

Simple, Sophisticated Long-travel Automation

Cartesian robots with the right design upgrades can take over manual transfer operations with ease



Manufacturing and packaging operations that still depend on manual material or parts handling operations can reap immediate benefits from a type of automation based on long-travel Cartesian robots with custom end-of-arm tooling (EOAT) and advanced sensing capabilities. These robots can support a variety of machines — performing otherwise manual tasks such as machine tending or transferring in-process parts — making long-travel Cartesian transfer robots a major upgrade to processes and operations.

These Cartesian robots, which are built around two or more coordinated linear positioning stages, may not be the first thing that comes to mind if you are new to automation. Instead, there's a natural tendency to equate robots with the 6-axis, articulated-arm models that you increasingly see on factory floors. Even experienced automation engineers may give Cartesian robots short shrift, focusing their attention on the 6-axis models.

Yet in applications requiring the robot to tend multiple machines, reach long lengths or perform simple, repetitive operations, ignoring the benefits of a long-travel Cartesian system can be a costly mistake.

The Six-axis Problem

Articulated arm robots have carved out a prominent spot in many automated manufacturing and packaging facilities — and for good reason. This style of robot, when properly sized, can handle large payloads with ease. They also have the flexibility to perform many different types of automated tasks through programming and end-of-arm tooling changes. For the right job, we're big fans of articulated arm robots, and we have a long history building custom robot arms for electronics assembly and medical applications.

But the advantages of 6-axis robots come at a price. Not only are these advanced robots expensive, they have a potentially high “robot density” in the sense that you'll likely need a unit for every one or two packaging machines. And while there are cases where a larger, expensive 6-axis robot has the reach to serve more than a couple of machines, these arrangements may require you to position your machines around a very large robot.

Articulated arm robots also have high secondary costs in the form of the safety guarding and floor space requirements as well as the expense of the skilled employees capable of programming and maintaining these robots.



The Case for Long-travel Cartesian

For many use-cases, Cartesian robots have the edge over 6-axis models. One reason relates to the robot density. A single long-travel Cartesian transfer robot can tend multiple machines without any need to rearrange machines around the robot.

By installing the transfer robots above the machines they tend, you also won't incur a floor space penalty. Safety guarding requirements are minimal too, at least compared to 6-axis models, since an overhead installation naturally separates robots and workers. Finally, Cartesian robots have lower-cost maintenance and programming requirements.

To reap these benefits, you'll need the right type of robot for the job, and not all Cartesian robot systems are created equal. In fact, if you look up Cartesian robots online, you'll find many smaller systems optimized for pick-and-place operations on production machinery or assembly operations. These are very different robots than the transfer robots useful in larger operations, which need to meet some more challenging technical requirements, including:

- **Long travel length.** For one robot to tend multiple packaging machines, you'll likely need the robot's longest travel axis to reach distances of 50 feet or even more. Many of the linear stages used in off-the-shelf Cartesian robots simply cannot reach those lengths.

CARTESIAN DE-PALLETIZING SYSTEM



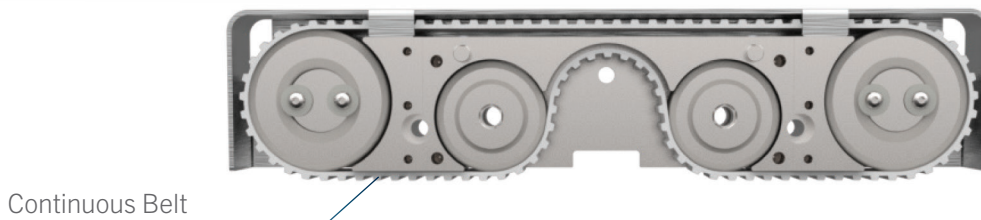
This de-palletizing robot is another good application for the Cartesian approach. It takes up less space than an equivalent 6-axis robot and allows selective manual operations if needed. This system also features laser sensors and custom EOAT that allow the robot to individually remove boxes from the pallet — even if the size and orientation of the boxes vary unpredictably.

- **Independently controlled carriages.** Long transfer robots become even more effective if multiple carriages can travel along the main axis, each performing a task independently. This ability is a huge force multiplier for Cartesian robots, allowing one unit to do the work of many.
- **Custom end-of-arm tooling.** While some packaging automation tasks may be able to use off-the-shelf EOAT, such as vacuum or finger grippers, we've found that purpose-built tooling has allowed us to handle goods more effectively, which in turn makes it possible to simplify the material handling systems that work in conjunction with the robot.
- **Simplified control architecture.** An emerging strategy for controlling Cartesian robots involves the use of motors with integrated servo drives rather than more traditional control architectures that rely on separate motors, drives and controllers — all housed within an expensive cabinet. For some robots, which may have complex motion needs, the traditional approach can be a valid approach. In most cases, though, integrated servo motors can more than handle the point-to-point motion control requirements of Cartesian systems. When you can use them, integrated servo motors can help maximize the cost advantage of a Cartesian automation system.
- **Selective Use.** Because Cartesian robots can be mounted above or behind the machines they tend, they also allow users to run the machines manually when needed — for example, for a short run of a special size. This selective use is difficult with floor 6-axis robots, which can block access to the packaging machine.

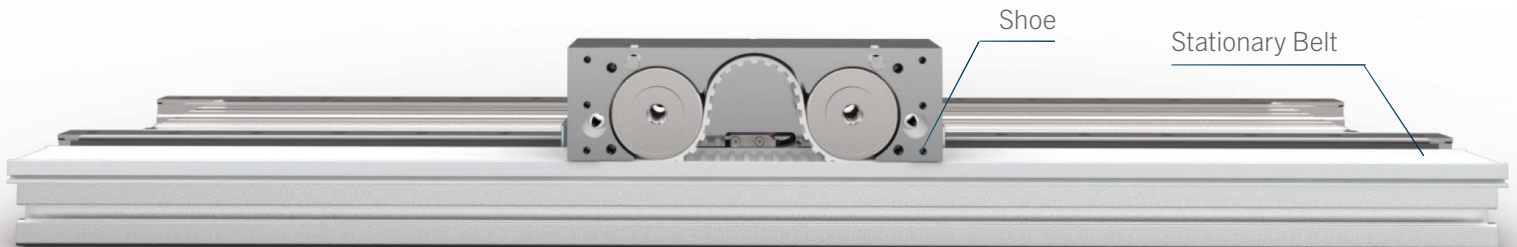
SERVOBELT LINEAR CARRIAGE STYLES

Offering speeds up to 4 m/s, ServoBelt™ Linear has two carriage styles, both capable of long travel distances—in excess of 50 feet is common. The Standard carriage is more compact and uses our dual-belt drive technology. This carriage style is suitable for most applications. The LoopTrack carriage is a design in which the upper drive belt loops continuously within the carriage itself. It prevents the possibility of belt sag in inverted or cantilevered applications and allows multiple independent carriages to operate on the same axis.

LoopTrack

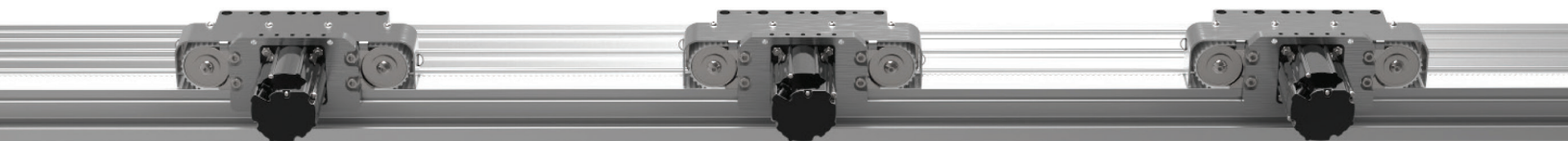


Standard



Multiple Carriage LoopTrack

ServoBelt LoopTrack supports multiple, independently moving carriages.



SOLVING THE LONG-TRAVEL CHALLENGE

A key enabling feature of long-travel robot transfer systems is the use of a moving motor as opposed to conventional recirculating belt systems. Engineers frequently choose belt-driven, stationary-motor designs in order to keep the moving payload light, but when Cartesian robot lengths reach four meters, the belt's weight typically exceeds that of the moving motor.

Long belts also introduce other difficulties in long-travel Cartesian robots. Maintaining driveline stiffness is another issue that impacts performance. Not only is it a challenge to maintain the tension in the driveline, belt tension is asymmetrical and varies throughout operation. This makes accurate, precise positioning with long recirculating belts overwhelmingly difficult — often not worth the high cost and effort.

Moving-motor linear stages keep belt lengths short, tight and are housed within the carriage to precise encoder readings. This accuracy is maintained regardless of the length of the Cartesian transfer system. Whether it is four meters or forty meters, these long-travel systems essentially have no limit to their effective lengths.



Successful Application Highlight

Long-travel Cartesian robot transfer units are employable in a variety of packaging industries as they are ideal for feeding, cartoning and tray forming machinery or separating nested cardboard containers for use on conveyor lines. Long-travel Cartesian robots can also handle palletizing and de-palletizing operations.

Produce packaging is a prime target for long-travel Cartesian robots. We recently delivered a set of long-travel transfer robots that showcase all of these technical features. Built for an agricultural packaging company in California's Central Valley, the robots integrate seamlessly with the company's existing IPAK tray formers. Each robot tends up to four machines at a time, filling them with stacked sheets of corrugated cardboard.

Installed above the machines, these 3-axis gantry robots are based on our ServoBelt™ Heavy linear motion stages. This stage design offers limitless travel lengths, independent moving carriages and the ability to mount the stage in any orientation. In these robots, the longest axis runs over the bank of tray formers and has a travel length of more than 50 feet.

To deliver sheets of corrugated cardboard into the four tray-forming machines, a robot first picks a load of cardboard from a custom-built dock that holds pallets of corrugated sheets. It then delivers the load to each tray former. Thanks to ServoBelt's speed, which tops out at 4 meters/second, the robots can easily keep up with the four tray formers — even at the full output of 35 trays per minute.



The safety guarding, which is based on a simple arrangement of overhead sliding gates and sensors that lock out the robot from the machine below, cost just a fraction of what a floor-mounted 6-axis robot would require.

Also included in this system are all the controls and custom EOAT capable of working with stacks of corrugated sheets that vary unpredictably in height and weight. The tooling is capable of handling payloads up to 50 kg without complaint.

The same cannot be said for the operators that used to load the machines. Picking up loads of cardboard from pallets and leaning over to insert them in the forming machines was back-breaking work that led to complaints of injuries. Automating these tasks allowed workers to be reassigned to less physically demanding tasks.

This large transfer robot is just one example of what's possible with Cartesian robot systems in a packaging environment. We've also developed palletizing and de-palletizing systems based on a very similar Cartesian approach. What all these robots share is the idea that three linear motion stages—working together and with the right sensors, controls and end-of-arm tooling—can be the most effective, efficient way to get started with the automation of packaging operations. No 6-axis robot required.

→ [Learn more at bell-everman.com](https://www.bell-everman.com)

MULTI-AXIS SERVOBELT™ LINEAR

