

Navigating the future of the Manufacturing industry



Atos



Five technologies that will shape the sector in 2025



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Executive summary

The manufacturing industry is in a constant state of flux – making leaps and bounds as it maneuvers the changes ushered in by the Digital Age. In the midst of this, CIOs, IT leaders and manufacturing executives are keen to navigate the evolving landscape, armed with transformative technologies that are ready to shape the industry all through 2025.

Our analysis of key developments covers digital product passports, spatial computing, ambient invisible intelligence, polyfunctional robots and agentic AI. Based on comprehensive analysis, extensive research, collaborations with technology partners and insights from customer executives, this paper outlines a forward-looking roadmap for adapting industry innovation to your business. Acting as a strategic guide, it provides decision-makers with a structured overview of technological trends that will transform the global manufacturing landscape soon.

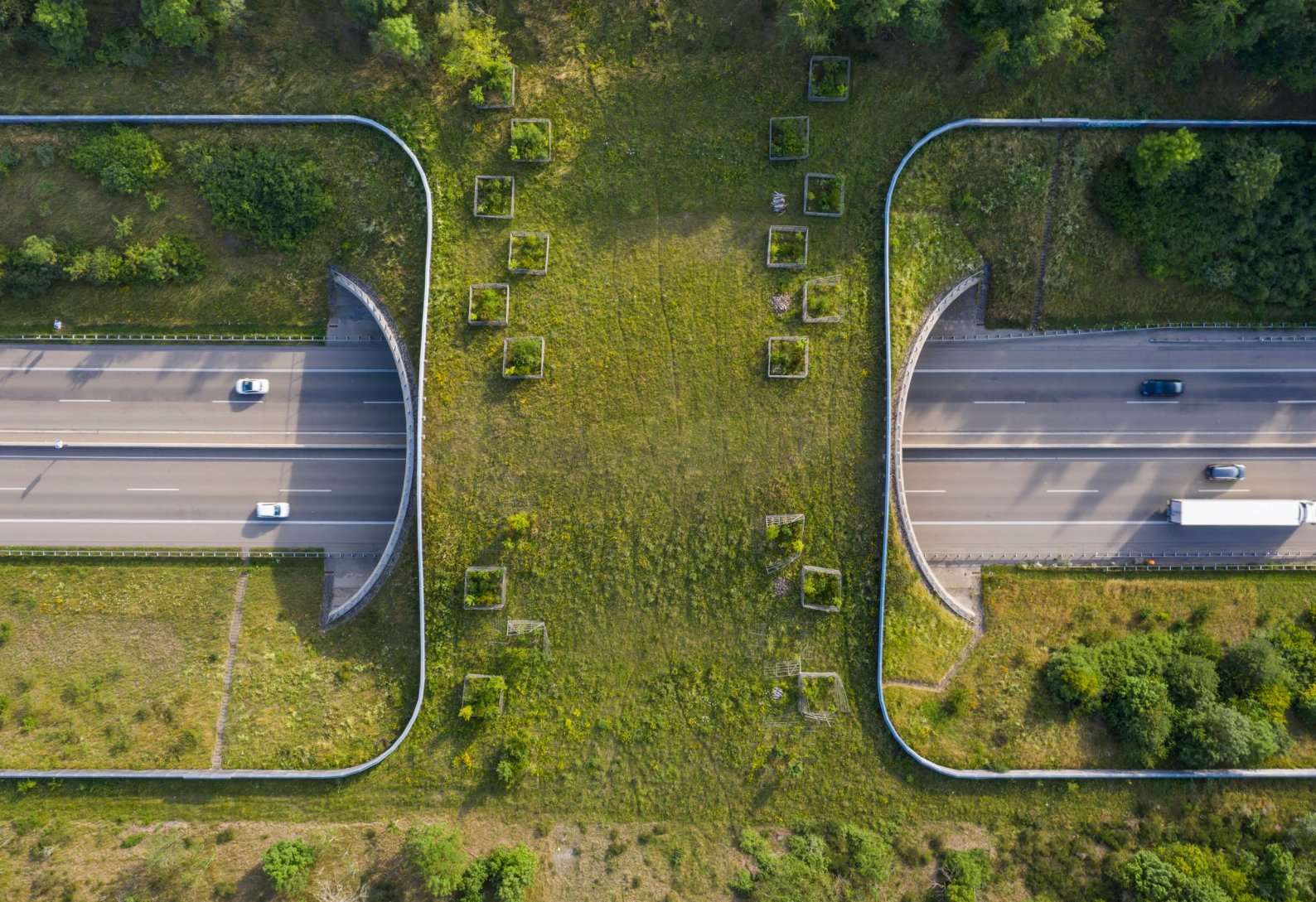
Best in class digital support, including advanced analytics, cybersecurity and lifecycle management will be essential for maximizing organizational efficiency, adaptability, and sustainability. In this paper, we aim to highlight the immanent need for manufacturers to invest in digital infrastructure and IT partnerships to fully harness the potential of these technologies.

Accelerating change in the Manufacturing industry

In today's rapidly evolving manufacturing and digital landscape, the success of CIOs, IT and manufacturing business technology leaders depends on their ability to anticipate and prepare for future opportunities. Effective leadership is defined by the foresight to recognize and profit from emerging technology trends that shape industries.



Next, we will dive into each of these, tracing their impacts on the global manufacturing ecosystem and sharing our forecasts.



Enabling a circular economy with digital product passport (DPP) ecosystems

As the world struggles with resource depletion and immense amounts of waste, the circular economy offers a sustainable model. This model ensures long-term resource availability, economic stability and growth.

Key to this approach is the goal of minimizing waste and pollution throughout the lifecycle of a product. This reduces greenhouse gas emissions, decreases landfill use and addresses issues like ocean plastic pollution by pushing for the recycling of products and the reuse of materials — crucial steps in addressing overconsumption in a resource-limited world.

However, implementing circular economy principles at a large scale introduces two main challenges:

- Tracking a product's entire lifecycle, from production to recycling, involves the secure exchange of sensitive data between numerous stakeholders with varying commercial interests.
- Being cautious in sharing business, product health or usage data, combined with doubts about the accuracy and integrity of received information, can hinder collaboration.

These challenges can be addressed on two levels:

- At an organizational level, introducing a trusted and neutral third party that manages data and access within the ecosystem is required to ensure transparency and neutrality.
- At a technical level, using cryptographic mechanisms such as blockchain protect data and ensure the integrity of information across the entire lifecycle.

Overcoming these challenges by implementing a digital product passport (DPP) ecosystem can provide significant advantages. The digital documents or data sets contain detailed information about a product's materials, components and lifecycle. This goes from first stage in production, to product usage all along to disposal and recycling. Product passports are used as secure digital records that provide transparency and access to relevant information for customers, manufacturers, recyclers and/or regulators.

Impact on the manufacturing industry



Enhanced product traceability

DPPs provide a comprehensive digital record of a product's journey. This allows manufacturers and consumers to trace the origin of raw materials and have transparency on manufacturing processes carried out during production. Furthermore, details on components used and their supply chain journey can be accessed. This traceability is essential for compliance with regulations, customer assurance and risk management.

Streamlined compliance

Regulatory compliance such as the EU regulation starting in 2026 is a significant challenge in manufacturing, particularly in industries such as automotive and discrete manufacturing. DPPs simplify regulatory compliance by storing data on product origins, components, and certifications. This ensures manufacturers can meet global and industry specific standards, rules and regulations.



Facilitating circular economy models

DPPs support circular economy initiatives. They provide data sets that are essential for product reuse, refurbishment, and recycling. Knowing the materials and components within a product precisely, manufacturers can recover valuable materials and minimize waste, thereby extending the availability of natural resources.

Quality assurance and customer confidence

With DPPs, manufacturers can provide transparent and easily accessible information about product quality, maintenance history and any issues that might have occurred during usage. This transparency builds customer trust and allows companies to support after-sales services more effectively.



Supporting product lifecycle management (PLM)

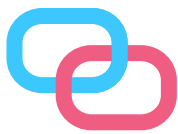
By digitally managing a product's lifecycle data, DPPs ease PLM efforts, from design and production to end-of-life stages. They enable companies to make better-informed decisions about product improvements, sustainability efforts and resource utilization.

We anticipate that digital product passports (DPPs) will become a key enabler of the circular economy starting in 2025.

Facilitating an augmented workforce with spatial computing

Spatial computing represents a shift in how users interact with technology by using augmented reality (AR), virtual reality (VR) and mixed reality (MR) in their physical world. This convergence allows users to engage with digital objects in 3D, creating more immersive and realistic experiences. Whether for training, simulations or virtual collaboration, spatial computing moves beyond the limitations of traditional computing interfaces such as screens, keyboards, and touch devices. They use more intuitive interactions through gestures, voice commands and even eye tracking. These natural forms of input enhance accessibility and responsiveness, deepening the connection between humans and machines.

Impact on the manufacturing industry

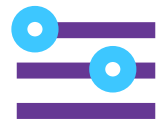


Remote collaboration

By creating virtual and augmented workspaces, spatial computing enables teams to collaborate on 3D models or data in real time, regardless of geographic location. This enhances teamwork and accelerates the development process across distributed teams.

Digital twins for simulation and optimization

Spatial computing enables the creation of digital replicas (digital twins) of machines, systems, and even entire factories. These digital twins enable real-time monitoring, simulation, and optimization that can be used to improve overall productivity and predictive maintenance capabilities.



Context-aware navigation and services

Overlaying useful information about your physical environment can facilitate context aware services, where users are guided through real spaces using additional virtual information.

Immersive employee training

Spatial computing can offer lifelike simulations that provide hands-on learning experiences for employees. Augmented work instructions and real-time quality inspections improve worker performance. This applies particularly to safety-critical or complex manufacturing environments.



Virtual showrooms and customer engagement

Companies can use spatial computing to create virtual showrooms, enabling customers to interact with products before they are manufactured and physically present. This technology also enhances employee engagement by providing interactive and visual product demonstrations.

Spatial computing is a game-changing technology for the manufacturing industry. It enables efficient processes, improves collaboration, and provides innovative approaches to employee training and customer engagement.

As the industry continues to embrace this technology along with the rise of smart glasses technology, the augmented workforce will be better equipped to handle the complexities of a modern manufacturing environment.

Creating Smarter Factories with ambient invisible intelligence

Ambient invisible intelligence describes the integration of advanced technologies into the environment in such a seamless way that they become invisible to users. This concept involves embedding sensors, artificial intelligence (AI), machine learning (ML) and Internet of Things (IoT) devices into everyday surroundings. With this, the systems can understand, anticipate, and respond to human needs without direct interaction or noticeable interference.

A wide range of use cases can be found in the manufacturing industry, where its seamless integration into the production environment can drive efficiency, safety, and innovation. By embedding smart devices into equipment and processes, manufacturers can create smarter factories that operate more autonomously and adaptively. The technology for low-cost tags and sensors has become more affordable by 2025, making it economically attractive.



Impact on the manufacturing industry



Smart energy management

Ambient intelligence can optimize energy usage throughout the manufacturing facility. By monitoring lighting, heating, cooling and machinery operation, the system can reduce energy consumption when production is low or during non-peak hours. It automatically adjusts the environment based on occupancy, temperature, or time of day. This lowers costs and enhances sustainability without disrupting workflows.

Automated quality control

With ambient intelligence, quality control can be integrated into production lines invisibly. Cameras, sensors and AI-based image recognition can analyze products in real time and check for defects or deviations from the standard. This allows instant corrections without requiring human oversight, improving product quality, and speeding up the inspection process.



Dynamic supply chain management

Ambient intelligence can be used to track and manage raw materials, components and finished products in real time. IoT sensors embedded in pallets or containers provide up-to-the-minute information on inventory levels, location of assets and their movement. The system can automatically reorder supplies when stocks are low or optimize logistic routes to avoid delays. This can improve overall supply chain efficiency.

Worker safety and monitoring

Ambient intelligence can monitor the work environment to enhance safety by tracking dangerous conditions or worker behavior in real time. For instance, wearable sensors can monitor workers' health and alert supervisors if someone is fatigued or experiencing health issues. AI systems can also detect potential hazards, such as malfunctioning equipment or unsafe temperatures, and automatically trigger alarms or shut down machinery to prevent accidents.



Sustainability and waste reduction

Monitoring production waste and energy use in real time helps manufacturers make their operation more sustainable. AI can identify inefficiencies in resource use, suggest process improvements, or even automatically adjust settings.

Ambient invisible intelligence is transforming manufacturing by making operations more autonomous, more efficient, and safer.

With its ability to predict, monitor and optimize processes, ambient invisible intelligence allows manufacturers to focus on innovation and growth while reducing costs and improving productivity.

Enhance flexibility and adaptability with polyfunctional robots

Polyfunctional robots in manufacturing are versatile robots, designed to perform multiple tasks or functions across various stages of production. Unlike traditional single-function industrial robots, which are typically specialized for a single task such as welding or assembly, polyfunctional robots can handle a variety of tasks, ideally without extensive downtime or reconfiguration time.

These robots are particularly valuable in modern manufacturing environments where flexibility and adaptability are essential for responding to changing production needs and customized demands.

Impact on the manufacturing industry



Material handling and assembly

A polyfunctional robot may be used to transport raw materials to assembly areas, assist in assembling components, and move finished products to storage or shipping areas. This capability reduces the need for separate robots for each task, simplifying operations.

Inspection and quality control

Equipped with cameras, sensors, and machine learning algorithms, polyfunctional robots can inspect products for quality assurance as they move through various stages of production. They can detect defects, measure dimensions and check alignment. This leads to high quality standards without the need for separate inspection stations.

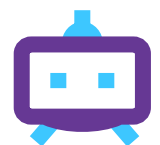


Packaging and sorting

Polyfunctional robots can handle packaging and sorting tasks in addition to production tasks. For instance, they can pack assembled items, label them, and sort them according to destination or order specifications, thereby improving efficiency in the post-production phase.

Machine tending

As machinery needs to be loaded and unloaded with raw materials or parts, polyfunctional robots can perform machine tending tasks. They can tend to different machines at separate times, making production more adaptable.



Automated guided tasks across multiple stations

Polyfunctional robots can move between various stations, adapting to different functions at each location. For example, in electronics manufacturing, a single robot may handle soldering, testing and assembly, depending on the product's stage in the assembly line.



Polyfunctional robots can achieve their full potential in manufacturing only if a robust digital infrastructure, seamless integration, and ongoing support are ensured. These robots generate substantial data on production, equipment performance, product quality and more. Harnessing this data through AI and machine learning is unlocking key insights for predictive maintenance, process optimization and quality improvements. Considering their connectivity to corporate networks or the internet, polyfunctional robots may become potential targets for cyber threats, making it critical to implement comprehensive security measures. This includes firewalls, intrusion detection and encryption to protect sensitive information and maintain operational integrity.

It is equally important to manage the complex network requirements of these robots because they rely on stable, high-bandwidth connectivity for smooth operations. This includes deploying high-speed wireless networks, like 5G and IoT frameworks. The robots need to communicate effectively and coordinate themselves with centralized control systems.

Adequate IT is key for effective deployment and management of polyfunctional robots. Seamless integration, advanced analytics capabilities, robust security, and comprehensive lifecycle support (including fleet management) are necessary. These core elements empower robots to reach their full potential, creating adaptive, efficient, and secure production environments capable of meeting the rigorous demands of Industry 4.0.

Improving production autonomously using agentic AI

Agentic AI systems represent a new paradigm in autonomous decision-making, designed to operate independently within defined parameters. Unlike traditional automation, which relies on pre-set instructions, agentic AI is goal oriented. It adjusts dynamically to real-time conditions in the production environment and is continuously learning and optimizing as it operates. By making independent decisions and improving overtime, agentic AI provides manufacturers with a powerful tool for adaptive, self-managed production systems.

IT services are vital in developing and maintaining the digital architecture that supports agentic AI. By building data pipelines, storage and processing infrastructures, IT architectures ensure agentic AI systems have reliable and real-time access to relevant data. Integrating agentic AI with manufacturers' ERP, MES and IoT systems creates a cohesive ecosystem for seamless data-driven decision-making.

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Predictive maintenance

By analyzing equipment health and usage data, agentic AI autonomously assesses maintenance needs. Proactively predicting issues and scheduling repairs, it reduces unexpected downtime and extends the equipment's lifespan.

Dynamic quality control

To minimize defects and optimize yield, agentic AI monitors production quality in real time and adjusts autonomously when indicated. By adjusting machine settings during operation, it ensures consistency and flags potential quality issues without human interaction.

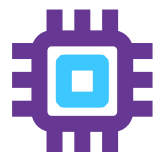


Supply chain optimization

In response to delays or disruptions, agentic AI autonomously re-routes shipments, adjusts inventory levels and sources alternative suppliers to maintain a smooth production flow.

Energy management

Agentic AI autonomously adjusts machine operations to optimize energy use, particularly during peak cost times or when more energy-efficient methods are feasible. Production becomes more adaptable.



Production line optimization

By assessing workflows and identifying bottlenecks, agentic AI reconfigures production lines independently to maximize efficiency. This adaptability is especially valuable in environments with variable demand or frequent product changes.

Agentic AI represents a transformative step for manufacturing, enabling systems to not only automate tasks but to actively manage and enhance production autonomously. This capability makes manufacturing smarter, more flexible, and resilient and positions companies for success in a dynamic market.

Adopt. Adapt. Acclimatize.

Digital technologies offer manufacturing CIOs, IT and manufacturing business technology leaders unique chances to drive transformation and gain a competitive advantage.

At Atos, we empower leaders to navigate and capitalize on key technology trends — from digital product passports and agentic AI to ambient intelligence, spatial computing and polyfunctional robotics. As illustrated in this paper, these innovations are setting new standards for efficiency, sustainability, and resilience across the production landscape.

Through digital product passports, manufacturers can achieve enhanced traceability, streamlined compliance and more sustainable operations that align with circular economy principles. Spatial computing is enhancing real-time collaboration, immersive training, and advanced simulations, fostering an augmented workforce. Ambient invisible intelligence is embedding advanced capabilities directly into production environments, enabling predictive maintenance, energy optimization and seamless quality control. Polyfunctional robots and agentic AI represent a leap toward adaptable, autonomous production lines that dynamically adjust to changing conditions.

Initial training and ongoing optimization of AI models are crucial for supporting continuous learning and adaptability over time. Furthermore, deploying, monitoring and updating AI models as production demands evolve require fine-tuning of parameters to enhance predictive and adaptive capabilities. Through seamless integration, advanced analytics, secure connectivity, and lifecycle management, IT empowers manufacturers to implement flexible, intelligent, and secure production environments for their businesses to flourish. To realize the full potential of these technologies, manufacturers must invest in a robust digital infrastructure and work closely with IT partners who provide necessary expertise in integration, advanced analytics, security, and lifecycle management.

Atos is a global leader in digital transformation and is dedicated to driving next-gen solutions across industries. It plays a crucial role in providing best-in-class integration, AI-powered analytics, secure connectivity, and resilient cybersecurity solutions to support manufacturers in their digital transformation journey, not just to adopt but fully leverage transformative technologies. By embracing these advancements, manufacturers will enhance operational efficiency and position themselves for success in a rapidly evolving and digitally driven marketplace.

As the industry demonstrates foresight and adaptability, manufacturers are set to reach new levels of innovation, operational excellence, and sustainability in the years ahead. Now is the time for leaders to assess their current technological landscapes, embrace emerging trends and shape the future of manufacturing.



About Atos

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