RIGHTHAND™
ROBOTICS

5 Key Factors

to Consider to Successfully Deploy Robotic Piece-Picking

Contents

Robotic piece-picking rises sharply

We project robots will pick 100s of millions of e-commerce items by the end of 2020. Whether it's because companies find it difficult to hire and retain sufficient warehouse resources or need to improve the cost-efficiency of warehouse operations, robotic piece-picking implementations continue to trend rapidly upward.

A key reason for this trend is that robotics plays a key role in improving the accuracy and timeliness of moving products into, through, and out of warehouses—which is critical for forging and maintaining a strong brand reputation with retail end consumers. Robotics comes into play at a number of warehouse transition points, when items are selected from storage, sorted after moving downstream on conveyors, and finally at order pack-out.

In the competitive world of e-commerce, this new form of warehouse automation is a strategic weapon: helping forward-thinking retailers fulfill customer orders "right now" through the convenience of online buying, whether delivery is to the home or for pickup at a store.

The choice to use robots to piece-pick items in fulfillment operations can give your company the ability to reduce warehouse costs and increase order accuracy. Robotic systems also reduce manual touchpoints in warehouses, which improves throughput predictability.

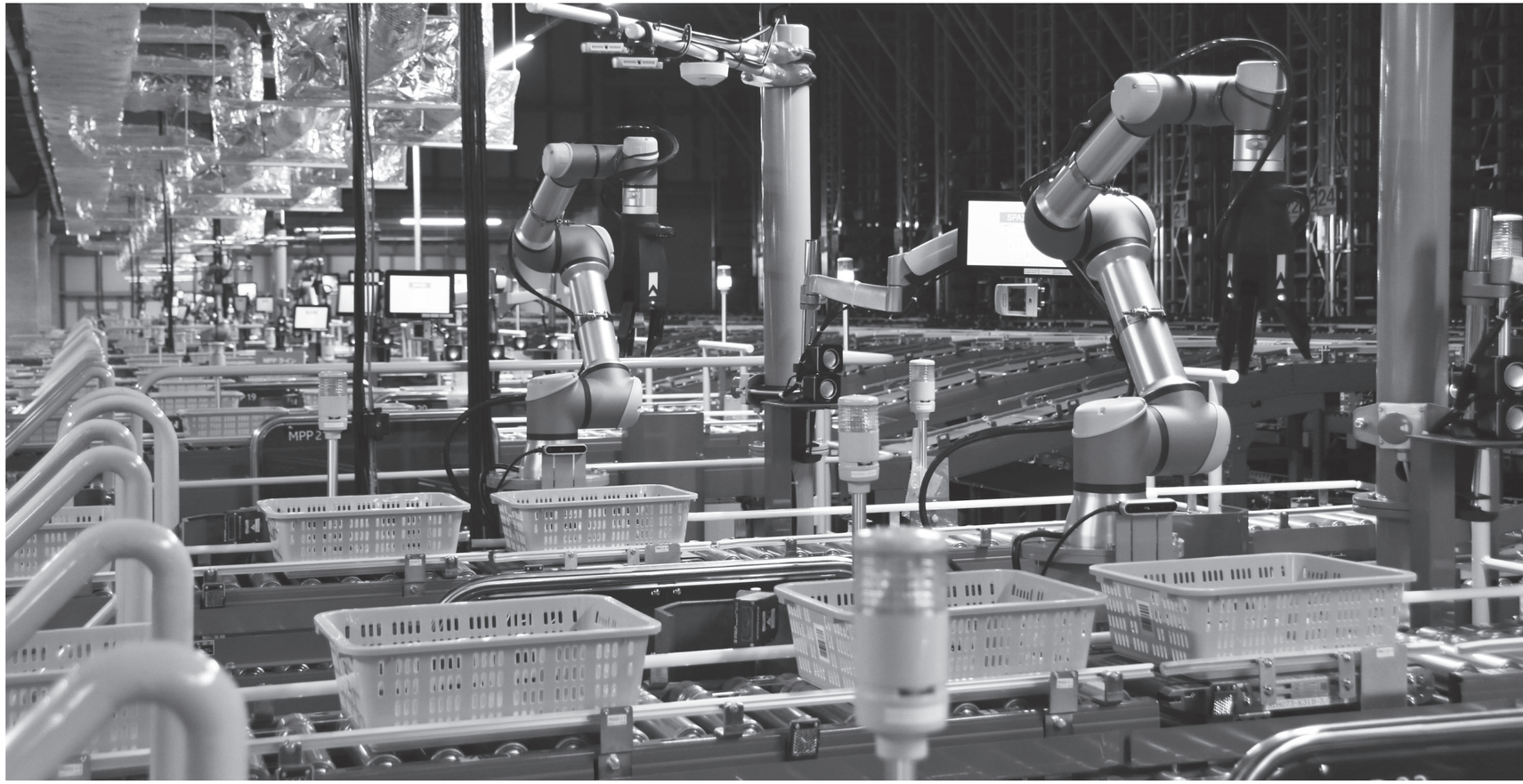
In addition, with individual associates managing small fleets of autonomous robots, robotics technology can increase labor productivity by more than 400 percent. This in turn frees up personnel to tackle more complex tasks elsewhere in the order-fulfillment process.

But the transition from an all-manual, item-handling warehouse to a mix of robotic and manual processes does not happen overnight. Transformations require advance planning and organizational alignment to succeed, depending on the scale of robotic piece-picking systems to be deployed.

This white paper presents five key factors to consider as part of a program to deploy robotic piece-picking. While the technology is approaching plug-and-play status, it's important to think about how you will operationalize and use robots to maximize their benefits--both from the perspective of how they will interact with your team as well as how they will integrate with your virtual warehouse execution systems.

1

FACTOR
Operational Objectives



The first key area to examine is your operation objective. It's important to consider your strategic reasons for deploying robotic piece-picking.

- Do you have a large enough pool of labor within commuting distance of your facility to keep up as online order volume grows?
- Is it a necessary component for your warehouse operations as you transition to a "bricks and clicks" customer experience model?
- Are you automating primarily for the long-term cost savings?
- Are you considering changing the way you handle products at certain points in the warehouse
- If robotic piece-picking proves valuable, will you want to use it in retrofits of existing facilities, only in new greenfield designs, or both?
- Will this new automation need to integrate with multiple material handling systems and software environments in order to maximize its strategic value?

If you answered yes to this last question, it's important to look at a modular solution that could be used across multiple variations of software and the material-handling equipment that you currently own and operate.

But perhaps you are considering robotic piece-picking automation for a combination of these reasons.

However you answered, it's important to be clear: You will be investing significant time and energy into the process and need broad support across your organization to achieve the intended benefits within reasonable timelines.

Since piece-picking systems are still maturing and gaining market acceptance, you may find that traditional industry consultants do not have a wealth of first-hand experience. You may need to rely on a combination of your engineering team, consultants and system vendors themselves to build your evaluation plan, facility design, and overall business case.

2

FACTOR
Item Set
(product assortment)

Assuming a clear business reason has been identified, the first technical consideration in determining your readiness for robotic piece picking is to understand how your item set aligns with robotic item-handling capabilities.

For retailers supporting almost any mix of online and physical stores, the SKU (Stock Keeping Unit) assortment, and/or range of items, may include hundreds of thousands of unique products. Many everyday retail product categories are pickable by robots—ranging from grocery to health and beauty, pharmacy, electronics, and clothing.

But some items are not as easily pickable, such as those that tangle, are porous, or have a complex shape. Packaged items should use fixed, closed packaging if picked by robots. Otherwise, the packaging may open when picked.

The chart on the next page provides nominal dimension and weight (dimweight) guidelines for determining if your items are suitable for picking with intelligent robotic grippers. The good news is that for many retailers, these smaller items represent 70-90% of the outbound demand.

If your product set is entirely made up of bicycles and kayaks or sofas and coffee tables, you will not likely find a good robotic option for item handling in the near future, unless you manage to standardize packaging or are able to find partners to develop customized solutions.

But one limitation you should not accept for a robotic picking system is the need to teach the system each SKU based on detailed item models. An effective solution will be “model-free” and able to pick items it is seeing for the first time--as well, or almost as well as, items that it has handled a million times. This is an absolute requirement, assuming your product mix changes over time, with seasonal items, changes to packaging and branding, or if your corporate buyers elect to carry new product categories.

How items are arranged in the totes or containers and presented to the robot can also be important. Flat, thin items are easier for robotic vision systems to see when they are laid flat versus the thin edge facing upward. They also present a larger, flat surface for the gripper to achieve an initial suction grasp on the item.

In general, storage guidelines that help robots see and grab items will also help their human counterparts in the facility. Imagine if you look into a particular tote and find it hard to distinguish one item from another and would need to think about how to reach in in order to successfully grasp a single product in one motion.Now imagine how hard it will be for a robotic system.

While there may be some tradeoff between absolute maximum storage density that can be achieved by “stuffing” items into storage locations, this is incidental when compared to the overall benefits of automated picking. Minimizing dunnage or loose packaging mate-

Characteristics of Items That Are Readily Handled By a Robotic Piece-Picking System

Item Parameter	Nominal Range	Extended Range
Weight	2kg	5kg
Dimension	1cm - 20cm	0.01cm - 40cm
Packaging	Bottle, Box, Blister Pack, Bag (All bagged items must be sealed)	Poly Bag, Glass and Other Fragile Packaging (All bagged items must be sealed)

For items that fall outside of the above range, reach out to a qualified provider to verify pickabilty

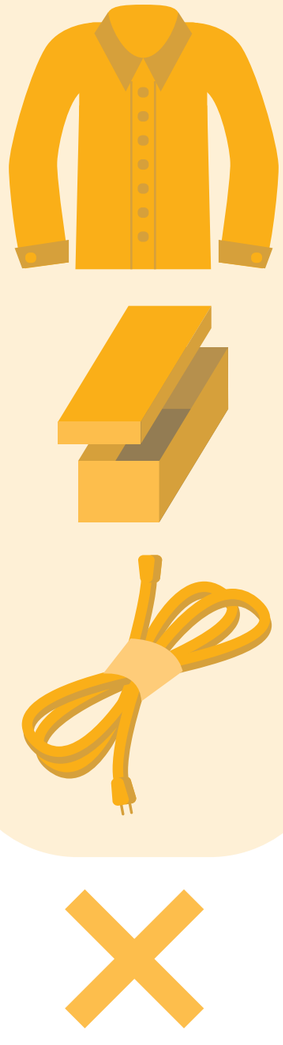
Categories like
Groceries, Health & Beauty, Pharmaceuticals, Electronics & Consumer, Apparel

Items in Bags, Blister packs, Tubes Hangtags, Boxes

Items that tangle
(should be packaged)

Items with open packaging
(should have secured packaging)

Items that are porus or complex
(tend to multi-pick)



rial in inventory totes is also key to optimizing performance and is an existing best practice for standard warehouse operations.

It's also important to evaluate the ability of robotic systems to pick items from tightly-packed totes and to reliably get the last item out of an inventory storage tote—especially in cases where the item is small, slides into the corner of the tote, or lies in a challenging orientation. These are topics to discuss with your robotic automation vendor.

Most importantly, the solution must pick all items gently enough so they arrive at the end consumer in prime condition and without any damage to the packaging. If you have a high percentage of fragile items in your product set, verify with your provider as to the viability of a robotic solution. For example,if you are a wine glass business, you may need to reconsider whether robotics piece-picking is the right investment choice right now.

As you assess robotic solutions, also consult with a piece-picking expert to evaluate the robotic pickablity of your items. Robotic piece-picking system providers can provide guidance on what percentage of your outbound order volume is robot-ready based on these factors:

- The dimension and weight analysis of your SKU master item list
- The typical packaging classes for your product set
- How items are typically arranged within containers presented to the robot

Item qualification testing with a limited sample of products can help confirm the findings of these initial analyses and give confidence to both your engineering and operations teams.

3

FACTOR
Material Workflow

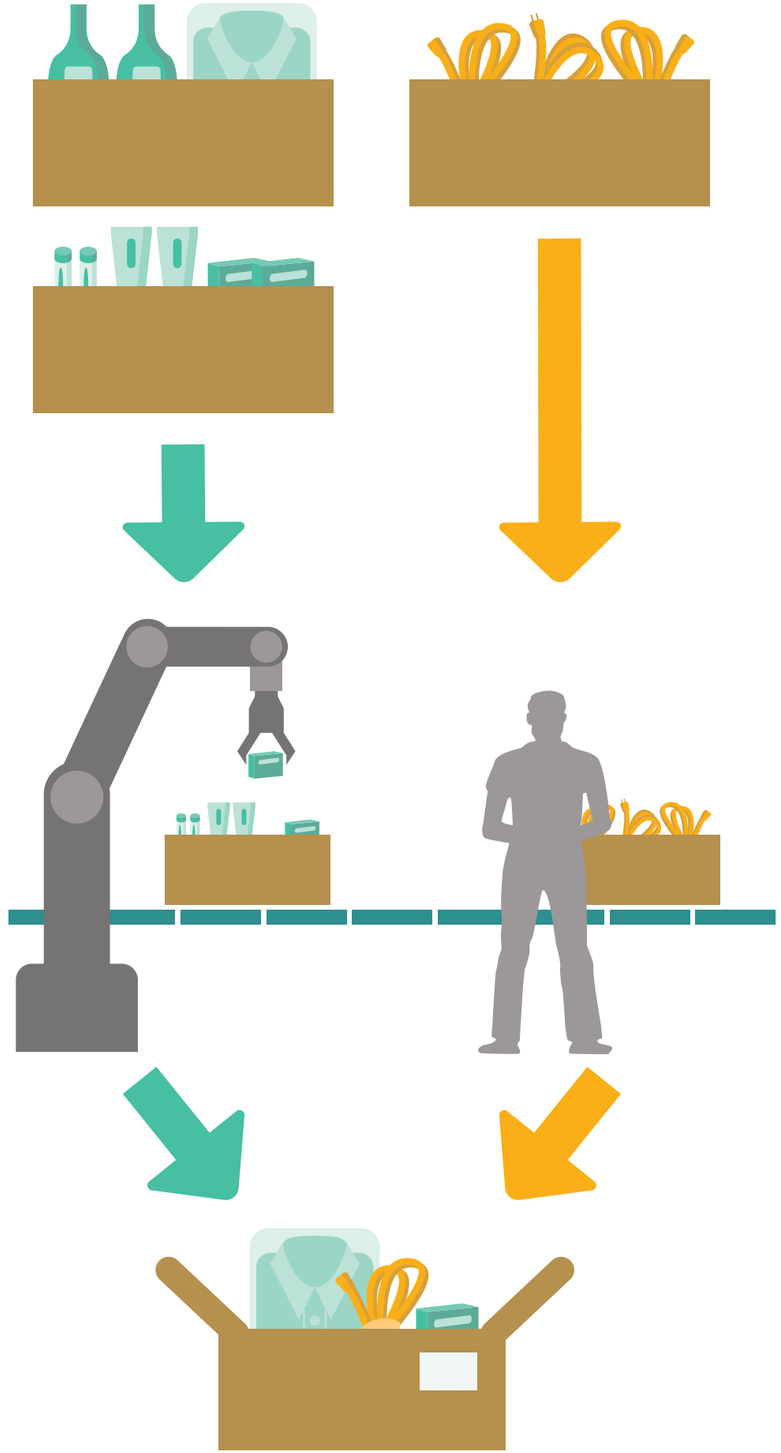
While there are a number of processes in a warehouse where automated picking systems can be useful, narrow your focus to one or two high-impact processes to get started. The process should be simple enough to automate with a stationary picking robot, and common enough in your facilities such that the savings entitlement is sufficient to justify the overall effort.

Your picking solution provider will need to understand whether there will be one or more sources for items, one or more destinations in which to place items, and whether these destinations will be specific totes, cartons or a mix. The workflow may require item identification (such as barcode scanning), which is another key requirement for the robotic system.

Your item set will very likely include some items that are pickable by robots and some that are not, the so-called "non-pickables." If so, consider how to handle process flows for both item classes and how to merge items together to finalize orders at pack-out. This will require a plan for a mix of robotic stations and manual stations.

Your piece-picking system provider should be able to help you define the mix and set clear expectations on system utilization, throughput and tradeoffs as you work together to define project scope. Your system integrator and Warehouse Execution Software provider also play important roles in this design discussion, especially as you look forward to scale out.

As part of the workflow design, the new system should be capable of participating in existing material flows for inventory control and quality assurance for cases where there are exceptions detected on either the inbound source side of the process or on the outbound side. This part of the workflow design will impact the physical workspace and system integration, so it is best to discuss and set expectations early in the planning discussion.



4

FACTOR
Physical Workspace

Planning physical workspaces for robotic piece-picking systems is comparable to planning workspaces for people but with some caveats. Even a flexible piece-picking system needs a largely obstacle-free workspace in order to simplify the real time nature of the path-planning process.

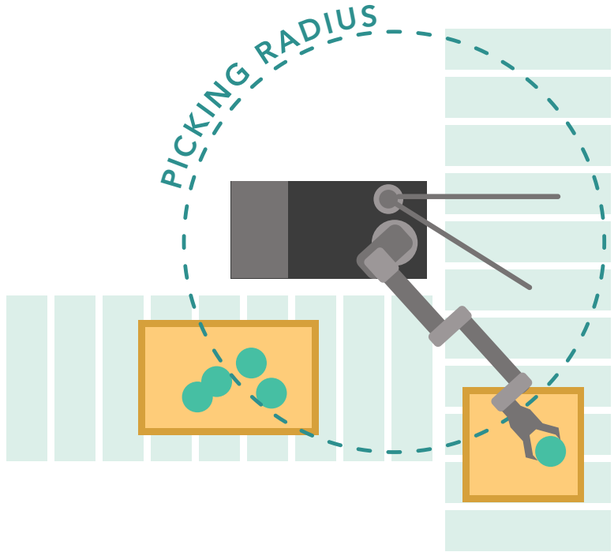
Unlike many manufacturing robotic applications, bin picking, by its nature, presents items in an unstructured way, meaning the path to grab and move the next item picked is a bit different from the previous one. So there needs to be space around the arm to get there—the less complex and open the physical space, the better it is for the robot, and the algorithms that must do motion-planning in a fraction of a second .

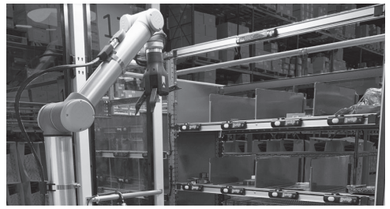
You will thus need to create "robot-friendly" workspaces where the robots can easily reach the containers they pull from as well as the destinations where items will be placed, which can range from totes to conveyor belts, and put wall cubbies. Another key factor is the number of source containers that will present items to each robot.

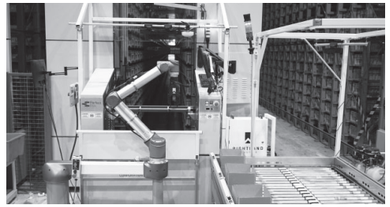
The leading picking systems feature a reach of greater than one meter. The system provider can provide details and help you understand the best configuration for source and destination containers.

Advanced systems can optionally include barcode scanning. The placement of barcode scanners cannot interfere with the vision of the robotic picking machine and should not overly constrain the robot arm movements. This is expertise the robotic system provider should offer.

If you are building a new greenfield facility, it's usually easier to create physical workspaces that will enable robots to operate at optimal throughput. Conversely, deploying robotics in existing brownfield facilities is more challenging, and you may sacrifice some system performance. In some cases there may not be enough space to install robots where you need them, which will require re-working your workflow or retrofitting existing warehouse equipment. If the strategic goal has targeted significant savings and operational benefits, these additional investments in your first projects may be justified.







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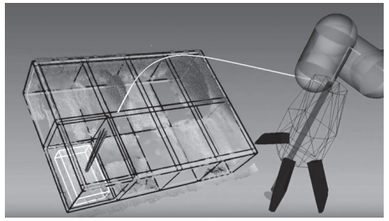
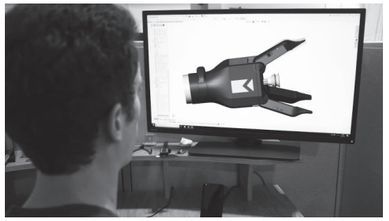
FACTOR
System Integration





System integration can be thought of at two levels: the first involves taking intelligent gripping systems, robotic arms, computer vision, a computing platform and any ancillary devices such as barcode scanners to create a functional picking system that can accomplish a warehouse picking task. While it's possible to purchase all of these components separately and then configure them on your own in a do-it-yourself approach, it's generally best to purchase systems where all the components and modules have been chosen and qualified by one vendor. The components are more likely to work optimally, and if there is a performance issue, you will have just one vendor to turn to in order to remedy the situation.

The second level of integration marries the picking system into the software stack for the warehouse operation. The robotic picking system should have a simple software API to accept commands from typical warehouse system packages, such as Warehouse Execution Software and Warehouse Management Software.

Similar to how screen-based GUIs and pick lights are used to manage the workflow in a manual workstation, the API enables the host software to send jobs to the robot and for the robot to report back on job status. A simple task is to pick an item from the source and place it in the destination container. A more complex task is to pick an item, scan a barcode, and report the code to the warehouse software, wait for confirmation that the code is valid, verify that an empty tray is approaching, and then place the item into a moving sortation system.

In all cases, the robotic system needs to report to the host if there is an error that prevents it from successfully completing the task. Exception cases may include an empty source tote, the destination container that does not arrive, the system failing to pick an item, or the system dropping an item during movement from source to destination.

Depending on the nature of the exception, the warehouse software may trigger an action, such as routing a source tote to an inventory control station, requesting the goods-to-person system to retrieve another tote with the same inventory item, or short the order and route it for downstream quality assurance.

These flows will largely mirror similar processes in manual operations but should be thought through with the picking solution provider to ensure reliable and predictable behavior.

For the infrequent case when normal exception flows cannot be triggered, it is important to have the ability to monitor the robot fleet from a centralized control center. The individual staffing this position will have visibility into the status of each robot under her command and the capability to review and resolve exceptions leveraging video pick replay functionality. Having one person, the robot supervisor, managing a fleet of robots delivers the overall labor productivity benefit in order fulfillment operations. Finally, if the supervisor is unable to resolve an issue, they could dispatch an associate to the particular robot for additional toruble-shooting.

Advanced piece-picking solutions also generally incorporate artificial intelligence and machine learning that allow robots to improve performance as they are used in production. In order to leverage this capability fully, you will need to discuss network implementation and bandwidth requirements with your system vendor.

One advantage of a successful system collaboration is that any additional robots added to the facility will receive the full "experience" of the robot fleet, so there is no ramp-up time for them to reach full productivity. This is true within one warehouse or across multiple warehouses in your network, assuming similar item sets.

DON'T FORGET THE 3Rs

For your robotic piece-picking workflow, consider the range, rate and reliability you will require from each robot. You will be likely to identify a solution that helps you manage the costs and complexity of piece-flow by evaluating solutions based on how well they deliver on these "3Rs" of robotic piece-picking:

RANGE refers to the number of SKUs a robot is capable of picking, scanning and placing within a given warehouse workflow. The leading solutions can handle millions of SKUs without the need for learning detailed 3D item models.

RATE pertains to how many units a robot can pick and place within one hour. Some systems can move 1,000 units per hour for a simple workflow. For each robotic system, the rate must meet or exceed the throughput of the manual station it will replace so that the robot does not become a bottleneck and impede downstream operations or back up conveyor buffers.

RELIABILITY relates to quality—the percentage of picking, scanning and placing tasks that robots perform correctly without damaging any items. Reliability also refers to availability (how many hours per day the system is ready to perform work) and autonomy—the amount of work the robot can do unassisted before manual monitoring and intervention is required. The best systems can run 24 hours per day with limited planned maintenance. Manual intervention should be infrequent as measured by impact on system throughput. Robot systems should also require little or no change to the existing physical infrastructure and integrate easily with conventional warehouse software systems.

Achieving high standards in the 3Rs will help you ensure your customers receive the correct items on time and in proper condition. The higher the metrics across the range, rate and reliability attributes, the greater the throughput of your warehouse operations, and the greater your ability to achieve predictable capacity while also meeting the expectations of your end consumers.

NOW IS THE TIME FOR ROBOTIC PIECE-PICKING

To properly plan your robotic piece-picking project, start by reviewing the five factors in-depth. You can streamline your journey by also keeping these additional tips in mind:

- Define your business objectives, your 3R needs, and whether you will benefit most from a retrofit or a greenfield project.
- Determine which of your items are robot-pickable and which items should continue to be picked manually.
- Consider how items will be stored and how you will eliminate dunnage from source totes.
- Select a workflow that is significant to your business.
- Work with your solution provider to decide how you will manage the probable mix of manual and automated picking.
- Collaborate with your vendor on workspace design.
- Plan a well-thought-out software integration with clearly articulated exception handling procedures.

Following the deployment of your robotic piece-picking solution, track the key performance metrics and iterate or adjust as needed. It may take some tuning to maximize the benefits, but the journey will pay off over the long term. We hope this framework is useful as you conduct your planning process and begin working with robotics solution providers.

Given the pace that robotics technology is maturing, now is the time to automate your piece-picking processes or plan for a deployment. By doing so, you can keep ahead of the competition and continue meeting customer demands for faster fulfillment.

For more information on deploying a robotic piece-picking solution in your warehouse, contact RightHand Robotics at info@righthandrobotics.com or submit an inquiry about a project you're considering. We can also help you determine if robotic piece-picking is the right move for your operation. And to learn more about the 3Rs (range, rate and reliability) continue your piece-picking journey with Gripping Lessons at www.righthandrobotics.com/blog

RightHand Robotics (RHR) builds a data-driven intelligent picking platform, providing flexible and scalable automation for predictable order fulfillment. The software-driven, hardware-enabled modular solution is capable of adapting to any picking situation bringing reliability to order fulfillment in growing industries such as electronics, apparel, grocery, pharmaceuticals, and more. RHR was founded in 2015 by a DARPA challenge-winning team from the Harvard Biorobotics Lab, the Yale GRAB Lab, and MIT, intent on bringing grasping intelligence powered by computer vision and applied machine learning to bear on real-world problems. The company is based in the U.S. near Boston, Massachusetts, with offices in Frankfurt, Germany and Tokyo, Japan.

For more information,
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