

A network diagram with black nodes and lines, overlaid on a background of light blue nodes and lines. The diagram shows a series of interconnected nodes forming a path across the top half of the page.

WHITE PAPER

# Unlock New Dimensions of Value with Right-Sized Packaging, Sequencing and Orchestration

Accelerate financial, operational and environmental benefits

# Abstract

This white paper outlines the challenges of manual packaging with regard to eCommerce fulfillment and explains why automated packaging solutions will experience steady growth for the next five years. A business case for integrating right-sized packaging with automated storage and retrieval systems (ASRS) and goods-to-person (G2P) picking is presented. Strategies for utilizing sequencing and orchestration to realize new levels of value are shared along with two case studies. Finally, criteria for finding the right technology partner are provided.

# Contents

- 02 - Abstract
- 03 - Definitions of Key Terms
- 04 - Why Right-Sized Packaging is Gaining Momentum
- 05 - The Business Case for Integrating Automated Packaging
- 07 - Achieve New Levels of Value with Real-Time Sequencing and Micro Orchestration
- 09 - The Role of Team Alignment in Advancing Right-Sizing Strategies
- 12 - Criteria for Finding the Right Technology Partner

# Definitions of Key Terms

**AI** - artificial intelligence

**ASRS** - automated storage and retrieval system

**Box First** - an approach to right-sized packaging where a custom-sized box is created before items are picked

**Box Last** - an approach to right-sized packaging where a custom-sized box is created after items are picked

**Converged platform** - software platform that seamlessly integrates WMS, WES and WCS

**DIM** - dimensional weight, a calibration used to determine shipping costs

**GTP** - goods-to-person picking model

**KPIs** - key performance indicators

**Last-mile** - refers to the final step in a supply chain or service delivery

**Micro Orchestration** - the high-level coordination and dynamic management of the entire end-to-end warehouse workflow; orchestration coordinates all operations in real-time, optimizes resource allocation, prioritizes urgent orders and reroutes tasks based on current conditions

**RFID** - radio frequency identification

**Right-sized packaging** - an automation solution that replaces store-and-retrieve, pre-made box inventories by making it possible to create custom boxes on demand and then pack and ship goods directly from a packaging line.

**SaaS** - software-as-a-service

**Sequencing** - the order in which individual tasks within a process are performed

**Sustainable packaging** - an approach to packaging that focuses on minimizing environmental impact through its entire lifecycle by applying the principles of reduce, reuse and recycle and responsible material sourcing

**WMS** - warehouse management system, which manages all warehouse operations and connects with enterprise resource planning (ERP) business systems

**WES** - warehouse execution system, which orchestrates tasks for humans and machines in logistics operations

**WCS** - warehouse control system, which controls the automatic flow of goods in logistics operations

# Why Right-Sized Packaging is Gaining Momentum

Standardized packaging is frequently a bottleneck in operations. It's labor and space-intensive, prone to higher error rates and is increasingly more expensive. It's also difficult to scale and environmentally irresponsible. While all this is true, pre-made boxes still prevail in the majority of small, medium and large-sized warehouses.

In traditional, non-automated warehouses, standardized packaging systems typically offer a limited number of box sizes. Boxes are selected to fit the largest sized items. All too often, the result is oversized boxes and excessive void fill. Widely cited industry sources say the average amount of wasted space in eCommerce boxes is estimated to be between 40% and 60%. The bigger the box, the bigger its environmental impact. Oversized boxes take up more space on trucks, contribute to higher carbon emissions and add unnecessary waste to landfills.

Oversized boxes also have a big impact on shipping costs. Modern parcel pricing charges are usually based on actual weight and dimensional (DIM) or volumetric weight. When the amount of space a package occupies exceeds its actual weight, the shipping cost is based on DIM weight. As of 2025, major carriers round up each package dimension to the nearest whole inch before calculating the final DIM weight and determining the shipping charge. In essence, companies are paying to ship air and it's driving last-mile delivery costs considerably higher.

“ **Both FedEx and UPS have executed a mix of surcharges, rounding rule changes, DIM recalibrations and adjusted residential fees. The result of this strategic repricing of the parcel economy is double-digit year-over-year increases, even without new general weight increases.** ”

– TD Cowen and AMB Logistic

SupplyChain247 says, “Companies are turning to automated right-sizing solutions to cut waste, reduce costs and speed fulfillment while meeting Gen Z's demand for sustainable packaging.” Right-sized packaging is an automation solution that replaces the “store-and-retrieve” status quo by creating custom boxes on demand and then packing and shipping goods directly from a packaging line.

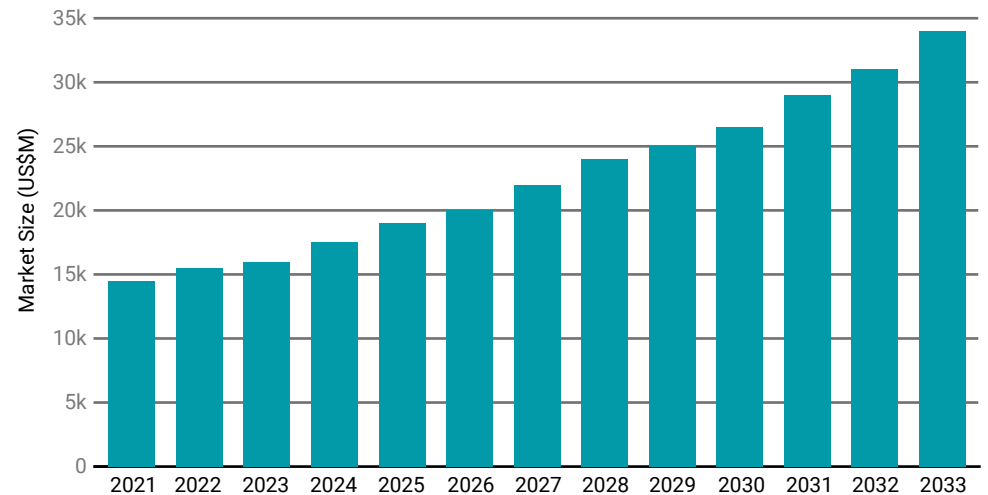


Figure 1. The U.S. packaging automation market is expected to grow at a compound annual growth rate (CAGR) of 7.6% from 2025 to 2033

We all need to work together to address the inefficient packaging methods created by eCommerce. In this paper, we will focus on how right-sized packaging, automated storage and retrieval systems (ASRS) and goods-to-person (G2P) picking can minimize the impact of eCommerce on people, profits and the planet.

# The Business Case for Integrating Automated Packaging

Pairing ASRS and GTP picking technologies with right-sized packaging is highly advantageous. ASRS and GTP transform how items are picked. Right-sizing transforms how items are packed. Integrating ASRS and GTP with automated packaging also transforms how businesses benefit, delivering three essential KPIs: Financial, Operational and Environmental.

## 1) Significant cost savings

Packaging specialist Packsize says, “By creating right-sized boxes in real time for each order’s specific dimensions, right-sized packaging delivers an average total savings of \$.70 per order.” These savings are based on:

- Reducing shipping costs because the box size is reduced by an average of 40% with right-sizing, which keeps DIM weight rates down
- Reducing and often eliminating the need for void fillers
- Reducing material waste by ensuring only the necessary amount of corrugated cardboard is used
- Reducing parcel shipping costs by up to 15%

*Integrating ASRS, GTP and right-sized packaging can reduce packaging labor by up to 90%. – Packsize*

In addition to these significant cost savings, right-sizing delivers predictable operating expenses, rapid return on investment (ROI) and a much better unboxing experience for consumers, which can help reduce customer churn.

## 2) Significant operational efficiency improvements

Automated packaging technology eliminates the need to pre-stock or pre-build boxes. Instead of having to allocate warehouse space to store boxes, packages are custom-made on demand. This enables more efficient use of space for packaging-related activities. Right-sizing also boosts throughput and eliminates repetitive tasks, which increases employee satisfaction. And because it improves accuracy, it lowers returns. Finally, right-sizing allows more packages to fit on delivery trucks and leads to fewer damages during transit because items fit snugly in right-sized packages.

### Right-Sizing Slashes Last-Mile Delivery Costs



There are two types of right-sizing workflows: box first and box last. Both streamline workflow, but each has advantages and challenges. In the **Box First Workflow**, the:

1. Order is received and dimensions are analyzed
2. Box is produced
3. Items are delivered to packing station
4. Operator picks items directly into the customized box
5. Box is sealed, labeled and shipped

This workflow not only results in a fit-to-size box, it minimizes handling, speeds packing and simplifies downstream consolidation. However, it requires accurate item data and is less flexible if substitutions or changes occur after the box is made.

In the **Box Last Workflow**, dimensions don't need to be secured ahead of time. The:

1. Order is received
2. Order is released
3. Items are consolidated
4. Dimensions are measured
5. Customized box is produced
6. Items are packed, sealed, labeled and shipped

## Real-World Results

- Up to 1,500 ready-to-pack boxes per hour per machine
- Up to 50% faster pack-out times
- Up to 90% reduction in packaging labor
- Up to 33% more packages on each truck
- Up to 40% reduction in cubic volume of shipments

– Packsize

### 3) Significantly smaller environmental footprint

Integrating ASRS and GTP picking with right-sized packaging can positively impact the planet. The three technologies work together to minimize the amount of cardboard, void fill and taping materials used in packaging for eCommerce orders. Using less material diminishes the waste sent to landfills.

At the same time, smaller packages increase the number of orders that can fit in a single shipment, which reduces the number of trucks on the road. Fewer trucks on the road reduces fuel consumption and transportation-related carbon emissions. This ultimately reduces the environmental impact of eCommerce.

Finally, right-sizing helps companies design for circularity by using materials like corrugated cardboard, which can be easily recycled and reused.

The business case for integrating ASRS, GTP picking and right-sized packaging is compelling. For organizations that have an extensive assortment of SKUs and ship millions of packages annually, it's hard to beat the financial, operational and environmental benefits of adding smart packaging to the automation mix.

# Achieve New Levels of Value with Real-Time Sequencing and Micro Orchestration

Realizing the full potential of right-sized packaging requires more than just connecting automated packaging with ASRS and G2P picking. Getting the biggest bang for your right-sizing buck requires getting these systems to dynamically work together in the most efficient way possible. That means achieving real-time sequencing and micro orchestration of goods, information, people, processes and automation technologies. Sequencing and micro orchestration amplify the benefits of ASRS, G2P picking and automated packaging. They are key to right-sizing success because they enable all systems to work together in real-time with no buffering between individual tasks, processes and workflows.

Micro orchestration is a relatively new term. To fully appreciate its impact, it's important to understand how automation, real-time sequencing and micro orchestration all work together in synergy to uplevel the impact of automation and build competitive advantage.

- **Automation handles individual tasks.** It uses intelligent systems to perform tasks with minimal human intervention. The goal of warehouse automation is to accomplish more tasks at a faster pace and with greater accuracy. Automation frees human workers for more strategic, higher value work.
- **Sequencing involves the order of tasks.** Sequencing determines the order in which individual tasks are performed within a single process. The goal of sequencing is to reduce wasted movement and downtime and increase speed.
- **Micro orchestration focuses on end-to-end workflow across the warehouse.** Micro orchestration is the high-level coordination and management of end-to-end workflows. The goal of orchestration is to help warehouses move beyond linear automation to enable dynamic fulfillment, which enhances agility and resiliency.

“ *There are two main types of orchestration; the higher type at a supply chain level and then micro orchestration of order fulfillment activities on the DC floor.* ”

– Supply Chain Digest

The biggest barrier to real-time sequencing and micro orchestration lies in software integration. Coordinating order sequencing and orchestrating multiple systems across layered software architectures is inherently complex. Warehouse management systems (WMS) typically handle sequencing. Orchestration can be managed with a separate orchestration layer, but it makes the software stack more complex than it needs to be and leads to lag times.

Ideally, orchestration should be handled with a converged platform that seamlessly integrates WMS, warehouse execution system (WES) and warehouse control system (WCS). A converged platform streamlines integration and eliminates extra layers of software. Integrating software makes it possible to utilize data across the order fulfillment process, from order processing to packaging. This is the only way to ensure that right-sized packages arrive at the right packing stations in the right sequence and at the right time.

Here are some recommendations for realizing real-time sequencing and orchestration in your warehouse.

<b>RECOMMENDED</b>	<b>NOT RECOMMENDED</b>
Utilize a warehouse control system that directly interfaces with individual machine controls, connects all logistics processes and balances workload facility-wide based on real-time feedback from each subsystem.	Introducing extra layers of interfaces, middleware or software platforms such as a warehouse execution system (WES) or multiagent orchestration platform. These inhibit real-time performance.
Use automation systems that are smart enough to run tasks on their own and dynamically adapt, so the work keeps flowing in the right order.	Using core logistics systems that aren't capable of providing 100% sequencing on their own.
Look for software that's built for automation.	Using software that was initially engineered for manual environments and has been adapted to support automation.
Choose a converged WMS, WES and WCS platform that instantly navigates a complex web of decisions, unifies data across the entire order fulfillment process and enables dynamic task assignment based on the current workload at any given time.	Relying on legacy WMS or ERP systems that lack full sequencing capabilities. This gap forces manual corrections when orders fall out of sequence, creating delays and human intervention to restore order flow.
Choose automation systems that leverage AI where it adds real value—such as improving adaptability, optimizing decisions and enabling continuous learning—without overcomplicating processes.	Relying on legacy systems that lack adaptive intelligence. These platforms can't respond to changing conditions or learn from data, leaving your fulfillment process rigid and vulnerable to inefficiencies.
Look for analytics solutions that collect data across all processes, streams and technologies to draw conclusions from one converged source of truth.	Relying on fragmented reporting tools that pull data from isolated systems. Without a unified source of truth, insights become inconsistent, decisions slow down, and opportunities for optimization are missed.
Look for cloud-based connectivity to support anytime, anywhere data access and exchange.	Limiting real-time visibility, traceability and agility.
Work with technology providers who have proven their ability to work with customers and third-party partners to enable micro orchestration of order fulfillment activities in the warehouse.	Trying to implement right-sized packaging and automated micro orchestration without the right expertise and technology. This often leads to integration challenges, inefficiencies, and missed performance goals.

Figure 2. Recommendations for realizing real-time sequencing and micro orchestration of ASRS, G2P picking and right-sized packaging.

# The Role of Team Alignment in Advancing Right-Sizing Strategies

## WALMART, KNAPP AND PACKSIZE ACHIEVE END-TO-END SEQUENCING AND ORCHESTRATION

To address the growing demands of eCommerce and enhance supply chain efficiency, Walmart embarked on a mission to transform traditional distribution centers. Walmart's Next Generation Fulfillment Centers (FCs) offer a vast range of SKUs to customers, improve service levels, speed delivery times, boost productivity and reduce last-mile delivery costs.

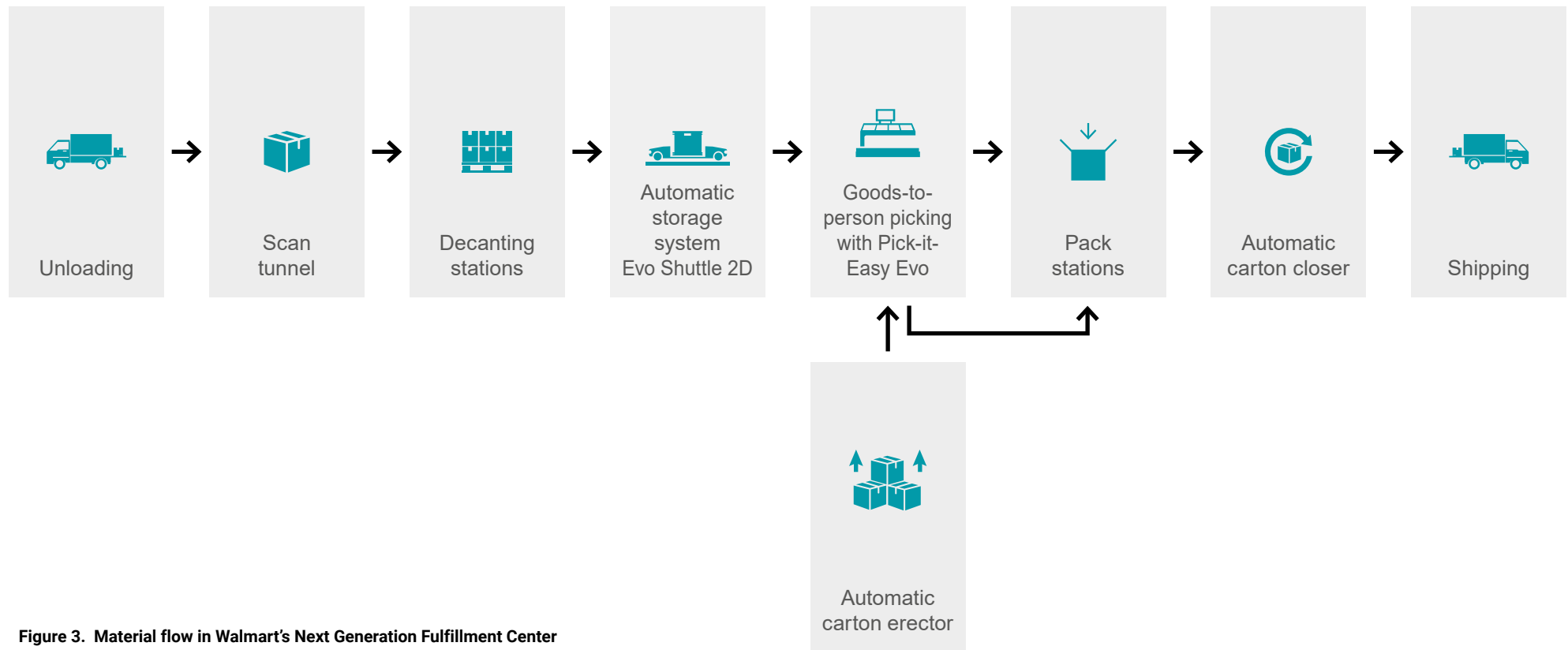


Figure 3. Material flow in Walmart's Next Generation Fulfillment Center

Keeping last-mile costs low while doubling throughput necessitates a new level of synchronization between intralogistics software and automation systems. Orchestrating all the different software stacks and synchronizing different automation systems requires tight collaboration between end users and OEMs.

The close collaboration between Walmart, KNAPP and Packsize achieved real-time sequencing and micro orchestration in a high volume, high throughput environment, which was a U.S. industry first. Here's an overview of the "box first" material flow in Walmart's Next Gen FC.

*The joint project by KNAPP and Packsize doubles throughput and storage capacity and reduces Walmart's cardboard waste by 26% and filling material by 60%. The tailored packaging sizes also lower shipping costs and are 100% recyclable.*



As soon as a customer order comes in, the source bin is automatically retrieved from the KNAPP Evo Shuttle high-performance storage system. In parallel, software uses master data to calculate the required size for the shipping carton. The carton is created in the Right-Sized Packaging On-Demand™ system so the shipping box is created before the orders are picked.



The source bin and the right-sized box are transported to GTP workstations. The bin and the box arrive at the workstation at the same time. Items in the order are placed in the custom box. Packsize says seeing this precisely sequenced and highly orchestrated fulfillment in action is "magical."



The order is then sent to a packing station. If needed, filling material is added to secure the items during transport. The completed order is closed with adhesive, scanned and weighed, either automatically or semi-automatically. The package is provided with an address label.



Once packing is completed, orders are automatically transported to the assigned zone and loaded onto vehicles that handle last mile deliveries.

The seamlessly sequenced, precisely orchestrated "picking-to-shipping" workflow creates up to **600 ready-to-pack boxes per hour per machine**, compared to manual packing where throughput averages just 45 cartons per hour. Deploying multiple machines in a single fulfillment center substantially scales packing throughput.

The Evo Shuttle, GTP picking and Right-Sized Packaging On Demand systems make it possible for Walmart to have orders packed, labeled and ready to ship in as little as 30 minutes. KNAPP's KiSoft software suite ensures that all intralogistics processes in Next Gen FCs function smoothly and efficiently, working hand-in-hand with Walmart's WMS.

# A SPORTS FASHION RETAILER, KNAPP AND PACKSIZE CUT COSTS WHILE IMPROVING SUSTAINABILITY

An international sports fashion retailer is working with KNAPP and Packsize to reduce costs while improving sustainability. The joint solution combines a KNAPP shuttle-based ASRS and GTP workstations as well as Right-Sized Packaging On Demand from Packsize. The integration and micro orchestration of these technologies allows the retailer to meet the growing demands of its eCommerce business while improving its environmental footprint.

The retailer uses the Box First approach. Once an order is received, KNAPP's intelligent software uses the product master data of every item in the order to determine the precise size needed for the shipping box. That information is then sent to a Packsize machine, which automatically creates a custom carton. The right-sized package and the tote from the ASRS arrive at the packing station so the picked items can be immediately placed in the box. Sequencing and micro orchestration of the entire end-to-end workflow is enabled in real-time.

*The international sports fashion retailer ships **6.2 million cartons annually** in its global operations. It expects automated packaging to **reduce carton size by up to 40%**, **shipping volumes by 45%** and **void fill by 30%**. The retailer will also save **3,100 miles in packaging tape** and **500 tons of CO2 each year** by reducing the amount of material used. Additional carbon reductions are delivered by **optimized truck loads**, which means **fewer trucks on the roads**.*

Right-sizing delivers significant warehouse space savings. And the savings won't stop there. Personnel costs will be radically reduced and consumers will have a significantly better box-opening experience.



Figure 4. Results from a 20 million parcel audit performed by Packsize.

While both Walmart and the international sports retailer use shuttle systems for high performance order fulfillment in a large warehouse, KNAPP can achieve real-time sequencing and micro orchestration in virtually any-sized warehouse, including small and medium-sized warehouses. KNAPP's flexible bot-based ASRS is a quick, easy and affordable way to get started with automation or expand an existing system.



AeroBot is designed for slow to mid-velocity throughput requirements and can be deployed in existing environments with different ceiling heights or irregularly shaped floor plans. It's ideal for the roughly 80% of warehouses worldwide that do not yet have automation.

# Criteria for Finding the Right Technology Partner

Choosing the right partner is paramount for any automation project, but especially important if your ultimate goal is real-time sequencing and orchestration. Look for a partner who:

- Provides business solutions, not just standalone automation systems or robots
- Helps you build a value chain across your entire logistics network
- Meets you where you are today and takes a holistic view of your environment
- Engineers the system that's right for you, which should involve workflow reengineering and a technology infrastructure roadmap that factors in future scalability and flexibility requirements

From a technology perspective, software that's purpose-built for modern supply chains is recommended. That means:

- A converged WMS, WES and WCS platform that looks at the entire facility, dynamically schedules order releases, treats storage holistically, factors in your priorities and makes determinations for you
- Flexible connectivity options – cloud or on-premises – to enable secure, real-time data access and decision-making based on strategy, resources and operational requirements
- Data-driven services that allow you to control maintenance costs and keep your facility infrastructure at peak performance



Figure 5. KNAPP's converged platform is engineered for integration of automation software, systems and services

When it comes to hardware, look for modular automation systems that can grow with you and are designed to work seamlessly together. Make sure there are pervasive sensor technologies that enable autonomous data collection. Ask for proven success of hardware, software and services in greenfield, brownfield and incremental deployment models, as well as customer examples and proof points that demonstrate the provider's ability to:

- Reduce costs by optimizing warehouse resources
- Interconnect manual and automated warehouse areas
- Expand to accommodate new business processes and warehouse technologies

From a cost perspective, look for a high degree of standardization with customization capabilities and configuration options. Finally, make sure your partner has years of experience in stable and reliable project management.

With KNAPP as your value chain tech partner, you can count on a consultative partner that can help you:

- Define your end goal and determine your space requirements
- Specify automation systems based on your SKU variability, throughput requirements, labor availability and efficiency goals
- Develop the business case for labor, space, material and shipping savings
- Design the warehouse layout for optimized workflow today and create a future-proof plan for scalability tomorrow

Make sure your provider embraces close collaboration with third-party providers, consultants and integrators to achieve real time sequencing and orchestration.

Some of the world's biggest and best supply chains rely on KNAPP to improve labor utilization, accelerate order fulfillment and increase warehouse efficiency. Our automation systems and intelligent software can build new levels of value across your supply chain too.

**“ By working closely with KNAPP and Packsize, Walmart is the first in the U.S. to deliver real-time sequencing and orchestration of order picking into right-sized, on-demand packaging in a high-volume fulfillment environment. ”**

– Fabricio Ruillova, Partnership Director - OEM, Packsize

# Proven Innovation in Automation



## The broadest technology portfolio on the market

KNAPP is the reliable partner for value chain innovation with integrated automation solutions in all sizes and for every step of the value chain—from production and distribution to point of sale. KNAPP provides proven software and hardware solutions for intelligent logistics automation. A collaborative approach and excellent service position KNAPP as a trusted, stable partner for success in retail, fashion, food retail, wholesale, pharmacy, healthcare, manufacturing, or ecommerce.

