
GreyOrange
Fulfilling the future in real time™
The
Next-Generation
Warehouse
Multilevel Fulfillment
Automation in Action

The rapid growth of ecommerce during the pandemic was driven by consumer expectations of retailers to evolve into end-to-end automated fulfillment dynamos overnight. Warehouse fulfillment operations had to change. What's more, today various economies around the world are looking at possible recessions, so warehouse fulfillment simply can't engage in business as usual.

Companies like Walmart and Amazon – which had already automated their fulfillment operations – emerged from the pandemic as the clear winners. And over the past two-and-a-half years, more companies have been using robots to automate their warehouses. Moving forward, automation must be fully embraced as aging demographics and shrinking workforces in countries ranging from the U.S. to China mean that the labor crunch isn't going away anytime soon.

People, processes and technology comprise most business solutions. Organizations need better processes and technology – along with people who have the right skills – to forge a lasting fulfillment solution. By automating various processes and tasks, retailers have been able to dramatically shorten dock-to-stock cycles and improve inventory accuracy. It's part of the reason why worldwide commercial robot revenue in warehouses is predicted to reach a compounded annual growth rate of over 23% from 2021 to 2030 and exceed $51 billion by 2030.

In short, leading retailers need next-generation warehouses to succeed into the future. The next-generation warehouse uses the latest technology to tackle the current challenges head-on. The next-gen warehouse uses automation design principles to implement fulfillment – across different warehouse types and footprints – and meet requirements for various inventory types.

This paper presents an example of how a real-life next-generation warehouse operates. The goal is not to show merely what's possible in an ideal scenario, but rather what's readily doable for retail and warehousing companies that are willing to embrace next-generation solutions for their most critical challenges.

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INTRODUCING THE NEXT-GENERATION WAREHOUSE

The next-gen warehouse is a large multilevel goods-to-person (GTP) facility designed to maximize productivity using automation. The warehouse has six or more floors comprising 650,000 square feet and provides 6.2 to 6.9 million liquid cubic feet (9.6 to 10.6 cubic feet per-square-foot) of storage. It holds 4.5 to 5.0 million SKUs and achieves average daily throughput of 530,000 units and up to 740,000 units during peak periods.

The warehouse achieves maximal productivity using intelligent automation on par with the leading multi-floor automated warehouse. Integrating various industry leading automation technologies – such as point-to-point (PTP) transport and GTP technologies and packaging and sortation robotics – the warehouse performs to meet the toughest business objectives and customer demands.

With a comprehensive automation solution, companies can turn a large multi-floor space into their own next-generation warehouse. To maximize productivity, the warehouse uses automation features including discrete order picking across floors, box-first pick process, minimal dependency on elevators, and minimal touchpoints for order consolidation. The operation can achieve various key objectives, including higher storage density, increased throughput, seamless scalability and enhanced flexibility to meet changing customer needs. The latest automation technologies help companies achieve high facility utilization, increased operator productivity and reduced operational costs, while increasing worker and customer satisfaction.

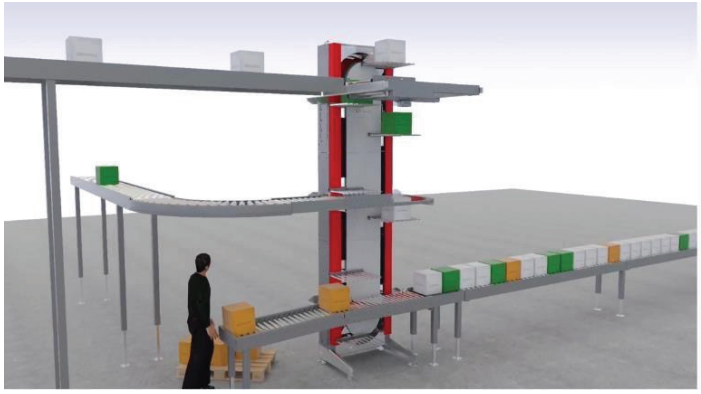
The sections that follow describe various essential warehouse automation technologies and workflows that every effective next-generation warehouse needs.

WAREHOUSE AUTOMATION TECHNOLOGIES

Point-to-point transport

Goods are transported to and from different points on a single floor using traditional conveyors and sorters. For floor-to-floor movement in a facility of this scale, however, elevators can create chokepoints. Vertical reciprocating conveyors (VRCs) are used to reduce chokepoints and improve speed and reliability. VRCs are integrated with traditional conveyors to improve transportability to the entire multi-floor facility and incur lower infrastructure costs than other interfloor transport options. But capacity challenges may not be entirely solved. VRCs can still create chokepoints, hinder the movement of SKUs and orders between floors, and prevent timely picking and shipping. The bottom line: A given floor's required capacity can still end up being greater than its theoretical capacity.

Figure 1: Vertical reciprocating conveyor



Goods-to-person transport

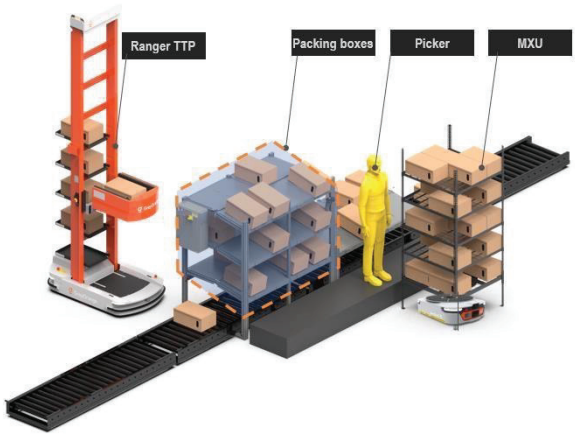
Two automated GTP material movement solutions are used together to boost throughput, accuracy and productivity. A rack-to-person (RTP) robot intelligently navigates the facility, bringing inventory to workers via mobile racks or mobile stock units (MSUs). A totes-to-person (TTP) robot picks and transfers order boxes from the automatic box creator to a putwall to facilitate consolidation and sequencing. The TTP bot picks and puts from any height, providing the flexibility to use the entire vertical storage height of the putwall.

Box-first automation

Implementing a box-first approach reduces touchpoints and increases efficiency in the picking and packing process. The dimensions of a box for a given order are shared with the automated box creation machine, which custom-builds the box prior to picking. After the order is opened, the SKUs and box are delivered via conveyor travel to a station, where the order is picked directly into the box.

Figure 2: Automatic box-first creation

Figure 3: Pick-to-box station



Flexible robotic sortation

On the ground floor, automated robotic sortation robots sort order boxes to their end destinations. At the end of the packing process, the bots receive boxes from a conveyor and drop them off at telescopic conveyors that deliver them to outbound trucks; this capability is part of today's emerging trailer-loading robot technology that is replacing capital-intensive telescoping conveyors. The ease of installation and flexible layout of this technology allows the customer to rapidly scale up or down, while avoiding single points of failure.

Figure 4: Intelligent movement-based sortation

Warehouse design/layout

Companies build best-in-class warehouse automation by integrating the various automation technologies discussed. The six-floor warehouse has AMRs deployed on five floors. The ground floor handles inbound, packing, sortation and outbound processes. Floors two through six handle storage and order picking. Floors two to four may be slotted for faster-moving SKUs to drive single-deep storage density and facilitate faster SKU access. Conversely, double-deep storage on floors five and six hold slower-moving SKUs to facilitate higher-density storage and cube utilization.

Figure 5: Floor G

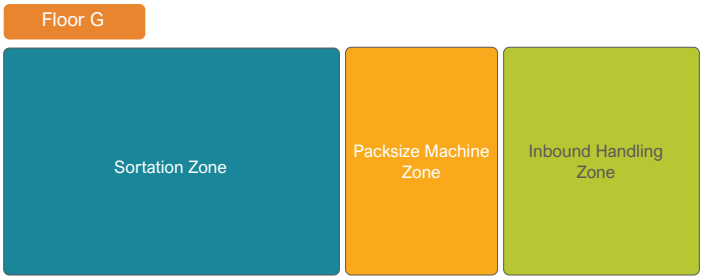


Figure 6: Storage floors 1.1

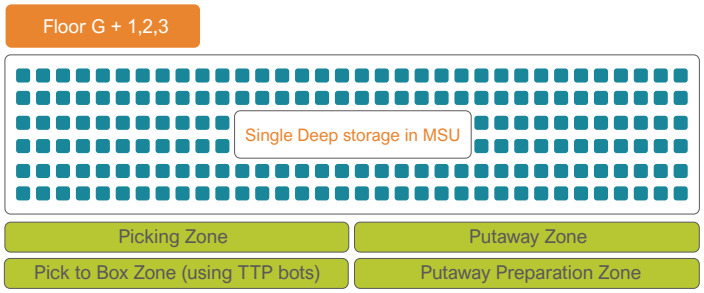


Figure 7: Storage floors 1.2

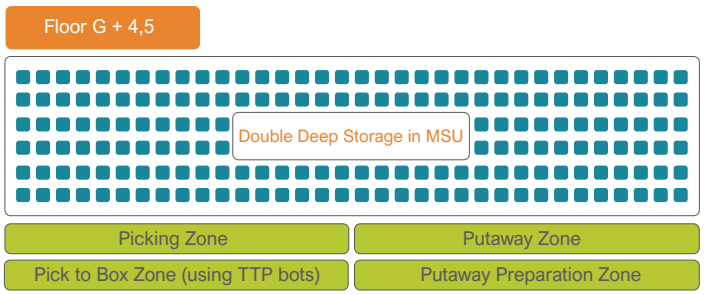
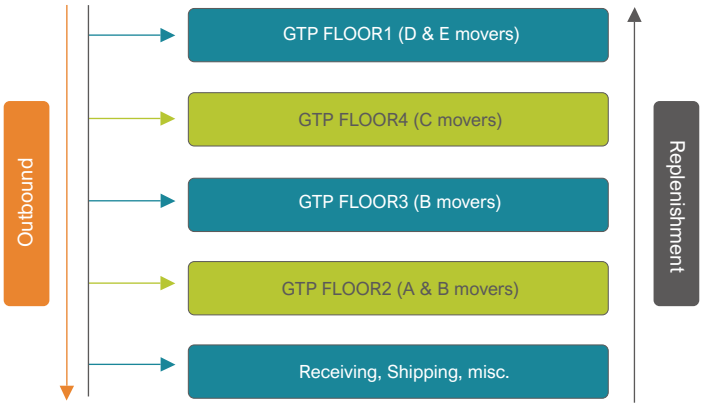


Figure 8: Floor view of the proposed FC design



Floor movement and storage

Inbound inventory is received on the ground floor and conveyed to higher floors based on SKU velocity. Faster-moving SKUs are stored on the bottom floor and slower movers on higher floors; alike SKUs are localized on the same floor, rather than spread across multiple floors. The inventory on each floor is stored in virtual sectors defined by the SKU department (e.g., apparel, electronics, etc). Movement across floors of inventory, order boxes and completed orders is accomplished via conventional conveyors, VRCs and sorters.

Orchestration

The fulfillment platform orchestrates optimal decisions across the warehouse. It analyzes design criteria and historical data from orders and inventory to determine inventory SKU velocity. By determining whether orders can be fulfilled with like-velocity SKUs – or whether they require multiple-velocity SKUs – the platform choreographs cross-floor movement to enhance throughput and efficiency. (Details on pareto and affinity can be found at the end of this paper).

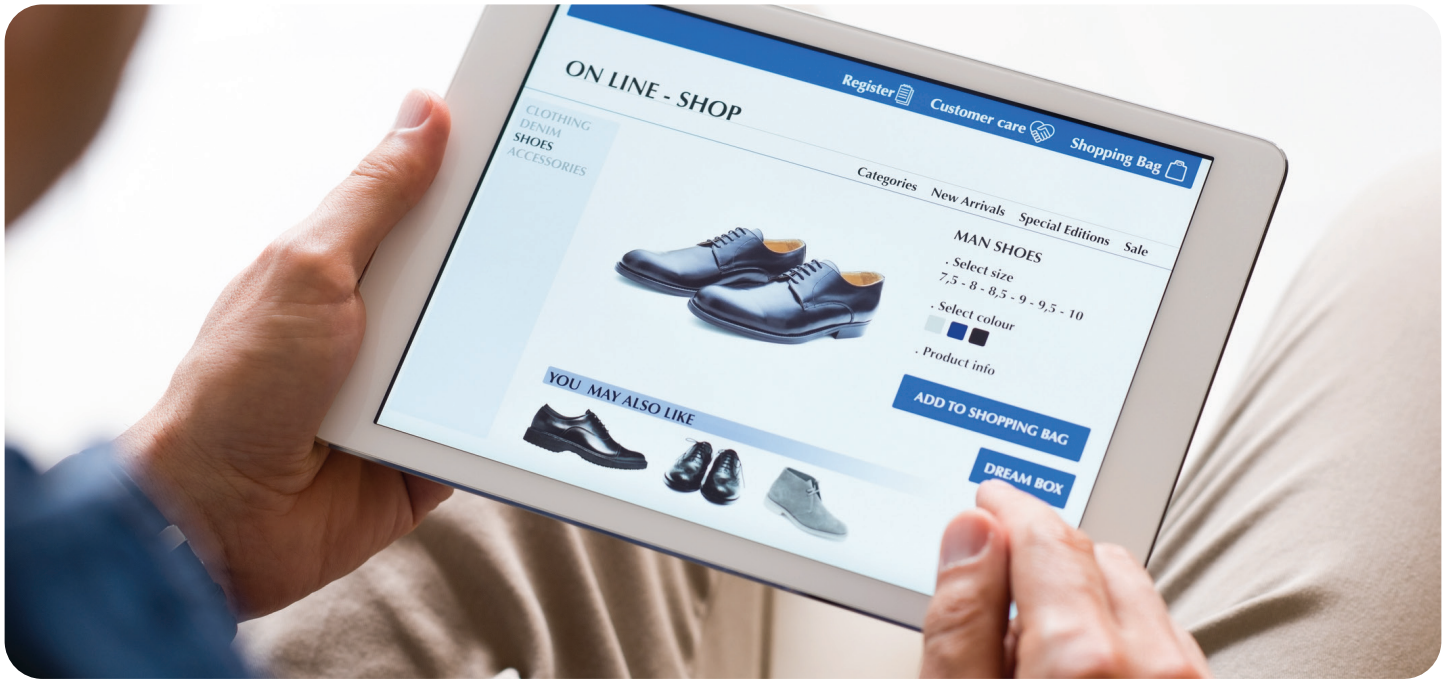
WORKFLOWS

Inventory relocation

Individual SKU demand varies depending on seasonal and other factors. SKUs are relocated based on velocity changes by five elevators installed specifically for this purpose and via cross-floor movements that are much nimbler than the order and SKU transport done by VRCs.

Inbound workflow

Arriving trucks are filled with floor-loaded cases. Cases are unloaded into roll cages and moved to conveyors and VRCs. The license plate numbers (LPNs) of each case are scanned and relayed to the fulfillment platform. The platform transmits the information to conveyors, which direct the cases to VRCs that take them to their floors. Operators open and decant the cases into roll cages that are moved to pick-put stations (PPSs) where they are inducted into inventory.

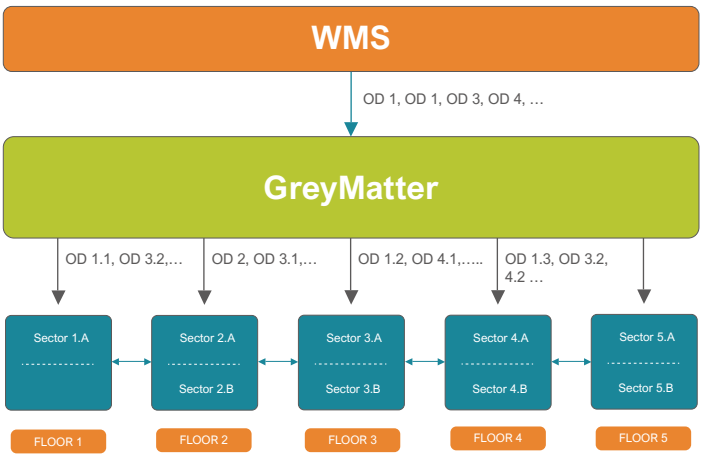


ORDER WORKFLOWS

Order orchestration

The fulfillment platform orchestrates order picking and consolidation across floors based on inventory location. Single-line orders are picked on individual floors. Multi-line orders are split into sub-orders that are batch-picked on source floors and sent to destination floors. Sub-orders are transported from their original floors and inducted as inventory on one end-destination floor for complete order picking; this process minimizes touchpoints, optimizes pick start-to-completion time, and maximizes resource utilization.

Figure 10: Overview of order orchestration across floors



Pick-to-box/box-first approach

The box-first approach helps optimize order flow. On-demand packaging machines on the ground floor create custom-sized boxes for each order. VRCs transport the boxes to end-destination floors. TTP bots take the boxes off the conveyor and bring them to PPSs, where they sit in a put-wall ready to be picked into.

Picking flow

Picking occurs on all five storage floors. Single-item and multi-item orders with the same velocity are picked without crossfloor movement. When multi-item orders require fulfillment across multiple floors, they are batch-picked and moved across floors to their pick-to-box destinations. Orders are picked across every floor where the needed SKUs are located. Batch-picked SKUs are transported via VRC to end-destination floors for induction as inventory. After the inventory is inducted, complete orders are picked/consolidated into their pre-designated boxes at PPSs.

Packing and sortation workflow

Completed order boxes travel on the VRC down to the ground floor. As part of the box-first approach, machines weigh, measure, tape, seal and label the boxes. Conveyors transport the boxes to sortation areas, where sortation bots receive and sort them to appropriate docks and trucks prior to shipment.

TOP 3 KPIs

The design of the warehouse flow discussed above was driven by three key performance indicators (KPIs), listed in order of priority as follows:

Storage capacity

The fulfillment platform orchestrates order picking and consolidation across floors based on inventory location. Single-line orders are picked on individual floors. Multi-line orders are split into sub-orders that are batch-picked on source floors and sent to destination floors. Sub-orders are transported from their original floors and inducted as inventory on one end-destination floor for complete order picking; this process minimizes touchpoints, optimizes pick start-to-completion time, and maximizes resource utilization.

Throughput

The designed solution can achieve an average throughput of 530,000 units per day and up to 740K units per day on a peak day.

Variable cost per unit (VCPU)/ Total cost per unit (TCPU).

The solution will be able to achieve a VCPU from $0.54 to $0.82, and a TCPU from $0.80 to $1.08.

FLEXIBILITY AND SCALABILITY: RAAS AND SAAS

The robot-as-a-service (RaaS) and software-as-a-service (SaaS) delivery models enable companies to deploy the automation technologies used in this solution, while minimizing up-front costs. But there still needs to be a significant investment in equipment, including accessories, VRCs, PPS, chargers and mezzanines. Customers benefit from continuous value delivery that is all included in the subscription fee including performance upgrades, firmware updates, maintenance, spares, remote monitoring and dedicated customer success support. RaaS provides clients the flexibility to invest variably in automation and the scalability to invest as their business grows and technology evolves. Meanwhile, SaaS enhances security using a cloud hosted software environment and allows customers to meet stringent recovery time objective (RTO) timelines. Moreover, RaaS and SaaS receive automatic updates from the cloud that obviate the need for manual version refreshes.

CONCLUSION

Manual fulfillment simply cannot handle high-SKU, high-volume ecommerce and omnichannel fulfillment. Companies seeking to grow in the largest and most competitive markets rely on the next-generation intelligent automation solutions to provide strategic advantages. Due to pandemic-accelerated ecommerce, the labor crunch and inflation – and now concerns about slowing economies – being a successful company is about much more than having a good product that customers want to buy. But despite the storm clouds on the horizon in various economies, the good news is that recession-proofing warehouse fulfillment is no longer a pie-in-the sky idea; rather, it's well within the realm of possibility. In fact, a company can execute on a vision that delivers their products to customers efficiently – and cost effectively – in any economy.

ABOUT GREYORANGE

GreyOrange is a global leader in automated robotic fulfillment and inventory optimization software. Our line of Ranger autonomous mobile robots (AMRs) – powered by our proprietary GreyMatter fulfillment platform – provide hardware agnostic fulfillment orchestration that responds to customer orders in real-time. Our solutions allow retailers, warehouse operators and third-party logistics companies to gain a competitive advantage by increasing productivity, empowering growth and scale, mitigating labor challenges, and reducing risk and time-to-market, while creating better experiences for customers and employees.

Powered by GreyMatter™

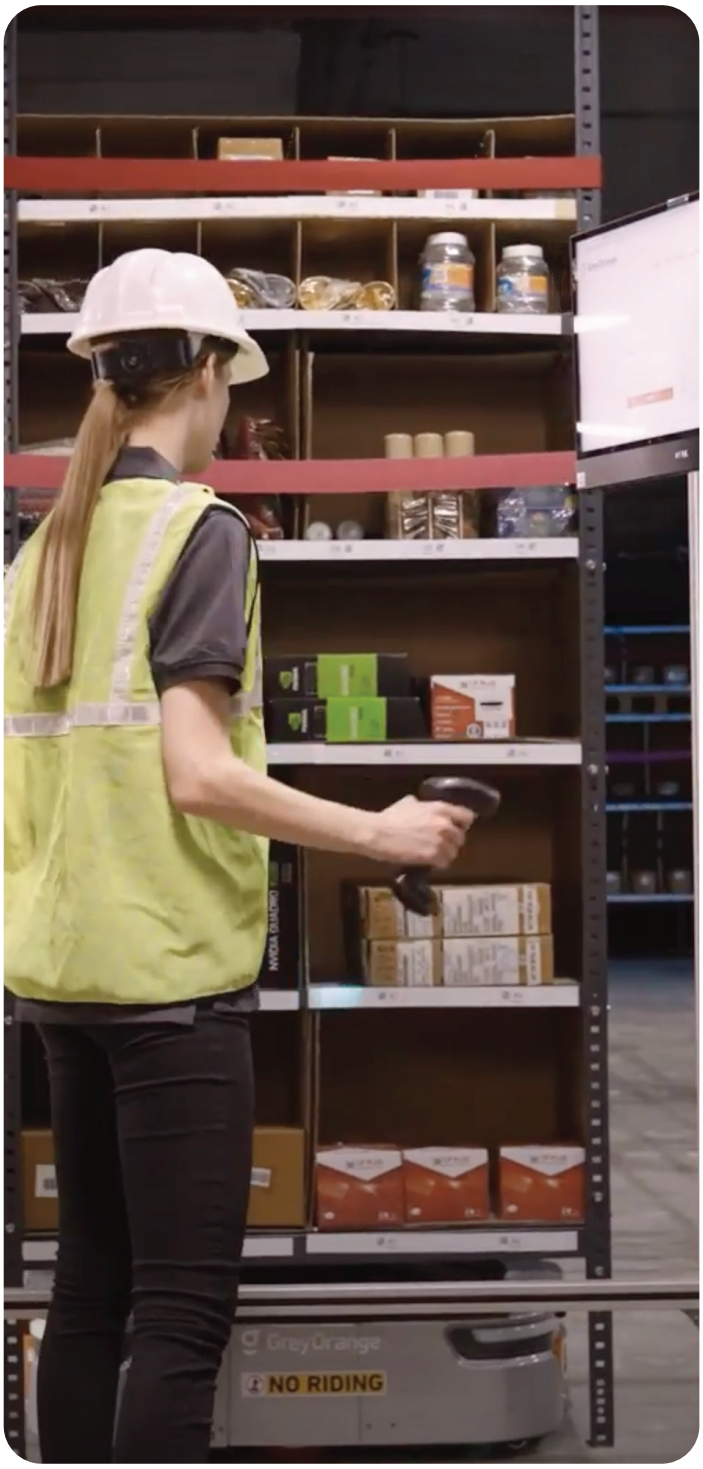
The GreyMatter fulfillment platform continuously solves to drive optimal decisions across our Ranger™ AMRs. GreyMatter provides efficient orchestration and rapid execution across the entire fulfillment operation – putting the right order with the right bot and the right picker. Providing end-to-end process orchestration from inbound to outbound, along with multiple bot orchestration, GreyMatter maximizes your smart warehouse performance. Featuring hybrid picking, multi-floor operations, dynamic order picking and planogram-based picking, GreyMatter delivers powerful business intelligence and customized analytics to achieve fulfillment success during unpredictable market conditions.

Industry leaders choose GreyOrange

An array of companies over a broad range of industries, sizes and locations employ GreyOrange to provide best-in-class automation services to meet their business needs. GreyOrange worked with one of the world's largest retailers to build a robot deployment plan over the course of four years based on business projections and seasonal needs. We designed and built a flexible facility to which technology can be added and removed on a monthly basis to meet demand for a large European-based fast-fashion company. We also worked with a prominent 3PL to enable a multi-national fashion retailer to meet extremely high volumes during peak demand periods using more than 500 robots.

Automate your warehouse today

The warehouse automation solution discussed in this paper was designed with a specific customer in mind. For this reason, calculations, metrics and KPIs cannot be directly applied to other customers without further investigation. We would welcome the opportunity to customize a solution to meet your company's warehouse fulfillment needs. Discover the value of GreyOrange solutions.



APPENDIX: STORAGE CAPACITY

Pareto: Order, SKU and inventory

	SKUs	Throughput	Inventory
A	3%	50%	45%
B	6%	20%	21%
C	9%	15%	17%
D	15%	10%	12%
E	67%	5%	4%

Order profile analysis

	SKUs	Throughput	Inventory	Singles	Multiple Single-Category Orders	Multiple Multi-Category Orders
A	3%	50%	45%	44%	26%	31%
B	6%	20%	21%	39%	6%	55%
C	9%	15%	17%	38%	5%	57%
D	15%	10%	12%	42%	4%	54%
E	67%	5%	4%	56%	6%	39%

Analysis of cross floor traffic

	Distribution of Cross Flow Traffic Movement				
From/To	A	B	C	D	E
A		33%	24%	15%	5%
B			9%	6%	2%
C				4%	2%
D					1%
E					

The GreyOrange design discussed in this paper employs single-deep, back-to-back MSU storage. SKU pareto and volume profiles indicate that this storage configuration provides the most efficient MSU retrieval and presentation for picking and right-sizing robot fleets. (Storage density can be increased by placing MSUs 2-deep, 3-deep and n-deep in storage lanes and reducing the number of aisles in the storage field).

GreyOrange accommodates n-deep storage when customer product mix and velocity warrant. We assign SKUs to different pareto classes and storage configurations dynamically based on changes in demand. Other similar solutions offer slightly more storage capacity by providing better cube utilization, including larger MSUs or deeper MSU storage lanes. While a larger, slower-moving SKU profile may warrant 2-deep or deeper storage lanes on upper floors, the GreyOrange design uses single-deep MSU storage to best handle certain SKU profile/volume characteristics. We also can accommodate n-deep storage and assign SKUs between storage profiles as volume characteristics demand.

We dedicate approximately 22% of floor area to pre-put and post-pick activities. While other solutions shrink this percentage to approximately 10% of floor space, we include this higher proportion to adapt to changing operational characteristics and growth surges. The result is that each product is touched an average of just two times, compared to approximately four touches for similar solutions.

Acronyms

AMR	Autonomous mobile robot
GTP	Goods-to-person
KPI	Key performance indicator
LPN	License plate number
MSU	Mobile stock unit
PPS	Pick-put station
PTP	Point-to-point
RTP	Rack-to-person
RTO	Recovery time objective
RaaS	Robot-as-a-service
SaaS	Software-as-a-service
TCPU	Total cost per unit
TTP	Totes-to-person
VCPU	Variable cost per unit
VRC	Vertical reciprocating conveyor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GET IN TOUCH
It's the right time to implement robotic sortation at your fulfillment center. Contact a GreyOrange representative to learn more today.
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