

# Seven Types of Warehouse Robots: Considerations for Leveraging Robots in the DC



## INTRODUCTION

The demand for fast and accurate order fulfillment continues to experience exponential growth, driving the increased need for labor. Labor costs continue to increase, and despite higher wages, companies are finding it a challenge to recruit, train and retain workers. Add to that measures required to keep workers safe, and robotic solutions become an attractive option for companies looking to increase productivity and reduce cost.

Robots can be used for different aspects of fulfillment, including picking (to reduce all or some of the walking/traveling that drives down productivity), physical pick and place (to reduce touches), packing, and transport of product between staging areas for put away or replenishment of inventory.

In this article, we will describe seven types of warehouse robots and their benefits, use cases and challenges providing a framework for how to think about leveraging robots in distribution operations.

### 1. ROBOTIC ARMS

Robotic arms have been used in manufacturing for decades and in case distribution environments for years. Advances in vision systems and end effector (gripper) technologies are now allowing for better piece picking applications and pick and put operations. The arms can be used at a Goods-to-Person (GTP) workstation or mounted to a mobile robot for each picking. They can also be mounted in place to handle repetitive tasks, such as loading empty cartons to overhead conveyor, placing discrete units to be inducted to a unit load sorter, and sorting units into outbound shipping lanes.

The benefits of these robots include reduced dependence on labor at pick stations, put walls, unit sorter induction stations and the shipping dock, as well as increased accuracy in pick and put processing. The key challenges to operational deployment remain:

- **Gripper applicators.** It can be a challenge to find a single type of end effector to handle the full array of product characteristics – gentle enough to handle crushable items but adept enough to handle odd-



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shapes. One possible solution is to deploy different gripper types and route product to the station best equipped to handle the product, but that requires a pick and pass process or the manual consolidation of orders downstream.

- **Visualization software.** The depth and dimension sensing of robotic vision systems have improved their ability to determine the edges of product, but the challenge is that the lighting must be good and reflective product can still be a challenge for these systems. It is also difficult for robots to see into small compartments (say, in a highly divided tote).
- **Product Variability and Limitations.** The weight range a robot arm is able to handle is still a limitation in some cases and depending on the range of products to be handled may require different arms to be considered in the design. You might design the operation for 90% of products under 5 pounds but cannot ignore how to handle the 10% of products that are heavier. Consideration of whether you will have one station that can do it all or design for pick and pass between stations with different robots.

Over the next 2 – 3 years we expect to see more robotic arms implemented at fixed workstations. This technology seems well positioned to handle some portion of the picking out of a Goods-to-Person systems and is easily scalable by expanding the number of robots as their capabilities and the business grows. In the future, we expect robot arms to increase in ability to pick from smaller compartment sizes and to handle a larger range of product sizes and characteristics.

## 2. COLLABORATIVE BOTS (CO-BOTS)

The primary advantage to co-bots is their ability to reduce the travel of pickers working collaboratively with them. Pickers spend most of their time walking and these bots reduce (but does not eliminate) some of the wasted walking that reduces productivity. Today, there are two primary types of collaborative robots:

- **Meet-Me Bots.** These robots travel through a pick area, stopping and waiting at a pick location for a worker who performs the pick. Workers move from



bot to bot within a dynamic zone, rather than traverse the full expanse of the warehouse.

- **Follow-Me Bots.** These bots travel to a worker and lead them from picking location to location for some or all of the picks on the bot. When full, the bot travels to a packing station and another bot is deployed to the picking worker’s location.

In addition to the labor and time savings associated with reducing travel, the benefits of these robots include increased productivity and the ability to safely co-exist with workers. These robots can also be deployed for inventory replenishment tasks. There is also a potential application where a robotic arm is added to the mobile platform to eliminate the need for a human to execute the pick.

“Meet-Me” and “Follow-Me” bots are both best suited for low pick density and high-volume environments. In addition to reducing travel for the worker in the picking area, the “first mile” and “last mile” travel are also automated. As discussed with Bot Sorter AMRs, automating the latter can also reduce the cost of costly sortation in a highly complex sorting scenario (i.e., from many picking areas to many different pack stations or zones). The key challenges to widespread adoption include:

- **Limited Capacity.** The number of totes or slots a single bot can handle is limited as compared with the capacity of a traditional pick cart. However, it’s possible to achieve comparable capacity using a tugger bot to tow a picking cart. This requires a design trade-off of wider aisles to accommodate the bot towing a cart.
- **Density Tipping Point.** The business case is hard to achieve in higher pick density environments because travel reduction is based on having the bot travel past locations without picks versus paying a worker for this travel. As the pick density decreases, the business case for bots increases.
- **Throughput Tipping Point.** The proportion of worker travel eliminated is based, in part, on the throughput of the system. As the throughput of the system increases, more bots and thus more workers are




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**“While AGVs and tuggers are more mature technologies, AMRs are more flexible and less expensive.”**

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needed. This implies that workers are working in a smaller area and their travel between bots is reduced. Thus, as throughput increases, the business case for bots increases (subject to worker and bot congestion).

Payback for these investments should not be solely based on labor savings. Rather, the business case should also factor in the cost to find or inability to find labor, and the cost of lower accuracy such as mis-picks and damage caused by humans.

### 3. MOBILE RACK GOODS-TO-PERSON (GTP) AMR

Mobile Rack GTP AMR robots bring inventory via mobile rack systems to workstations optimized for productivity. These “Come-to-Me Bots” offer more flexibility with how products are stored than other GTP solutions. The AMR robots transport product contained on storage units of various configurations (shelf units, garment on hangar, etc.) to GTP workstations. Some of the key challenges associated with these robots include:

- **Cube Utilization.** These types of robots and processes make poor utilization of the building cube. Use of structural mezzanines and mechanical lifts could counter this issue but add investment requirements and operational issues.
- **Productivity.** The GTP workstations in a mobile rack system yield a lower productivity rate when compared to other GTP technologies. An operator picking out of a tote (in a shuttle GTP) is more productive than one picking out of a rack.

### 4. ROAMING SHUTTLE AMRS

Roaming Shuttle AMRs are used to store and transport products in a high-density storage/retrieval environment, which is typically part of a GTP solution. The main advantage of these AMRs is that it allows the user to scale storage and throughput in a relatively independent fashion. That is, when more storage is needed, storage can be added with little to no additional investment required to facilitate the throughput (which may not have changed).





This is in contrast to fixed-shuttle GTPs where storage and throughput capacity are added in tandem. Roaming shuttles help to reduce overall building footprint by taking full advantage of the clear height of the facility. Some roaming shuttle systems are configurable to take advantage of odd-shaped spaces as well. They are gaining traction as part of local or micro-fulfillment solutions. Factors for consideration when evaluating these types of bots include:

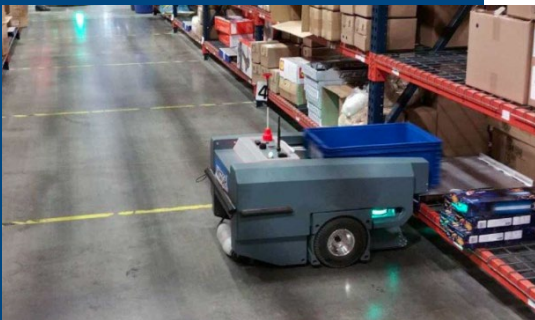
- **Congestion.** To achieve higher storage density, deep lanes or tall columns of totes are used. These strategies, however, require additional access time, which may limit throughput. Some suppliers have addressed this challenge with algorithms that “learn” and slot fast-moving SKUs to the locations that are more readily accessible for reduced access and transport time. The end result is that roaming shuttle systems will become “saturated” at some point (i.e., adding more shuttles does not increase throughput).
- **Tote Capacity.** These systems are built around a standard set of tote sizes. The tote size ultimately limits which products can be included in a shuttle-based GTP as compared with mobile rack solutions, which are nearly as flexible as a picking from bin shelving or wire deck. For example, a client considering the technology was deterred when they realized they would have to fold a coat if it were to be processed in this solution. Unwilling to compromise on the handling of this type of garment made mobile rack a better option for them.
- **Fire Suppression:** Top-loading roaming shuttle systems have unique characteristics when it comes to fire suppression. On the one hand, because totes are directly stacked on top of one another, there is little oxygen to feed the fire. On the other hand, it is difficult to isolate and get water to the point of the fire. Solutions are being developed to mitigate this issue.

## 5. UNIT LOAD TRANSPORT AUTONOMOUS MOBILE ROBOTS (AMR)

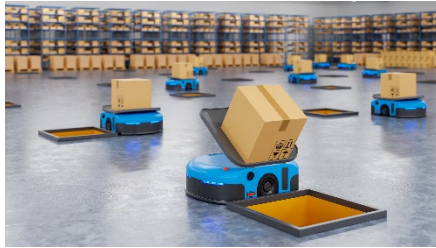
Unit Load Transport AMRs have been developed to address two fundamental limitations of the AGVs that have been deployed for years. The first is the restriction of AGVs to be deployed in areas either without other trucks or human movement or where AGVs can be given priority safely. The second is the cost of AGVs. Thus, AMRs are more flexible and less expensive. These robots are often used for transport of product for Put away, transport of pallets or totes across longer distances, such as from a Receiving to Staging Area or from Staging to Shipping. They can also be useful for moving stacks of empty pallets and transporting trash and dunnage. Less frequently, they are used for case picking co-bots. With these robots, there are a few issues that still need to be addressed:

- **Safety.** Their speed, the potential for damage when impact occurs, and sensors, which are not sophisticated enough to pick up human movement or respond quickly enough to avoid collision, are safety concerns when working in proximity to humans. Suppliers are working to address such issues, including the ability to “see” lift truck forks, which are low to the ground.
- **Vertical Lift Limitations.** These robots often do not have a mast with a lift/lower mechanism, thereby limiting their reach and current scope of use.
- **Source and Destination Stands.** Robots require dedicated sets of source and destination stands to pick up and drop product from the transfer device on the robot.

In the near future, you can expect to see AMRs with masts capable of lifting and lowering product at various heights, which will add the capability to store and pick product from selective rack. This will move the AMR mobile robot into the same distribution space currently dominated by AGVs.



## 6. BOT SORTER AMRS



Bot Sorter AMRs eliminate the need for a traditional, fixed-in-place sorter whose cost increases dramatically as the complexity of the sorting operation increases (e.g., the number of sorting destinations increase). They also offer greater flexibility in terms of the ability to make changes to the sorter placement and logics with minimal time and cost impact. They can pick-up product and perform a many-to-many sort or consolidate product from several areas of the warehouse. Pickup and discharge can be manual or from a conveyor line. The limitations of these bots include:

- **Throughput.** The robots are only business case justified in low- to medium-throughput applications. For high-throughput applications, a traditional sorter, even with its limitations, will provide a significant advantage in terms of throughput.
- **Cube Utilization.** These robots require a dedicated floor surface to operate properly. To utilize the full cube of building requires a mezzanine.

## 7. OTHER APPLICATIONS OF ROBOTS IN THE WAREHOUSE



Where ergonomic conditions are poor and result in injury, there are truck loaders and exoskeletons for assist in lifting, but these solutions are not yet cost justified. Truck loading and unloading AGVs are often challenged when there is wide variation in product to handle. In addition, these solutions typically have lower throughput than manual processes and require larger staging areas when compared to manual processes. Automated robotic arm options are still very expensive and have some of the same challenges. There is a sweet spot for these applications, but it's very narrow.

Cost, effectiveness, and lack of flexibility are sometimes cited as reasons for not deploying robots more widely. It is true that robots likely require a larger initial investment over analogous human-based solutions, when applicable. Also, robots, who still lack the critical thinking skills of a human, are still not typically as effective as a human operator in terms of speed and/or flexibility. But what we have seen is that robots used in the applications we



discussed above are better alternatives than other automation and have inherent advantages over purely manual solutions when a business case perspective is taken. In short, robots have passed other automated solutions and are gaining quickly on manual applications, and in some cases, already passed them.

Warehouse Execution System (WES) software is key to unlocking the value of robots in the DC and optimizing business critical operations. FortnaWES™ integrates seamlessly with any robotics or MHE solution. To learn more about how to maximize the ROI of your automation investments, speak to a Distribution Expert.

Pick and Place Robotic Arms	Co-Bots	Unit Load Transport AMR	Mobile Rack GTP AMR	Roaming Shuttle AMRs	Bot Sorter AMR

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