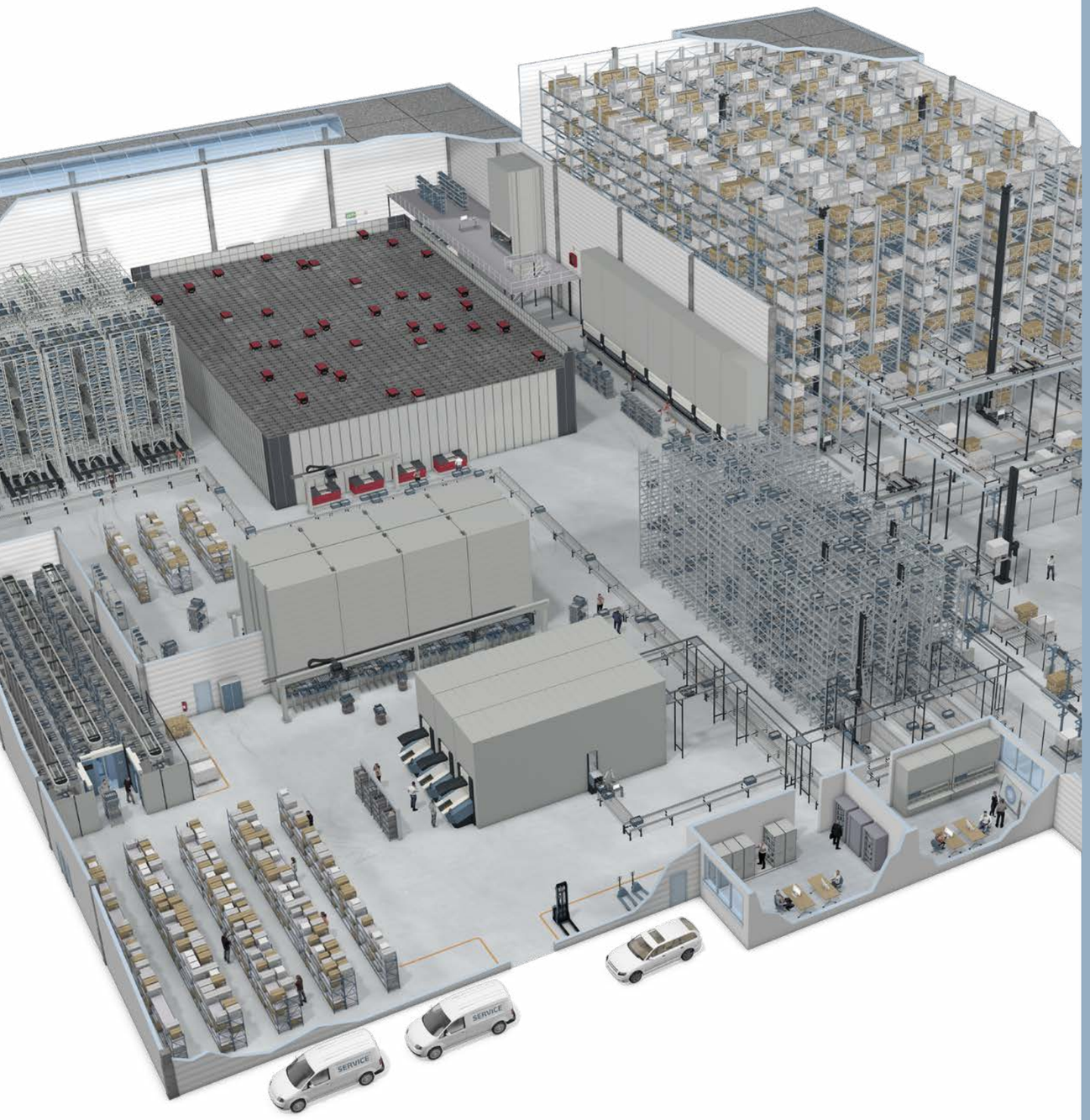
Warehouse Insights

ASRS 101 Comprehensive Guide

kardex



Introduction

Automated storage and retrieval systems (ASRS) combine high density storage with automation technology to store more goods in less space, and deliver those goods faster and more accurately than manual storage options.

Valued for their ability to free up floorspace in a warehouse, improve worker efficiency so businesses can do more work with less labor, raise order picking throughput to match rising customer demands, and improve inventory management control and visibility, it's no wonder that ASRS presence in fully and semi-automated warehouses is rising across the globe.

This is a comprehensive guide to all things ASRS. It is written for warehouse, distribution center, operations, and supply chains professionals who are looking to understand what this versatile automation technology has to offer and how it can solve problems within their operation. It covers everything from the very basics of ASRS, to cost and ROI, to applications and industries, and more. Navigate the sections below to find any information you're looking for based on where your business could see the quickest return, or work through the guide step by step and finish as an ASRS expert.

Section 1

What is ASRS?

"ASRS are advanced technological solutions designed to efficiently and automatically manage the storage and retrieval of goods."

At a glance – Benefits of ASRS

The benefits of implementing ASRS are significant and multifaceted, but at their core, ASRS help businesses:

- Save Space
- Reduce Labor Requirements
- Increase Pick Accuracy
- Improve Inventory Control
- Enhance Safety & Ergonomics

Skip ahead to **Section 2** for a deep dive into each of the five primary benefits of ASRS.

At a glance – Common ASRS applications

ASRS technology is most commonly used in environments where space optimization, inventory control, and fast material turnover are critical. These systems are prevalent in:

- Manufacturing facilities
- Distribution centers
- Retail warehousing

Skip ahead to **Section 5** for the full breakdown of common ASRS applications.

Automated Storage & Retrieval Systems

Automated Storage and Retrieval Systems (ASRS) are advanced technological solutions designed to efficiently and automatically manage the storage and retrieval of goods. These systems have been in use since the 1960s, evolving continually to integrate the latest in automation technology to meet the growing demands of modern warehousing, manufacturing, and distribution.

ASRS typically consist of high-density storage structures with integrated software and mechanical components that automatically place and retrieve loads from specific storage locations. By doing so, ASRS dramatically reduces the footprint required for storage and increases the speed of storing and retrieving inventory.

The versatility of ASRS makes it suitable for almost any industry where inventory management is a concern, proving especially beneficial in sectors with high-volume storage and retrieval needs or where precision and speed are business-critical.

Manual vs. Automated Picking

In traditional warehousing environments, manual picking involves workers physically moving to storage areas to collect items for orders – a process that can be time-consuming and error prone. Manual picking is also labor-intensive and often requires significant walking, lifting, bending, and reaching, all of which can lead to worker fatigue and injuries.

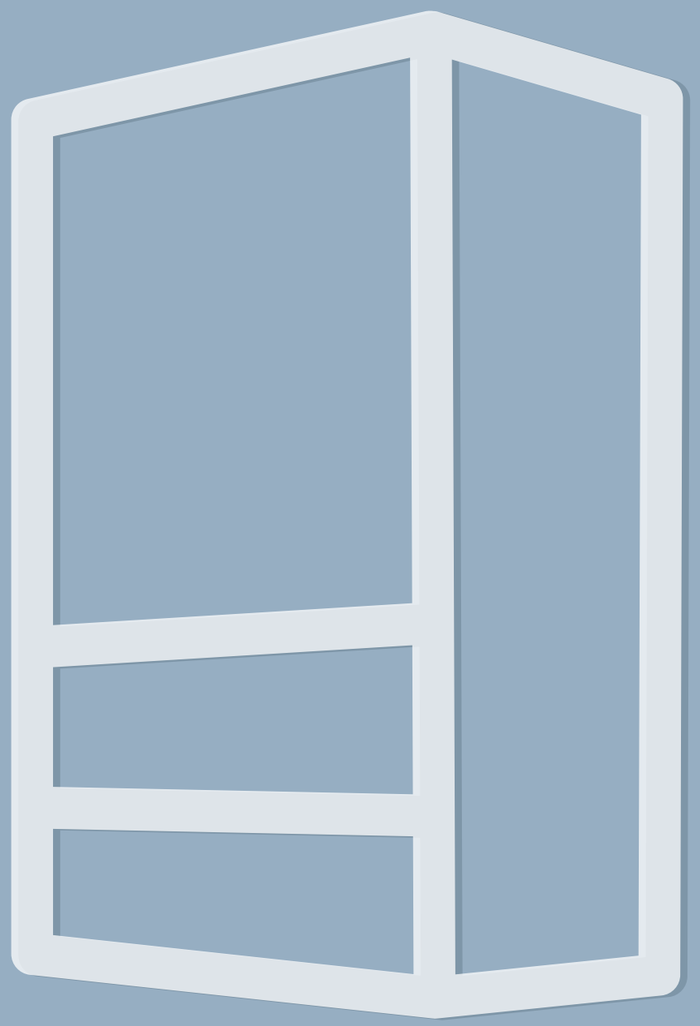
Contrastingly, automated picking systems like ASRS drastically reduce the need for physical labor to store and retrieve goods. By leveraging automated technologies such as Vertical Lift Modules (VLMs), robotics, AMRs, and conveyance systems, the required items are brought directly to an operator or to an automated packing area. This method not only speeds up the picking process but also enhances accuracy with features like pick-to-light or pick-to-voice systems that ensure correct item retrieval.

This integration of automation within the storage and retrieval process leads to significant improvements in throughput and productivity, addressing some of the most pressing challenges faced by industries today, including labor shortages and the need for rapid order fulfillment.

Understanding ASRS in Action

Section 2

Types of ASRS technologies



Choosing the right type of ASRS is a complex decision. The sheer variety of ASRS on the market means that selecting the appropriate system involves careful analysis of multiple factors including cost, scalability, speed, and the physical characteristics of the items to be stored and retrieved.

At its core, ASRS technology is renowned for its versatility and scalability, making it possible for multiple system types to effectively address the same logistical challenge. Whether a business requires high-density storage, rapid retrieval times, or enhanced inventory accuracy, there's an ASRS configuration to match.

At the end of the day, there are multitude of factors to consider when choosing the right ASRS technology for your application. These factors include simple things like available floor space and inventory size, and complex things like pick velocity and varying size between inventory types. We recommended you work with your local Kardex representative to help you find the right solution.

In the meantime, this guide is a great place to start to understand what's out there. This section discusses the three different categories of ASRS based on method of delivery and goes into detail about each of the seven types of ASRS available on the market today.

Three delivery methods

ASRS technologies can be divided into three major categories based on how they deliver goods:

- Tray based picking—an entire shelf or tray of product is delivered to an operator
- Bin based picking—an individual bin or tote of product is delivered to the operator
- Robotic picking—robots are used to deliver products to an operator

ASRS technologies at a glance

ASRS feature a diverse lineup of technologies that all work to achieve higher efficiencies in warehouse operations. Each solution has their own unique benefits and drawbacks, but often times multiple technologies can achieve similar results depending on the application. For this reason, the ideal solution will often include two or more different goods-to-person ASRS technologies, strategically matching the system to the different inventory profiles and handling characteristics required to create a complete, hybrid solution.

Side-by-side comparison of automated storage and retrieval technologies

Goods-to-person technology	Item velocities*					Storage density**	Floor space savings	Labor savings	Potential system throughput**	Cost savings
	very slow	slow	med	fast	very fast	1=worst to 5=best				1=least to 5=most
Vertical Carousel Modules		×	×			4	5	4	3	
Vertical Lift Modules		×	×			4	5	4	3	
Crane Based Mini-Load ASRS		×				4	4	5	2	
Vertical Buffer Modules		×	×			4	4	4	4	
Robotic Shuttles		×	×	×		4	4	5	5	
Robotic Cube Storage		×	×	×		5	5	5	4	
Floor Robots		×	×	×		3	2	4	4	

* It's not recommended to store very slow or very fast movers in automation.
** Dependent upon system design.

Tray delivery ASRS technologies

Vertical Carousel Modules

The Vertical Carousel Module (VCM) has been around for decades. Comprised of a series of carriers attached to a chain drive, a motor powers the carriers' bi-directional travel in a vertical loop around a track – similar to a Ferris wheel. These automated storage and retrieval systems deliver slow- to medium-velocity items safely and quickly to an ergonomically positioned work counter at the operator's command. Manufacturers add new bells and whistles with each revision, but the heart of the technology remains the same.

Offering throughput at rates of 100 to 400 lines per hour, higher rates can be easily be achieved with the addition of light-directed picking technologies and batching stations that allow picking of multiple orders simultaneously. Offering capacities of 1,430 pounds per carrier, the Vertical Carousel Module is a reliable and cost-effective solution that shouldn't be overlooked.

Learn more about Vertical Carousel Modules

Vertical Lift Modules

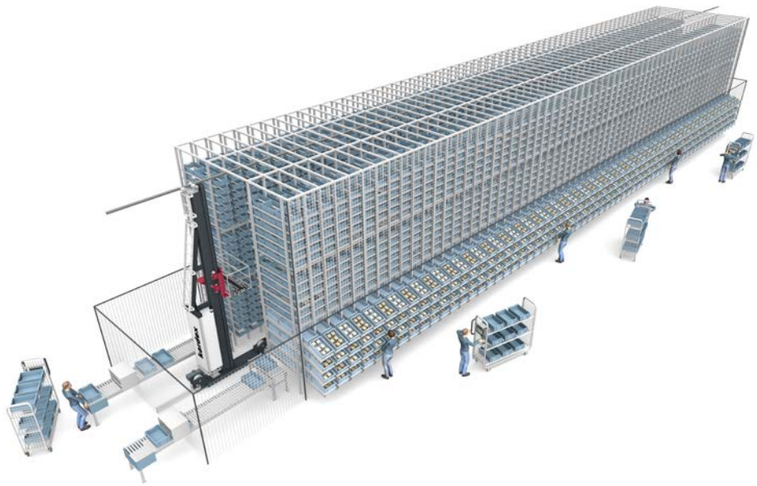
The most flexible technology in this category, the Vertical Lift Module (VLM) automatically adjusts when inventory changes. With trays capable of handling up to 2,200 pounds, this storage solution consists of two columns of trays with an inserter/extractor in the center.

The inserter/extractor automatically locates and retrieves stored trays of slow- to medium- velocity items and presents them to the operator at a waist-high pick window with throughput rates from 125 to 350 items per hour in standard systems. VLMs can be integrated with sophisticated batching stations for even faster picking or integrated with robotic picking technologies for fully automated operations.

Because the height of the items placed in each storage tray is measured as it is put away, the VLM stores the trays dynamically to maximize storage density, saving up to 85% floor space. The VLM is a great technology choice for businesses with changing inventory sizes.

Learn more about Vertical Lift Modules

Bin delivery ASRS technologies



Crane based Mini-Load ASRS

Mini-load systems handle loads with ease. With a single, crane-mounted load handling device dedicated to each extremely dense rack aisle, mini-loads handle products in cases, totes or trays. The cranes travel either on rails or wheels with fast acceleration speeds to deliver product to the operator via a workstation located at the end of the aisle.

The rack in a mini-load can provide single or double deep storage. The average weight per location is around 100 pounds in a single deep location and 200 pounds in a double deep location. Ideal for slow moving items, single deep mini-loads are capable of delivering 1 load per minute, for throughput rates of 60 to 100 lines per hour, while double deep mini-loads can deliver 2 loads at a time to achieve 120 putaways and 120 picks per hour. If you have 10,000 plus totes or over 25,000 SKUs to store, this is a great high-density storage solution.

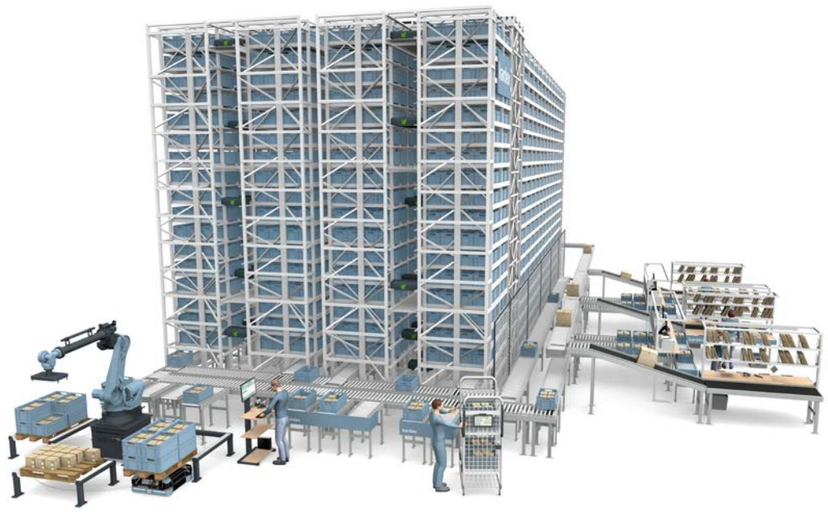
Vertical Buffer Modules

The Vertical Buffer Module (VBM) Kardex Miniload-in-a-Box is a modular, scalable, and highly energy efficient bin handling system designed for smaller applications that often can't cost justify a large, expensive system. The VBM consists of an enclosed shelving system with a movable mast running down a center aisle for picking and storing totes. The unit works ahead of the operator and queues up the next pick to maximize throughput.

Totes are delivered to an ergonomic turntable picking station or automatically handled via inbound and outbound conveyor. The machine can also be configured with a manual station for replenishment of totes during picking operations. Picking never needs to be interrupted for replenishment activities.

Learn more about Vertical Buffer Modules

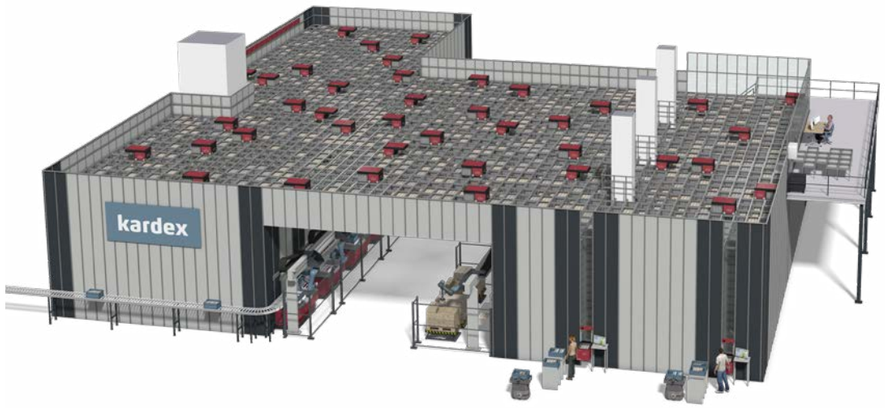
Bin delivery ASRS technologies



Bin Shuttle Systems

This dynamic storage solution uses bin shuttles to travel independently from level to level, riding on narrow rails at each storage level to deliver items to an operator station. Handling cases, totes or trays weighing from 35 to 110 pounds, this type of goods-to-person, automated storage system can deliver increasingly higher throughput (300–1,000 lines per hour) based on the number of bin shuttles inducted into the system.

These systems are modular, scalable and flexible – meaning they can be expanded with minimal structural modifications as business needs change.



Robotic Cube Storage

All robots work independently on the same grid (cube), wirelessly connected to the system and charge themselves when not in use. The controller and software act as the command center providing traffic algorithms. Robotic cube storage from AutoStore is the newest type of ASRS technology. In these systems, smart robots work at the top of the cube to shuffle, sort and retrieve bins and deliver them to a workstation (port) as needed.

Robotic cube storage systems are modular – it's easy to add robots or workstations as throughput demands fluctuate. The system is also configurable as the grid can be built to any shape or size warehouse.

Learn more about Robotic Cube Storage

Robotic delivery ASRS technologies

Mobile Robots (AGVs/AMRs)

These robotic delivery systems move inventory from one place to another using a fleet of mobile robots within a warehouse. Ideal for slow to medium velocity inventory, throughput ranges from 100 to 300 lines per hour and is dependent on the number of vehicles in the system – throughput can also be expanded easily with the addition of more vehicles. The standard weight capacity of 1,000 pounds per bot can also be increased with heavy-duty models handling up to 3,000 pounds per bot.

There are two common types of mobile robots – AGVs and AMRs – and while these technologies are similar, there are some key differences. Automated guided vehicles (AGVs) are good for repetitive and consistent tasks. They are guided by wires, magnetic strips or sensors that are put onto the facility floor. They then travel only along the marked, predetermined routes. While they can detect obstacles in the route, they are unable to travel off the predetermined path to navigate around them.

Autonomous mobile robots (AMRs) have onboard software intelligence allowing these mobile robots to navigate through a facility using maps (similar to how the GPS in your car works). Using the onboard maps combined with sensors and cameras, an AMR can survey the area and plan the best route to get from point A to point B in the warehouse while navigating around obstacles in its path.

Historically, they were most commonly used for the transportation of goods from one section of the warehouse to another in lieu of conveyor – for example transporting finished orders from a Vertical Lift Module work zone to a shipping area. Today, these ultra-flexible systems are being used for a variety of applications including picking, sortation, packing and replenishment.

Integrating pick & place robotics with ASRS

Pick and place robotics can be easily integrated with most ASRS to create a fully robotic solution. They can fully automate (de-)palletizing, replenishment and order picking by picking, handling and placing individual items as well as cartons and entire totes.

(De-) palletizing
Automated depalletizing after the incoming goods area is one of the most established applications using pick and place robotics. Robots can pick up items or cartons and place them in standard bins.

Replenishment
Robots can automatically pick up articles from pallets or transport systems and place them in an ASRS. With high-speed pick and place robots, it is possible to run the picking and replenishment process simultaneously or separately.

Order Picking
Robots pick individual parts from an ASRS and place them in a bin or on a transport system to create an order picking solution with higher throughput and greater accuracy.

Learn more about pick and place robotics

Section 3

Benefits of ASRS

The 5 key benefits of ASRS

This section provides an in-depth guide to the 5 key benefits of ASRS. Each benefit includes a description of potential challenges faced by companies that could benefit from ASRS, how ASRS addresses and resolves that challenge, and how a business can cost justify their ASRS solution based on eliminating or reducing the impact of that challenge.

1 Save space

2 Increase labor efficiency

3 Raise accuracy

4 Enhance inventory control

5 Improve safety & ergonomics

Save space

Warehouse space is expensive

Regardless of where in the U.S. your manufacturing or distribution operations are located, square footage is a significant cost. By implementing automated storage and retrieval systems, you can maximize your inventory density and reduce storage space costs.

While industrial square footage used by manufacturing and distribution operations throughout the U.S. may be a bit easier to come by, the cost of rent has slightly to moderately increased depending on where the facility is located. The Cushman and Wakefield Marketbeat Report reveals: "New completions (supply) continue to exceed net absorption (demand) causing the overall vacancy rate to trend higher. Still, at 5.8% as of Q1 2024, vacancy remains below its historical average of 7%."[1]

While demand for industrial space appears to be cooling, rent growth for industrial space is also slowing down. In Q1 2024, industrial rents increased by 6% annually, compared to 10% in 2023 and 20% in 2022. The US average industrial rent as of Q1 2024 is $9.79 per square foot. The West continues to have the highest industrial rents, rising 5% year-over-year to $14.05 per square foot. The Northeast followed closely, experiencing a significant 16% increase to $13.65 per square foot as of Q1 2024.[2]

These factors indicate a more balanced market with slower rent increases. Thanks to new supply, finding industrial space is getting easier for warehouse and distribution centers, but they'll still see rising costs.

U.S. industrial space by region vacancy & asking rent year over year[2]

Location	Overall Vacancy Rate Q1 2023	Overall Vacancy Rate Q1 2024	Average Asking Rent PSF Q1 2023	Average Asking Rent PSF Q1 2024
Northeast	3.4%	5.5%	$ 11.75	$ 13.65
Midwest	3.4%	4.9%	$ 6.28	$ 6.63
South	4.0%	6.6%	$ 7.28	$ 7.76
West	2.9%	5.7%	$ 13.32	$ 14.05
US Average	3.5%	5.8%	$ 8.90	$ 9.79

ASRS saves space in warehouses

Implementing high-density ASRS immediately reduces the amount of square footage required to store items within static shelving and pallet rack in two ways: one, by utilizing previously unused overhead space, and two, by compressing items stored within the technology for greater storage capacity.

An investment in ASRS enables much more highly compressed storage of the same number of stock keeping units (SKUs) previously held in static shelving, but within a smaller footprint. The resulting increase in available floor space can then be leveraged in one of two ways:

1. By storing a greater quantity of existing SKUs, or an expansion in the number of different SKUs, within the same amount of existing facility space.

2. Through repurposing the space via an internal expansion, such as adding other revenue-generating activities.

Making space make sense

Depending on the type of ASRS selected, the resulting space savings will range from 65% to 85%. To determine the potential cost savings associated with replacing static storage shelving or rack used within a manufacturing facility's parts, stockroom, warehouse or toolcrib area or within a distribution warehouse with ASRS, reduce the current cost of total square footage by a simple 80%.

This figure represents the amount of square footage saved from implementing an automated storage system. To determine the actual cost of the space, multiply the amount by your current rent per sq ft. For example, a manufacturing facility in the Northeast recovering 2,500 sq ft could save over $34,000 to the bottom line.

2,500 sq. ft. space savings × $ 13.65 cost per sq. ft.
= $ 34,125 Potential Savings

Do the math – Consider the value of added revenue.
Because an investment in an ASRS will free up anywhere from 65% to 85% of existing square footage currently used by static shelving or rack in a manufacturing parts, stockroom, warehouse or toolcrib area or within a distribution warehouse, the recovered space can be repurposed for other value added – and revenue generating – activities.

Calculate your potential space savings with ASRS

Increase labor efficiency

Labor costs a lot

Regardless of where a manufacturing or distribution facility is located within the U.S., labor is widely accepted to be one of the biggest operational costs. According to the U.S. Department of Labor's (DOL) Bureau of Labor Statistics (BLS) most recent figures, companies in the Warehousing and Storage subsector (North American Industry Classification System / NAICS 493), have seen rising labor compensation rates (~32% over 5 years) and labor hours worked have decreased (~2% over 5 years).[3]

Further, adding warehousing labor has become an increasing challenge. Unemployment rose drastically in April 2020 due to COVID. After the unemployment peak in summer 2020 (15.7%) unemployment within the BLS Warehousing and Storage parent sector, Transportation and Warehousing has dropped down to right about 4% in 2022 – on par with 2019 levels. Unemployment in this sector remains stable hovering just over 4% in the past 2 years.[4]

Even with unemployment returning to more normal levels post pandemic – when surveyed, more than 250 top logistics and supply chain managers said their three biggest workforce challenges revolve around labor:[5]

1. Finding and keeping qualified/skilled/dependable workers (62%)

2. Increasing workforce productivity (57%)

3. Controlling labor costs (45%)[8]

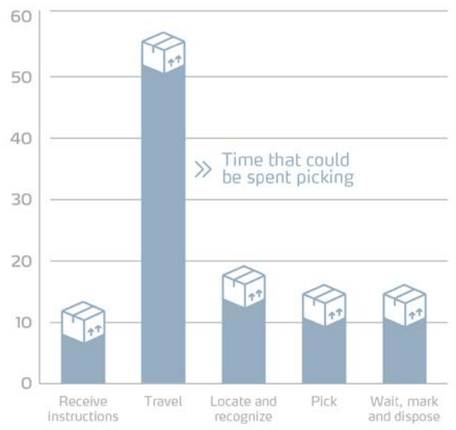
As labor continues to remain a top challenge, many manufacturing and distribution operations are considering automated storage and retrieval systems (ASRS) to boost operational productivity while prioritizing worker health and safety.

ASRS makes labor more efficient

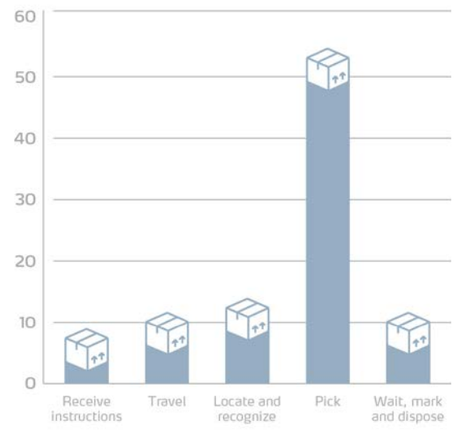
Manual vs automated picking operations
Picking involves much more than grabbing an item off a static storage rack or shelf. In the typical manual operation, picking means a warehouse associate receives a paper list of instructions about what to pick and where, travels to the correct storage location, refers to the paper pick list to determine the number of items required from the pick face, picks the items, confirms the pick by marking the paper, then delivers the items for packing.

In a manual picking operation, overall the worker spends over 50% of their time traveling to the item to pick. In an automated picking operation the items are delivered to the worker, reducing travel time to just over 10% of their time. Automation allows a worker to spend over 50% of their time actually picking items - making them far more productive than a worker in a manual picking operation.

Before automation

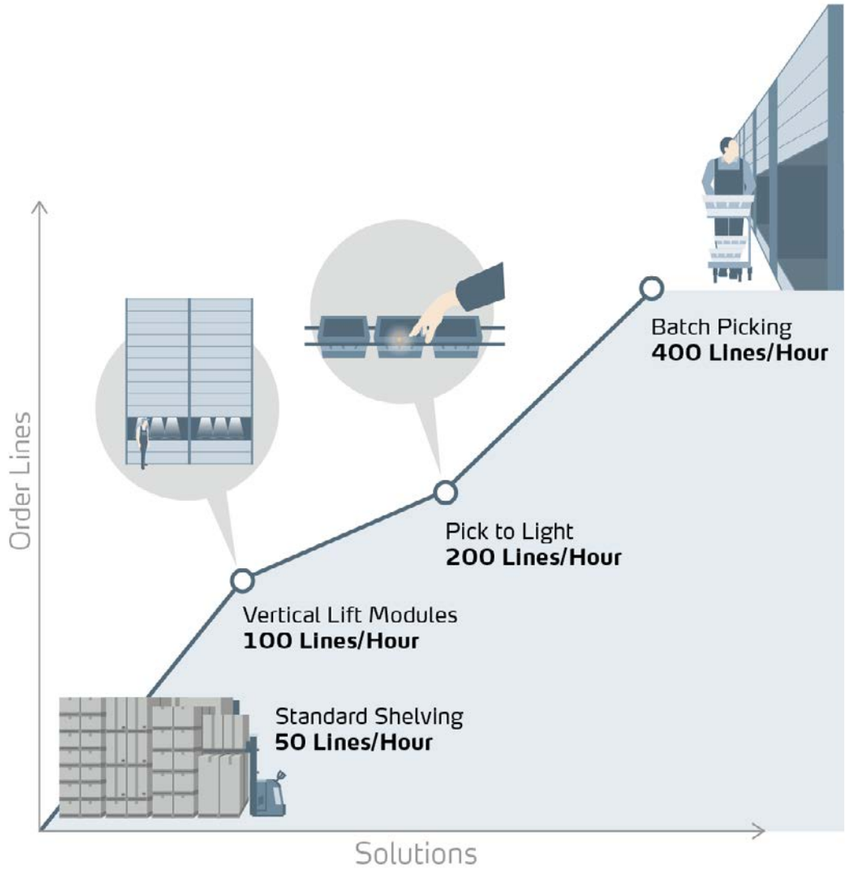


After automation



Eliminating travel times
Travel and search time in a manual storage operation can account for as much as 60–65% of a picker's time. ASRS technologies present stored items directly to an operator, eliminating time spent walking from one pick location to another. ASRS interfaces with both inventory management and order management software. Picks are sequenced so the machine's movement is optimized to match the required picks. All items can be picked in one rotation, or cycle, of the machine's storage bins or trays, maximizing pick time.

Because an automated solution enables just one worker to handle the picking assignments of multiple operators, as many as two-thirds of a facility's workforce can be reassigned to non-picking tasks without a loss of throughput. Facilities implementing an automated solution to increase picking capacities most often choose to maintain current labor levels to realize increased throughput or compensate for scarce or unreliable labor.



Productivity rates
Operators picking manually are often restricted to filling one order at a time, which severely limits productivity. Restricted to paper pick lists and a lack of picking optimization software, they may visit the same popular SKU pick faces multiple times in a day. For a facility with static shelving or pallet rack, this translates into pick rates of approximately 50 lines per hour.

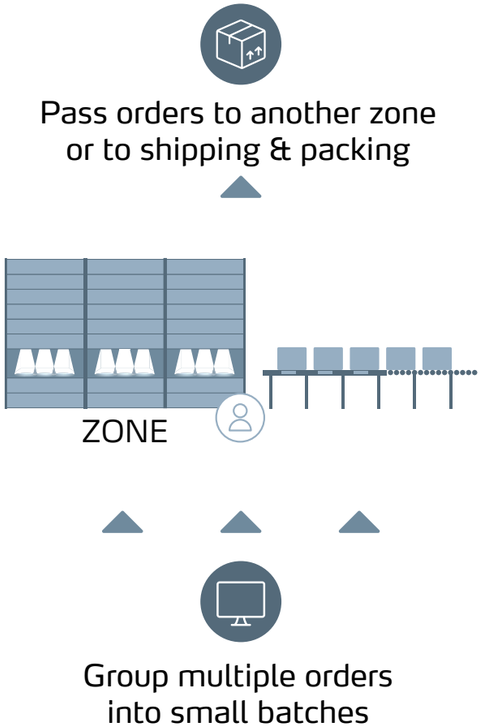
Alternately, an ASRS facilitates batch picking. This process groups orders with a common item, or items, together so that multiples of the same item are picked during one visit to the pick location, then sorted to their appropriate order totes for shipping at a nearby workstation. This means multiple orders can be filled at one time – up to 750 lines per hour, as shown in Table 3.

Table 3: System Comparison – Picking Rates

System	Bag & Tag (lines per hour)	Pick & Toss (lines per hour)
Shelving	10 – 35	30 – 75
Drawers	10 – 35	30 – 50
Flow Rack	25 – 45	75 – 150
Pallet Rack	35 – 60	95 – 200
Horizontal Carousel Module	75 – 200	225 – 750
Vertical Carousel Module	50 – 175	150 – 225
VLM	50 – 150	125 – 175

Batch picking with ASRS
Because ASRS utilize integrated inventory management software, batch picks can be completed in a single rotation, or cycle, of the unit. Batch picking with an ASRS eliminates bottlenecks associated with waiting for one last item to complete an order or to finish a manufacturing process. Should a “hot pick” come up, the ASRS easily accommodate a pause in the batch picking sequence, allowing a non-batched order to be fulfilled on demand to prevent additional holdups.

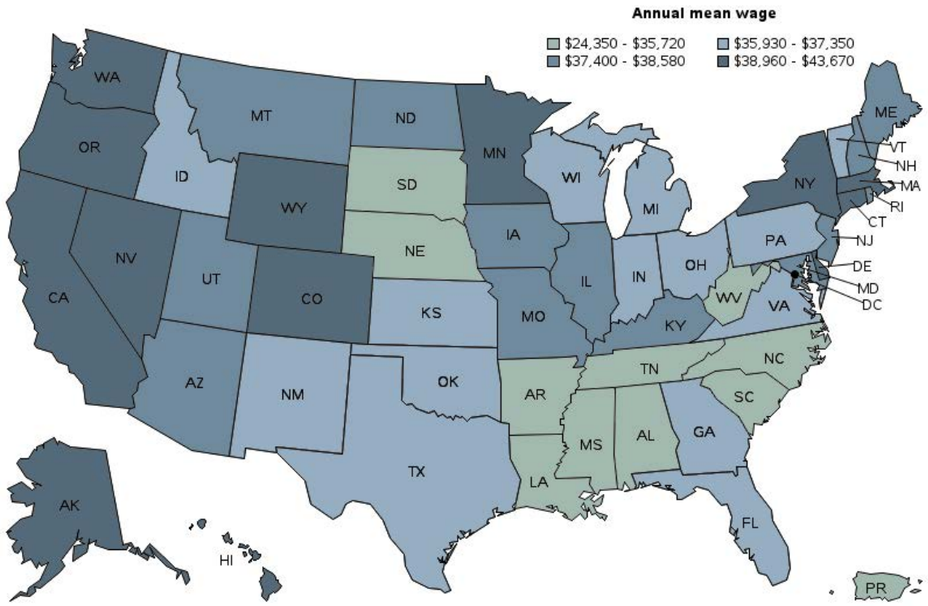
Batch picking can also be used to prioritize orders by importance or by inventory availability. This enables customer order cut-off times to be extended, increasing a company’s competitiveness and customer satisfaction.



Cost justifying based on Labor

Regional labor costs
Regionally, the annual mean (average) wage by state for workers who pick inventory – what the BLS terms as "Warehousing and Storage – Stockers and Order Fillers" – ranges from $24,350 to $43,670 as shown.[6]

Nationally, the BLS reports 451,860 people employed in this occupation in the warehouse and storage industry with a mean hourly wage of $21.13 and a mean annual wage of $43,950 (neither of these numbers are fully burdened.[6] To calculate the cost of benefits – such as health insurance and retirement savings – add another 36% to these wages.) For the purposes of this calculation, we've used the fully burdened mean annual wage of $59,772 ($43,950 mean annual wage plus 36% for benefits).



BLS annual mean wage map of material moving workers by state[6]

Do the math: How much does labor cost?
Once you determine your labor costs you can then do the math to calculate your potential labor cost savings when implementing ASRS. For example, using a fully burdened labor cost of $59,772, simply multiply by the number of people you can now reassign to other areas to find your total savings.

$ 59,772 × 4 people = **$ 239,088 in total labor savings per year**

Calculate your potential space savings with ASRS

Raise accuracy

Manual picking is error-prone

Most order fulfillment operations manually selecting required products to fill a customer order have experienced picking errors. That's because humans are prone to making mistakes.

In the typical manual distribution center, picking means an operator receives a paper list of instructions about what to pick and where, travels to the correct storage location, locates the correct item within that storage location, refers to the paper pick list to determine the number of items required from that pick face, picks the items, confirms the pick by marking the paper, then delivers the items for packing.

All of those steps are fraught with potential for error. Factor in increasing fatigue as an operator walks through a warehouse again and again throughout a shift, and the typically less-than-optimal lighting in most facilities, and it's easy to see why picking mistakes happen.

These picking mistakes, or mispicks, come in a variety of types. Among them:

- False article as a substitute or in addition to the correct products
- Wrong quantity (short pick or over pick)
- Omission error: an order line item has been forgotten
- Condition error: damaged products or improperly labeled articles[11]

So, while most operations understand mistakes will happen, very few have taken the time to calculate the true cost of those mispicks, and how they impact the bottom line.

Doing the math: How much does a mispick cost?
A survey of 250 supply chain and distribution managers across the United States, United Kingdom, France and Germany found "distribution centers are losing an average of nearly $390,000 per year due to mispicks."[7]

The cost of a picking mistake includes not only the cost of the item, but also the expenses to ship it back, processing the item, returning it to stock and potential loss of customer satisfaction. Further time is lost in correcting the mistake by picking, packing and shipping the correct item back to the customer.

More than half of those surveyed experience a mispick rate over 3% while another 19% of facilities don't even measure mispicks.[7] Although 3% sounds like a slim margin for improvement, it adds up quickly, as illustrated here:

A facility picking 250 lines per hour, averaging three SKUs per order, and running one 8-hour shift per day picks 6,000 items daily. If 3% of those picks are incorrect, that translates to 180 mispicks. The cost of each mispick... can average as much as $25 apiece, or more. Therefore, 60 mispicks equal $4,500 in lost revenue a day.

- Distribution centers are losing an average of nearly $390,000 per year due to mispicks
- Cost of a picking mistake includes not only the cost of the item, but also the shipping, processing, returning and customer satisfaction
- An estimated 50% of facilities experience ongoing mispick rates over 3%

Automation increases picking accuracy

Reducing mispicks: Light-directed solutions boost picking accuracy
Automated, goods-to-person storage and retrieval systems (ASRS) – such as Vertical Carousel Modules (VCMs), Vertical Lift Modules (VLMs) and Vertical Buffer Modules (VBMs) – deliver items directly to an operator, eliminating walk and search time, as well as fatigue. In addition to delivering the items directly to the operator, ASRS can be equipped with light-directed picking features which reduce human error by helping operators with four basic functions:

1. Picking a specific or active item
2. Putting an item in an active order or location
3. Communicating a message such as a quantity or description of the item
4. Completing the pick and moving on to the next pick

Light-directed picking technologies have evolved into complete message centers that communicate to the operator the precise area within the unit of the item to be picked, display the part number or description, pinpoint the exact location, direct either picking or storage and indicate the required quantity. Not only do these devices dramatically reduce picking mistakes, but they also lead to happier customers who are more likely to buy again.

Integrate inventory control software
To achieve the highest degree of picking accuracy, integrating inventory management software with an ASRS enables smart functionality such as inventory monitoring. In addition to keeping track of the contents stored within the machine, the software also interfaces with a facility's warehouse management system (WMS) and enterprise resource planning (ERP) systems. This function allows managers to closely monitor stock levels in real time – and potentially eliminate physical counts – for better inventory control.

For example, in systems equipped with an RF barcode scanner, the operator can be required to scan each picked item. The data captured by the scanner is relayed to the inventory control software, which verifies that the picked part is the same one required by the order. This barcode recognition feature can also be used when replenishing inventory in the system. During restocking, the operator scans both the item and its destination to verify placement into the correct storage location. Adding scanning to a storage and retrieval system ensures additional accuracy in order picking and SKU replenishment, significantly reducing mispicks.

Use barcode scanners
For operations that stock a few high dollar value items or regulated products, the software can be configured to require a barcode scan only when triggered by certain parameters. Qualifiers can be limited to certain transactions, product types or item storage locations, selectively boosting accuracy and control without sacrificing pick speed.

For facilities requiring an operator to match part numbers or pick items from a specific batch, lot or serial number—visual verification can be tedious and error-prone. For these applications, barcode scanning can be used to verify with the inventory management software the correct item has been picked, saving time and ensuring accuracy.

Finally, in highly regulated industries such as medical device, healthcare and pharmaceuticals, the same software functionality can be leveraged for its track-and-trace capabilities. The software maintains a record of the item, the date it was picked, the operator who picked it and the order it fulfilled. Should a defect be identified, or a recall required, the software can quickly determine the locations of both stocked and shipped products.

Light-directed technologies
To increase picking accuracy up to 99.9%, the following light-directed technologies can be added to automated storage and retrieval systems:

Display LED-Navigator
Integrated with VCMs and VLMs, this dynamic pick-to-light technology displays information for the operator. It uses light as a communication tool to provide part descriptions, quantities and other messages to help an operator select the correct item and amount for order fulfillment.

Light pointer
Used with VLMs or VBMs, this system deploys a LED or laser light mounted on a slider that moves on a guiding system within the access opening of the unit. Software-driven, the light pointer also swivels to project the light beam in the depth direction of the machine to illuminate any position within the storage tray or tote. The light identifies the precise location of the item to be picked or replenished, eliminating search time.

Position indicator light bar
Incorporated into the access openings of both vertical lift modules and vertical carousel modules, these LED lights illuminate in alignment with the position of the required item where it is stored in the tray.

Put/Batch lights
These light-directed picking modules direct an operator to put or store items in a specific or active location when replenishing stock. They can also be used for order consolidation, batch picking and sortation at workstations located near the ASRS.

In addition to these light-directed technologies, automated storage and retrieval systems can also incorporate radio-frequency (RF) scanners for barcode verification of picked items, voice-directed picking modules that give verbal commands to operators wearing a head-set or scales that verify the correct number of small parts have been picked based on their weight.

Light-directed picking system add-ons that dramatically reduce mispicks

	Capabilities			Integrates with		
	Picking	Putting	Message	VCM	VLM	VBM
Display LED-Navigator	×	×	×	×	×	
Light pointer	×	×			×	×
Position indicator light bar	×	×		×	×	
Put/batch lights		×	×	×	×	×

Accuracy impacts the bottom line

Increasing pick accuracy, even by less than a percent, will not only contribute to a dramatic reduction in picking mistakes, but it will also result in tremendous cost savings. Further, customer satisfaction will improve, likely leading to an increase in repeat purchases.

Just how much cost savings can result from using automated storage systems that incorporate light-directed picking technologies? The table below shares two examples of the cost savings that can be gained by reducing pick error from 1% to 0.1%. Reducing the mispick rate even slightly yields a 90% cost savings.

Calculate the savings from fewer mispicks

	1% mispick rate	0.1% mispick rate
Lines per hour	250	250
Average SKUs/order	× 3	× 3
SKUs picked per hour	= 750	= 750
One 8 hour shift	× 8	× 8
SKUs picked per day	= 6,000	= 6,000
Mispick rate	× 1%	× 0.1%
Mispicks per day	= 60	= 6
Average cost of a mispick	× $25	× $25
Total lost revenue per day	= $1,500	= $150
Working days per year	× 260	× 260
Total lost revenue per year with 0.1% mispick rate	= $390,000	= $39,000
Savings per year between 1% and 0.1% mispick rate		**$351,000** **90% cost savings**

4 Enhance Inventory Control

Inventory can be tough to keep track of

Effective inventory control is a persistent challenge for many warehouses. As operations scale and the volume of goods handled increases, maintaining accurate inventory records becomes increasingly complex. Manual tracking methods, while traditional, are often prone to human error, leading to misplaced items, inaccurate stock levels, and inefficiencies that can significantly impact the overall productivity of a warehouse.

One major issue is the difficulty in maintaining real-time visibility of inventory. Without accurate, up-to-date information, warehouses struggle to make informed decisions about restocking, order fulfillment, and space utilization. This lack of visibility often results in stockouts or overstocks, both of which are costly. Stockouts lead to missed sales opportunities and dissatisfied customers, while overstocks tie up capital in unsold goods and take up valuable storage space.

Additionally, the manual organization of inventory is labor-intensive and inefficient. Employees spend significant time searching for items, which could be better spent on higher-value tasks. This inefficiency not only slows down the fulfillment process but also increases labor costs. Furthermore, the physical strain associated with constant searching and handling can lead to workplace injuries, affecting worker morale and productivity.

Finally, the scalability of traditional inventory management systems is limited. As warehouses grow and diversify their stock, the complexity of managing inventory increases exponentially. Without an automated solution, scaling operations while maintaining accuracy and efficiency becomes nearly impossible. This bottleneck can stifle growth and hinder the ability to meet market demands effectively.

Make inventory control easy with ASRS

ASRS improves inventory control
Determining how and where received inventory should be stored depends on many factors, including the types of products and by frequency of picking/velocity of movement (fast, medium, slow or very slow). Most operations focus their inventory optimization efforts solely on their fast movers – which typically comprise just 20 percent of their inventory. That leaves 80 percent of inventory (medium and slow movers) available for further optimization and control through slotting.

The slotting process determines the most appropriate place to store each item in a warehouse, including within an ASRS, based on pick velocity. This means fast and medium movers should be in the most accessible areas, while slow and very slow movers should be stored in areas less accessible.

Information from a WMS, ERP or integrated ASRS inventory management software can be leveraged and integrated with the slotting process for even greater inventory control. By ensuring these software systems are inter-connected for ongoing communication, repetitive – and potentially error-prone – data entry can be avoided. This also enables broader inventory visibility in real time, resulting in a reduction in search time through faster and easier accessibility. Finally, this integration enables the software to automatically reslot product as needed to accommodate changes in inventory, special promotions or seasonal peaks.

Better Organization – To help find the items even faster, partitioned trays or totes can be used for better organization making it easy to locate small components. Further, the inventory management software monitors the status of every item to organize stored products by frequency of picking together, or by their usage association to individual pieces of automated equipment and the maintenance required.

Pick accuracy
To ensure the right item is picked, ASRS can be equipped with a range of validation tools. This might include an RF barcode scanner used to capture barcode data associated with an item. The information captured by the scanner is relayed to the inventory management software, which verifies the picked part is the same one required by the order. For facilities requiring an operator to match part numbers or pick items from a specific batch, lot or serial number – visual verification can be tedious, time consuming and error-prone. For these applications, barcode scanning can be used to verify with the inventory management software that the correct item has been picked, saving time and ensuring accuracy.

Alternately, ASRS machines can be equipped with indicator lights to illuminate the item's location and pick quantity required for even higher accuracy. This cuts the time spent searching for a specific stock keeping unit (SKU) within the storage tray.

Item Protection – When stored on shelves, parts are exposed to dirt and dust common in distribution, warehousing and manufacturing operations. This shortens their useful ife and renders them unsuitable for use – creating scrap and waste. Because ASRS machines can be fully enclosed, the items they store are kept clean and protected. Not only does pick accuracy improve, but the parts picked are always in good usable condition.

Track and trace
For highly regulated industries – such as medical devices – the same ASRS inventory management software functionality can be leveraged for its track-and-trace capabilities. That's because the software maintains a record of the item, the date it was picked, the operator who picked it and the order it fulfilled. Should a defect be identified, or a recall required, the software can quickly determine the locations of both stocked and shipped products.

The inventory management software also provides traceability. To access stored contents, authorized operators can be required to first input a software-traceable personal login and password. For operations wishing to keep track of consumables (such as lubricants and filters) or shared tools and gear (from screwdrivers and ratchets to welding helmets and other safety items) required to service equipment, this additional measure of accountability allows depleted, missing or misplaced items to be quickly traced back to an individual.

Theft Prevention – In contrast to open shelving which allows anyone passing by the opportunity to grab something off the shelf, an ASRS can be secured, requiring a software-traceable personal login before operation. This allows missing or misplaced goods to be traced back to an individual. The enhanced level of accountability and security eliminates inventory shrink and its negative impact on the bottom line.

Replenishment
Since the ASRS inventory management software can keep track of every item within the machine, it can be pre-programmed to send an alert when an item is approaching out-of-stock, triggering a call for replenishment from safety stock stored elsewhere. Upon placement of replenishment inventory into the machine, the software leverages barcode recognition by requiring the operator to scan both the item and its destination to verify placement into the correct storage location. This creates additional inventory control, preventing replenishment errors.

Inventory turn
With integrated inventory management software, an ASRS ensures items are picked by pre-set standards to optimize inventory turn. This ensures product is used well before its expiration date, or the oldest items are used first by directing first in, first out (FIFO) or last in, first out (LIFO) picking.

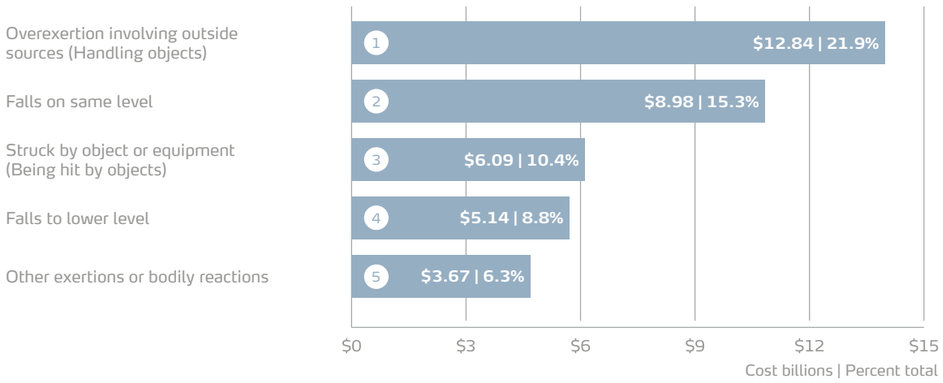
Cycle counting
In open shelving spread across hundreds or thousands of square feet, items can simply get lost. It can be a challenge to know how many items are in stock, and their precise location. Regular cycle counts can help account for items but are time-consuming and not up-to-the-minute current. Because an ASRS with integrated inventory management software tracks every item stored within the machine, managers can closely monitor stock levels in real time – and potentially eliminate physical counts – to reduce the amount of inventory they must have on hand.

Improve Safety & Ergonomics

Warehouse tasks are tedious and injury-prone

When it comes to warehouse and distribution employees, more organizations are deploying ergonomically designed automation systems. These ergonomic solutions help workers complete picking and order fulfillment tasks while simultaneously eliminating the risk of injury. In addition to enhancing safety, these systems can boost productivity and reduce a variety of costs – positioning both workers and companies for operational success.

The Workplace Safety Index complies and classifies all non fatal worker injuries yearly. Interestingly the top 5 all occur within the workplace - involving overexertion, falls or accidents and can in some cases be prevented with improved worker safety and ergonomics.[8]



Common ergonomic injuries and their costs
Serious, non-fatal workplace injuries cost U.S. businesses nearly $59 billion in according to the annual workplace safey index's non-fatal worker compensation injury claims last year, that's over $1 billion a week.[8] Within the Index's top ranking of the most frequent causes of those injuries, two of the top five are associated with the physical exertion most frequently seen in retrieval of stored items.

1 **Overexertion**
"Injuries related to lifting, pushing, pulling, holding, carrying or throwing, cost businesses $12.84 billion in direct costs and accounted for nearly one quarter of the overall national burden."

5 **Exertion/reaction**
injuries resulting from tasks such as "bending, reaching, twisting climbing, crawling, kneeling, sitting, standing, walking or running were responsible for 6.3% of the overall injury burden, costing U.S. businesses $3.67 billion.

Workers' compensation insurance covers the direct costs of occupational injury and illness, such as medical costs and wage replacement (indemnity). How much might an ergonomic injury cost?

The average cost per medically consulted injury can be **$42,000 per employee** (on average). This figure includes estimates of wages lost, medical expenses, administrative expenses and employer costs, but exclude property damage costs except to motor vehicles.[9]

Employers, however, also experience significant indirect costs associated with a worker injured on the job. That's because there are so many hidden or unanticipated expenses resulting from an employee injury. According to Occupational Safety and Health Administration (OSHA), possible indirect costs can include (but aren't limited to):[10]

- Training temporary or replacement employees
- Accident investigation and implementation of corrective measures
- Lost productivity
- Repairs of damaged equipment and property
- Costs associated with lower employee morale and absenteeism

Clearly, the costs of an ergonomic injury can add up.

Regulations and recommendations
Although OSHA has not established a maximum limit on how much weight a person may lift or carry,[11] it does offer recommendations for the prevention of musculoskeletal disorders – including muscle strains and lower back injuries. The agency also notes, the Bureau of Labor Statistics (BLS) found transportation and warehousing to be one of four industries with the highest rate of musculoskeletal disorders related to lifting heavy items, bending, reaching overhead, or pushing and pulling heavy loads.[12]

Taking the establishment of guidelines a step further, the National Institute of Occupational Safety and Health (NIOSH) has developed a mathematical calculation to evaluate risk factors for manual material handling tasks, such as lifting and lowering. According to Revised NIOSH Lifting Equation (RNLE), the maximum recommended load weight that a healthy worker can lift under ideal conditions is 51 pounds.[13] When six other variables are multiplied into the equation (horizontal location of the load; vertical location of the load; distance the load is moved; degree of twisting required; frequency and length of lifting activity; and the worker's grip on the load), that maximum weight decreases.[13]

Companies that are well versed in these ergonomic issues often have dedicated Health, Safety and the Environment (HSE) teams to ensure workers are safe on the job. They have already established safe handling practices, such as blocking warehouse aisles when forklifts are retrieving or placing items stored at heights and using spotters to warn pedestrians and other workers in the area of activity overhead. Others have begun lowering the maximum load weight they will allow an employee to lift unassisted to 35 pounds – a full 16 pounds less than the NIOSH recommendations – as an aggressive measure to further prevent musculoskeletal disorders.

NIOSH and OSHA recommend that workers use powered equipment – such as automated storage and retrieval systems (ASRS) and cranes outfitted with an electric hoist[14] – as an alternative to lifting loads manually.

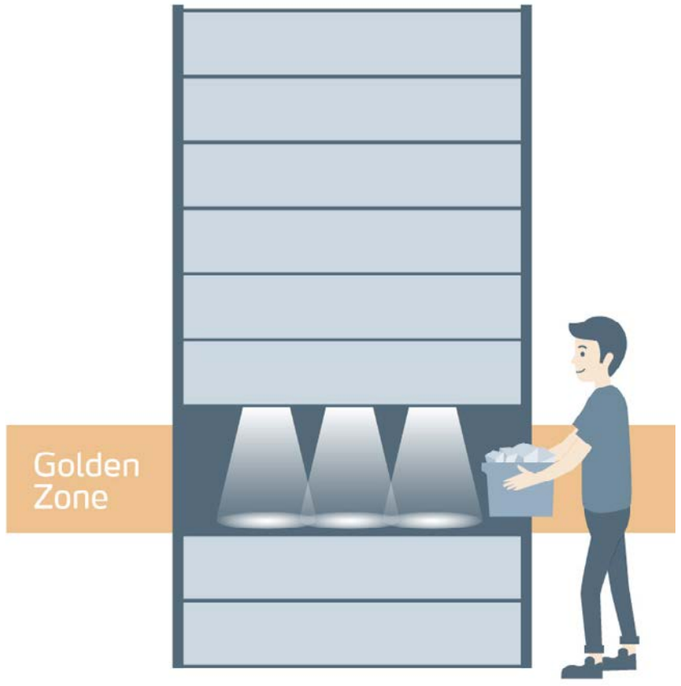
ASRS reduces the risk of injury

Minimize fatigue, improve accuracy
Automated storage and retrieval systems eliminate unproductive and physically tiring travel and search time by delivering required items directly to the operator on command. Workers in conventional warehouses spend as much as 60% of their time walking to product, searching for it on a shelf and climbing on a ladder to reach items stored high or kneeling to access items stored low. With an ASRS, a worker no longer has to spend as much time on travel or retrieval of items. Not only does limiting an operator to just a few steps to complete picking tasks dramatically reduce fatigue, it also boosts picking rates dramatically.

Further, a less-fatigued worker is a more accurate one. Tired operators are more likely to make mistakes. In addition to minimizing fatigue caused by exertion, these automated goods-to-person systems can prevent errors when equipped with a variety of supporting technologies. Additions such as light-directed picking systems and monitors that display images of the items to be picked further errors, resulting in up to 99.9% picking accuracy.

Go for the gold(en zone)
Every item stored in an ASRS is delivered to the operator at the optimal ergo-nomicwork height, called the “Golden Zone,” or waist-high. Shelves, trays, totes or bins of products presented in the waist-high golden zone eliminates bending down to retrieve an item stored low or stretching up to grab an item stored high.

The machines also minimize unnecessary or excessive motions required for retrieval of items from drawers or shelves, such as reaching, stretching, bending, pushing, pulling, or stooping. Likewise, ladders, climbing and forklifts are not needed to place or retrieve items.



Tray extraction
Further, VLMs can be equipped with a manual or automatic tray extractor for even easier load handling. With a manual extraction device, the operator can easily glide the tray completely out of the VLM and onto a cart. The tray of items can then be rolled to any destination within the facility, such as a workstation for parts kitting or a work cell that requires tooling stored within the VLM. Upon its return, the extraction device accepts the tray with minimal operator effort.

Ideal for heavier loads (such as heavy parts, tooling, dies and molds), the automatic tray extractor mechanically slides the tray out of the machine. This ergonomic assist function prevents a worker from having to reach inside the system to pull the tray or item out.

Need a lift? Add a hoist
VLMs can be engineered to hold a range of different load capacities per tray, including 4-foot-wide goods weighing more than 2,200 pounds up to 13-foot-wide items weighing more than 1,700 pounds. Loads that heavy are impossible for an operator to lift. For such situations, a VLM can be equipped with an integrated, overhead crane and electric hoist to provide further ergonomic handling assistance.

With an integrated hoist, an operator using a handheld, wired control pendant can safely and confidently direct the lifting of the load from the tray, then position it as needed. To accommodate different load types, the hoist can be outfitted with a variety of customized below-the-hook attachments, end effectors or specialized tooling. For safety and control, the hoist maneuvers the load to its destination precisely, at a fraction of the rated speed.

The hoist takes the strain of lifting the load off the worker, further reducing fatigue and lowering injury risk. It also handles products gently to minimize damage and waste. Unlike forklifts, which are involved in up to 62,000 accidents and 87 deaths annually[15] and can be costly to own and maintain, the integrated crane and hoist operate only with the VLM.

Section 4

Cost justifying an ASRS project

Making sense of the cost of ASRS

What contributes to the cost of ASRS?

The most obvious cost contributing to an ASRS solution is ultimately the equipment/technology you choose. In a large or highly specialized ASRS system there might be some upfront costs for system analysis and design to reconfigure your facility to maximize the benefits of automation, but here are the main factors impacting the cost of the equipment itself.

The cost of an automated storage and retrieval system (ASRS) can vary widely

One standalone vertical carousel to manage your MRO parts (think $80K) costs vastly different from a fully integrated ASRS mini-load system managing over 80,000 SKUs (think $3M+).

Starting costs of an (ASRS) Automated Storage and Retrieval System:

- Vertical Carousels $70,000+
- Vertical Lift Modules $95,000+
- Vertical Buffer Modules $180,000+
- Mini-load ASRS $750,000+
- Unit-load ASRS $1,000,000+
- Multi-Shuttle $1,000,000+
- Robotic Cube Storage $1,500,000+

Let's walk through the five different elements that impact the total cost of a complete solution. The good news is dynamic automated storage solutions often provide an ROI of under 18 months due to the labor, space and picking efficiencies they offer.

ASRS technology

ASRS systems are typically made up of a movable component (an inserter/extractor, moveable crane, robotic delivery system) and a static storage area (shelves, racks, bins). Rule of thumb is the larger you go the less expensive the cost per cubic foot is. This is because the moving parts are the most expensive part of the system. The storage area is static and less expensive to expand. Thus the cost per cubic foot comes down as the unit size increases.

Environment

The environment the technology operates in will also impact the cost of the unit – clean room and climate controlled (cold, hot, dry) environments will increase the cost of the unit. In addition to the environment within the unit, the location of your facility might require the unit to meet seismic requirements in earthquake zones.

Stored products

The physical size of your inventory – specifically items that are extra-long or large – can increase the cost of the machine. The weight of the stored products might require a heavy-duty machine with stronger trays or bins. Products requiring special handling – such as hazardous chemicals and liquids, bio-medical products, electronics (ESD), food products and pharmaceuticals – might increase the price of the ASRS solution.

Machine controls

The cost of the machine controls can vary depending on the type of technology. Generally speaking, the more moving parts and the larger the system – the higher the controls cost.

Required throughput

The speed in which you need to retrieve stored products from the system will impact the cost. The faster the throughput (time to retrieve/pick a stored item from the system) the higher the cost.

Software

Most ASRS can provide basic inventory management from the onboard controls. Different levels of inventory management software can be added for increased inventory control and order picking capabilities. Most inventory management software is available in tiered packages where the cost increases as you add more features. This allows a semi-customizable solution in most cases and keeps you from paying for features you don't need.

For more advanced operations, the inventory management software can be integrated directly with an existing WMS or ERP system. Some ASRS technologies can also interface directly with an existing WMS. Software integrations can be complicated - but are well worth the time, effort and cost depending on your objectives.

Delivery & installation

Another piece of the cost is shipping and delivery of the unit from the manufacturing site to your facility and the installation onsite. These costs should also include the dismantle, takeaway and disposal of your existing system and any work that needs to be done to prepare the area for the new technology (reinforced floor, relocation of overhead duct work or sprinkler heads, outside installations with new enclosures, installations between floors, etc.).

When planning installation costs, consider the location of the unit within your facility:

- **Are your doors large enough to get the machine parts to the installation area or does the machine have to be uncrated in another area (or outside)?**
- **Is the installation area free and clear and easy to move around?**
- **Do you have fork and scissor lifts, or will these need to be rented?**

Implementation

Once the equipment is installed, there are costs associated with implementing the new technology into your existing processes. These costs are highly dependent on the size of your operations and the depth of the integration you are striving for.

Moving beyond a stand-alone ASRS product into a total solution has major benefits but can come with added costs. The first is the machine interaction cost – how items will go into the ASRS and how they will come out. Will a person be responsible for getting items in and out of the machine(s)? If so, do they require an ergonomic hoist, a manual transport cart? Also consider supporting technologies – such as light or voice directed picking technology, barcode or QR scanning, etc. Or will the ASRS interaction be highly automated with an automatic conveyor transport or robotic picking.

Also consider how the parts within the ASRS will be organized. Most often ASRS solutions require totes, bins and dividers to use the space within the system most efficiently and get optimal productivity rates. These can be included in the machine costs, but sometimes are not – so be sure to account for these.

Then it's time to load parts into the ASRS. Do not underestimate the time and cost of the parts move. This is often overlooked and brushed aside with a "we can do it ourselves" attitude. However, it takes many painstaking hours, days and sometimes weeks to configure the locations within the ASRS and then physically move parts from one system to another.

It might be in your best interest to have an expert advisor from the ASRS manufacturer manage the entire implementation for you – including the machine interaction process, installation and parts move.

In addition, when replacing an existing solution, parts often must be moved to temporary storage and then into the ASRS. With a clear and well-thought-out plan, a parts move can happen in a weekend with minimal impact to your operations. There is definitely a cost associated with a parts move, but it's often one worth paying someone else to do it for you. ASRS implementation can be very simplistic or extremely complex depending on your level of integration.

Ongoing costs

Initial basic user training is often included with the machine or software costs; but it's important to plan (and budget) for regular updated training. As the users get comfortable with the new technology they will benefit from a short refresher training a few months after initial installation – now with a working understanding of the technology and processes. This is also true for organizations with high turnover. A "train the trainer" user philosophy can work well, but don't overlook the benefit of some occasional updated training from the original manufacturer.

If you don't plan for maintenance, your machine will plan it for you.

For the future success of the ASRS, it's critical you budget and plan for the recommended scheduled preventative maintenance as suggested by the manufacturer. Most often, preventative maintenance is included (and required) by the manufacturer within the warranty phase. After the warranty expires, it's up to you to keep the technology maintained. Regularly scheduled preventative maintenance will help to reduce or eliminate unplanned downtime.

For optimal efficiency, inventory within the ASRS should be regularly analyzed and re-slotted within the system. Over time you will find inventory that was once a fast moving "hot" SKU is now a slow mover. As the pick frequency of the SKU changes, so should its location within the ASRS. Slotting philosophies can vary slightly between automated storage technology – but you always want fast moving inventory in the most accessible locations. While there isn't a hard cost associated here (however your time is a soft cost!); be sure to plan a regular slotting review (monthly, quarterly, semiannually) to keep your ASRS investment running at peak performance.

Cost justifying an ASRS project

Calculating your potential savings with ASRS

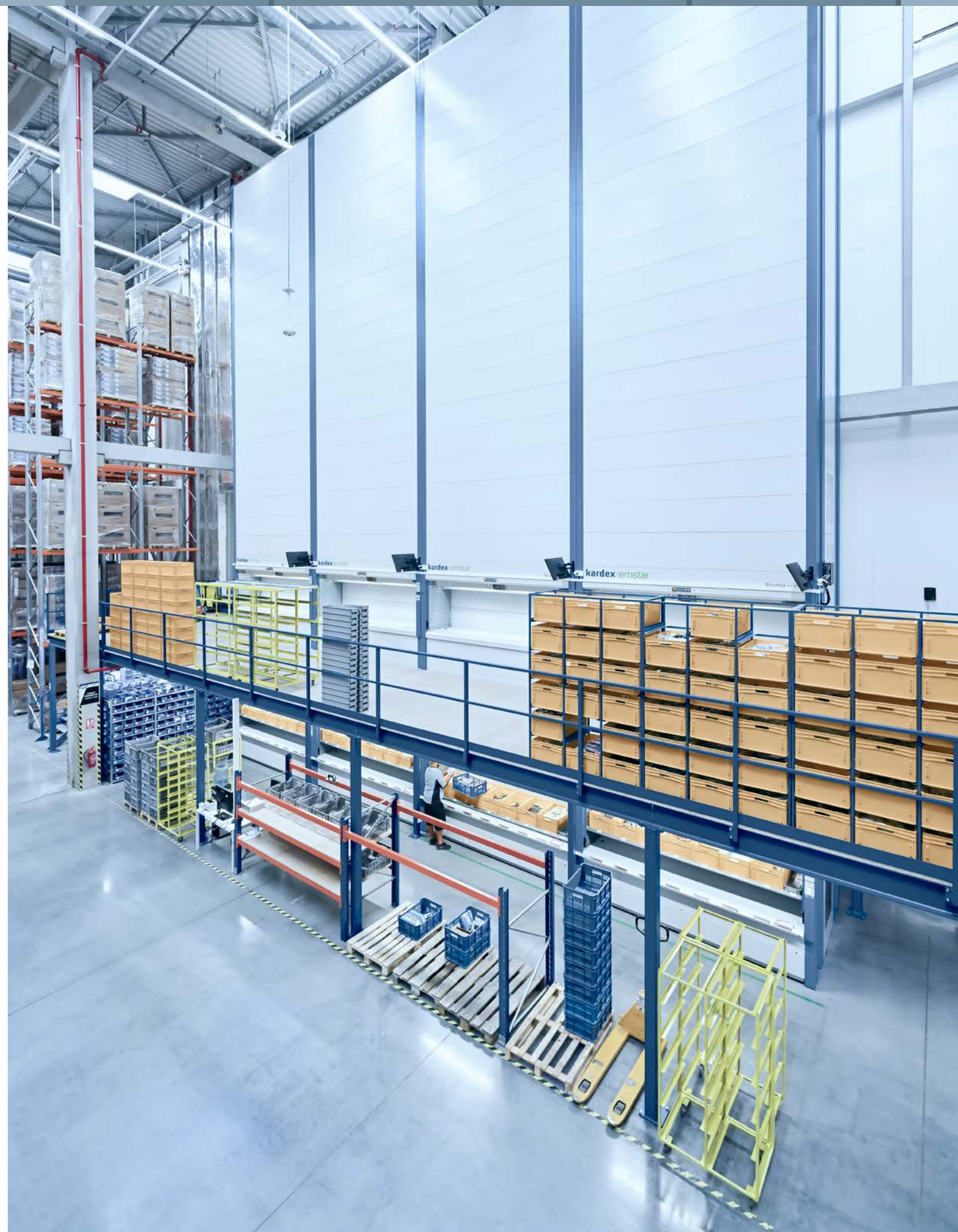
ASRS Projects often don't cost justify based on a single benefit – in fact it usually requires two or three of the five benefits to pull a project into profitability.

Sound like a lot of work? Don't worry – click here to go straight to our free online ASRS Savings Calculator.

This calculator is a designed to help businesses evaluate the financial benefits of implementing ASRS. It provides a detailed analysis of the various cost-saving aspects associated with ASRS: space utilization, labor reduction, accuracy improvements, ergonomic benefits, and throughput enhancements.

By inputting specific data related to their current operations, businesses can see a comprehensive breakdown of potential savings and efficiency gains. The calculator considers factors such as the current cost of space, labor expenses, error rates, and the impact of workplace injuries. It then projects how these costs would be reduced through the adoption of ASRS technology.

This tool is essential for businesses looking to justify the investment in automation by clearly illustrating the financial returns and operational improvements that can be achieved.



Consider the cost of floor space

A dynamic storage solution dramatically reduces the footprint needed for storage by optimizing space utilization. Originally occupying 100,000 square feet at a cost of $800,000 per year, the dynamic system now efficiently uses just 20,000 square feet, costing $160,000 annually. This change recovered 80,000 square feet, translating into substantial cost savings of $640,000 per year. This is because the cost per square foot remains constant at $8, but the reduction in needed space decreases overall costs.

	Your current system	Dynamic storage solution
Total yearly cost of warehouse or distribution area	$800,000	$160,000
Square feet of warehouse or distribution area	100,000	20,000
Yearly cost per square foot	$8	$8
Recovered floor space (sq. ft.)	0	80,000
Cost savings per year		**$640,000**

Consider the cost of labor

With the introduction of a dynamic storage solution, the number of employees required for picking operations was reduced from six to two. Given that each employee costs $50,000 annually, this reduction in labor force led to a decrease in total labor costs from $300,000 to $100,000 annually, achieving labor cost savings of $200,000. This reduction is attributed to the increased efficiency and automation capabilities of the ASRS, which minimizes the need for manual handling.

	Your current system	Dynamic storage solution
Number of employees picking	6	2
Cost of employee per year (fully burdened)	$50,000	$50,000
Total labor cost per year	$300,000	$100,000
Cost savings per year		**$200,000**

Consider the cost of accuracy

Errors in picking processes are costly, and by improving accuracy from a 2% pickerror rate to 1%, significant savings are realized. Given that each pick error incurs an average cost of $25, reducing the error rate effectively halved the cost associated with picking errors – from $300,000 to $150,000 annually, resulting in savings of $150,000 per year. This improvement in accuracy is facilitated by the precision and reliability of the ASRS technology.

	Your current system	Dynamic storage solution
Total picks per day	2,500	2,500
Pick error rate	2%	1%
Average cost of pick error	$25	$25
Total cost of picking errors per year	$300,000	$150,000
Cost savings per year		**$150,000**

Consider the cost of ergonomics

Improving workplace ergonomics with an ASRS not only enhances worker safety but also reduces financial liabilities from injuries. The number of workers' liability and injuries decreased from one per year to 0.25, with each incident costing $100,000. This reduction decreased the total liability cost from $100,000 to $25,000 per year, resulting in annual savings of $75,000.

	Your current system	Dynamic storage solution
Workers liability and injuries per year	1	0.25
Standard liability claim	$100,000	$100,000
Total liability cost per year	$100,000	$25,000
Cost savings per year		**$75,000**

Consider the value of throughput

The implementation of a dynamic storage solution enables a more efficient picking process, increasing the number of line items picked per person. Oftentimes, warehouses choose to forgo the labor savings described above in favor of dramatically increased throughput. Instead realizing any labor savings, they keep the same amount of order pickers and reap the rewards of more productivity.

With 6 people picking 240 working days, this increase in efficiency raised the total number of line items picked from 453,600 to 1,814,400 per year. With an average revenue of $5.51 per line item, this increase in throughput could potentially generate an additional $7,497,344 in revenue annually.

	Your current system	Dynamic storage solution
Revenue generated	$2,500,000	$9,997,344
Number of people order picking	6	6
Sustained number of line items picked per person per hour*	45	180
Sustained number of line items picked as a company per year**	453,600	1,814,400
Average revenue per line items picked	$5.51	$5.51
Additional revenue opportunity per year**		**$7,497,344**

Consider the value of recovered floor space

When leveraging ASRS to reduce the required warehouse space, the recovered floorspace can be used for additional revenue-generating activities. Multiplying the revenue per square foot by the amount of floorspace recovered reveals your potential additional revenue opportunity per year.

	Your current system	Dynamic storage solution
Revenue generated	$2,500,000	$2,500,000
Square feet of warehouse or distribution area	100,000	20,000
Revenue per square foot	$25	$25
Recovered floor space (Sq. Ft.)	0	80,000
Additional revenue opportunity per year**		**$2,000,000**

* assumes standard rack and shelving without software, picklights or batching, assumes dynamic solution includes multiple machines in a workstation with software, picking and batching.
** assumes 240 single shift working days per year

Section 5

Common ASRS systems applications

ASRS are used to manage small parts inventories, sub-assembly, work-in-process, maintenance and repair parts and large tools and dies in a variety of applications found within manufacturing and distribution facilities. Common applications include:

- Storage
- Order Picking
- Kitting
- Order Consolidation
- Buffering
- Assembly
- Tools, Dies & Molds
- Maintenance & Repair Parts
- Replishment & Returns
- Climate Controlled & Clean Room Environment

Storage

ASRS provid e high-density storage for parts and components crucial in manufacturing processes. These systems efficiently utilize vertical space, allowing facilities to store more in less floor area, thereby optimizing the storage environment and reducing material handling requirements.

Order picking

ASRS systems enhance order picking operations by offering compact, fast, and reliable access to items. This automation brings stored items directly to operators, streamlining order fulfillment and reducing picking errors through advanced software integration that manages inventory and tracking.

Kitting

In kitting applications, ASRS manage the receipt, grouping, and storage of component parts for assembly. These systems organize parts into pre-determined kits, storing them until needed for assembly lines, which simplifies production processes and reduces assembly time.

Order consolidation

ASRS provide a compact solution to efficiently manage order consolidation. They temporarily store incomplete orders, securely holding them until the remaining items are gathered and the order can be finalized, enhancing the efficiency of order processing.

Buffering

For operations requiring process buffering, ASRS offer a highly dense storage solution. They effectively manage workflow fluctuations by storing excess products temporarily until needed in the production cycle, thus maintaining continuous operation without delays.

Assembly

In assembly applications, ASRS store work-in-process or sub-assemblies until they are needed later in the manufacturing process.
This capability ensures components are protected and readily available, facilitating a smoother workflow and quicker assembly times.

Tools, dies & molds

ASRS provide ergonomic and secure storage for heavy and often expensive tools, dies, and molds required in automated production processes.
By automating the storage and retrieval, these systems reduce the risk of damage and injury, improving tool management and accessibility.

Maintenance & repair parts

For maintenance and repair operations, ASRS systems offer compact, organized storage of parts onsite. This reduces downtime by ensuring that necessary parts are easy to find and retrieve, thereby speeding up maintenance tasks.

Replenishment & returns

ASRS systems streamline the management of inventory for replenishment and returns. They automate the storage and retrieval processes, enhancing the efficiency of these operations and reducing the labor typically required for manual handling.

Climate controlled & clean room environment

ASRS are particularly effective in environments requiring controlled conditions such as cold, clean, and dry storage. They maintain the integrity of sensitive items by providing stable environments that protect against contamination and temperature variations.

Section 6

ASRS solutions by industry

ASRS offer benefits across many industries, and are capable of adapting to each industry's unique operational challenges to enhance efficiency, save space, and streamline processes. The applications of ASRS are diverse and versatile, tailored to meet specific industry needs from manufacturing and distribution to specialized sectors like healthcare and public administration. This section explores just some of the ways ASRS can be integrated into various industry settings, highlighting how each can leverage these dynamic systems to improve productivity, increase inventory control, and enhance worker ergonomics. While the examples provided illustrate common applications, the potential uses of ASRS extend far beyond these scenarios, demonstrating the system's adaptability and wide-ranging utility in numerous other contexts.

- Administration & Service
- Automotive & Transportation Equipment
- Chemicals
- Consumer Goods
- Wholesale / Retail / E-Commerce
- Electronics
- Energy / Mining
- Healthcare / Hospitals
- Mechanical Engineering
- Pharmaceuticals
- Public Administration & Government
- Third-Party Logistics / Transportation

Administration/Services

Storage
Efficiently stores documents, records, and office supplies, reducing the space required and improving retrieval times.

Automotive & Transportation Equipment

Kitting
Handles the assembly of automotive parts kits for production lines, ensuring that all necessary components are grouped and accessible.

Tools, dies & molds
Securely stores and retrieves bulky or heavy automotive tools and dies, which are essential for vehicle manufacturing and maintenance.

Maintenance & repair parts
Provides quick access to frequently used parts, reducing downtime in automotive repair and maintenance tasks.

Chemicals

Buffering
Offers chemical manufacturers the ability to store sensitive materials safely before they are needed in the production process, adhering to strict safety and environmental standards.

Climate controlled & clean room environments
Manages the storage of chemicals that require specific environmental conditions to maintain their integrity.

Consumer Goods

Order picking
Enhances the efficiency of order fulfillment processes for a wide range of consumer products, from household items to electronics, ensuring fast consumer delivery.

Replenishment & returns
Manages inventory levels effectively to handle returns and keep popular items in stock.

E-Commerce/Retail/Wholesale

Order picking
Critical for managing a high volume of diverse orders, especially during peak shopping seasons, to meet consumer expectations for rapid delivery.

Assembly
Useful for gift wrapping or special packaging services offered by e-commerce platforms.

Replenishment & returns
Optimizes the handling of returns, a common occurrence in online shopping by quickly restocking returned items and maintaining accurate inventory levels.

Electronics

Storage
Manages a wide array of components and finished products, optimizing space with high-density storage solutions.

Kitting
Supports the assembly process by organizing electronic components into kits, streamlining production lines.

Climate controlled & clean room environments
Manages the storage of electronic components that require specific environmental conditions to maintain their integrity.

Energy/Mining

Maintenance & repair parts
Stores critical equipment and tools needed for maintenance and repairs in energy production or mining operations, ensuring they are protected and ready for use.

Tools, dies & molds
Manages the storage of heavy and expensive equipment used in drilling and mining operations.

Hospital

Order picking
Enhances the management and dispensing of medical supplies, ensuring that the correct items are available for various hospital departments swiftly and accurately.

Climate controlled & clean room environments
Ideal for storing sensitive medical supplies, such as pharmaceuticals or sterilized instruments, under strict conditions.

Mechanical Engineering

Kitting
Facilitates the assembly of mechanical components by organizing them into ready-to-use kits.

Tools, dies & molds
Provides efficient access to heavy tools and molds used in manufacturing mechanical components.

Pharmaceuticals

Climate controlled and clean room environments
Essential for storing sensitive pharmaceutical products that require controlled temperatures and sterile conditions.

Order picking
Ensures accurate and rapid handling of medications, which is crucial for both manufacturing processes and distribution to healthcare providers.

Public Administration/Government

Storage
Manages a variety of materials, from office supplies to sensitive documents, ensuring security and quick accessibility.

Order consolidation
Helps in organizing and distributing various governmental resources efficiently.

Maintenance & repair parts
Stores critical equipment and tools needed for maintenance and repairs in government DOD operations, ensuring they are protected and ready for use.

Third Party Logistics (3PL)

Order picking
Central to the operations of 3PL providers, improving the efficiency and accuracy of order fulfillment for various clients.

Replenishment & returns
Manages stock levels and handles returns effectively, crucial for maintaining service quality in logistics.

Section 7

Choosing an ASRS provider

6 things to consider

Choosing the right ASRS partner is a strategic decision that influences not just the efficiency of your warehouse operations but also the long-term growth and adaptability of your business. By focusing on these six areas, you can select a provider that not only meets your current needs but also supports your future goals. Each factor – from reliability and quality to innovation and support – plays a crucial role in determining the success of your ASRS implementation.

1 **Reliability**

2 **Quality**

3 **Support network**

4 **Innovation**

5 **Software integration**

6 **Customization capabilities**

1. Reliability

- Evaluate the historical stability and industry presence of the ASRS provider. A company with a long and established track record is likely to offer more reliable systems and robust support.
- Consider the provider's global footprint and the extent to which they can support international operations if your business requires it.

2. Quality

- Assess the manufacturing quality of the ASRS systems. Providers who use high-quality materials and adhere to stringent manufacturing processes are likely to offer more durable and reliable systems.
- Quality also extends to the lifespan and maintenance requirements of the systems, which can significantly affect long-term operational costs.

3. Support network

- Look for a provider with a comprehensive support network. This includes not only the initial installation and setup but ongoing maintenance and technical support.
- Evaluate the responsiveness and availability of the provider's support team. A robust service network ensures minimal downtime and efficient resolution of any issues.

4. Innovation

- Investigate the provider's commitment to innovation and their ability to adapt to the changing technology landscape. This is crucial for keeping your operations at the cutting edge and ensuring system scalability.
- Check if the provider continually updates their product offerings with the latest technology and if they have a proven track record of innovative solutions tailored to complex needs.

5. Software integration

- Examine the software solutions offered by the ASRS provider. Effective software integration is crucial for optimizing warehouse operations and ensuring smooth communication between different systems.
- Consider providers who offer customizable software solutions that can be tailored to meet the specific needs of your business and can seamlessly integrate with existing IT infrastructure.

6. Customization capabilities

- Determine the extent to which a provider can customize their solutions to fit your specific operational needs. Customization can be a critical factor in ensuring that the ASRS solution aligns perfectly with your operational workflows.
- Customizable solutions also mean that the system can grow and adapt with your business, adding value over time and ensuring a better return on investment.

Section 8

About Kardex

Kardex is a global industry partner for intralogistics solutions and a leading supplier of automated storage solutions and material handling systems. The Group consists of two entrepreneurially managed divisions, Kardex Remstar and Kardex Mlog.

Kardex Remstar develops, produces, and maintains dynamic storage and retrieval systems and Kardex Mlog offers integrated materials handling systems and automated high-bay warehouses.

The two divisions are partners for their customers over the entire life cycle of a product or solution. This begins with the assessment of customer requirements and continues through planning, realization, and maintenance of customer-specific systems. It ensures a high level of availability combined with low total cost of ownership and operation.

Learn more about Kardex

Bibliographical references

1 Cushman & Wakefield. (n.d.). U.S. industrial marketbeat. Cushman & Wakefield. https://www.cushmanwakefield.com/en/united-states/insights/us-marketbeats/us-industrial-marketbeat

2 Cushman & Wakefield. (2024). U.S. industrial marketbeat: Q1 2024. Cushman & Wakefield. https://cw-gbl-gws-prod.azureedge.net/-/media/cw/marketbeat-pdfs/2024/q1/us-reports/amer/us_industrial_marketbeat_q1_2024.pdf

3 Bureau of Labor Statistics. (n.d.). Warehousing and storage: NAICS 493. U.S. Department of Labor. https://www.bls.gov/iag/tgs/iag493.htm

4 Bureau of Labor Statistics. (n.d.). Unemployment Rate - Nonagricultural Private Wage and Salary Workers, Transportation and Warehousing. U.S. Department of Labor. https://data.bls.gov/timeseries/LNU04034168

5 Material Handling & Logistics U.S. Roadmap. (n.d.). Material Handling & Logistics U.S. Roadmap. http://www.mhlroadmap.org/

6 Bureau of Labor Statistics. (2023). Stockers and order fillers: Occupational employment and wages, May 2023. U.S. Department of Labor. https://www.bls.gov/oes/current/oes537065.htm#:~:text=53%2D7065%20Stockers%20and%20Order,power%20equipment%20to%20fill%20orders

7 Vein, J. (2020). The high cost of inefficient warehouses. Vehicle Service Pros. https://www.vehicleservicepros.com/distribution/parts-distributor/aftermarket-technology/article/21181922/the-high-cost-of-inefficient-warehouses

8 Liberty Mutual Insurance. (2023). 2023 workplace safety index. Liberty Mutual Insurance. https://business.libertymutual.com/wp-content/uploads/2023/08/WorkplaceSafetyIndex_WP.pdf

9 Ving. (2022, June 14). How much do workplace accidents cost your company? Ving Blog. https://blog.vingapp.com/how-much-do-workplace-accidents-cost-your-company

10 Occupational Safety and Health Administration. (n.d.). Business case for safety and health: Costs. U.S. Department of Labor. https://www.osha.gov/businesscase/costs

11 Occupational Safety and Health Administration. (2004, March 29). Standard interpretations. U.S. Department of Labor. https://www.osha.gov/laws-regs/standardinterpretations/2004-03-29-1

12 Bureau of Labor Statistics. (n.d.). Musculoskeletal disorders (MSDs) in the workplace. U.S. Department of Labor. https://www.bls.gov/iif/factsheets/msds.htm

13 2Lift. (n.d.). Safe lifting practices. 2Lift. https://2lift.com/safe-lifting

14 National Institute for Occupational Safety and Health. (2007). Elements of ergonomics programs: A primer based on workplace evaluations of musculoskeletal disorders. Centers for Disease Control and Prevention. https://www.cdc.gov/niosh/docs/2007-131/pdfs/2007-131.pdf

15 Forkify. (n.d.). Forklift accident statistics. Forkify. https://forkify.com/guides/forklift-accident-statistics/