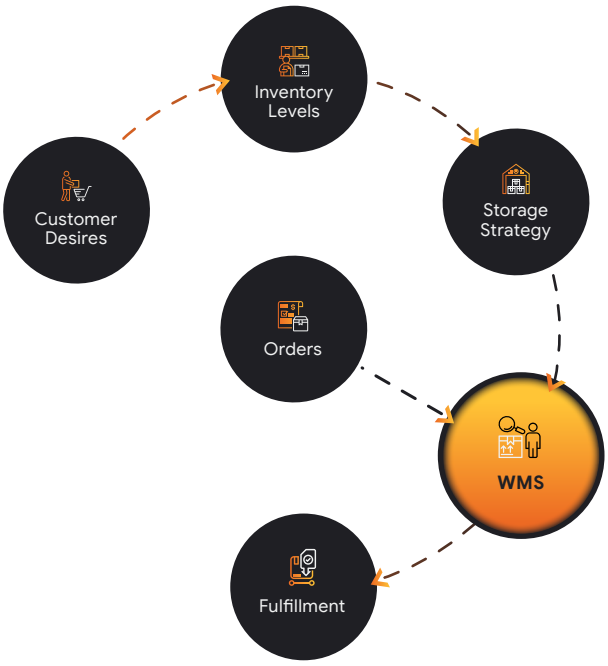
> ***" Your WMS or Warehouse Execution System (WES) needs to be flexible enough to handle variability and uncertainty by utilizing smart order-fulfillment algorithms and policies. Real-time control will adapt to things like an accumulation in a specific location and pause orders to combat that and reallocate labor to keep the flow moving. Adding software solutions that enable visibility and real-time interference is a huge trend in running warehouses today."***
>
> - Dr. Dima Nazzal, Director of Professional Practice, Stewart School of Industrial and Systems Engineering; Research Director, Center for Health and Humanitarian Systems at Georgia Institute of Technology

Not only can a powerful digital twin enable automation in and of itself, but it can also address the limitations of an obsolete WMS, which can be a limiting factor in realizing the full potential of your automation hardware. When accurate and timely data is combined with sophisticated IT systems, the true potential of warehouse automation can be unleashed.

Until this decade, the WMS was not much more than an inventory database. Market forces and customer desires would inform managers of which storage strategy to adopt but it was difficult to assess the impact of strategic changes in the short term. Cycle counting was the default method to check inventory levels, which were then tracked in the WMS and compared against incoming orders to create a picklist. Everything flowed linearly, with limited ability to manage operational efficiency based on the real-time status of the warehouse.

Today, warehouse digital twins are increasingly able to connect different aspects of warehouse operations – thus enabling changes to the inventory strategy in real-time. Such automation systems can dynamically react to human errors such as miscounted inventory levels and support managerial priorities of revenue growth and profit maximization.

Before



After

Step 4: Technology Selection

The business case for technology automation solutions involves a dual consideration here - balancing 'cheaper' options that generate value sooner against more 'expensive' options that may replace them or create more value in the long term. Clearly, it is unwise to jump directly to the 'final' solution since markets, industries, and technologies constantly evolve. If a warehouse has been using the same technology and processes for decades and there is an attempt to replace most of the manual operations with robots at once, the chances are everything will grind to a halt while the automation solutions get integrated with existing processes.

To circumvent this issue, stakeholders must start with a well-identified operational issue that can be solved with technology, and then try to find the best solution for that specific use case. For example, if your warehouse has high labor turnover and new employees struggle to find the right items to fill orders, installing a pick-to-light system could vastly improve your fulfillment accuracy and picking efficiency.

> ***" Once you have an understanding, and this can evolve with time, ask yourself the steps that you should be taking. You should be looking for quick wins and exploring options by testing them to see if they work or not. Don't try to be perfect in the first shot. But every decision must be a step to get there."***
>
> - Professor Benoit Montreuil, Coca-Cola Faculty Chair in Material Handling and Distribution; Director, Supply Chain & Logistics Institute; Director, Physical Internet Center at Georgia Institute of Technology

Conversely, you may work in an innovative culture, familiar with technology adoption, and looking for the next automation enabler. In this case, you might evaluate Automated Guided Vehicles (AGVs), such as floor robots or collaborative robots. These modular, scalable, and flexible solutions can greatly reduce walking distance and travel time.

> ***" One thing that I've discovered in this business is that you can have solutions that look different, but on a total cost basis and total productivity basis they quite often come out to be very similar. We spent years developing performance and cost models for different equipment types, especially for picking pieces. We looked at a variety of operating conditions using north-eastern US cost factors for the analysis. We varied all the operating strategies and applied the operating strategy that gave the best results for each technology. We found large areas where the different technologies were actually cost-competitive with one another. That really was surprising. "***
>
> - Professor Gunter Sharp, Professor Emeritus, Stewart School of Industrial and Systems Engineering at Georgia Institute of Technology

When it comes to automation, the cost of integration, maintenance, support, and upgrades matters as much – if not more - as the cost of deployment. For example, RFID and local positioning systems may have become most affordable but they lack integration with the overall supply chain and often create more operational costs than savings. Similarly, mini-load and carousel-based AS/RS are extremely expensive and while they may provide significant labor savings, they also remove a great deal of flexibility from the warehouse.

Step 5: Execute the Plan

Managers love to plan. Sometimes, they plan so much that they never get to finish what they started! It turns out that the best way to execute a change is to just get started – beginning with a frank conversation with relevant stakeholders. Allocate funding with support from finance, seek advice from IT on integration, obtain buy-in from upper management on measures of success, secure approval from safety teams, and communicate effectively with operations managers and front-line employees.

To help in effectuating the change, consider relying on the Automation Change Model. It is an iterative, 7-step approach based on world-class project and change management frameworks that focus on generating quick wins. This method to manage change can be repeated as many times as necessary – factoring in competing or complementary automation options, driven by technical, operational, and business factors.

At this stage, you should have a comprehensive view of the technology you plan to integrate with the context of the problem that it is expected to solve. The problem should be narrow enough to be able to implement one iteration of the

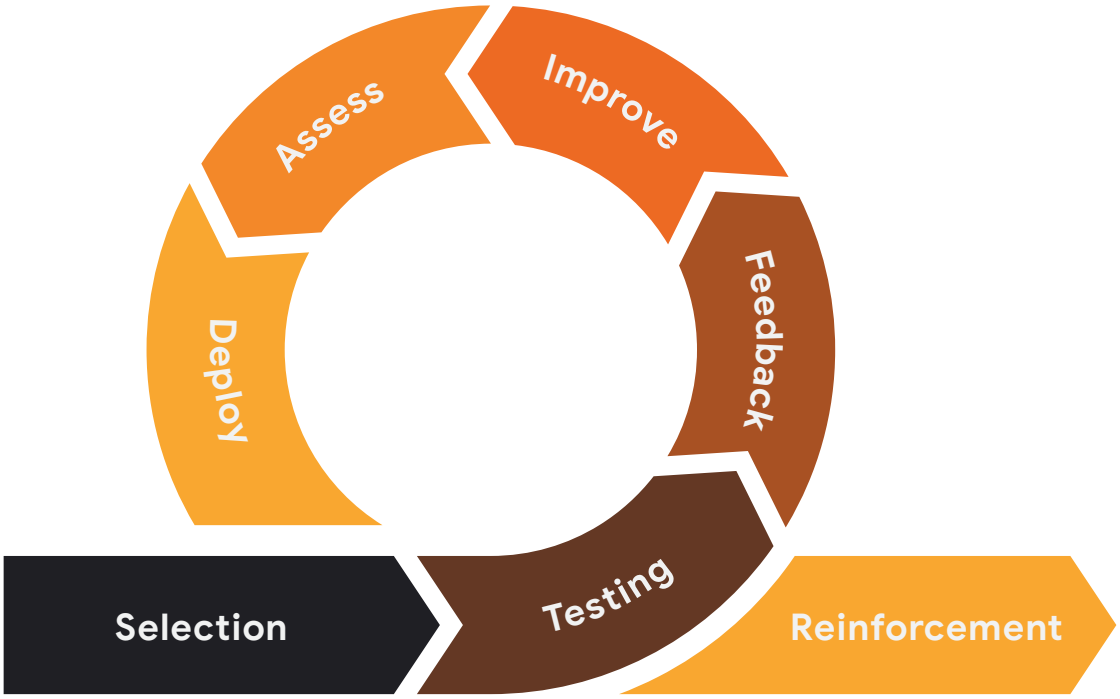
Automation Change Model, yet broad enough to accurately represent a specific warehouse operation as a whole.

The next step is to form a hypothesis about the desired improvement due to warehouse automation. This should include a specific, measurable result and the time frame in which you expect to achieve this result. Then run the automation experiment and proactively seek feedback, positive or negative, from the relevant stakeholders throughout trials – usually conducted in the form of proof-of-concept and pilot projects.

Ask open-ended questions, objectively evaluate the responses, and refine your assumptions about the technology being adopted. This is the time to embrace failure - figure out what aspect of the automation works, what does not, and the root causes for each. After you have refined the warehouse automation plan based on results from hypothesis testing, it is time for the Assess phase, which is essentially the same as the Testing phase but on a larger scale.

Once again, focus on quick wins and celebrate the successes, so you can leverage them to gain stakeholder support. A robust communication plan will keep everyone on the same page as to why automation is needed. Whether the trial is successful or not, document the learnings and reference information, and share it across the whole organization!

How you reinforce the change due to automation will depend on the organizational culture and structure of your company. Typically, it would involve putting controls as well as incentives in place to ensure broad adoption of the new automation system.



In Conclusion, A Concrete Example

Unmanned aerial vehicles, also known as drones, are one of the automation options in the warehouse context. While commercial drone technology is not yet mature enough to enable deliveries inside large warehouses or distribution centers, it is ripe for use cases such as inventory counts. Autonomous aerial inventory scans can be used to not only save time and labor costs but also to improve worker safety and productivity. Moreover, the use of warehouse downtime and the availability of image and video data for the inventory can further enhance the return from investments in inventory drones.

The Automation Change Model described earlier is ideally suited for the adoption of UAVs for warehouse inventory management. This automation can be deployed in multiple iterations, each of which de-risks certain aspects of technology adoption via on-site demos, proof-of-concept projects, pilot deployments, pre-production trials, and finally full-scale production roll-outs. A series of quick wins, combined with careful analysis of metrics such as barcode accuracy, location accuracy, drone productivity, etc. can help refine and cement the business case for integrating autonomous drone fleets into warehouse inventory operations. Real-time inventory data from aerial scans can be directly fed into the WMS, thereby enabling a digital twin of the warehouse – one that can be accessed remotely by corporate executives, auditors, and external stakeholders.

Glossary

AGV – Automated Guided Vehicle: A robot that traverses over even flooring under its own navigation and is typically used to transport heavy materials.

ASRS – Automated Storage and Retrieval Systems: Broadly used to describe the category of computer-controlled inventory storage mechanisms that handle loads and deliver them to the user when called.

Automation Change Model – A new, seven-step method for deploying technological changes in warehouse operations, based on Agile frameworks and Kotter's Change Model.

Digital Twin – A warehouse management system or warehouse execution system that accurately reflects the current state of the warehouse and its inventory, thereby allowing operators to make decisions that optimize operational efficiency in real-time.

MRO – Maintenance, Repair, and Operations: The group of activities and products associated with the upkeep and repairs of commercial plants, facilities, and buildings.

NVA – Non-Value-Added: From Six Sigma methodologies; any activity that does not directly contribute to revenue generation. In contrast to Value-Added activities, which are necessary to deliver value to customers.

UAS – Unmanned Aerial System: Any unmanned aircraft including the controller and communications.

SKU – Stock Keeping Unit: a distinct type of product or service available for commercial sale.

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