

## 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 workers pushing carts around in warehouses and manually filling orders—which is very flexible but not very cost-effective. Kiva Systems uses a new approach to order fulfillment: 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 be moved to any operator.



### Successful Installations Worldwide

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

- Staples
- Walgreens
- Boston Scientific
- Zappos (acquired by Amazon in 2009)
- Crate & Barrel
- Saks Incorporated
- The Gap
- Quiet Logistics
- Diapers.com

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

Kiva Systems ranked number 6 (number 1 in logistics) in the Inc. 500 ranking of the fastest-growing private companies in the United States.

## 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 picks out the correct item and places it in the carton. Completed orders are stored on separate pods, ready to be picked up and moved 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 counter rotating the screw, a pod can 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 & 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 & 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 Piperlime 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."

"Other material handling approaches would have required us to integrate different technologies to handle units, cases and pallets, as well as a wide range of product sizes," said Ken Pucel, Executive Vice President, Operations, at Boston Scientific. "Kiva is able to provide us a proven solution with the flexibility and ease-of-use of a single technology for our needs."



For further information: [www.kivasystems.com](http://www.kivasystems.com)