

WHITE PAPER

Automating box handling in retail logistics



BostonDynamics



Boston Dynamics' Stretch[®] robot unloads shipping containers with intelligence and speed, increasing throughput and improving employee safety.

Today's retail consumers have high expectations—endless selection, same day delivery, free shipping, and hassle-free returns. Although e-commerce only represents a fraction of total retail sales in the United States, major retailers are retooling their in-house operations for a future in which online sales will continue to increase—and robotics systems are poised to play a vital role.



In 2023, online channels accounted for 15.4 percent of retail sales in the United States—a 5.5 percent increase from 2022.¹ This represented \$1 trillion out of a total of \$6.5 trillion in overall retail sales.² According to Forrester, overall US retail sales should total \$6 trillion by 2029, with online sales comprising 30 percent, or \$1.8 trillion.³

Rather than solely supply goods to brick and mortar stores, retailers must now provide “omni-channel” fulfillment that includes a mixture of direct-to-consumer (DTC) shipments and online purchases delivered to stores for pickup. In fact, some experts predict retail stores are destined to become essentially showrooms and pickup points for sales made online.⁴

One leading retailer embracing an omni-channel approach could operate more than 200 distribution centers in the United States. Each center might include over 1 million square feet of space and employ more than 600 personnel responsible for unloading and shipping over 200 trailers a day to support up to 100 stores within a 150 mile radius.⁵ The close proximity of stores to customers would enable faster delivery times.

For e-commerce networks in the United States, dedicated e-fulfillment centers can average about 855,000 square feet. These centers are often strategically located near major highways and population centers to optimize accessibility and speed up delivery, in many cases placing a substantial portion of the U.S. population within a one-hour drive of a distribution site.⁶

¹ Coppola, D. (2024, February 28). E-commerce share of total retail sales in the U.S. 2000-2023. Statista. Retrieved from <https://www.statista.com/statistics/185351/share-of-e-commerce-in-total-value-of-us-retail-wholesale-trade-sales/>

² <https://www.statista.com/statistics/272391/us-retail-e-commerce-sales-forecast/>

³ Forrester. (2023). US online retail forecast, 2024 to 2029. <https://www.forrester.com/report/us-online-retail-forecast-2024-to-2029/RES181385>

⁴ Rodrigue, J.-P. (2020). The distribution network of Amazon and the footprint of freight digitalization. *Journal of Transport Geography*, 88, 102825.

⁵ Walmart. (n.d.). About Walmart from <https://corporate.walmart.com/about>

⁶ Rodrigue, J.-P. (2020).

3PLs and retailers embrace digital transformation

Third-party logistics providers (3PLs) that move retail goods have likewise seen the economic benefit. DHL has approximately 400,000 employees in more than 220 countries and territories worldwide. Over the past three years DHL Group has invested over €1 billion in automation in its contract logistics division alone. Across its global network, the Group now uses more than 7,500 robots, over 200,000 smart handheld devices, and close to 800,000 IoT sensors to optimize operations, enhance working conditions for employees, and deliver measurable value for customers. Today, more than 90% of DHL warehouses worldwide are equipped with at least one automation or digitalization solution.⁷

The rise of automated systems

In response to this new logistics landscape, retailers have invested in elaborate automated storage and retrieval systems (ASRS). These include computer-controlled equipment that automatically place and retrieve items from storage areas with minimal human intervention. Systems can include cranes, carousels, and autonomous robots that shuttle goods, sort packages, place items into bins, and stack packages on pallets. The systems are very large, essentially the size of a building, and can cost tens of millions to build.



⁷ High, M. (2025, May 15). DHL to deploy 1,000 Boston Dynamics robots in warehouses. Supply Chain Digital Magazine. <https://supplychaindigital.com/news/dhl-deploy-1-000-boston-dynamics-robots-warehouses>

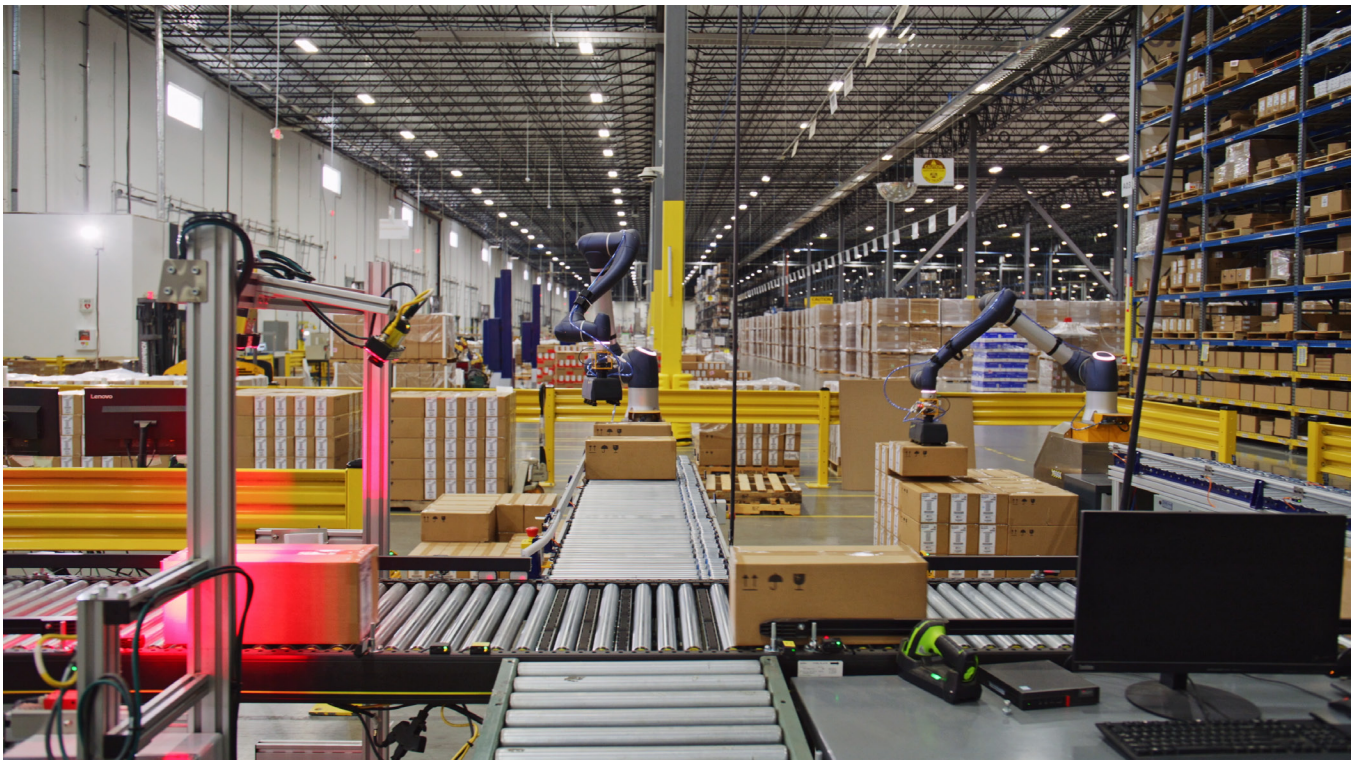
Can a robot unload boxes?

Of the various roles that robots play inside the warehouse, unloading loose boxes from trailers was once considered a “holy grail” application because it perplexed robotics engineers for years.⁸ What may seem like a straightforward task is actually quite complex. Not only must a robot securely grip boxes of different shapes and sizes, it must also be able to “think on its feet” when determining the best strategy for tackling the unloading of each wall of boxes in a trailer.

Palletized or floor-loaded

Trailers generally arrive with cases either placed on pallets or stacked loose, floor to ceiling. Pallets are favorable for heavier goods or when items need to be kept stable and organized. They can be removed from the trailer using a pallet jack or forklift. The trade-off is that pallets take up valuable space inside the trailer, reducing the amount of cases that can be packed inside.

On the other hand, floor-loaded trailers are common for lightweight goods or when maximizing space is the priority, as in the case of overseas shipping containers. The downside is that someone—or something—has to unload each box one at a time, which is dull and labor-intensive work. After years of research and development, Boston Dynamics' Stretch robot has emerged as the industry leader for box handling robots.



¹⁰ Oitzman, M. (2022, October 27). Fox Robotics closes \$20M funding round. The Robot Report. <https://www.therobotreport.com/fox-robotics-closes-20m-funding-round>

How Stretch works

Available commercially since 2022, Stretch is an autonomous robot that unloads floor-loaded trailers and shipping containers. Unlike humanoid robots with legs or hands, Stretch resembles a more traditional industrial robot, albeit one that is mobile, battery-operated, and requires no tethers or air lines for operation.

Stretch has a square base with a footprint the size of a standard pallet. Omni-directional wheels enable the robot to move in any direction, and to travel on ramps. The centerpiece of Stretch is an articulating arm. The arm has seven degrees of freedom and can rotate 180 degrees on a turntable. At the end of the arm is a gripper with an array of suction cups connected to a powerful vacuum system.

Stretch can lift cardboard cartons of various sizes weighing up to 50 pounds, or 23 kilograms, with a wide range of freight, from shoes to microwave ovens. Each cup can activate suction independently, directing suction only where needed—and turning off suction where it's not, as in boxes with openings at the top—to create the best seal possible.





Mobile and intelligent

When it starts to unload a trailer, Stretch will grip a case from the top, front, or side. The arm and turntable will then rotate 180 degrees so Stretch can place the case on a conveyor belt, either a telescopic or flexible accordion-type conveyor. Meanwhile, Stretch is already using its 360-degree vision to select the next series of cases in the trailer before the arm and turntable spin back around.

Stretch uses machine learning to make decisions as it evaluates the best plan for picking and placing. The robot's vision system integrates cameras, sensors, and lidar to create a three-dimensional scan of the trailer, boxes, and general surroundings. As it works, Stretch takes photos using onboard lighting to determine which cases it will pick next. Stretch also uses photos to confirm cases are moving along on the conveyor, and that none have gotten stuck.



Stretch can also locate and recover cases that have fallen to the floor. If a box shifts and falls during the unloading process, Stretch detects the box on the ground with its lidars, retrieves it, and places it on the conveyor before resuming unloading.



Gentle giant

Stretch is a gentle giant when it comes to handling packages. Because of its advanced vision system and strong vacuum gripper, Stretch can even handle crushed or deformed cases. The robot takes into account many variables in general, just as a human would. And, like a human, the robot adjusts how it lifts cases based on their weight. A heavier package may prompt Stretch to pick from the side to ensure it has a strong grasp on the box for transfer to the conveyor. Stretch works from top to bottom. It might take a few cases from the left first to open up more room so it's easier to remove the cartons from the right as it's turning around and placing the boxes on the conveyor.

Stretch will even adjust its pace as needed. Because the robot “sees” the environment around it, when the robot is near walls and obstacles it will plan different paths to pick and place boxes.



Multipick capabilities

Stretch is capable of grasping and placing two or more cases on the conveyor at once as long as their combined surface areas aren't larger than the gripper itself. For example, Stretch can grip two large 16-pound boxes simultaneously, something a manual unloader would likely not attempt. This multipick feature enables Stretch to dramatically improve throughput. Stretch can unload up to 800 boxes an hour.



Label orientation

For warehouses with an ASRS that scans box labels as they enter the building, using the Label Sense feature may be ideal: Stretch will place cases on the conveyor with the labels facing the same direction each time. Warehouse cameras will scan the barcode on each label to enter a given case into the system. The barcode tells the ASRS where the case needs to go inside the warehouse. The entire inbound process can be automated.



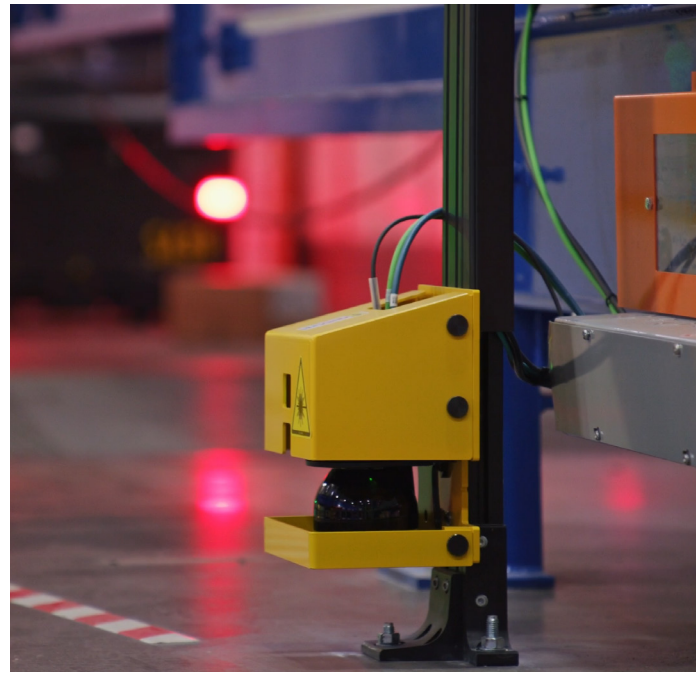
For example, operators might program Stretch to place cases so that labels appear in the upper left hand corner when they pass in front of the scanner. The gripper can rotate to position the case in the correct configuration. In situations where a mixture of labeling styles makes it impossible for Stretch to place cases in the correct way each time, users can program Stretch with a secondary preference. Because Stretch can place cases with such accuracy, retailers don't have to invest in additional expensive camera systems designed to capture multiple sides of a case.

Safety all around

To ensure the safety of employees working in the area, the Stretch solution includes lidar on the telescopic conveyor to create a virtual fence. As a result, physical safety barriers aren't required. Lines on the floor denote the safety perimeter. If a person crosses that line while Stretch is in operation, the robot ceases working in an instant to avoid potential injuries.

Deployment and ease of use

Designed for minimal disruption during installation, Stretch can be ready for operation in less than a week. The robot's battery system allows it to operate for more than one shift, with the option of shore power connections for extended runtimes.

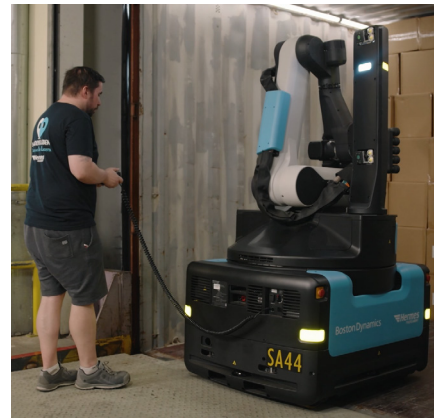


Stretch's setup is user-friendly and employees learn to operate the robot quickly under the training of Boston Dynamics instructors. Employees are often able to run Stretch within an hour of training, and receive full certification to train others in only two days. Operators drive Stretch into position using a handheld, wired pendant similar in size to what a person might use to control a drone or remote-controlled car. Once Stretch is in position, operators switch over to a touch-screen console that displays a step-by-step wizard for starting the robot. The steps include a checklist for preparing the trailer, pairing the robot to the workcell, and tapping a play button to set Stretch in motion. The user interface of the console uses images and clear calls to action, eliminating any guesswork, which is especially helpful as Stretch deploys into geographies where English is not the first language. The pendant displays instructions in seven languages.

The on-site Boston Dynamics certification program ensures that designated employees understand how to operate Stretch on their own. The newly certified employees are able to train their peers, so even in case of staff turnover, a site can still have trained Stretch operators on staff. In fact, a single operator can control and monitor multiple Stretch units if necessary. Stretch requires minimal supervision. Operators can monitor Stretch as it works, or are free to attend to other tasks and come back to the robot later.

Benefits of using Stretch in retail logistics

Stretch addresses one of the toughest, most tedious logistics tasks in retail: automating the job of unloading trailers and containers. For retail companies, increased efficiency in this task means faster product flow from inbound to storage or picking stations, supporting the rapid fulfillment demands of retail. Stretch also produces detailed data about its operations, allowing operators to view its progress into containers and the speed at which the robot is currently working. This allows teams to time when to call in the next truck for Stretch to unload, and to better match shipping forecasts with Stretch's capabilities.



For companies handling large volumes, this translates to quicker order fulfillment and faster transit from trailers to storage. Stretch made an immediate impact at companies such as DHL Supply Chain, Gap Inc., Arvato, and the Otto Group. In fact, DHL was the first company to commercially deploy Stretch in early 2023.⁹ As part of a strategic collaboration, the company had earlier piloted Stretch at multiple sites, allowing Boston Dynamics to conduct detailed analyses as DHL provided feedback on the robot working in real-world conditions.¹⁰ DHL has gone on to deploy Stretch at sites across the United States moving product for Carhartt and other retailers, as well as sites in Germany and the United Kingdom.

By keeping the flow of goods steady, Stretch can help warehouses avoid bottlenecks across other stages such as sorting, picking, and packing. This capacity for continuous, high-speed unloading is especially beneficial during seasonal peaks, when retailers are under intense pressure to meet demand.

Enhancing workplace safety and reducing injuries

Working in the transportation and warehousing industry can be strenuous. In 2023, the sector reported over 255,000 cases of nonfatal work injuries, the fourth largest amount behind health care, retail trade, and manufacturing.¹¹ Manual unloading of heavy boxes poses significant physical strain. Stretch eliminates much of this risk. The robot allows workers to avoid repetitive lifting and lowering and focus on more strategic, value-added tasks. This shift can lead to a safer workplace overall and reduce the costs associated with medical care and workers spending days away from work. Stretch's ability to reduce the risk associated with manual trailer unloading aligns with retailers' broader goals to improve employee safety and lower operational costs.

⁹ "DHL Supply Chain Achieves First Commercial Deployment of Boston Dynamics' Stretch™ Robot." DC Velocity, January 31, 2023. <https://www.dcvelocity.com/articles/56491-dhl-supply-chain-achieves-first-commercial-deployment-of-boston-dynamics-stretch-robot>

¹⁰ All Innovation. No Boundaries. (n.d.). Behind the scenes of the strategic collaboration between Boston Dynamics and DHL Supply Chain. DHL Supply Chain. <https://dhlinsights.dhlsupplychain.dhl.com/all-innovation-no-boundaries>

¹¹ U.S. Bureau of Labor Statistics. (n.d.). Number and rate of nonfatal work injuries by industry. U.S. Department of Labor. <https://www.bls.gov/charts/injuries-and-illnesses/number-and-rate-of-nonfatal-work-injuries-by-industry.htm>



Scalability and quick deployment

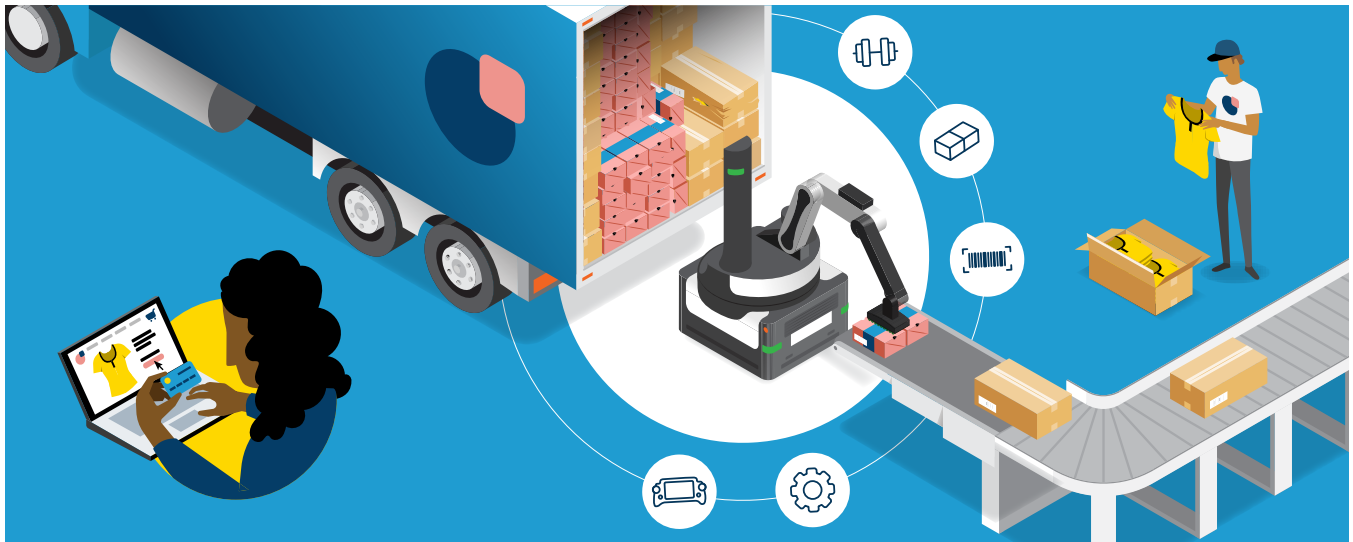
Stretch's compact design and straightforward setup make it a scalable option for retailers with multiple distribution centers. With its small footprint, mobile base, and advanced vision system, Stretch can navigate tight spaces and adjust to ever-varying configurations of stacked boxes in trailers. Installation is brief and in just days Stretch can be moving boxes on site. Its general adaptability has shown to be a strong selling point for retailers who deal with varied packaging and need a solution that can handle different kinds of inventory.

Integration with warehouse systems

Boston Dynamics has plans to integrate Stretch with broader warehouse management systems (WMS) and fleet management software. This future capability will allow Stretch to collaborate with other robotic systems—such as autonomous mobile robots (AMRs) or automated sorting systems—enabling more coordinated logistics within warehouses.

As Stretch's capabilities expand, it could take on additional tasks such as palletizing and order building, further streamlining operations and increasing ROI for companies that invest in a versatile automation infrastructure.

In summary, Boston Dynamics' Stretch robot is well-positioned to address key pain points in retail logistics by increasing throughput, enhancing safety, offering quick scalability, and adapting to diverse inventory needs. This makes it an essential investment for retailers aiming to optimize logistics efficiency and reduce reliance on manual labor in physically demanding tasks.



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