



Compact
scalability
through
easier
warehouse
automation



Dense Storage Whitepaper



Compact Scalability is an intelligent and adaptable concept for automated logistics systems, which is redefining flexibility and efficiency in modern warehousing. The groundbreaking approach seamlessly combines innovative robotics, intelligent software and state-of-the-art hardware to redefine how businesses meet their fulfilment demands.

These scalable solutions will maximise storage capacity within a given footprint while adapting effortlessly to the customer's needs – vertically, horizontally, and with seamless integration. This scalability offers a key advantage, enabling businesses to expand their storage and throughput capabilities without requiring major overhauls to their existing infrastructure. Compact Scalability empowers businesses to grow smarter, faster, and more efficiently.

At the core of Compact Scalability is a robot pallet shuttle system to provide an automated storage and retrieval system (ASRS) designed with modularity for flexible expansion. This will allow 'shuttles' to be added or removed to meet demand fluctuations, peak seasons or business growth. As demand grows, the system can scale horizontally by adding aisles and lanes seamlessly. This allows incremental investment rather than a large upfront overhaul, making it cost-effective and highly efficient.

Integrating a Lift into the pallet shuttle ASRS transforms it into a dynamic 3D storage system, enabling vertical scalability and maximizing space utilization. Moreover, this addition not only supports immediate compact scalability but also provides a flexible foundation to accommodate future increases in demand, allowing the system to scale seamlessly as operational needs evolve.

The benefits of compact scalability

Compact scalability in warehouse operations illustrates how accessible automation and integrated solutions provide significant flexibility, empowering businesses to respond quickly to market changes while optimising costs through incremental system growth. Highly scalable installations can start small, minimizing initial investment, and then expand as needed, or even contract in response to shifting demands. This adaptability enhances productivity and efficiency, allowing warehouses to succeed despite labour shortages and rising volumes across multiple channels.

What is driving the need for compact scalability?

To mitigate supply chain risk in a turbulent world, many manufacturers are looking at nearshoring, which expands the need for localised parts picking. In retail, e-commerce growth continues to place demands on order picking operations. According to Statista, in 2023, global retail e-commerce sales reached an estimated \$5.8 trillion. Projections indicate a 39% growth in this figure over the coming years, with expectations to surpass \$8 trillion by 2027. Real estate company CBRE has estimated that every additional \$1bn spent online translates into demand for 1 million square feet of warehouse space.

For many warehousing operations, these global macro trends filter down to an evolving customer base and expanding volumes that will need to be served through more productive and efficient warehousing and order picking operations. There is an ever more complex assortment of goods or growing numbers of ever smaller orders to fulfil. Customer expectations on lead times are shrinking from days to just hours, placing pressure on businesses to stock, pick, pack and ship from smaller, local facilities, and efficiency in handling returns is gaining far greater prominence as retailers battle to protect margins.

Being unresponsive to such changing business conditions and having an inability to maintain high service levels will demonstrate unreliability to customers, closing off growth opportunities.

In storage terms, many warehouses have little room to manoeuvre, with optimum warehouse occupancy rates of 80–90%. Peaks, particularly in ecommerce, will push the occupancy to the high end of that range, maybe even beyond. Above 90% occupancy however, the warehouse is deemed to be overcrowded, and decisions need to be made regarding finding more space.

Momentum towards high density automation to meet these challenges is growing, with one-quarter of warehouse sites expected to have some form of automation installed by 2027, according to Interact Analysis. Increasingly this is involving flexible robots, and it is anticipated that in 2025, over 4 million commercial robots will be installed in over 50,000 warehouses, up from just under 4,000 robotic warehouses in 2018, according to ABI Research.

Consider the following:

- Do you anticipate changes to your business that will impact warehousing?
- Are your order volumes growing?
- Can you meet the service levels required?
- Do you have capacity in terms of space to cope with demand fluctuations ?
- Does your warehouse have the ability to expand?
- Does your business have a broader strategy in terms of future customers, service and product offerings that may impact on the warehouse?
- What level of growth is the business expecting year-on-year?
- Who will your likely customers be?
- Will your inventory requirements change?
- Will your picking profiles change?
- What financial resources are available for your automation project?
- What rate of growth are you expecting?
- What period of return on investment is acceptable?
- Where would investment in automation produce savings?
- Can a longer term, stepped approach to investing in automation be adopted?

The challenge of space constraints

You can significantly expand your storage capacity without having to buy or rent a new warehouse. Available space in many warehouses is often insufficiently used and in some cases far more than half of the possible storage space goes to waste. Under-utilised or inefficient warehouse space can be costly. Most warehouses do not use the available vertical space, yet enormous storage potential lies fallow here. By utilising vertical space more effectively warehouses can increase their storage capacity by up to 50%.

For companies seeking to future-proof their warehouses by ensuring that their specifications are fit for current and future needs, high density automation and robotics offer a great storage solution. They provide the density to locate as much product as possible on a given footprint to enable the fulfilment of a company's business plans.

In addition to not wasting available, expensive floor area, systems will often need to make effective use of any type of warehouse, including irregularly-shaped pockets of the site that are common in older developments or in urban areas.

Consider the following:

- Is your warehouse space constrained?
- Do you have room for expansion?
- Do you wish to avoid the cost and disruption of moving to a new warehouse?
- Are you seeking to future proof your warehouse?
- Have you conducted a warehouse capacity analysis?



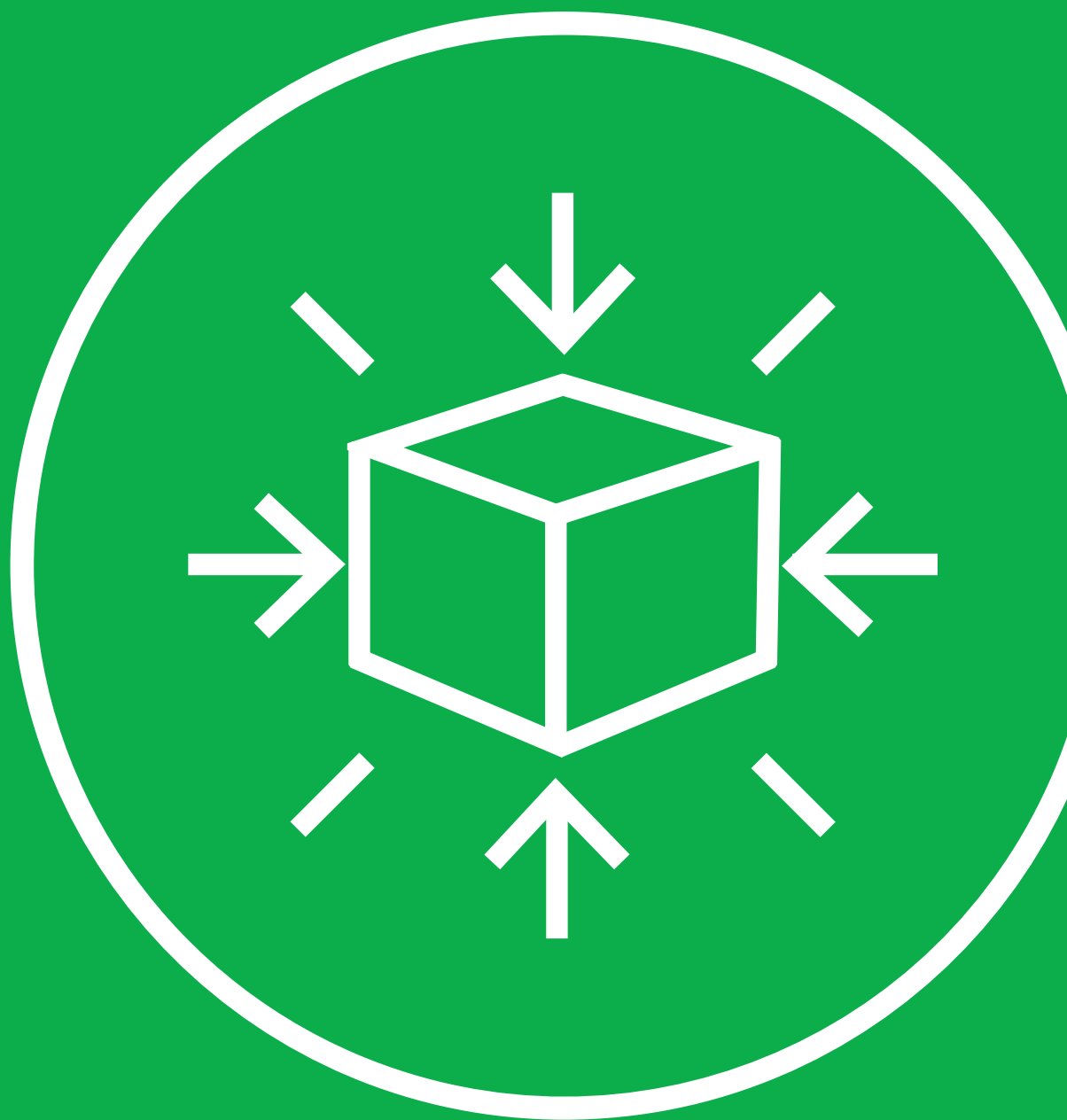
The challenge of scalability

With constant, and often rapid, changes in the business environment, companies striving for growth need the ability to handle rising volumes and be ready to make the most of increased demand. They also want to avoid frequent stockouts and order fulfilment delays, without the incurring the cost of overstocking. There are also shorter term scalability issues around handling peaks and providing reliability of service. Individual robotic shuttles can be added as demand requires. This is much easier than complex reconfiguration of conventional, stacker crane-based systems. In addition, with shuttle systems, robots can be added and/or moved between the levels of a system to optimise throughput. You don't have to use, and incur the expense of, the whole capacity. At low volume times, just use a few robots – at the peak, introduce the whole fleet.

This scalability also provides redundancy to increase warehouse availability. If a robot fails it can be replaced and normal operations resumed with minimal disruption. If a conveyor or a stacker crane, fails, this is likely to shut down operations in at least one aisle, perhaps more, for an indefinite period of time.

Consider the following:

- Do you need a scalable system that will grow to support business growth?
- Are you anticipating future growth of the business?
- Is your business seasonal?
- Do you have peaks in demand?
- Do you need to maintain redundancy to ensure high service levels?



The importance of modularity

Modular design is the key to scalability. It provides a set of building blocks to create a system from simple, standardised 'plug and play' technology to minimise complexity and cost of upgrading. Installations can start small and then expand or, if needed, they can downsize just as easily without significant engineering. Modularity also enables a fast roll out for projects.

Solutions should adapt to the customer environment, not the other way around. Modular systems make it easier to optimise space within a warehouse with different roof heights and a footprint that is not a straightforward rectangle or square, making use of space that would remain empty with other systems.

Consider the following:

- Is your warehouse an irregular shape?
- Is your warehouse a new or old building?
- Are you making full use of your warehouse ceiling space?

The importance of flexibility

Flexibility provided by robotic systems comes from the ability of individual shuttles to be reprogrammed offline and added or removed to accommodate operational requirements, giving easy automation with 'plug-and-play', not just for the initial installation but for continuing once a system is installed. With conveyors or cranes, the operator is stuck with the geometry and to a large extent with the operating procedures these systems have been designed to support, such as different pick routines. Reconfiguring a conveyor run, or rerouting a fleet of Automated Guided Vehicles (AGVs), is a significant engineering task involving closure of part or all of the warehouse.

- Do you need flexibility to meet changing requirements?
- Do you experience peak seasons and/or spikes in demand?
- Does your stock profile change?
- Does your warehouse operate different pick routines?



MovuTM
robotics



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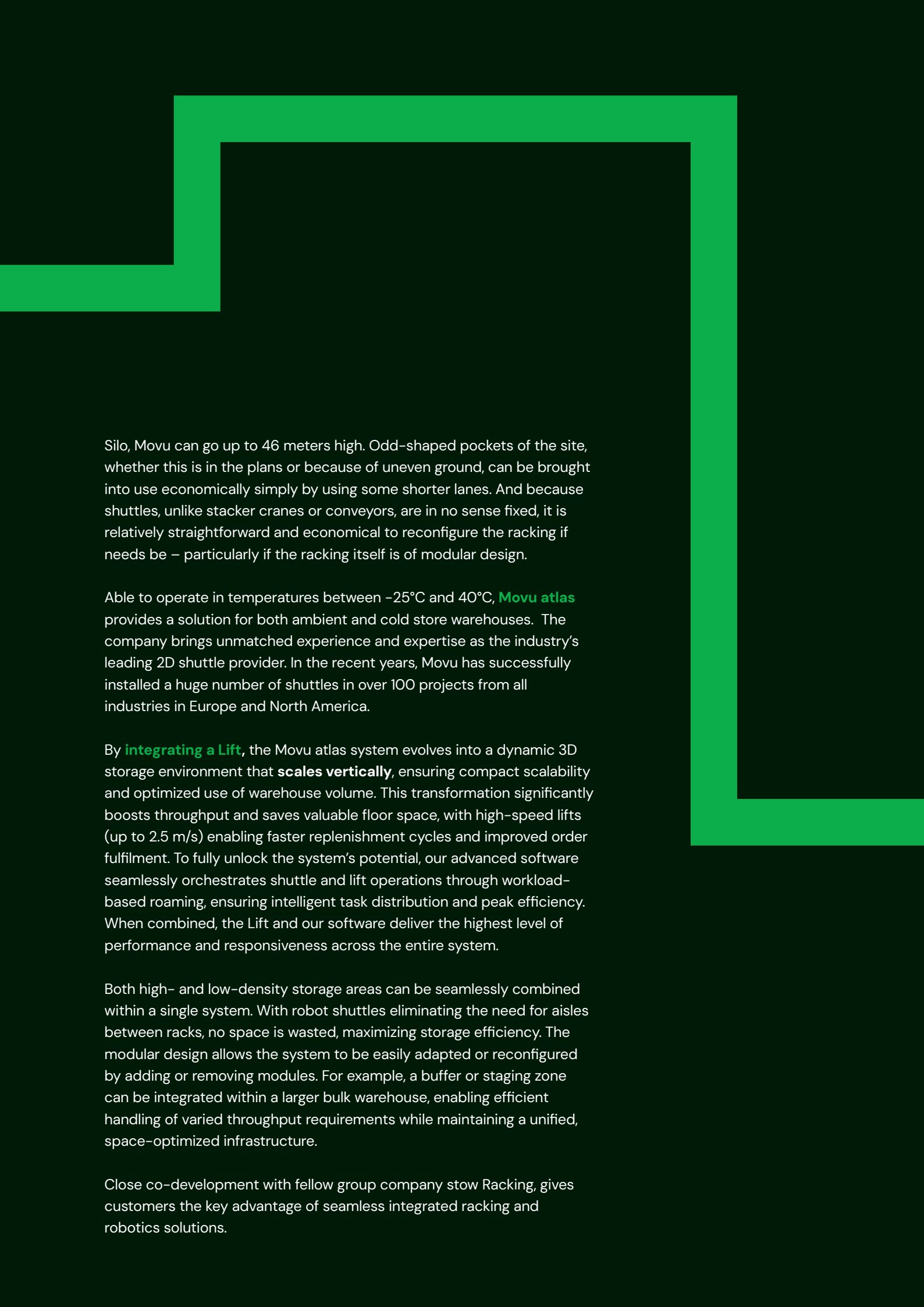




How to achieve compact scalability through appropriate technologies

Movu Robotics presented the appropriate technologies for achieving Compact Scalability at LogiMAT 2025. The **Movu atlas ASRS** is designed with modularity for flexible expansion. It can be added or removed on demand according to fluctuations, peak seasons or business growth. The pallet shuttle system allows for incremental investments rather than a large upfront overhaul, making it cost-effective and highly efficient. As demand grows, the system can **scale horizontally** seamless addition of extra aisles and lanes.

Pallet shuttles operating within deep lane storage racking, and managed by intelligent software, offer a number of advantages besides greatly reducing the amount of 'wasted' aisle space required. With robot shuttles, no space is lost because aisles between the racks are not necessary. In terms of space optimisation there is up to over 50% more storage space. There is no particular limit to vertical height – up to 32 meters is common inhouse, and in the case of a



Silo, Movu can go up to 46 meters high. Odd-shaped pockets of the site, whether this is in the plans or because of uneven ground, can be brought into use economically simply by using some shorter lanes. And because shuttles, unlike stacker cranes or conveyors, are in no sense fixed, it is relatively straightforward and economical to reconfigure the racking if needs be – particularly if the racking itself is of modular design.

Able to operate in temperatures between -25°C and 40°C , **Movu atlas** provides a solution for both ambient and cold store warehouses. The company brings unmatched experience and expertise as the industry's leading 2D shuttle provider. In the recent years, Movu has successfully installed a huge number of shuttles in over 100 projects from all industries in Europe and North America.

By **integrating a Lift**, the Movu atlas system evolves into a dynamic 3D storage environment that **scales vertically**, ensuring compact scalability and optimized use of warehouse volume. This transformation significantly boosts throughput and saves valuable floor space, with high-speed lifts (up to 2.5 m/s) enabling faster replenishment cycles and improved order fulfilment. To fully unlock the system's potential, our advanced software seamlessly orchestrates shuttle and lift operations through workload-based roaming, ensuring intelligent task distribution and peak efficiency. When combined, the Lift and our software deliver the highest level of performance and responsiveness across the entire system.

Both high- and low-density storage areas can be seamlessly combined within a single system. With robot shuttles eliminating the need for aisles between racks, no space is wasted, maximizing storage efficiency. The modular design allows the system to be easily adapted or reconfigured by adding or removing modules. For example, a buffer or staging zone can be integrated within a larger bulk warehouse, enabling efficient handling of varied throughput requirements while maintaining a unified, space-optimized infrastructure.

Close co-development with fellow group company stow Racking, gives customers the key advantage of seamless integrated racking and robotics solutions.

Improving picking performance

Compact scalability can be further enhanced by integrating a **Picking Tunnel**, an efficient, space-optimised pathway that facilitates streamlined order picking within the Movu atlas ASRS. While often integrated at ground level, the tunnel can also be implemented on a mezzanine level, offering greater design flexibility based on warehouse layout. Designed to support high-density pallet storage and retrieval, the tunnel enables smooth interaction between automated shuttles, vertical lifts, and various picking methods. These can range from manual solutions, such as hand pallet trucks or electric pallet trucks to advanced autonomous mobile robots like **Movu ifollow**. This flexibility allows customers to choose the picking method that best matches their operational needs and investment strategy.

Compact Scalability for totes

For Compact Scalability in tote storage, Movu offers **Movu escala**, an all-in-one, rack-and-robot storage and retrieval system to handle totes. It maximises warehouse resilience by leveraging modular applications for unparalleled adaptability. Automatically moving up, down and within storage locations, each shuttle reaches up to five units deep. No need for space-consuming conveyors, lifts or aisles; this high-speed, high-density system is one of the world's most flexible 3D ASRS for bins.

Integrating seamlessly with Movu escala for future proof automated order preparation at the picking workstation, a new version of Movu eligo picking robot is a state-of-the-art robotic solution designed for high-speed and highly efficient item picking operations. It can pick up to 1200 items per hour, reduce the number of manual 'touches' required for order fulfilment or replenishment and can reach a pick success rate greater than 99%. Equipped with advanced vision systems, AI-based algorithms and versatile handling tools, eligo is tailored for modern warehouses that demand precision, speed and adaptability in dynamic environments.

To ensure the seamless operation of automated storage systems for bins in Movu escala, the innovative **Movu Overfill Detection** is a camera-based vision system that identifies items and bins that exceed storage boundaries, preventing overfilled bins from entering the system and ensuring safe, uninterrupted operations.



The intelligence behind Compact Scalability

A vital component of our solution is software perfectly aligned with racking and automated shuttle systems to optimize overall performance. Movu offers a comprehensive three-tier operational control within the Movu WES (Warehouse Execution System), simplifying the management of shuttles, racks, and elevators. At the top level, Movu Ops interfaces with the customer's higher-level system to receive orders and prepare them for processing. Next, the Movu Tower assesses available resources, selects the most suitable shuttle or autonomous mobile robot (AMR), and coordinates task assignment. Finally, Movu Pilot executes the orders at the individual shuttle or AMR level, ensuring seamless, efficient warehouse operations.

Compact Scalability in action

A Movu Robotics atlas pallet shuttle system gives leading logistics service provider Kris De Leeneer (KDL) approximately 45,000 storage locations and the capacity to manage a potential throughput of up to 11,000 pallet movements a week. Importantly, the system fulfils KDL's need for flexibility by allowing pallet throughput to be increased simply by adding more shuttles, while the modular rack can be extended to increase capacity to help futureproof the facility. Shuttles can easily be added or removed as demand requires. A swap facility allows the shuttles to change levels automatically so if, for example, there is a large number of pallets on one level, a shuttle can be brought in from a less busy level to improve its throughput. When installed, the rack gave plenty of space for new customers the facility having the ability for its rear wall be removed if required to allow an extension of the modular rack and the addition of more shuttles, potentially doubling the capacity to 90,000 pallets.

BIO-FROST Westhof, Germany's only purely organic vegetable freezing company, has a pallet shuttle storage and retrieval system featuring a stow Racking silo, served by Movu Atlas shuttles. This provides efficient automated flow of goods and high-density storage in a six-level silo to hold over 5,000 pallets of frozen goods in a cold store. The scalable Movu Atlas system allows the addition of shuttles to increase throughput and store greater quantities of vegetables during the harvest peak. For example, performance can be scaled up by having two shuttles operating on the same level.

Another installation, this time for a company serving the chocolate industry, further demonstrates the Compact Scalability of a Movu Atlas pallet shuttle system. It not only helps to handle the significant peaks of Christmas and Easter but also facilitates future growth.

Last example is the first-time integration of the Movu OPS WES with the Movu atlas Shuttle System at ODT's logistics center, a project that transformed a traditional warehouse into a software-controlled high-density logistics facility. The system provides over 31,000 storage locations across 14,000 sqm of warehouse space, operated by 20 autonomous shuttles on four levels and five high-speed lifts, with a throughput capacity of up to 6,000 pallet moves per day, around the clock. The existing racking infrastructure was fully reused, making this a sustainable brownfield project.



ODTH Rumst



Conclusion

Simple, standardised plug and play solutions for warehouse automation and robotics deliver increased productivity yet are more accessible and more scalable. They create an impressive business case, even operating 'off-peak' at well below capacity there is a rapid Return On Investment with labour redeployed to other tasks, such as picking. But it is at peak times when these systems really come into their own, ramping up throughput without any corresponding increase in labour.

The modularity of Movu atlas and escala enables warehousing operations to easily scale to accommodate growth without the cost of an additional building. In addition to driving operational gains and cost savings, these technologies offer significant energy efficiency benefits: Movu atlas consumes up to five times less energy than traditional solutions like stacker cranes, resulting in over 80% energy savings. This combination of compact scalability and low energy consumption positions warehouses for long-term sustainability and future success.

With stow Racking supplying dedicated racking solutions for Movu's atlas and escala systems, high-performance racking is seamlessly integrated with intelligent automation. Customers benefit from a true 'one-stop shop' experience, offering a single point of communication to streamline project delivery and ensure high-performance warehousing. Central to this integration is our full black box solution, which powers the seamless incorporation of Movu Ops within the installation, enabling smooth coordination between hardware and software for optimal system efficiency.





No warehouse
left behind.

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