



Augment Trailer Unloading *Before Automating It*

Robotic Solutions are
Not Ready for Every
Warehouse Task

GORBEL[®]
A C L A S S A B O V E



Dull, Dirty and Dangerous... this must be the perfect job for a robot.

You've just hired another warehouse associate. Eager and excited, you hope that they are strong and healthy enough for all your hardest jobs. And as you pass a trailer being unloaded by your sore and already tiring team, you wonder if they're ready to schlep boxes in a 90-degree trailer for 8 hours per day.

Truck unloading is considered the “holy grail” of warehouse automation because it's hard, repetitive work – turnover rates are high and it doesn't require a lot of training, just a lot of backbreaking labor. However, our customers tell us that in most use cases, robots aren't ready for prime time because of these limitations:

1

Speed

Robots are too slow in most unload scenarios, both in terms of pick/place, but also the speed of moving between trailers. Associates with ergonomic conveyors are quick, and turn dock doors faster.

2

Inflexibility

Robots do not have the flexibility to unload most floor loaded trailers. Variations in package size, weight, material reliability, and load variations can all cause problems.

3

Capital Expense

The capital investment is too high, and the ROI is too low, for the average warehouse.

4

Space

In many warehouses, robots take up too much room, especially if physical fencing or light curtain zones are needed to keep workers safe. Collaborative robot technology is another option, but tends to be slower and have less weight capacity.

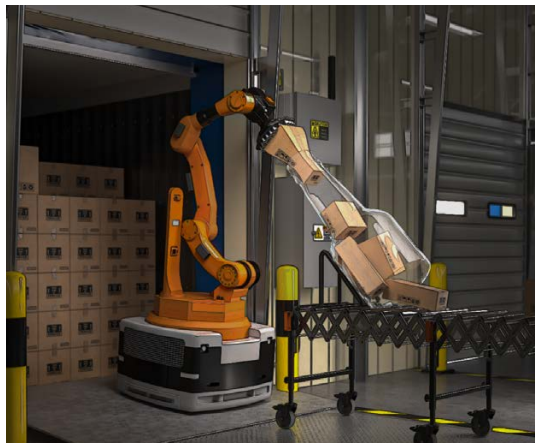
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Training and Maintenance

As more automation is added to your warehouse, you need more skilled technicians on staff to keep everything running.

CHALLENGE 1: SPEED

Your investment should not create a bottleneck



Your case rate helps predict the speed at which you can unload a full truck; that is, the number of **cases per hour (CPH)** that you can unload per dock door.

Here we compare three unload methods, each unloading a 53' trailer filled with 1,365 boxes that are 20 x 16 x 14" in size. Each box wall has 35 cases, and there are 39 box walls.

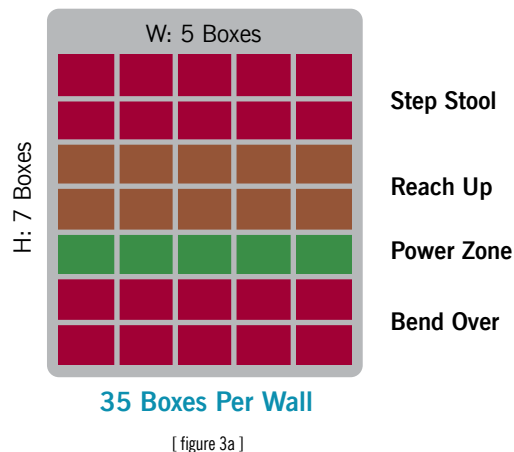
Robots are excellent at unloading boxes or cases that do not have much variation in material or size, so this is a perfect use case for an unload robot.

Unload Method	Manual Unload	Robotic Unloader	Ergonomic Conveyor System (Worker Augmentation)
Total Packages	1,365		
CPH (Cases Per Hour)	450	586	1,249
Unload Time Per Trailer (Theoretical Minimum)	3 hr. 1 min	2 hr. 20 min	1 hr. 5 min
Drop Rate 1 every other box wall (39 walls)	1 in 70 cases		
Time to Correct Drops (Minutes Per Trailer)	+ 2 min	+ 8 min	+ 2 min
Intervention Rate	N/A	0.25%	N/A
Interventions Per Trailer		4	
Intervention Time (Est.)		+ 9 min	
Unload Time Per Trailer (Actual)	= 3 hr. 3 min	= 2 hr. 37 min	= 1 hr. 7 min

CHALLENGE 1: SPEED

Manual Unloading

Traditional methods of unloading a trailer involve a combination of brute force, pallets and/or carts. Pushing carts or pallet jacks is hard work, and if your team is lucky, you will have forklift or conveyors to help you unload the trailer.



Each 35-piece box wall takes the two associates around 5 minutes in total, giving us a case rate of 450 total cases per hour (CPH).

35	<5	450
piece box wall	minutes	cases per hour

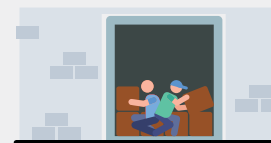
For this example, we assume two associates are unloading the trailer, each loading boxes onto their own pallets.



1. Associate A & B first bring two pallets into the trailer.



2. Associate A is on a step-stool unloading the top 10 boxes, which are out of reach, handing each box to Associate B.



3. Associate A & B each pick boxes from the box wall (see figure 3a).

- 10 boxes must be reached up for, above their ergonomic power zones.
- 5 boxes are picked within their ergonomic power zones.
- 10 boxes must be bent over for, and picked from the floor, below their ergonomic power zones.



4. Associates A & B fill pallets, each with 16 boxes, they are removed from the trailer, shrink wrapped, and stored by a third associate.

5. Repeat steps 1-4.

CHALLENGE 1: SPEED

Robotic Unloading

A key benefit of robotic vacuum grippers is the ability to pick multiple cases at a time. This is possible if the packages are relatively uniform in size and stacked neatly, to ensure that the suction cups contact the top of each box. Packages must be within the weight capacity of the robot; most can handle up to 50lbs.

There are some inefficiencies in this pick process due to the robot sitting in between the conveyor and box wall, requiring the arm to travel long distances between picking and placing each box. In total, each 35-piece box wall takes about 3-minutes 35-seconds, giving us a case rate of 586 cases per hour (CPH).

35

piece box wall

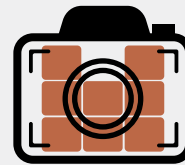
3+

minutes

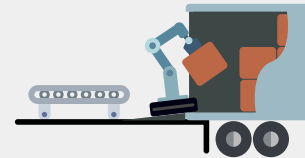
586

cases per hour

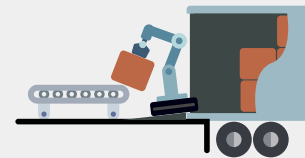
For this example, the robot is unable to pick multiple packages because they each weigh 34lbs. The unload operation involves the following steps:



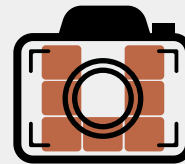
1. Photograph the box to determine the pick point.



2. Swing the arm forward to pick the box.

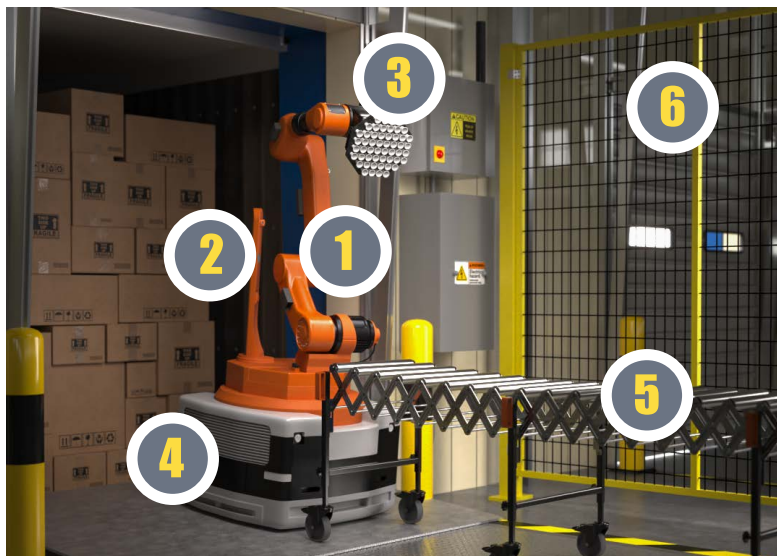


3. Swing the arm backward to place the case on the conveyor.



4. After each box wall, the robot will have to re-image the trailer, then move forward.

CHALLENGE 1: SPEED



Robotic Unloading

Unless the warehouse has additional automation in place to palletize, sort or store each package that the unloading robot drops onto the conveyor, two associates are still needed to handle the packages once they are out of the trailer.

The associates can pick each case within their ergonomic power zone from the conveyor, providing both ergonomic benefits and labor savings. They will populate each pallet with 16 boxes, then shrink wrap and store them.

New mobile robotic unloading systems typically comprise of five main components:

1

A six-axis robotic arm.

2

A vision system to identify boxes and guide the robot.

3

A vacuum gripper to pick cases.

4

A mobile platform to move to each box wall, and in and out of the trailer.

5

A conveyor system to pull packages from the trailer, after they're dropped onto it by the robot. This can be a telescoping or flexible conveyor.

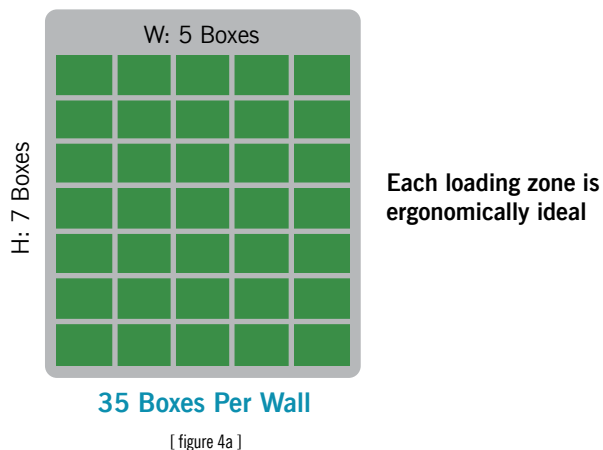
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Safety fencing/guarding.

CHALLENGE 1: SPEED

Portable Ergonomic Conveyor

New ergonomic conveyors, with an operator platform and pivoting conveyor, allow one associate to bring a conveyor directly to the package; rather than picking and placing it, you simply slide the package onto the conveyor, minimizing strenuous lifting.



One operator can easily achieve a case rate of 1,249 CPH.

35	1	1,249
piece box wall	operator	cases per hour

Downstream, you will need 3 associates to keep up with this high case rate, palletize and shrink-wrap pallets. While this adds some labor, your total man-hours have been reduced significantly. You have lowered the cost to unload each trailer by greater than 50 percent.

A typical trailer unload process will look like this:

-  1. Drive the ergonomic conveyor into the trailer.
-  2. Adjust the platform and conveyor height to stay within your power zone.
-  3. Slide the box onto the conveyor.
-  4. Readjust conveyor position (angle and height), and platform height, as needed, to allow you to slide the box onto the conveyor (see figure 4a).
5. Repeat steps 1-4 until the trailer is unloaded.

CHALLENGE 1: SPEED



Case Drops and Interventions

Trailers can be hazardous—box wall avalanches and dropping cases can occur whether you are unloading manually, with a robot, or an ergonomic conveyor.

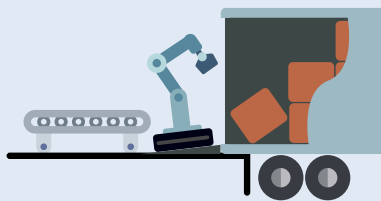
When a robot drops a case, it typically must move backwards to the drop location, so the package is within reach of the robot arm. It will image, pick, then place the box onto the conveyor, then drive back to the box wall. This whole process can add an extra 24-30 seconds per dropped case. Box wall avalanches can further complicate and slow down the pick process.

In this example, each 53' trailer has 39 walls of boxes, and we assume that 1 box is dropped every other box wall, on average. That adds only a couple of minutes to a manual or conveyor unload but adds 8-minutes per trailer to a robotic unload.

Additionally, robots may find themselves in a situation that their hardware or software cannot overcome, requiring manual intervention by an associate. It is estimated that this occurs less than 0.5% of the time, but these disruptions require a human to be notified, intervene with the unload process, and get the robot back on task.

In the trailer example with our 1,365 packages, assuming a generous 0.25 percent intervention rate, that is at least 3 instances per trailer. Assuming it takes the technician a total of 3-minutes, on average, to get to the trailer, reset the robot, and get it back on task, that adds another 9-minutes to our trailer unload time.

As box count per trailer increases, the time spent on these issues will grow proportionally.



1,365
packages

.25%
intervention rate

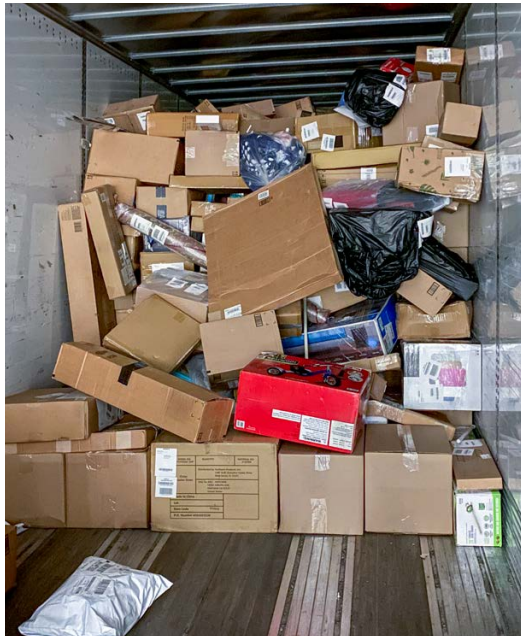
3
instances

3
minute reset

9
added minutes

CHALLENGE 2: INFLEXIBILITY

Trailers with neatly stacked, similarly sized boxes are great for robots...
But unstructured loads remain difficult



Robots are good at doing the same things repeatedly – picking items from known locations, with little variation, and repeating the process over and over again.

Floor loaded containers (FLC's), also called “loose loaded” or “fluid loaded” containers, do not offer much predictability; this is particularly true in retail cross docks, sort or distribution centers. Floor loading is selected for two primary reasons: this method lets you get packages tight to maximize container utilization and minimize shipping costs per piece. You can also avoid having to use chemically treated pallets.

Per ISPM 15 (the International Standards for Phytosanitary Measures No. 15), you must treat wood materials used for shipping in international trade.

This prevents the spread of harmful organisms (i.e. pests and diseases) lingering in the wood.

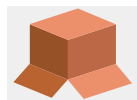
Most FLC's have varying package weights and sizes, as the shipper fills every nook and cranny. These variations can add complexity to the robot pick process and depending on the level of variation, could increase the human intervention rate per container.

It is also common for FLC's to have boxes that are jammed together along the width or height of the container, making the packages stick together and hard to remove. This can be caused by operators wedging product into the container or from humidity changes causing boxes to swell.

CHALLENGE 2: INFLEXIBILITY

Variation of Packaging

Most automation systems use robots with flexible vacuum technology as its **end of arm tooling (EOAT)**. And most of the time these robots lift cardboard boxes. Cardboard is an inexpensive, durable material, but it has many shortcomings, making it difficult to reliably handle boxes with vacuum EOAT.



Poorly glued/taped
Contents fall out the bottom of the package during lifting



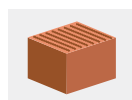
Depressed height
Wrong pick-up coordinates



Poor stiffness
Wrong placement coordinates



Damp/wet cardboard
Boxes tear open during lifting



Porous cardboard
Insufficient vacuum for lifting



Lashing straps
Cause leakage with suction cups



Display boxes
Vacuum pulls off the perforated lid

Weight of Packages

We've all seen poorly packaged boxes. Whether they used cardboard that was too thin, or they were rationing tape, the item feels like it could fall right out the bottom of the case. Picking the package from the top or side with a vacuum gripper, and inadequately supporting the bottom of the case, could cause a heavy package to burst open. Best case: your team will have downtime cleaning up the mess. Worst case: your box falls right onto the robot or conveyor with a high impact force, hurting someone, or damaging the contents and your equipment.

Most commercially available robots can pick up 20-30kg (44-66lbs). While this addresses many packages, this limits its usability by many companies. In trailers with mixed loads and high variation, an overweight package could be dropped or require manual intervention, posing an ergonomic risk for workers and lowering the robot's productivity.

CHALLENGE 2: INFLEXIBILITY



Mixed and Obscure Loads

In loads with a mix of pallets and floor loaded boxes, robots are impractical because of the associated set up and positioning time. Since forklifts will mainly handle pallets, a time-consuming back and forth is created between the forklift operator and the robot. You will waste more time than you save. The reality is that most associates would rather get in the trailer and unload it themselves than deal with the constant setup and tear-down required for a mixed load.

Porous or non-uniform items like tires, bags, rugs, or totes are challenging for a robot to pick without specialized EOAT. These loads must be unloaded by associates or an ergonomic conveyor. Robots are best for cases or boxes with limited variation in size or material, with robust packaging that contain robust contents.



Tires



Rugs



Bags



Totes

CHALLENGE 3: PRICE TAG & ROI

Robots provide great long-term return on investment, but require significant upfront capital for your initial investment

Using a manual unload process as the baseline, we can see that both robotic pick and place and portable ergonomic conveyor systems offer substantial cost reductions per unload operation. Using the same *actual unload time per trailer* figures from page 2, we see the savings stack up as we race each unload method against one another to unload ten trailers.

Using robots can allow your team to spread out and steadily cover more containers or other warehouse tasks. When you are in peak season or have limited dock space, unloading containers as fast as possible is critical for eliminating storage, demurrage, waiting and/or drop charges.

Four associates, with a portable ergonomic conveyor, can unload two containers faster than four employees helping two robots unload two separate dock doors.

Unload Method	Associate Team A	Associate Team B	Robot A	Robot B	Ergonomic Conveyor
Trailers to Unload	5	5	5	5	10
Associates Per Dock Door	3	3	2	2	4
Unload Time Per Trailer (Hours)	3 hr. 3 min	3 hr. 3 min	2 hr. 37 min	2 hr. 37 min	1 hr. 7 min
Trailer Unload Time Per Team (Hours)	+ 15 hr. 15 min	+ 15 hr. 15 min	+ 13 hr. 5 min	+ 13 hr. 5 min	+ 11 hr. 10 min
# of Associates	X3	X3	X2	X2	X 4
Total Unload Time (Hours)	45 hr. 45 min	45 hr. 45 min	26 hr. 10 min	26 hr. 10 min	44 hr. 40 min
Total Man Hours	= 91 hrs. 15 min		= 52 hrs. 20 min		= 44 hr. 40 min
Burdened Labor Rate	\$20		\$20		\$20
Total Cost to Unload 10 Trailers	\$1,825		\$1,047		\$893

CHALLENGE 3: PRICE TAG & ROI

Payback and Return on Investment

Portable ergonomic conveyor systems are typically only 25 to 50 percent the cost of most robotic unloaders, achieving your payback within 9-18 months after your purchase date.

Early adopters of robotic unloaders, running 2 robots each at 2 shifts per day, may achieve a 2-year payback period. With robots, your long-term return on investment will be substantial if you can entirely eliminate warehouse labor, but the investment to get there is substantial.

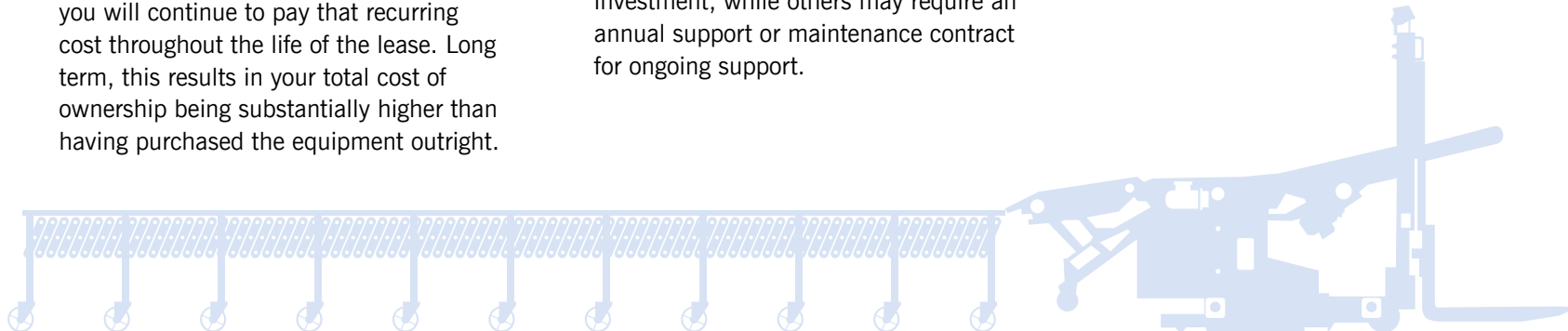
Many suppliers are offering equipment on lease or via a **RaaS (Robots as a Service) model**, which are great options to add capacity during busy season, or test equipment before purchase. However, you will continue to pay that recurring cost throughout the life of the lease. Long term, this results in your total cost of ownership being substantially higher than having purchased the equipment outright.

Overlooked Costs

Any powered system will require an electrical drop and likely some sort of on-site installation. These are costs that may be overlooked, so be sure to ask your robot or conveyor supplier to provide an overview of typical install expenses.

A benefit of automation is the ability to deploy firmware and software updates to systems that are already in the field. But this can also bring some “hidden costs”. These updates could improve the robot’s speed, safety, pick accuracy, or add new capabilities beyond simple unload operations. Some automation providers are committed to deploying these updates for free, as part of your investment, while others may require an annual support or maintenance contract for ongoing support.

With a steady and routine flow of predictable packages, a robot can be a great initial step into warehouse automation. Full downstream automation requires that your entire SLAM (scan, label, apply, manifest) system is fully automated as well, dramatically increasing your investment required, which is prohibitively cost-expensive for even the largest warehouses to tackle all at once.



CHALLENGE 4: MORE SAFETY = MORE SPACE

When warehouse floor space is at a premium, portability and flexibility is key



Even the best forklift drivers can struggle to safely navigate overcrowded or old warehouses, whose architects could have never imagined the space requirements for modern warehouse technology nor the modern package volumes of E-commerce.

Ergonomic mobile conveyors can be driven from trailer to trailer, in just a matter of minutes.

In many warehouses, floor space is at an absolute premium. Several robotic offerings are on mobile carts, while others are immobile and permanently mounted to the concrete floor of the warehouse. With the addition of physical safety equipment, this takes up even more space.

CHALLENGE 4: MORE SAFETY = MORE SPACE

Safety

Safety sensors must be incorporated into the robots to keep associates safe when they work around these systems.

There are generally three approaches:

1

Physical Guarding or Fencing

Physical guarding or fencing is required when deploying traditional industrial robots. Until cobots were introduced, robots did not include built in sensors or software to automatically stop operation if a collision was detected, posing a serious risk of injury, or even death. Physical guarding or fencing are affordable, low maintenance methods to improve safety, but take up considerable space. They must be large enough to not inhibit any motion of the robot, typically up to the robot's maximum reach, with its largest payload in hand, in every direction it travels.

2

Safety Sensors and Light Curtains

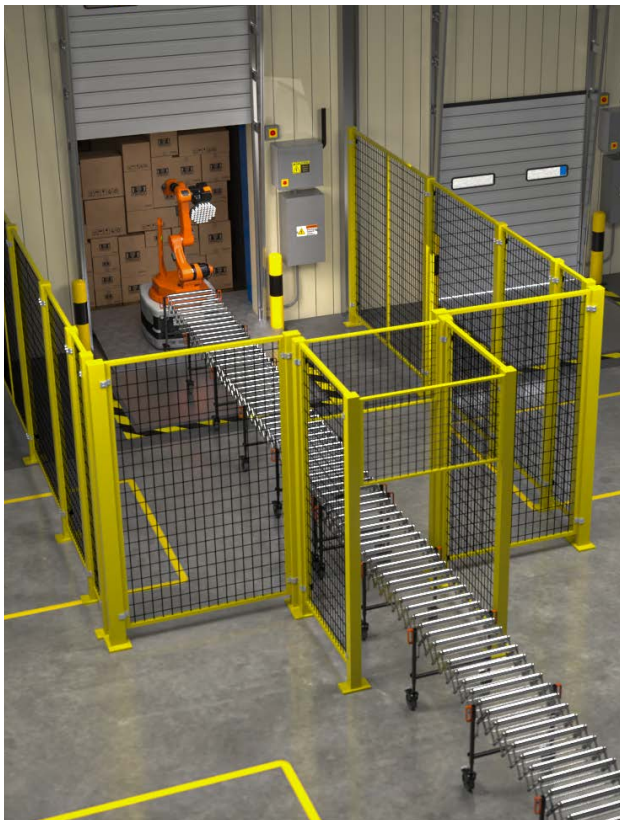
Safety sensors and light curtains can reduce the space requirements of a robot but tend to complicate the integration process and ongoing maintenance, while also carrying a higher price tag. Proximity sensors or light curtains can allow for multiple zones of safety, with the first zone reducing the speed of the robot to a safer level, and the next zone triggering an emergency stop (E-stop). If you do not clean them daily, this can lead to needless downtime as you overcome unnecessary E-stops.

3

Collaborative Robots

Collaborative robots (also called “cobots”) have built in safety sensors to detect collisions and advanced software capabilities to let the robot maintain productivity without compromising a worker's safety. Cobots can eliminate large and expensive safety systems that are traditionally needed when deploying a robot. A safety assessment must always be performed before deploying a cobot, if you wish to use it without any additional safety guarding or external sensors. For example, if the robot is picking up sharp metal parts, which pose a safety risk to workers, guarding will be needed to prevent injuries.

CHALLENGE 4: MORE SAFETY = MORE SPACE



Portability

With permanently mounted robots or conveyors, your ability to turn a dock door is at the mercy of how fast it unloads a container and how fast you dock the next truck. Docking the next trailer at another door will render the robot useless while you wait. And if you do not have a truck on site to move the next trailer, you cannot use the robot at all.

Extensive safety guarding may be required for robotic unloaders. In some cases, it is impossible for forklifts to pick up pallets in mixed-load trailers alongside a robot because hard fencing or guarding would block the forklift's path.

Additionally, to move a mobile robot to a new dock door, you must move the fencing or guarding, reinitialize your safety sensors, and/or must invest in additional guarding to make the transition faster between dock doors.

Ergonomic mobile conveyors can be driven from trailer to trailer, in just a matter of minutes, or moved out of the way if a forklift or pallet jack needs to take the lead on a pallet within a mixed load, without posing a safety risk or requiring a shutdown. This portability gives warehouse managers the flexibility needed to adapt to the constant stream of trailers coming in and out of the warehouse each day.

CHALLENGE 5: UPSKILLED WORKFORCE, TRAINING AND MAINTENANCE

Robots do the job of lower paid workers, by replacing them with expensive engineers and technicians.



Upskill Your Workforce

As more automation is deployed into warehouses, the opportunity for warehouses to offer career and professional growth is immense. Associates can add more value in the warehouse and keep automated systems humming, while benefiting from higher wages and increased job satisfaction.

Warehouse management will need to plan for these long-term expenses as they support higher salaries and investments in training. Even if you use a robot to eliminate five \$40,000 salaries, you may need to hire a robotics engineer at a \$100,000 salary, or more, cutting your ROI in half.

Most robotic systems can be learned within just a couple of days. Trainer certifications can take 1-week, or more, with service and preventative maintenance training taking longer.

CHALLENGE 5: UPSKILLED WORKFORCE, TRAINING AND MAINTENANCE



Preventative Maintenance

There are no magic machines that require zero preventative maintenance (PM). Just like putting oil in your car, conveyors and robots require routine, scheduled PM's to operate effectively and last in your operation.

Portable ergonomic conveyors require maintenance at about every 500 hours of use. This will typically range from basic cleaning to tightening conveyor belts. After prolonged usage, you may need to flush hydraulic fluids and complete other routine preventative maintenance.

Robotic unload systems range in complexity and design, so if you are considering automation, ask about the recommended PM schedule, maintenance services, along with typical costs and downtime involved.



To learn more about
Portable Ergonomic Conveyor Solutions visit:

gorbel.com/warehouse-solutions

To learn more through video visit:

youtube.com/@destuff-it



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