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Rethinking Flexibility in Manufacturing:

From Robot Capabilities to System-Level Automation

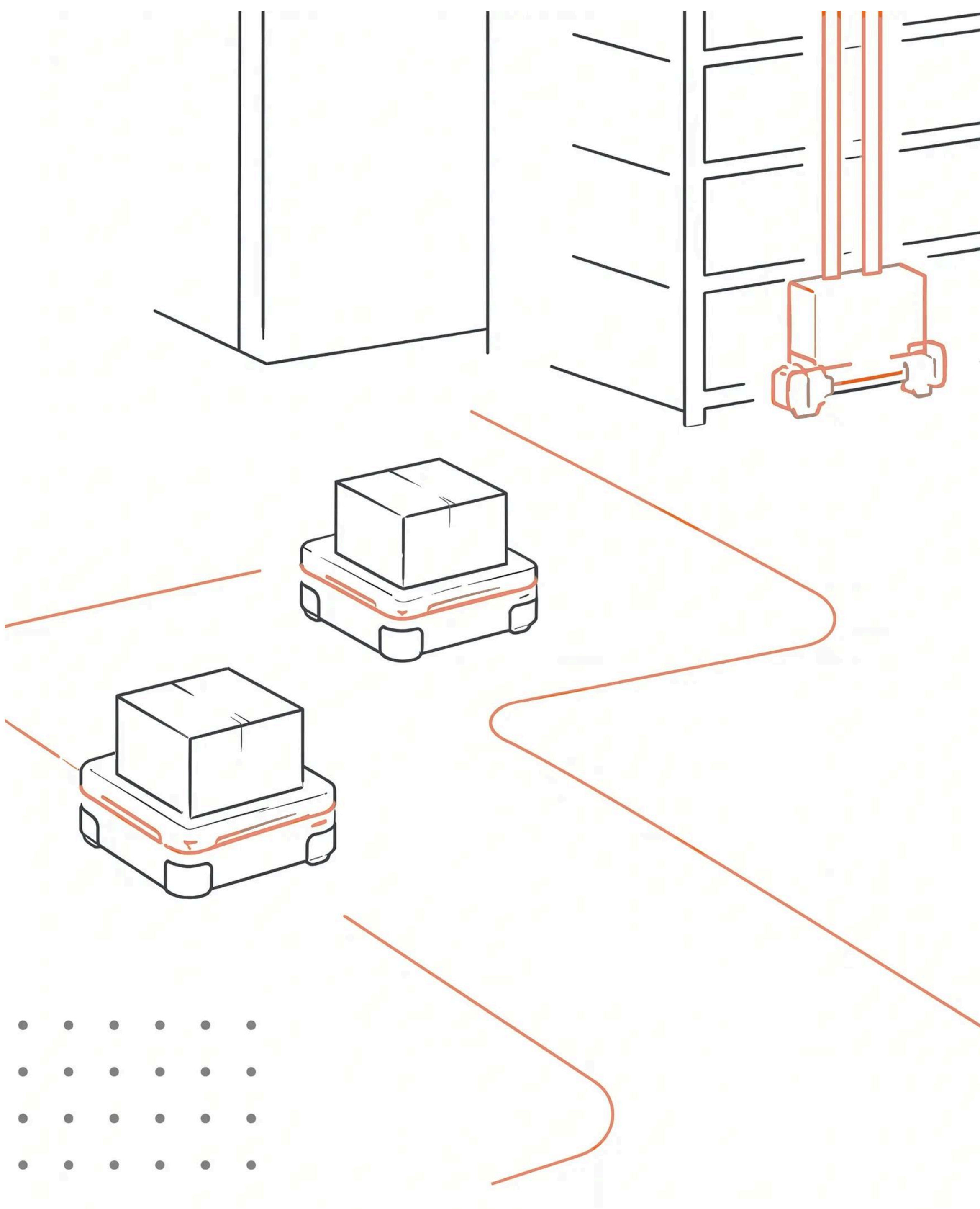
Around **64%** of manufacturing activities globally could be automated with currently demonstrated technologies — *McKinsey*

542,000 robots were installed in 2024 — more than double the number 10 years ago — *IFR*

Up to **70%** of digital transformation and automation initiatives fail to achieve their intended goals — *McKinsey*

Executive perspective:
a shift toward capability-driven automation

Manufacturing is entering a new phase.



For decades, automation was defined by systems — large, fixed, and optimized for a single purpose. Today, that paradigm is shifting. Production environments are becoming more dynamic, product lifecycles are shrinking, and variability is increasing.

As a result, automation is no longer defined by what a system is built to do — but by what it is capable of adapting to.

DID YOU KNOW?

According to McKinsey, **around 64% of manufacturing activities globally could be automated with currently demonstrated technologies,** highlighting the significant untapped potential.

However, adoption continues to lag behind this potential. 542,000 robots were installed in 2024 — more than double the number 10 years ago. Yet adoption remains heavily concentrated in large enterprises, with SMEs facing barriers such as integration complexity and lack of flexibility.

This gap between potential and reality is not primarily driven by a lack of technology. In most cases, the limiting factor lies in how automation is implemented and integrated into existing production environments.

Manufacturers are not struggling to find automation solutions — they are struggling to deploy them in a way that is flexible, scalable, and efficient. According to McKinsey, up to 70% of digital transformation and automation initiatives fail to achieve their intended goals, largely due to integration complexity and organizational challenges.

IN SHORT

The challenge is no longer whether processes can be automated, but how effectively automation systems can adapt to real production conditions. This is where the next generation of robotics plays a decisive role.

The limits of traditional automation architectures

Traditional automation systems were designed for stability.

They excel in environments where processes are fixed, volumes are high, and variation is minimal. In such contexts, dedicated industrial automation delivers efficiency, speed, and consistency.

However, these systems also come with inherent limitations:

1. They are difficult to reconfigure
2. They require significant upfront investment
3. They are optimized for single, predefined applications

As production environments became more dynamic, these limitations created a growing need for more flexible solutions.

This is where collaborative robotics emerged.

Collaborative robots (cobots) were introduced as a more adaptable alternative to traditional industrial robots — designed to be easier to deploy, simpler to program, and capable of operating in more flexible production settings. Especially for SMEs, cobots have become a key enabler for entering automation.

However, while cobots significantly improve flexibility, they have historically faced their own set of constraints. Limited reach, payload restrictions, and accessibility challenges often required multiple systems or complex layouts to cover a single process.

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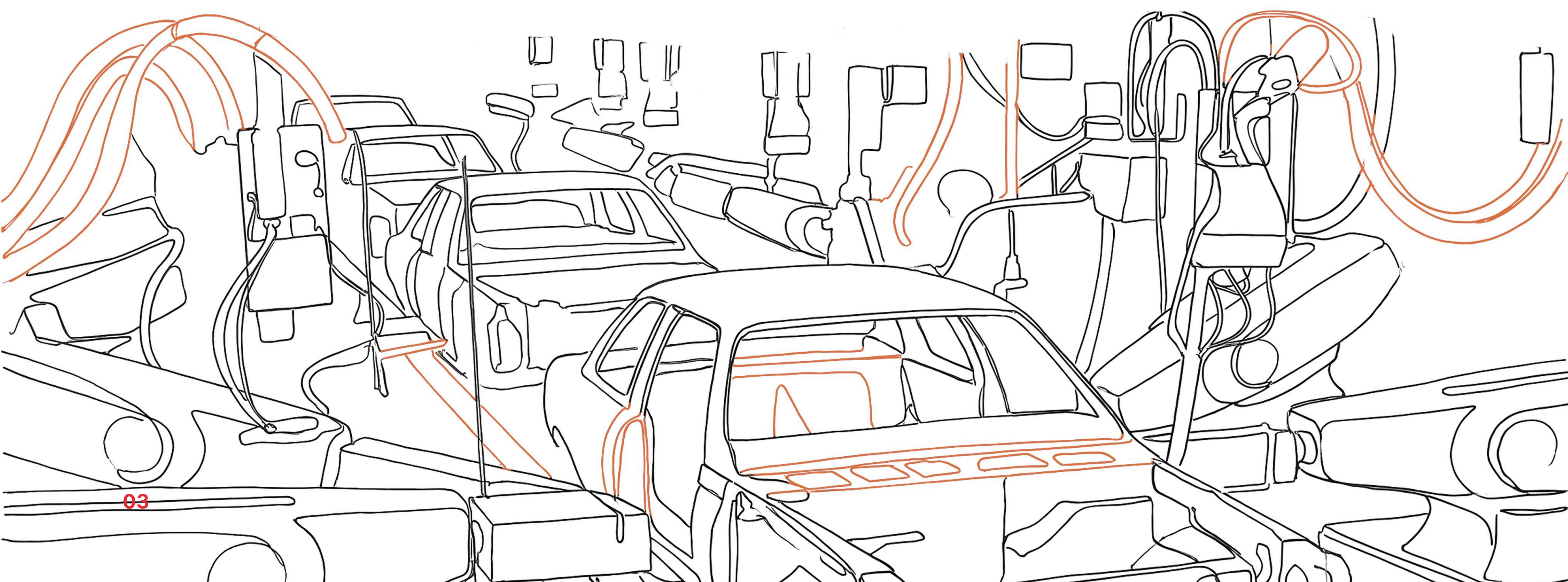
The result is a familiar challenge: instead of fully flexible systems, manufacturers often end up with fragmented solutions — automation islands rather than connected, scalable production environments.



Expanding the capability envelope: why reach and payload matter

A new generation of collaborative robots is addressing these limitations.
At first glance, improvements in reach and payload may appear incremental. In reality, they represent a fundamental shift in what can be automated — and how.

Greater reach enables a single robot to cover a larger workspace. Tasks that previously required multiple stations can now be consolidated. This reduces system complexity and simplifies layout design.

Higher payload capacity expands the range of applications a robot can handle. From heavier components to more complex tooling, a single system can now address a broader set of tasks.

Additional degrees of freedom, such as a seventh axis, further enhance flexibility. They allow robots to operate in confined spaces, reach around obstacles, and perform more intricate movements with ease.

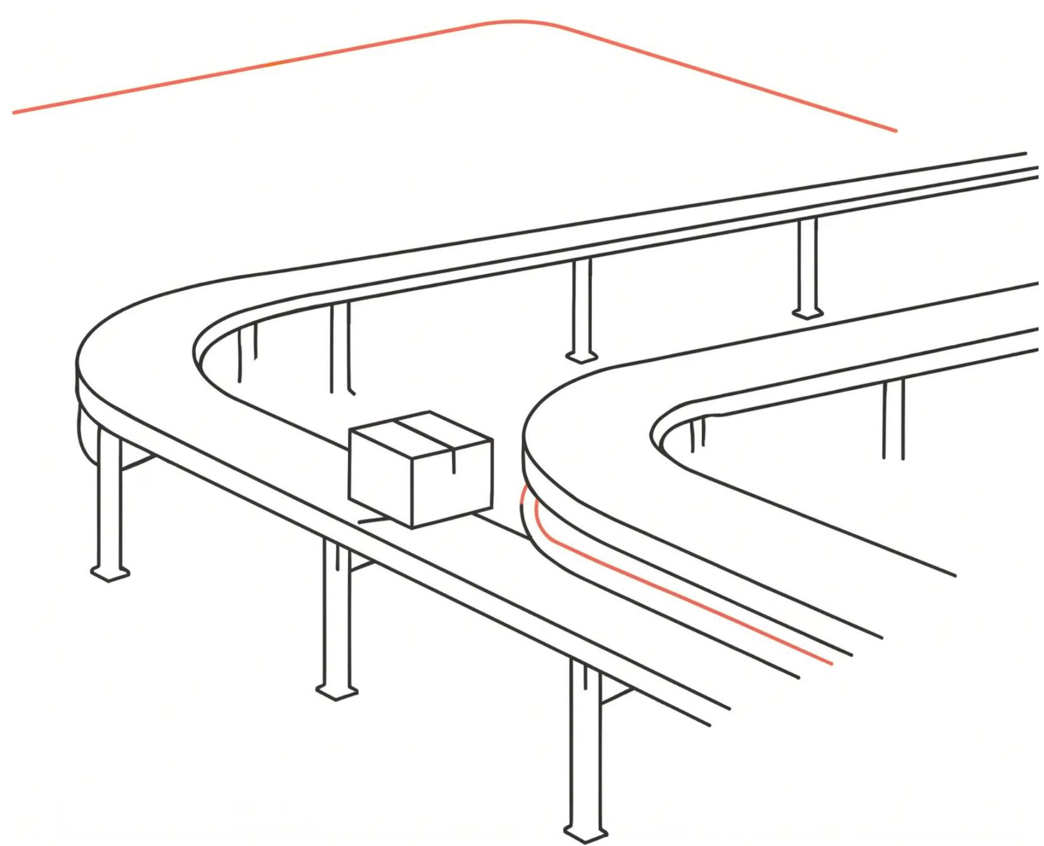
This is particularly relevant in brownfield environments, where space is limited and production layouts have evolved over time. According to the Capgemini Research Institute report, 60% of reindustrialization efforts in Europe and the United States are focused on brownfield approaches.
In such settings, robots with extended reach and the ability to navigate constrained spaces can be integrated into existing lines without major redesign — unlocking automation potential where traditional systems would not fit. These capability gains are not just technical improvements - they directly translate into measurable operational benefits.

DID YOU KNOW?

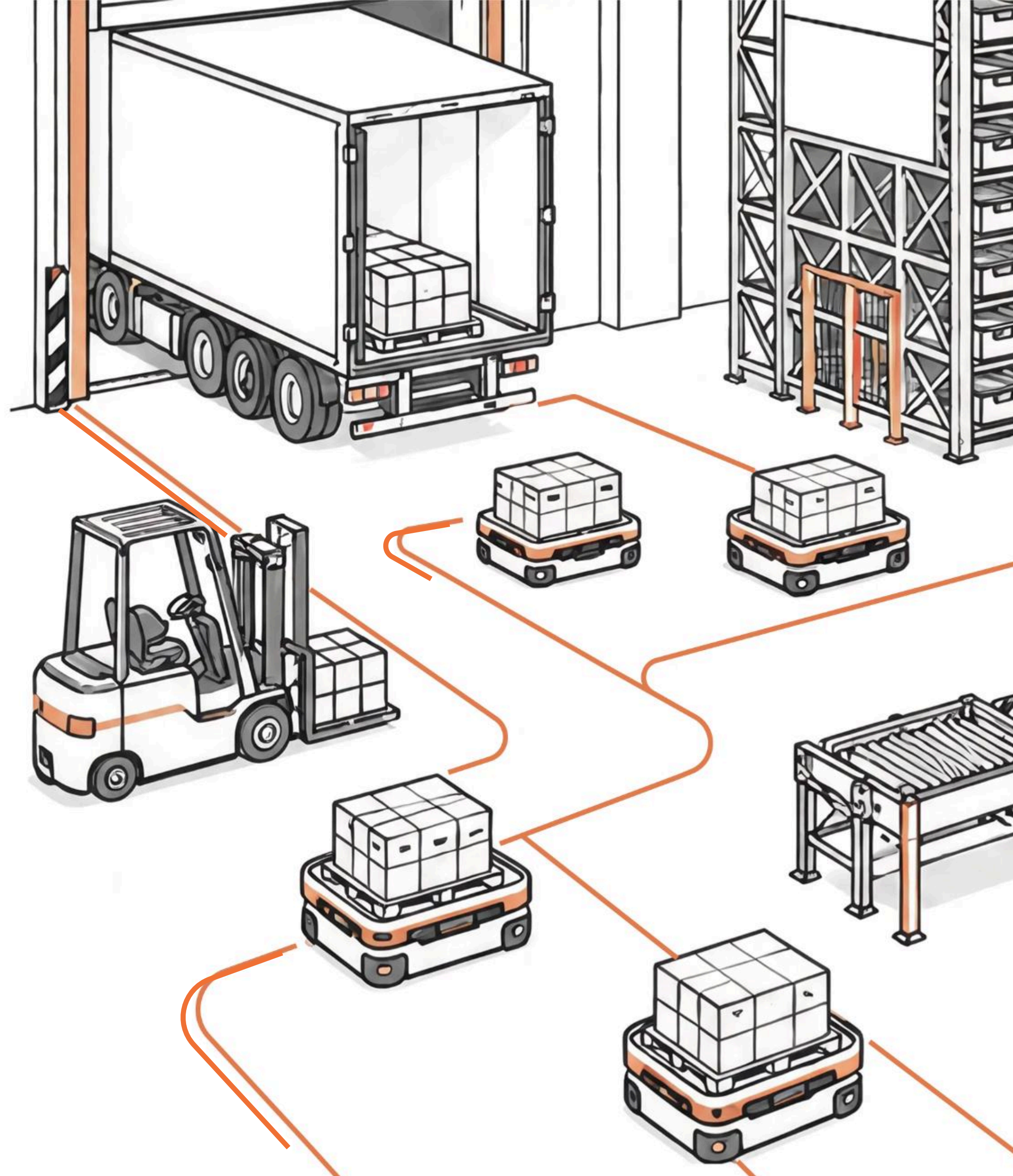
Research shows that improving production flow and eliminating bottlenecks can increase **productivity by 15-30%** in manufacturing environments.

In addition, **studies on flexible automation and robotics adoption** indicate that companies implementing adaptable automation systems can significantly reduce changeover times and improve overall equipment effectiveness (OEE), enabling faster response to shifting production demands.

By extending reach, payload, and flexibility, modern collaborative robots directly contribute to these improvements - enabling simpler systems, fewer interfaces, and more continuous production processes.



This evolution also opens the door to new deployment models. Combined with mobile platforms such as AGVs or AMRs, robots are no longer limited to fixed positions. Instead, they can move between workstations, support multiple processes, and further increase system utilization.



Together, these factors expand what can be described as the "automation envelope" - the total set of tasks that can be automated by a single system.

The implications are significant

1. Fewer systems are required to achieve the same output
2. Layouts become more compact and efficient
3. Reconfiguration becomes faster and more cost-effective
4. Automation becomes feasible even in confined and existing (brownfield) environments
5. Mobile deployment enables new levels of flexibility and utilization

IN SHORT

In short, enhanced robot capabilities do not just improve performance — they redefine how automation systems are designed.

From robot to system: capability alone is not enough

However, robot capability alone does not guarantee productivity.

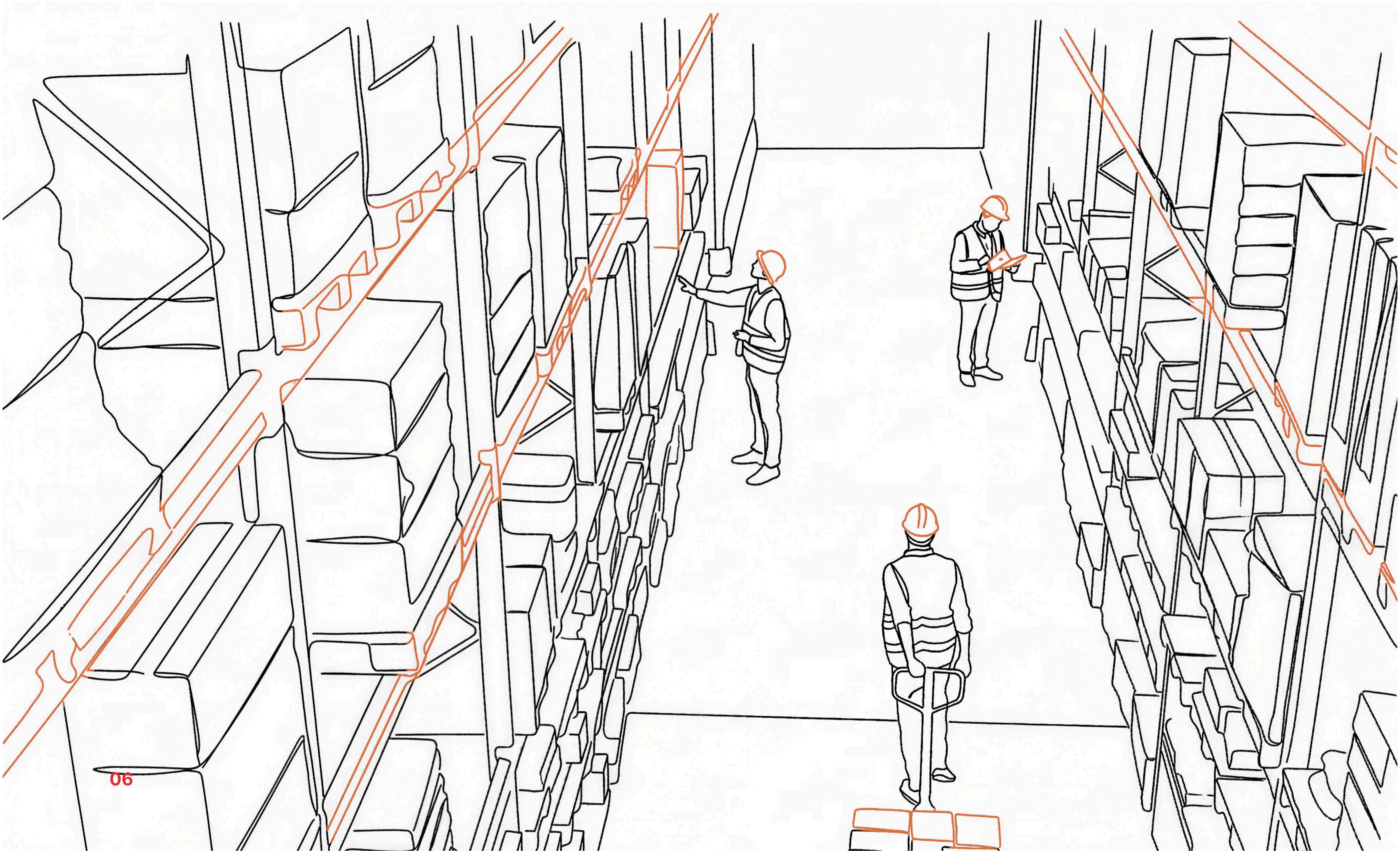
A highly capable robot operating in isolation will always be constrained by its environment. Without efficient coordination, even the most advanced system cannot deliver optimal results.

System integration can account for up to 40–60% of total automation costs

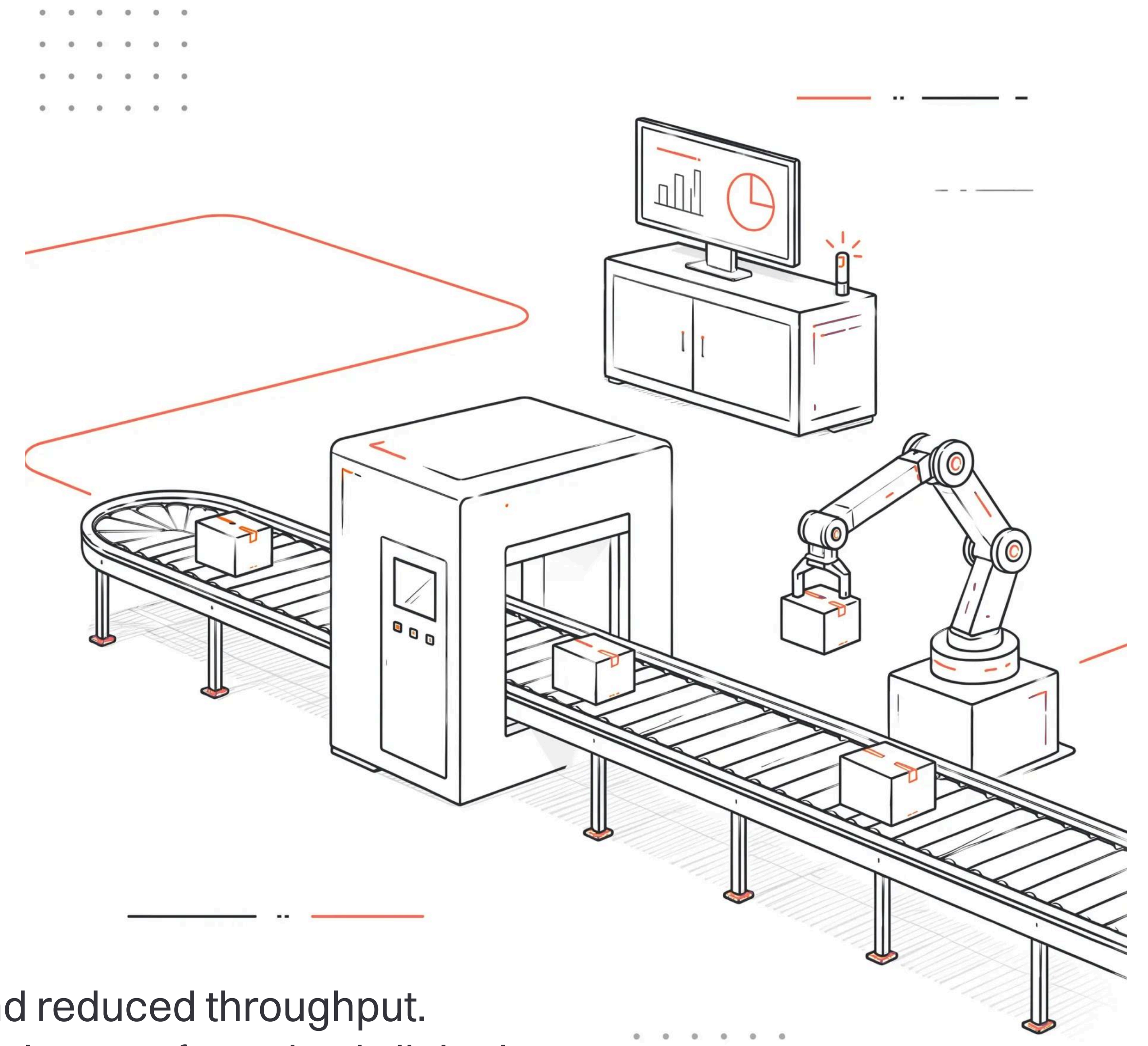
Industry experience consistently shows that integration is a major factor in automation success. In many projects, system integration can account for up to 40 - 60% of total automation costs, reflecting the complexity of connecting machines, processes, and workflows into a functioning whole. Challenges related to synchronization, material handling, and system interoperability often limit overall performance.

DID YOU KNOW?

Automation is not a hardware challenge — it is a system challenge.
To unlock the full value of advanced robotics, capabilities must be embedded within a coordinated and well-designed production system. This requires more than robots. It requires the integration of motion, control, and material handling into a unified architecture — where each component contributes to overall system performance rather than operating in isolation.



The role of material flow: connecting capabilities to throughput



At the core of any production system lies material flow. Robots create value by performing tasks such as assembly, handling, or inspection. But their effectiveness depends on the timely and reliable delivery of parts.

Inefficient material flow leads to idle time, bottlenecks, and reduced throughput. Studies show that a significant share of production losses in manufacturing is linked to waiting times, transport inefficiencies, and process interruptions — rather than the performance of individual machines.
Conversely, well-designed flow systems enable continuous operation and maximize system utilization.

This is where conveyor and transfer systems play a critical role. They provide:

1 Consistent and predictable part delivery

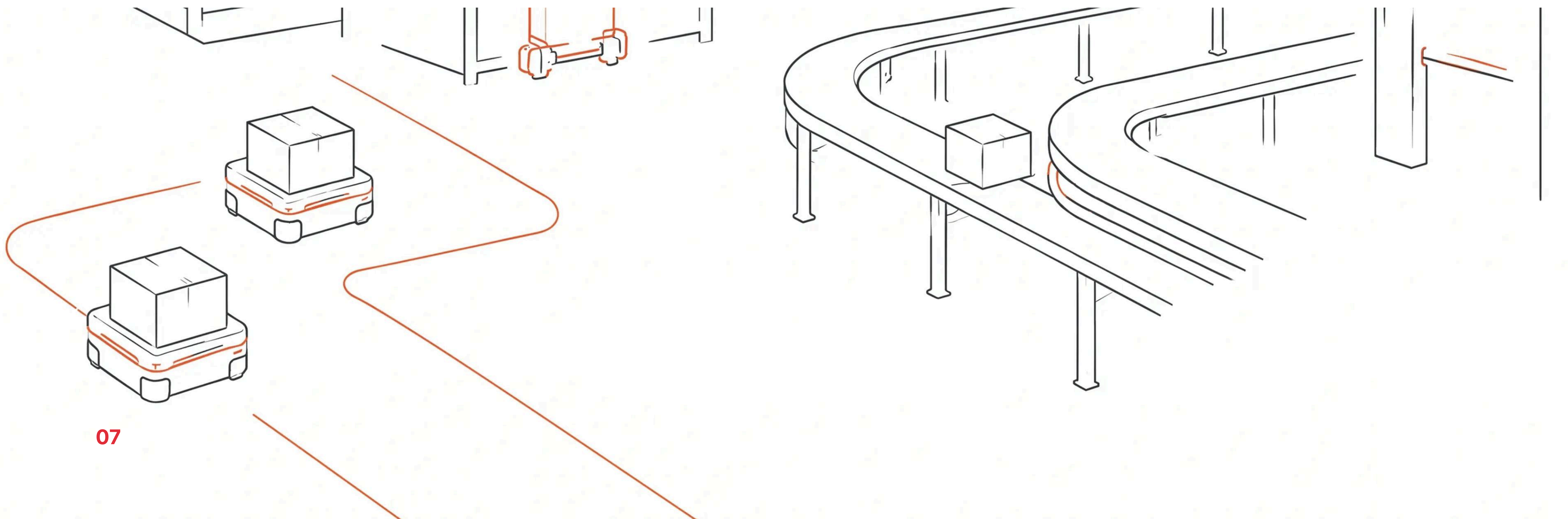
2 Buffering between process steps

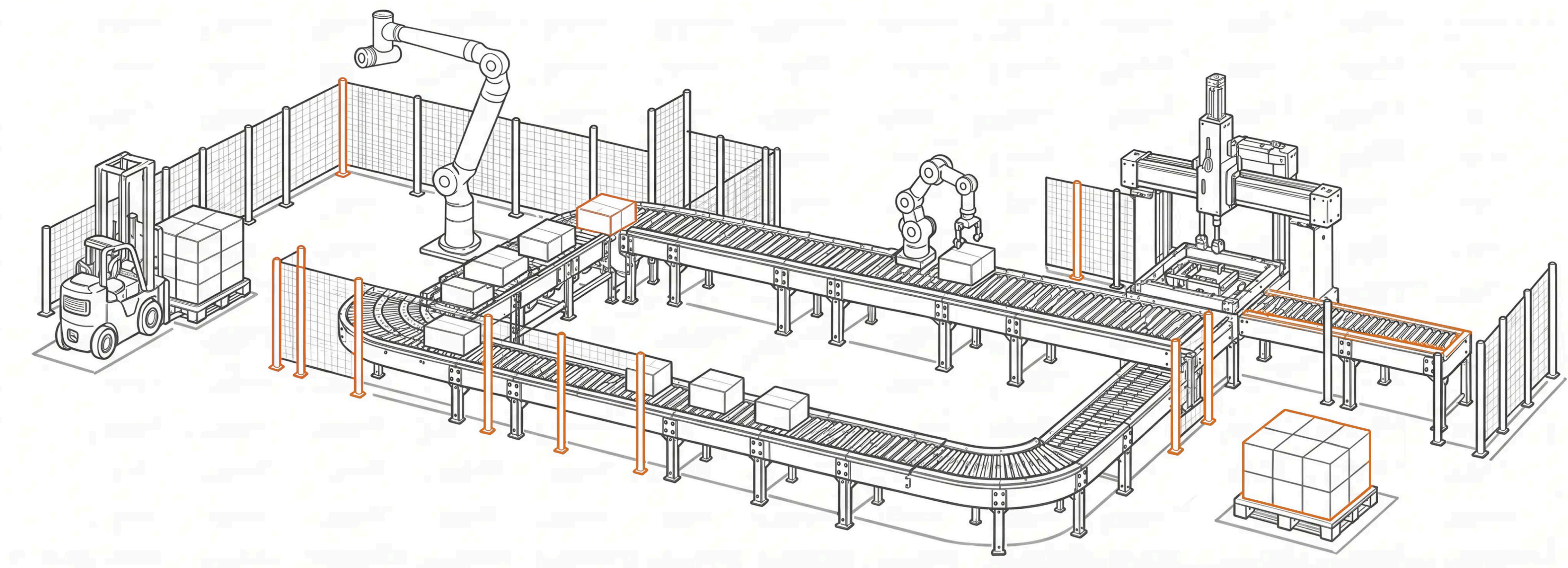
3 Decoupling of operations to increase flexibility

But modern material flow goes beyond simple transport.

Integrated automation: a system-level perspective

Integrated solutions combine conveyor systems with linear motion technologies, intelligent control platforms, and decentralized drive systems to create synchronized, responsive production environments. This enables real-time coordination between robots, machines, and material flow - ensuring that each process step operates in harmony with the overall system.





Lean manufacturing principles emphasize that flow efficiency is often more important than process efficiency. A perfectly optimized workstation cannot compensate for poor flow across the system.

The implication is significant: as production environments become more dynamic, inefficiencies in material flow are no longer just operational inconveniences - they become structural limitations. Systems that cannot ensure continuous flow risk underutilizing automation investments, increasing lead times, and limiting their ability to scale or adapt.

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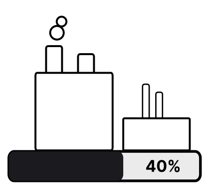
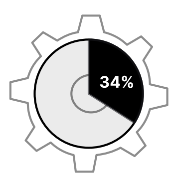
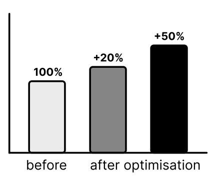


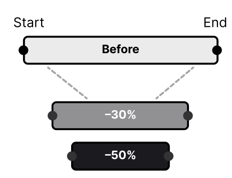
Manufacturing plants operating at average OEE levels leave roughly **40%** of production capacity unused



34% of all efficiency losses come from unplanned equipment downtime



Implementing production optimisation strategies can lead to a **20-50%** increase in productivity

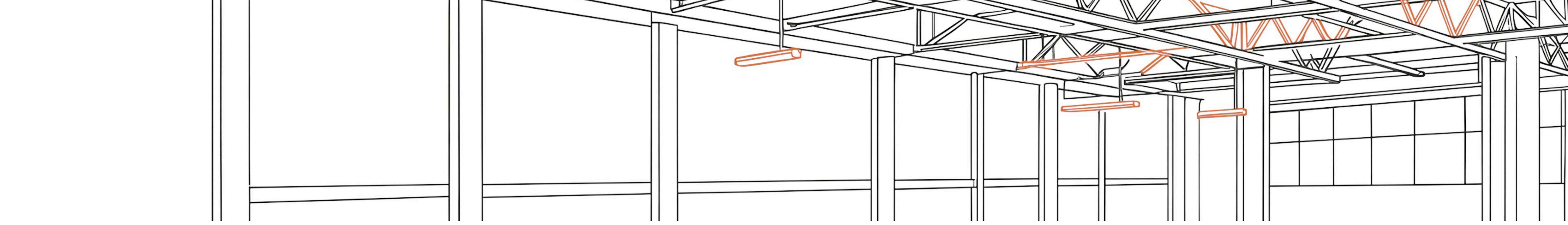


Manufacturers implementing capacity-based scheduling typically achieve **30-50%** reductions in production lead times

Integrated automation: a system-level perspective

Achieving this level of performance requires integration across multiple domains.
Modern automation systems combine:

1. Robotics for flexible task execution
2. Conveyor systems for material flow
3. Control platforms for coordination
4. Sensors and vision systems for data and feedback



The real value of automation emerges when these elements are designed to work together as a system.

This is increasingly important as system complexity grows. According to McKinsey, integration and system orchestration are among the primary drivers of cost and complexity in automation projects, often outweighing the cost of hardware itself.

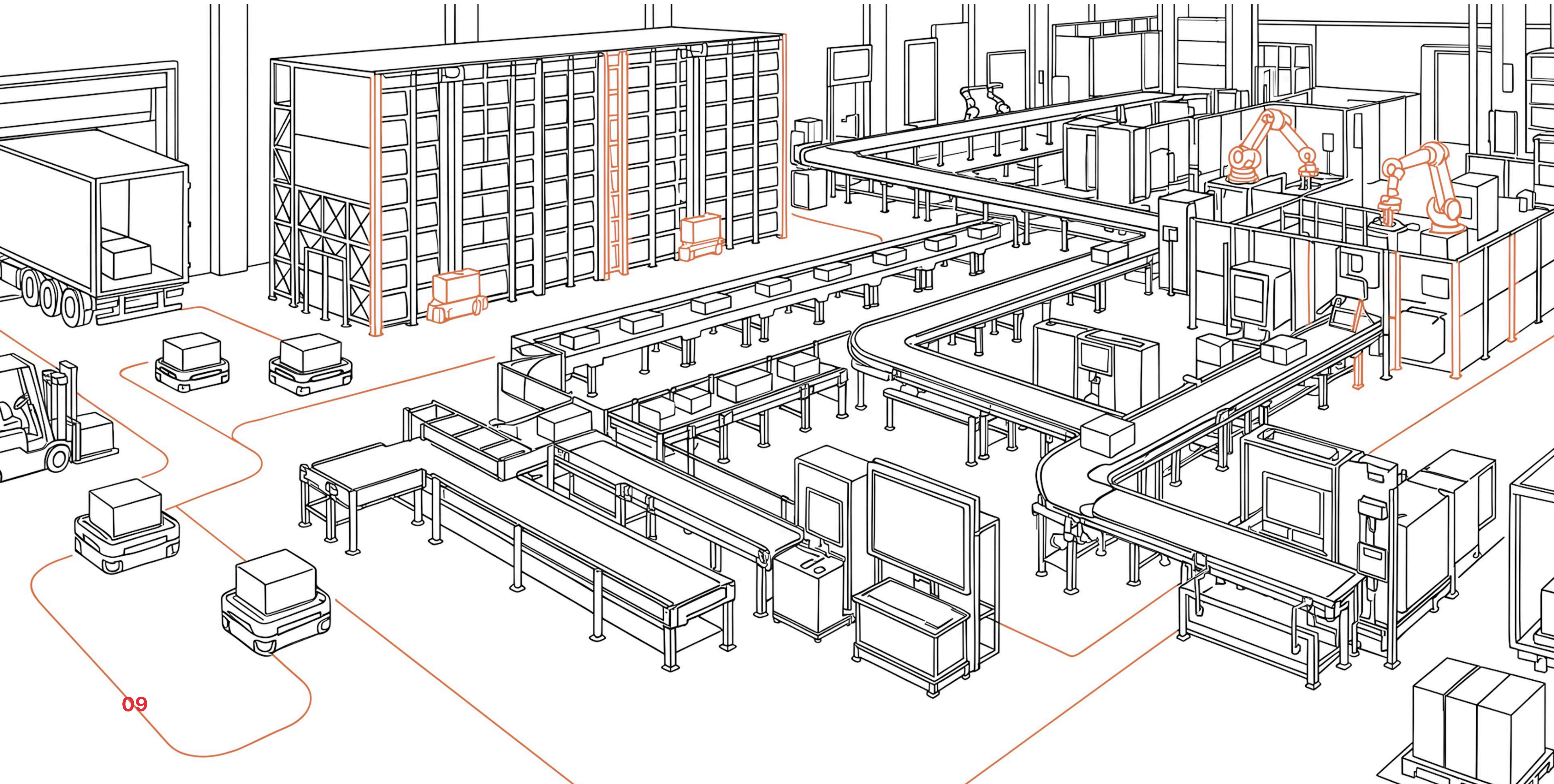
In this context, material flow becomes a defining factor. Conveyor and transfer systems do not only move parts — they synchronize production. Well-designed material flow systems enable:

- ☑ Continuous throughput across processes
- ☑ Reduced waiting times and interruptions
- ☑ Higher overall system utilization

Conversely, fragmented flow leads to hidden inefficiencies. Studies show that waiting and transport-related losses can account for a substantial share of non-value-added time in manufacturing systems, directly limiting throughput and responsiveness.

Together, robotics, material flow, and system coordination form a cohesive ecosystem - where performance is determined not by individual components, but by how effectively they interact.

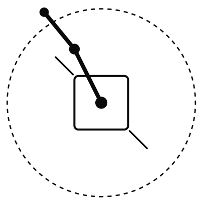
The advantage of such an approach lies in reducing complexity. Instead of integrating multiple standalone solutions, manufacturers can design systems that are inherently connected, scalable, and easier to manage.



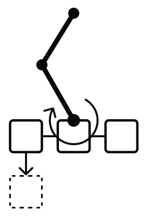
Use case patterns: where capability meets integration

The combination of advanced collaborative robot capabilities and integrated systems creates new design possibilities.

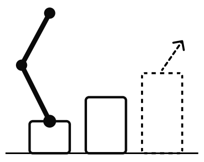
Several patterns emerge across industries:



Reduced system footprint
With extended reach and higher payload, **collaborative robots** can cover larger work areas. Combined with modular conveyor systems, this enables more compact layouts.



Flexible cell design
Reprogrammable **cobots**, together with modular material flow systems, allow production cells to adapt quickly to new products or processes.
Unlike traditional fixed automation, cobot-based cells can be reconfigured with minimal effort - supporting frequent changeovers and evolving production requirements.
In practice, flexible manufacturing systems have been shown to reduce changeover times by up to 50–70%, significantly improving responsiveness.



Scalable automation
Collaborative robots enable a modular approach to automation.
Manufacturers can start with a single cobot-based cell and expand incrementally. Additional robots, conveyor modules, or process steps can be integrated over time - without redesigning the entire system. This approach reduces complexity and investment risk while maintaining long-term scalability.

Strategic implications for manufacturers

The evolution of automation has important implications for decision-makers.

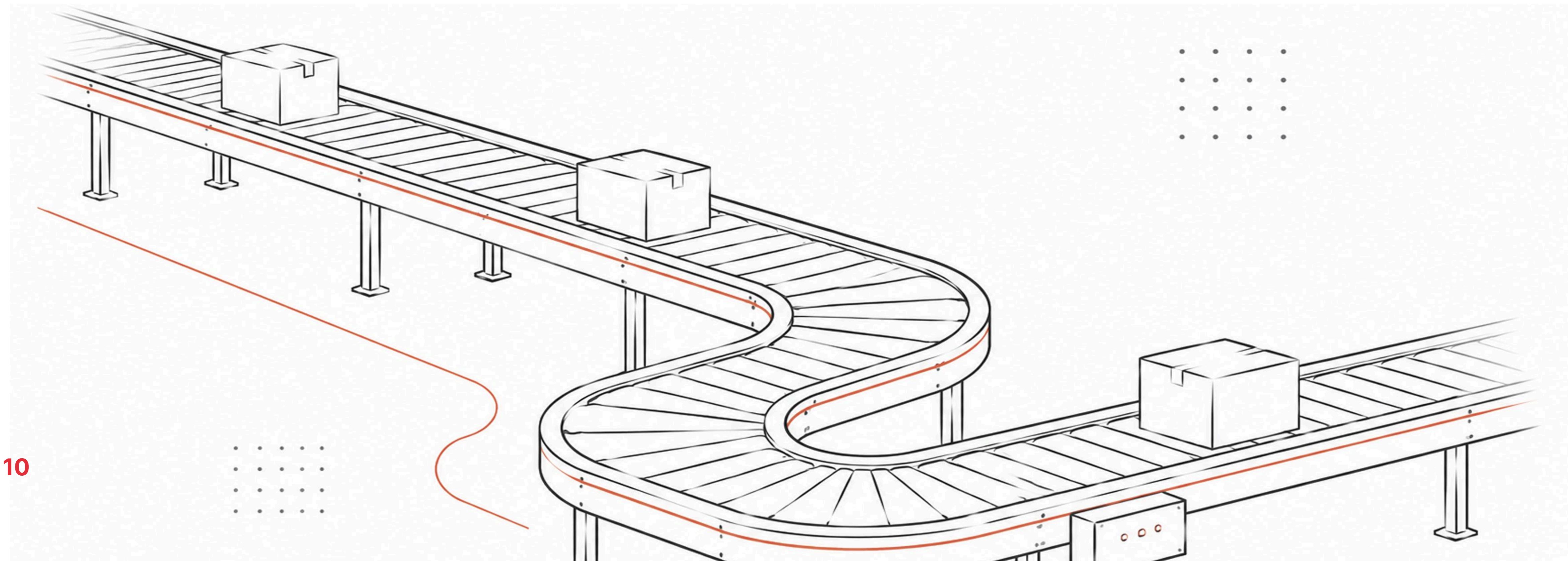
First, automation should be evaluated based on capability coverage - not individual use cases. With advanced collaborative robots, the question is no longer which single task can be automated, but how much of the process can be covered by a flexible, reprogrammable system.

Second, system design must be considered from the outset. The true value of cobots is only realized when they are integrated with material flow, motion, and control systems. Decisions about robotics and system architecture are therefore inherently interconnected and should be addressed holistically.

Third, flexibility is becoming a competitive requirement. Collaborative robots - by design - enable faster reconfiguration, easier redeployment, and adaptation to changing production needs. Companies that leverage this flexibility will be better positioned to respond to shifting demand, product variation, and shorter lifecycles.

IN SHORT

These considerations shift the focus from short-term efficiency gains to long-term operational resilience - where adaptable, cobot-enabled systems form the foundation for scalable and future-ready production.



Conclusion: from components to systems

Manufacturing is moving beyond isolated automation solutions.

Advances in collaborative robot capabilities — particularly in reach, payload, and flexibility — are fundamentally expanding what can be automated within a single system. What was once fragmented across multiple stations can now be consolidated, simplified, and made more adaptable.

At the same time, the true value of these capabilities is only realized when embedded within integrated systems. Material flow, enabled by conveyor and transfer solutions, ensures that robotic flexibility translates into continuous, high-performance production.

This shift is already delivering measurable impact. Studies show that manufacturers who adopt integrated, flexible automation systems can improve productivity by up to 30% while significantly increasing responsiveness to changing demand.

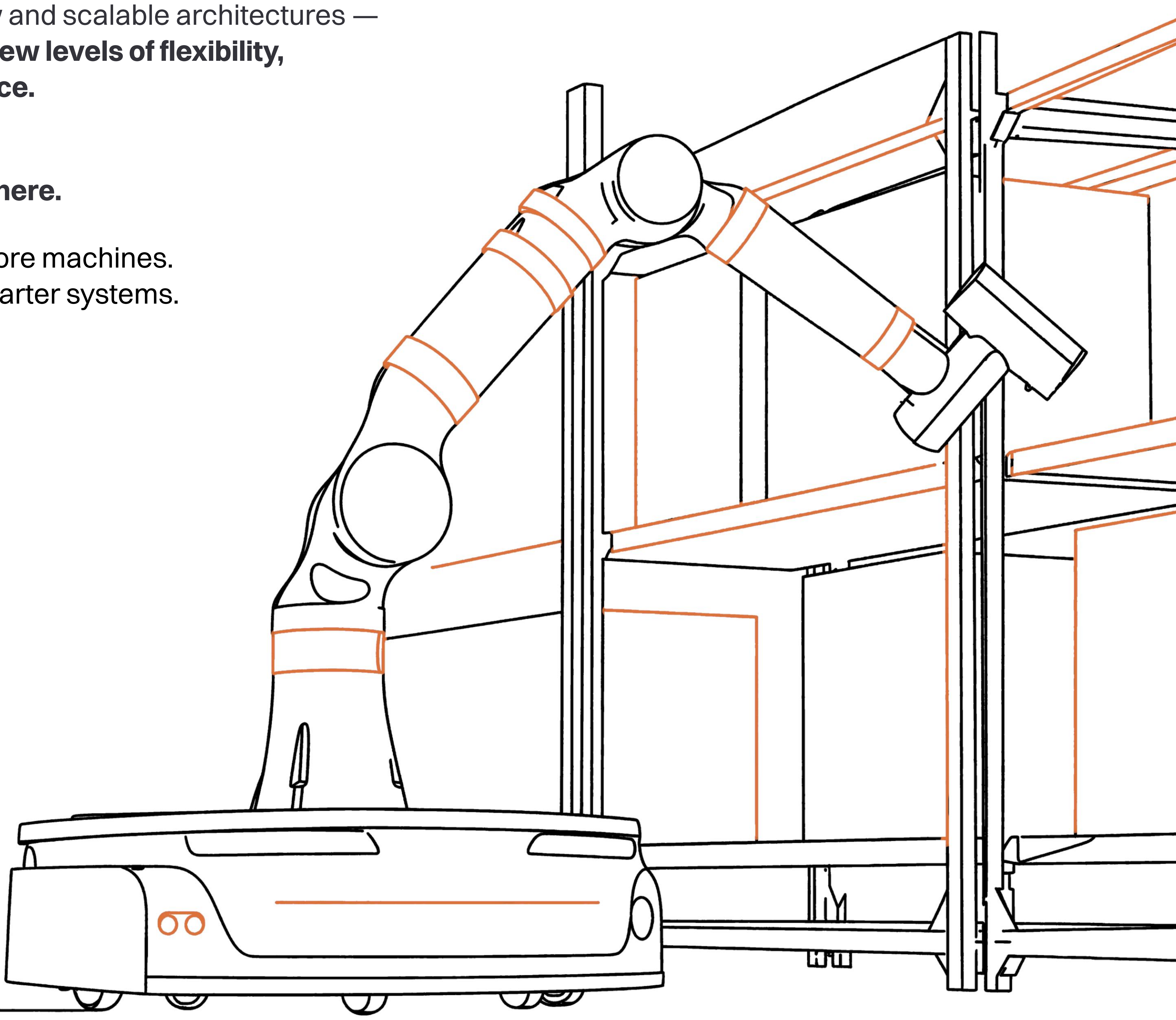
The implication is clear: the future of automation is not defined by individual technologies — but by how effectively they are combined.

For manufacturers, this represents both a challenge and an opportunity.

Those who continue to deploy isolated solutions risk increasing complexity and underutilizing their automation potential. Those who embrace a system-level approach — combining collaborative robotics with integrated material flow and scalable architectures — **will be able to unlock new levels of flexibility, efficiency, and resilience.**

The next step in automation is already here.

It is not about adding more machines.
It is about designing smarter systems.



Ready to explore the next step?

Every production environment is different. The right automation approach depends on your processes, your products, and your growth ambitions.

If you are exploring how advanced robotics, integrated systems, and optimized material flow can work together in your operations, now is the time to take the next step.

Let's explore what is possible.

Kassow Robots: advanced collaborative robotics for flexible production

Kassow Robots' latest generation of collaborative robots is designed to expand the automation envelope. With extended reach, higher payload, and a unique 7-axis design, these cobots enable manufacturers to consolidate tasks, operate in confined spaces, and adapt quickly to changing production needs. Their ease of programming and mobility make them particularly well-suited for dynamic environments.

Bosch Rexroth's modular systems: enabling continuous and scalable material flow

Bosch Rexroth's conveyor and transfer systems as well as their mobile robotics kit ROKIT provide the backbone for efficient material flow in modern production environments. Their modular design supports scalable system architectures, making it easier to expand or reconfigure production lines as requirements evolve.

ctrlX AUTOMATION and integrated motion solutions: connecting the system

To fully unlock the value of flexible robotics and material flow, system-wide coordination is essential. ctrlX AUTOMATION by Bosch Rexroth provides an open automation platform that connects robots, conveyors, and machines into a unified system — enabling real-time synchronization, seamless data exchange, and flexible system integration.