

Inbound process determines efficiency of Autostore

In warehouses, historically, the inbound process hasn't always received the attention it deserves. Traditionally, most of the focus has been on storage systems and the pick-and-pack process. However, with the rise of e-commerce and the growing need for automation and robotics, there's been a growing emphasis on advanced automated Goods-to-Person (G2P) systems.

Ironically, it's e-commerce that now requires us to place more emphasis on the inbound process to ensure the efficiency of the entire system. Vincent Weinschenk of WHEREHOWS discusses four strategies for the inbound process in the context of various Autostore projects.

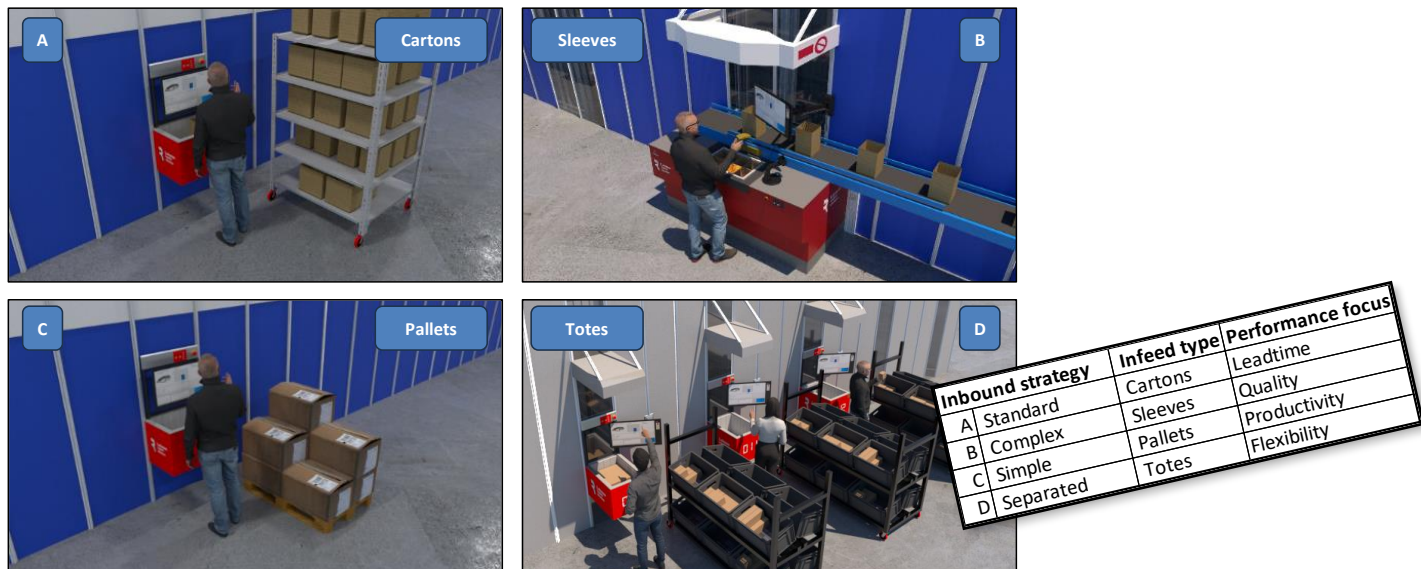


Image 1: Four inbound strategies

Expansion of product variety ("longtail") increases inbound complexity

In Autostore and other G2P systems, the focus is typically on the outbound pick process, aiming to reduce labor costs, increase pick productivity, reduce pick errors, and shorten order processing time.

Nevertheless, the inbound process, especially in e-commerce operations, has become increasingly important for the overall efficiency of G2P systems like Autostore. This is because the inbound process has become considerably more complex due to e-commerce, resulting in higher labor costs and longer dock-to-stock lead times.

Everyone knows that e-commerce leads to a significant increase in the number of orders and order lines, with smaller quantities per order line. However, what is often overlooked is that e-commerce also leads to a significant expansion of the product variety, with a strong increase in the "longtail" assortment. This has led to a substantial increase in the number of order lines and smaller quantities of products per receipt line, often resulting in receipts that require a lot of sorting and inspection.

How Autostore works at its core

Autostore is a compact Automatic Storage & Retrieval System (ASRS) designed to maximize storage density and efficiency. Autostore features a grid of storage bins that are stacked vertically in a dense, three-dimensional grid.

The core of Autostore is its many small robots, responsible for storing and picking bins containing items in the grid. When a bin needs to be picked or stored, the software calculates the most efficient route on the grid. The robots transport the bins to designated pick ports where items are picked.



What inbound does with Autostore...

The inbound process directly influences how well the Autostore system operates. It affects the number of bins in the system, the space it occupies, how bins are sent to the pick ports, and the costs of the process.

There are different strategies for the inbound process depending on the quantity, size, and speed of incoming products. Attention is also given to reducing errors and minimizing the time it takes to move products from receipt to storage.

In some cases, it's practical to store products in bulk before they're brought into Autostore. In other cases, products can be placed directly into Autostore. The choice depends on how much inventory you want to have and how quickly you need it. It's also essential to ensure there's enough inventory to fulfill orders. Sometimes, it's necessary to store extra inventory to avoid running out.

Additionally, having duplicate storage locations, both in Autostore and the warehouse itself, can be helpful. This allows picking large quantities of products from the warehouse, saving time and preventing Autostore from running out of stock too quickly. The downside is that this often requires a consolidation step.

To manage the complexity of the inbound process, it may be necessary to decouple processes. This involves separating sorting and inspection tasks from entering products into the Autostore system. This can help improve quality and efficiency.

It's essential to plan and analyze the inbound process from the beginning because it has a significant impact on how well the entire system operates. Physically mapping and measuring the process on the shop floor is often necessary because data quality is often not good enough for complex inbound processes.

Decoupling to manage complexity

I have conducted various design studies recently, where a G2P (Goods to Person) system was chosen as the solution. In these projects, we thoroughly analyzed and designed the inbound process. The way received products are entered into the G2P system can vary, depending on the project and the specific G2P system used. In this case, we're discussing four projects where we chose an Autostore solution as the basis for further development.

Depending on order volumes, product characteristics, and inbound complexity, we found that in three of the projects, it's preferable to decouple the inbound process. Decoupling means separating time-consuming, complex, and labor-intensive tasks such as sorting and inspection from simple and fast entry tasks.

For these entry tasks, "sleeves" (cardboard boxes) are either placed directly into Autostore bins, or products are transferred from "totes" (transport containers) to Autostore bins. To save space, bins are divided into compartments (1/2, 1/4, 1/8, or even 1/16 bin), optimizing and streamlining the receiving process.

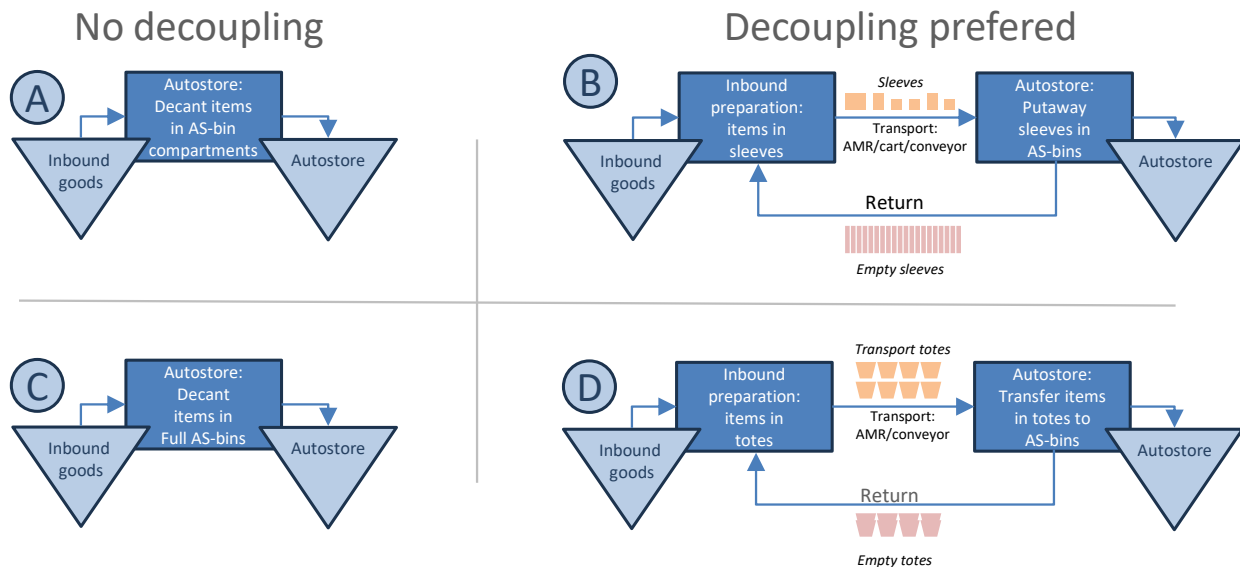


Image 2: Four inbound processes

Table 1 presents the four projects with key figures and an indication of whether decoupling has been applied or not. Additionally, I notice that in most situations, multiple strategies can be used side by side or are even required. In almost all cases, relatively large products are sent directly to the port. If this results in a significant daily volume, it's advisable to assign multiple specific ports to handle it.

Design indicators	Zone	Company 1 Wholesale	Company 2 Omnichannel	Company 3 Ecommerce	Company 4 Wholesale
# inbound lines/day	Autostore	700	1.175	1.000	875
# inbound locs/day		1.200	1.900	2.400	1.750
# inbound full bins/day		100	400	100	550
# locs/SKU inbound		1,9	2,0	2,5	2,6
Description/type	Other zone	Non, only Autostore	Non-Binnables	Non-Binnables	Binnables - Fastmovers (PTL)
# outbound lines/day	<i>Total</i>	<i>12.000</i>	<i>20.000</i>	<i>40.000</i>	<i>20.000</i>
	Autostore	12.000	18.000	38.000	14.000
	Other zone	None	2.000	2.000	6.000
# outbound orders/day	<i>Total</i>	<i>3.500</i>	<i>2.000</i>	<i>8.500</i>	<i>3.300</i>
	Autostore only	3.500	1.550	8.000	2.000
	Other zone	None	350	200	300
	Consolidation	None	100	300	1.000
ABC-distribution	Autostore	20%/78%	20%/80%	20%/86%	20%/85%
Batchfactor		1,1	1,4	1,2	1,1
# SKU's on stock	<i>Total</i>	<i>25.000</i>	<i>34.000</i>	<i>50.000</i>	<i>31.000</i>
	Autostore	25.000	24.000	45.000	30.500
	Other zone	None	10.000	5.000	500
# binlocs in system	Autostore	20.000	50.000	80.000	40.000
Other systems in study	Competing systems	(Zonepick+VLM+ Shelves+Conveyor)	AMR-Shuttle Shuttle systems Attabotics	(Zonepick+VLM+ Shelves+Conveyor)	AMR-Shuttle Shuttle systems Attabotics
Free height warehouse (m)	Storage area	12	8,0	7,5	12
Decoupling	Inbound	No	Yes, totes	Yes, sleeves	Yes, sleeves
Ecommerce type	B2B / B2C	B2B	B2C	B2C	B2B

Table 1: Key figures of four design studies with G2P system solution

Four main strategies for the inbound process

Four main strategies have been developed for the inbound process and have been evaluated based on various key indicators. These strategies vary in how they organize the receipt and processing of goods. It's possible to use multiple strategies alongside each other as long as there's enough receiving capacity for each strategy. Incoming goods can vary in terms of volume, complexity, and product dimensions, and the combination of these factors determines which strategy is the most suitable.

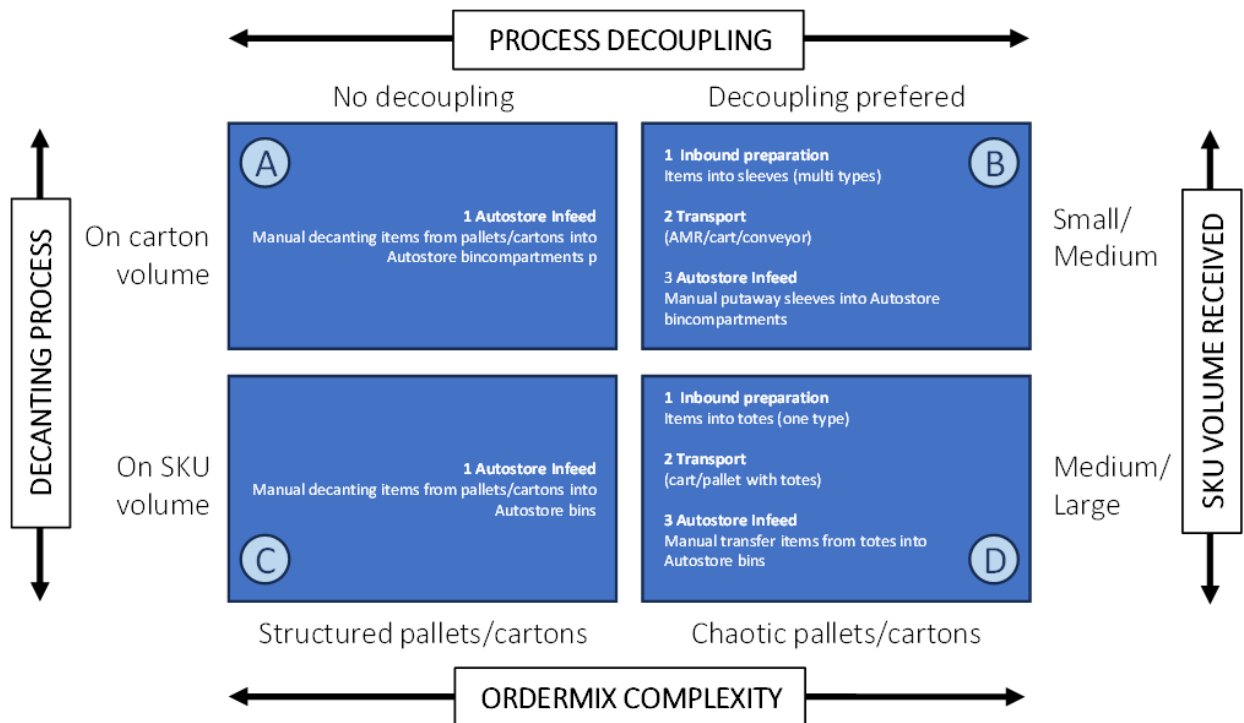


Image 3: Matrix with four approaches for inbound strategy

Process Decoupling refers to splitting the receipt process into different steps. It may be necessary to decouple the process when there are significant differences in capacity requirements between preparatory tasks and input into Autostore. Decoupling can be necessary for various reasons, such as the distance between receipt and input into Autostore, differences in process duration, or processing capacity.

Ordermix Complexity refers to how received goods are structured and mixed. It indicates the complexity of incoming orders and whether they contain a wide variety of SKUs (Stock Keeping Units). The complexity of the order mix influences which strategy is most suitable.

The Decanting Process involves transferring the contents of boxes to an Autostore bin. It shows whether the processing is done box by box or SKU by SKU, meaning all boxes belonging to one SKU are processed together.

Strategy A: Standard process (Emphasis on speed)

- Goods are received and inspected directly at Autostore.
- Receiving goods is straightforward, and smaller quantities are processed.
- Goods are placed directly from pallets or boxes (containing only one product type) into Autostore storage bins.
- The ratio of received goods to input into Autostore is approximately 1:1.



Strategy B: Complex process (Emphasis on quality)

- This is the most complex approach.
- It involves intricate shipments with many different products, often mixed together.
- Requires extensive inspection and selection work.
- The process is divided because the capacity for preparatory tasks and input into Autostore varies significantly.
- Administrative or physical process errors pose the greatest risk.
- The ratio of received goods to input into Autostore is approximately 6:1 or even larger.



Strategy C: Simple process (Emphasis on productivity)

- This process is designed for straightforward receipt.
- It involves a limited number of boxes with only one product type per pallet.
- Inspection and input occur directly into Autostore.
- This process is often used in combination with more complex processes.
- The ratio of received goods to input into Autostore is approximately 0.5:0.5, meaning one operator can handle the entire task.



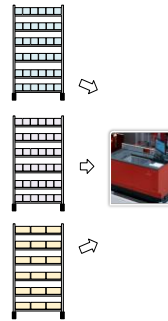
Strategy D: Separated process (Emphasis on flexibility)

- This process falls in complexity between the other strategies.
- Decoupling of sorting and inspection of goods and input into Autostore is necessary.
- Autonomous mobile robots (AMRs) or conveyors can be used to bridge the distance.
- The ratio of received goods to input into Autostore typically varies between 1:1 and 2:1, depending on the specific process.

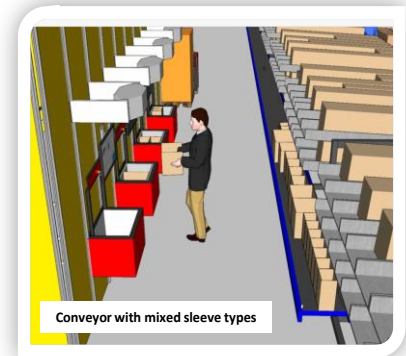
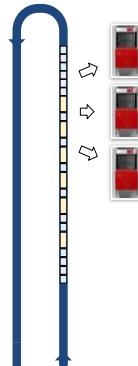


The complex process has two variations

At the wholesale company, the process is separated using carts. There are only six receiving stations, and there is enough space between these stations to accommodate multiple carts. Each cart is filled from both sides and contains only one type of sleeve. The filled sleeves are transported to three ports (one sleeve type per port) and placed one by one into the Autostore system. This ensures that empty storage bins can be easily replenished by Autostore.



At the e-commerce company, the process is separated using a conveyor belt. This conveyor belt is fed with filled sleeves from 12 receiving stations. At the end of the conveyor belt, the filled sleeves are picked up and placed in four receiving ports. Each receiving port is intended for one type of sleeve. This not only provides an organized and structured process but also simplifies control from Autostore.



In both processes, when the filled sleeves are placed in the Autostore bins, an empty sleeve is manually removed from the bin. In the case of the carts, the empty sleeve is placed on the cart, creating an exchange. For the conveyor belt, empty containers are placed in cassettes, and when these cassettes are full, they are replenished at the flow rack by the inbound worker.

Image 4: Two approaches for complex inbound process

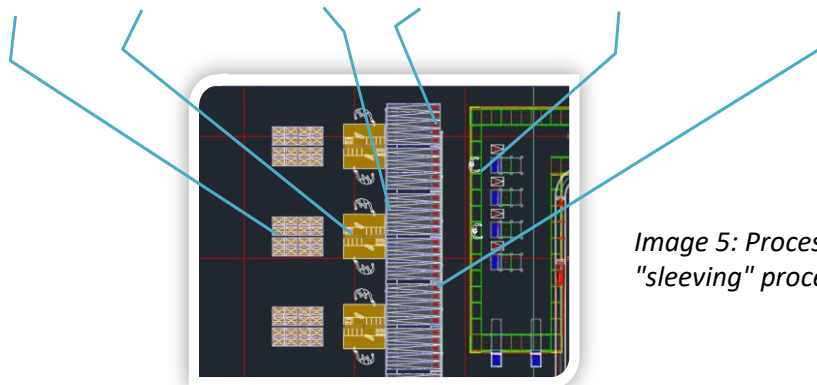


Image 5: Process steps in the "sleeving" process



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Conclusion

When designing warehouse robotics and automated systems, the inbound process often receives too little attention. Typically, the focus is on storage density, capacity, and picking productivity. However, it's the process through which goods enter the warehouse that plays a crucial role in the overall system's efficiency.

With the growth of online shopping, we are not only witnessing an increase in work on the outbound side but also on the side where products enter the warehouse. Additionally, the expanding product range and the receipt of smaller quantities add complexity to the process.

To address this complexity and ensure the process's quality, it's essential to organize the inbound process effectively. For straightforward processes, direct processing is often the most efficient approach. However, for more complex processes, it's necessary to decouple the receipt process from the input of products into Autostore.

To achieve a successful design, a thorough analysis of the inbound process is required, both based on available data and by examining the situation on the shop floor. It's crucial to physically map the process, conduct checks, and take measurements because data quality is often insufficient or unknown for complex inbound processes.