

## Mobile-Robot-Enabled Smart Warehouses

Order fulfillment is a multibillion-dollar business. Existing solutions range from the highly automated—whose cost-effectiveness is inversely related to their flexibility—to people pushing carts around warehouses manually filling orders, which is very flexible but not very cost-effective. Kiva Systems uses a new approach to order fulfillment in which operators stand still while the products come to them. Pallets, cases, and orders are stored on inventory pods that are picked up and moved by hundreds of mobile robotic drive units. As a result, any product can go to any operator.



### Successful Installations Worldwide

Kiva Systems has deployed dozens of installations worldwide, including a 1,000-mobile robot system for a retail company in the United States. Customers include:

- Crate and Barrel
- Diapers.com
- Dillard's
- Gap
- Gilt Groupe
- Office Depot
- Saks Fifth Avenue
- Staples
- Timberland
- Toys "R" Us
- Von Maur
- Walgreens

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Founders Mick Mountz, Peter Wurman, and Raffaello D'Andrea received the 2008 IEEE/IFR Invention and Entrepreneurship Award in Robotics and Automation, whose aim is to foster innovation paired with entrepreneurial spirit, and to promote the best possible use of synergies between science and industry in the fields of robotics and automation.

Kiva Systems was purchased by Amazon.com in 2012 for \$775 million.

## System Description

Kiva uses hundreds of mobile robots and powerful control software to provide a complete fulfillment solution: storing, moving, and sorting inventory. Instead of being stored in static shelving, flow racks, or carousels, products are stored in inventory pods in the center of the warehouse while operators stand at inventory stations around the perimeter.

- When an order is received, robotic drive units retrieve the appropriate pods and bring them to the worker, who selects the correct items and places them in the carton. Completed orders are stored on separate pods, ready to lift up and move to the loading dock when the truck arrives.
- The Kiva drive units are differential-drive, two-wheeled robots with a patent-pending mechanism for lifting pods off the ground. This mechanism is essentially a large actuated screw—by rotating a drive unit underneath a pod and simultaneously counterrotating the screw, a pod may be lifted off the ground.
- A suite of sensors on the drive units and custom control software and algorithms allow the vehicles to safely navigate the warehouse. Coordination is aided by a hierarchical layer similar to that used in air traffic control systems.
- The drive units share information about their environment and use that knowledge to adapt. As a result, the performance of the vehicles, and hence the system, improves over time. In addition, adaptation and learning ensure that the system is robust to changes in the environment.

## Select Customer Quotes

“Our customers expect to get great value and service from Crate and Barrel, but they also care about our carbon footprint. This played a role in our selection of Kiva Systems,” said John Ling, vice president of supply chain management and logistics at Crate and Barrel. “Kiva’s mobile robotic approach is not only the most cost-effective way to automate pick, pack, and ship operations, but also the greenest. The robots themselves are energy efficient, plus the entire robot zone can be operated with almost no lighting.”

“Using a flexible, automated order fulfillment system helped our Pipelime operations scale to increased capacity over the critical holiday season,” said Chris Black, vice president of operations at Gap Inc. Direct. “The system freed up our employees’ time, allowing them to focus on processing a higher volume of customer orders faster and to ensure more accuracy. We’re looking forward to leveraging Kiva’s system when we expand our online business internationally.”

“We have been implementing warehousing technology for over twenty years, and Kiva has the only practical automated solution that supports the diversity of pick-pack-ship operations we run,” said Bruce Welty, founder and CEO of Quiet Logistics. “Kiva is the first automation approach we’d be willing to bet our business on. Kiva’s innovation immediately cuts hard costs, increases throughput, and improves service levels to give us and, more importantly, our customers a tremendous competitive advantage.”



For more information, visit [www.kivasystems.com](http://www.kivasystems.com).