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Published by i4.0 Today

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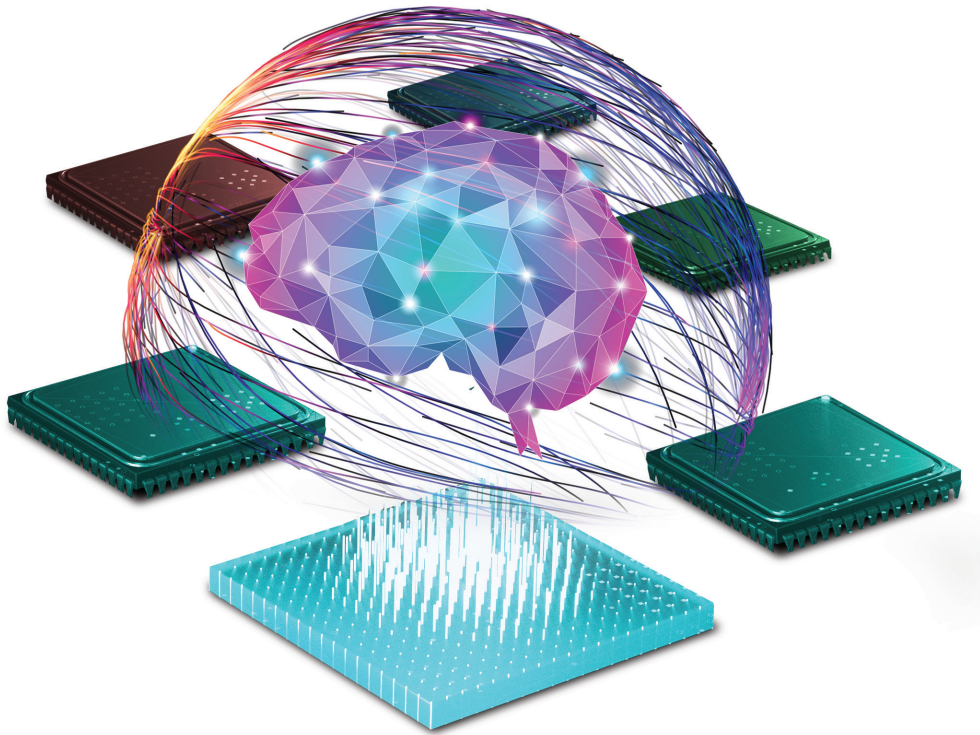
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Beneath the Surface

The Rise of Intelligent X-Ray Inspection

By Charlie Zhu, Senior Director, Product Development Engineering, Nordson.

As electronic systems grow more complex and vital to critical applications, the tolerance for uncertainty is shrinking fast. Reliability and precision are no longer differentiators – they’re the baseline. Yet the defects that threaten them often lie deep within the package, invisible to optical inspection. For decades, X-ray systems have been the industry’s eyes, revealing hidden flaws that compromise performance and yield. Today, AI is giving those systems a brain. Powered by deep learning, today’s cutting-edge intelligence-infused platforms are transforming inspection from a passive checkpoint into a proactive source of insight. Here, Charlie Zhu, Senior Director, Product Development Engineering at Nordson Advanced Technology Solutions, explores how AI is reshaping the X-ray inspection process. As he explains, “the future of inspection isn’t just about higher resolution. It’s about creating systems that learn, adapt, and grow smarter with every component they analyze”.

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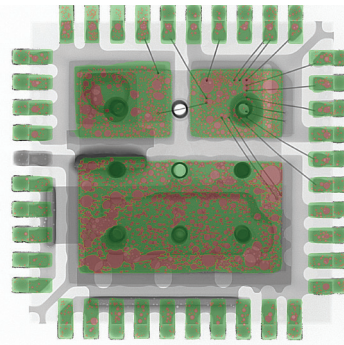
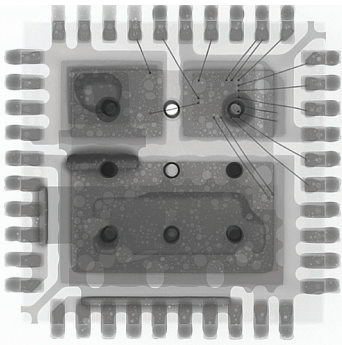
Instead of relying on rigid, pre-programmed rules, AI models learn to distinguish genuine defects from background noise by analyzing vast inspection datasets.

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From Static Images to Intelligent Insights

Within semiconductor packaging and advanced electronics assembly, X-ray inspection plays a critical role in verifying internal structures and ensuring device reliability. Traditional X-ray inspection has long leveraged machine vision algorithms, effectively employing contrast, shape, and intensity thresholds to pinpoint potential defects – methods that have historically proven robust across many applications. As modern electronics have evolved in complexity, however, the nuanced nature of these designs, featuring overlapping

components, stacked die structures, and subtle material variations, has presented a growing need for advanced interpretation. For example, a resistor positioned over a Ball Grid Array (BGA) ball might create darker regions that legacy systems could misclassify as defects, reducing inspection efficiency and leading to higher false call rates. Even beyond these challenges, achieving consistent, high-quality inspection still relies heavily on skilled engineers, demanding deep expertise, constant calibration, and process knowledge that’s difficult to scale.



QFN X-ray image and after processing by Nordson Intelligence Algorithm

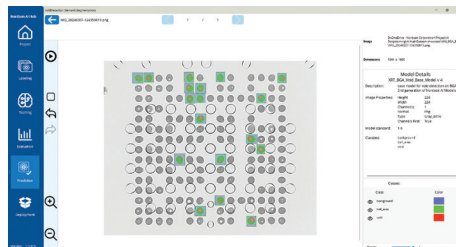
AI, particularly deep learning, fundamentally changes this paradigm. Instead of relying on rigid, pre-programmed rules, AI models learn to distinguish genuine defects from background noise by analyzing vast inspection datasets. "AI changes the game," explains Charlie Zhu, who leads development of the Nordson Intelligence Platform: the software backbone behind Nordson's global portfolio of advanced inspection systems. "Instead of tuning dozens of parameters, our deep learning models learn directly from annotated data. They understand not just contrast, but gradient, shape, and context – making pixel-level decisions that can often surpass human judgement in both consistency and accuracy."

Within Nordson's Automated (AXI) and Manual (MXI) X-ray systems, this intelligence enables models to recognize the true characteristics of a void while ignoring irrelevant features such as overlapping components. The result is inspection that goes beyond visualization, with smart, nuanced interpretation built into the model itself. By dramatically reducing the need for manual parameter tuning, AI lowers the barrier to effective setup and production: operators no longer need to be machine vision experts to achieve reliable results. AI extends detection beyond human limits, often identifying subtle or previously invisible defects to deliver the most accurate and consistent results possible – ultimately then delivering measurable gains in productivity and yield.

Turning Data from a Byproduct into a Strategic Asset

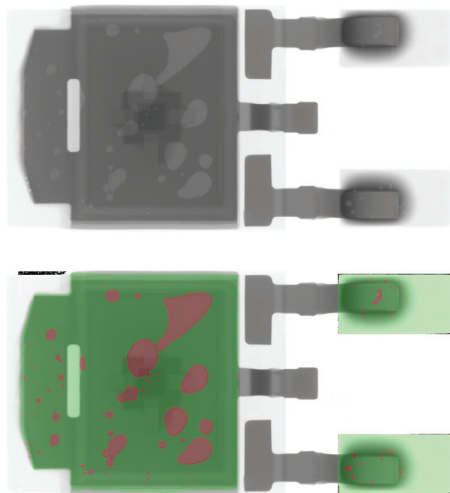
In conventional inspection, the X-ray image is the end product – a snapshot used primarily to remove defective parts. When inspection systems are enriched with AI-driven intelligence, it becomes the start of something larger and far more powerful: a continuous feedback loop that connects inspection data to broader, long-term process improvement. Every scan and image contributes to a growing dataset and dynamic learning cycle that helps the system advance, adapt, and optimize, turning inspection data from a byproduct into a strategic manufacturing asset.

At the heart of this evolution for Nordson, is the company's Machine Learning Operations (MLOps) framework, which orchestrates how every image – including those containing potential defects – fuels ongoing model development. Foundational AI models are continuously enhanced with customer-specific data, creating systems that are not only more accurate but, increasingly, tailored to each production environment.



Nordson AI-Hub Void Detection Segmentation - BGA

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Foundational AI models are continuously enhanced with customer-specific data, creating systems that are not only more accurate but, increasingly, tailored to each production environment.”



Power Transistor X-ray image and after processing by Nordson Intelligence Algorithm

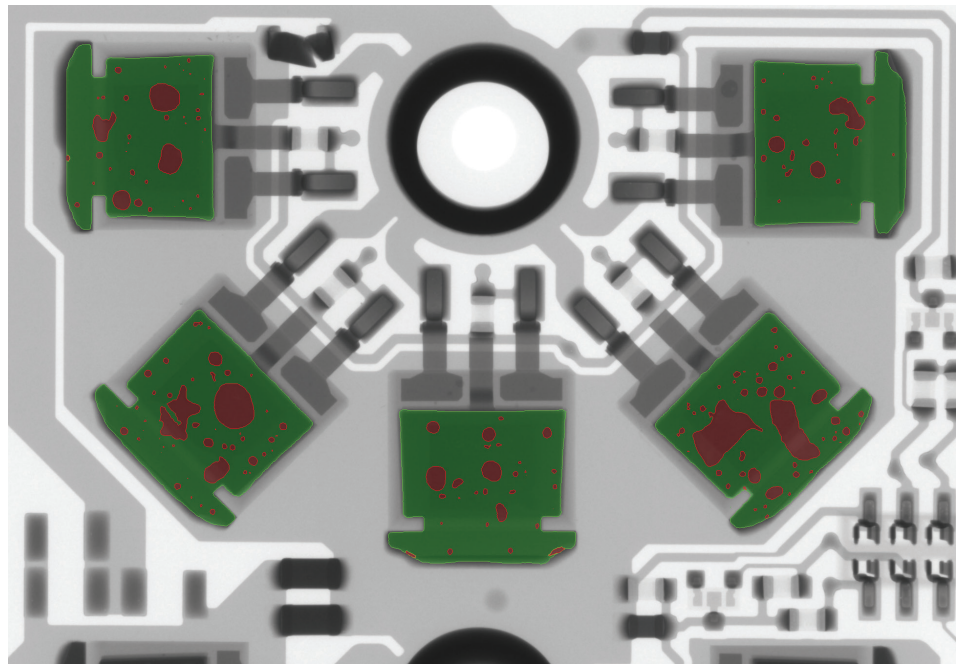
"When you look at the value of AI for manufacturers, it's not just in training the model, it's in informing the process," explains Zhu. "As these models become more widely adopted, their rate of learning grows exponentially, drawing on ever-richer datasets from real production environments. A baseline model designed for void detection, for example, can be fine-tuned with a small amount of customer data to achieve exceptional accuracy, and adapting to new products or materials in a fraction of the time once required.

"Before deployment, each model is rigorously validated using metrics such as Intersection over Union (IoU) to confirm alignment between AI predictions and ground truth annotations provided by human experts, with stringent performance thresholds. Crucially, this cycle is continuous, not a one-time event. As new product variants or subtle defect patterns emerge, the model can be retrained and revalidated, ensuring it evolves in lockstep with production."

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The heart of next-generation X-ray inspection is not just in seeing more, but in learning more, with systems that shape future performance, and continuously improve.

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AI-generated renderings clearly show defects and reduce false calls (Power Transistor).

Real-World Proof: AI's Adaptability in Action

The promise of AI is impressive in theory, but its true impact is proven on the factory floor. The value of ML-powered X-ray inspection shines in its adaptability, versatility and efficiency, delivering tangible results where it matters most. A common concern, especially in high-mix, low-volume environments, is the investment required to train a model for each new product. However, the advent of transfer learning has fundamentally changed that equation.

A recent study with an automotive customer offered powerful proof of this flexibility in action. Nordson's team trained an AI model for void detection using a small dataset of just 220 BGA balls from a single batch. The outcome was remarkable: without any retraining, this same model delivered high accuracy across multiple, distinct part numbers. Setup times were significantly shortened, and strong inspection performance was achieved without the need for massive datasets.

The AI model also successfully established a more objective baseline for inspection and standardized the process, overcoming the subjective variations that can arise among human operators and ensuring consistent, repeatable results, batch after batch. "Perhaps most notably, this success with transfer learning set the stage for scaling similar models to a wider range of X-ray inspection tasks, laying the groundwork for a unified, intelligent framework across our entire portfolio," continues Zhu. "For manufacturers, it demonstrates that a single, well-trained AI model can serve as a broad and long-term asset – adaptable to new production scenarios with minimal effort – and that the initial investment delivers lasting returns through a flexible, scalable solution."

The Future is Software-Driven

The evolution of X-ray inspection reflects a broader transformation across manufacturing: intelligence is becoming the true differentiator. Hardware remains essential, but it's the software layer – the models, data, and adaptive

frameworks – that now determines how effectively a system can learn, evolve, and contribute to process optimization.

This software-centric approach directly addresses the industry's most pressing challenges. With tools like the Nordson AI Hub, customers can train and manage models securely on-premises, maintaining full control over sensitive data and intellectual property. For teams that value collaboration or rapid scaling, Nordson's secure cloud channels and Model Marketplace provide a flexible pathway for developing and deploying tailored models. Engineers can access solutions refined for specific applications while upholding rigorous standards of data privacy and eligibility.

Beneath these capabilities lie Nordson's proprietary low-level libraries, built specifically for manufacturing environments where precision, reliability, and performance are non-negotiable. By tightly integrating model logic with hardware behavior, these libraries ensure consistent, high-performance operation – bridging the gap between intelligent algorithms and the realities of the production floor.

In essence, software-defined inspection represents more than a technological shift; it's a philosophical one. The heart of next-generation X-ray inspection is not just in seeing more, but in learning more, with systems that shape future performance, and continuously improve. Powered by deep learning, industry-informed MLOps and secure, customer-focused platforms, we can empower manufacturers to not only detect what's hidden, but truly understand and advance their processes – driving smarter decisions, higher yields, and lasting competitive advantage. And as manufacturers embrace this new paradigm, they move toward operations that are not only more efficient, but more intelligent, autonomous, and resilient – laying the foundation for a truly adaptive factory of the future.

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Accelerate AI Inspection

N-Intelligence AI-Hub simplifies the development of deep-learning models

Nordson Intelligence's AI-Hub standalone ML software gives users full control to improve inspection accuracy and rapidly deploy solutions across diverse applications. Its guided workflow streamlines every step—data preparation, model building, performance evaluation, prediction, and deployment. Count on Nordson to continue to advance and scale AI solutions across Nordson software platforms.

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Bridging the factory divide: Why unified IT/OT visibility is critical for manufacturers

By Daniel Sukowski, Global Business Development Industry & OT, Paessler.

For many UK manufacturers, the biggest digital challenge is making sense of the enormous amounts of data that is collected. Production environments are increasingly data-rich, yet critical information still lives in two very separate worlds, and too often OT and IT environments are monitored, secured, and managed in isolation.

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As machinery, production systems and enterprise platforms become more tightly connected, the reliability of one layer is now inseparable from the performance of the other.

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This divide is more than a technical inconvenience; it is a strategic risk embedded in the very fabric of industrial operations. This year alone, downtime was predicted to have cost UK and European manufacturers over £80 billion. Is the issue with the programmable logic controller (PLC)? A sensor? Network latency? A misconfigured server? In high-volume industries like food and beverage, pharmaceuticals, and consumer packaged goods, every minute spent troubleshooting can quickly translate into thousands of pounds in lost output, wasted materials, and delayed deliveries.

The problem lies in the lack of shared visibility. Manufacturers typically rely on separate platforms, teams, and processes to monitor IT and OT. This fragmentation makes it difficult to form a complete picture of system health, performance,

and risk. As factories become more connected and production more flexible, this blind spot becomes harder to justify.

Why IT/OT convergence can not wait

Manufacturing is under increasing pressure to operate with greater flexibility, efficiency and resilience, as customer expectations shift towards shorter lead times, consistently high product quality and more personalised product ranges. At the same time, the sector is dealing with widening skills gaps and an expanding cyber threat landscape, while production environments become progressively more interconnected through industrial IoT and edge computing. Together, these forces are reshaping what “normal” looks like on the factory floor and raising the bar for operational visibility and control.

In this context, the traditional separation between IT and OT is becoming much harder to sustain. As machinery, production systems and enterprise platforms become more tightly connected, the reliability of one layer is now inseparable from the performance of the other. Real-time monitoring relies on stable networks, predictive maintenance depends on consistent, trustworthy data, and operational decision-making is only as strong as the infrastructure that supports it. When these environments are managed in isolation, manufacturers are left reacting to issues rather than anticipating them, limiting their ability to operate with the speed and agility modern production demands.

This is why IT/OT convergence is now an operational necessity. The objective is not to replace established systems, but to connect them in a way that gives teams a single, coherent view of performance, risk and system health across the entire production environment, enabling faster diagnosis, better collaboration and more confident decision-making.

The role of industrial edge architecture

One of the most important enablers of this shift is the rise of industrial edge computing. By processing data close to machines and production lines, edge platforms reduce latency, improve real-time responsiveness, and limit the need to push all data to central data centres or the cloud.

However, edge infrastructure on its own does not solve the visibility problem. Without unified monitoring, manufacturers risk creating a new layer of complexity rather than simplification. Edge devices, controllers, gateways, networks, and enterprise systems all need to be observed in a coordinated way if organisations are to trust their operational picture.

This is why partnerships between industrial platform providers and monitoring specialists are becoming more important. In the case of Siemens and Paessler's cooperation, the focus is on enabling unified monitoring capabilities to operate directly at the industrial edge, bringing IT and OT visibility closer to the machines themselves. The strategic value lies not in individual products, but in the ability to bridge environments that previously operated in isolation.

Moving from reactive firefighting to proactive operations

The operational impact of unified IT/OT visibility becomes clear when looking at day-to-day manufacturing realities. Traditionally, many factories operate in a reactive mode, responding to failures only after they occur. Investigations are manual, time-consuming, and often rely on tribal knowledge rather than shared data.

When IT and OT systems are monitored through a single operational lens, this dynamic begins to shift. Teams can spot anomalies earlier, identify performance trends, and resolve issues faster. Root cause analysis becomes data-driven rather than assumption-based, and collaboration between teams becomes more natural because everyone is working from the same information.

Early implementations of unified monitoring approaches have already demonstrated tangible results, including significantly faster root-cause identification, reduced unplanned downtime, and measurable improvements in overall equipment effectiveness (OEE). In high-volume, 24/7

production environments, even marginal gains can translate into additional production capacity and improved service levels for customers.

Building more resilient and adaptive industrial operations

Unified IT/OT monitoring is not just a technical upgrade, it represents a shift in how manufacturers think about resilience and adaptability. As production systems become more software-defined and data-driven, the organisations that succeed will be those that can see, understand, and act on operational data in real time.

The future of manufacturing will be defined less by the number of connected devices, and more by how effectively organisations can manage the complexity that connectivity creates. Bridging the divide between IT and OT is therefore not a project with an end date, but an ongoing capability that supports continuous improvement.

By establishing shared visibility across machines, networks, and applications, manufacturers can move away from firefighting and towards optimisation. The result is not only greater efficiency, but more robust, flexible, and future-ready industrial operations.

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Security therefore rests on a blend of clear visibility and confident human judgement, supported by processes that help teams act without hesitation.



Why traditional cyber defences are no longer enough

How evolving attack techniques are exposing the limits of legacy security tools in engineering and manufacturing

By Nathan Charles, Head of Customer Experience, OryxAlign.

Ransomware groups and criminal networks now use automated toolkits that move with a speed few organisations can match. Recent threat analysis shows that most global firms cannot keep pace with AI-powered attacks. Here, Nathan Charles, Head of Customer Experience at managed IT and cyber security partner OryxAlign, explores why traditional defences are losing ground as attackers adopt AI-enabled methods, and how engineering and manufacturing organisations can adapt their security strategies to stay resilient.

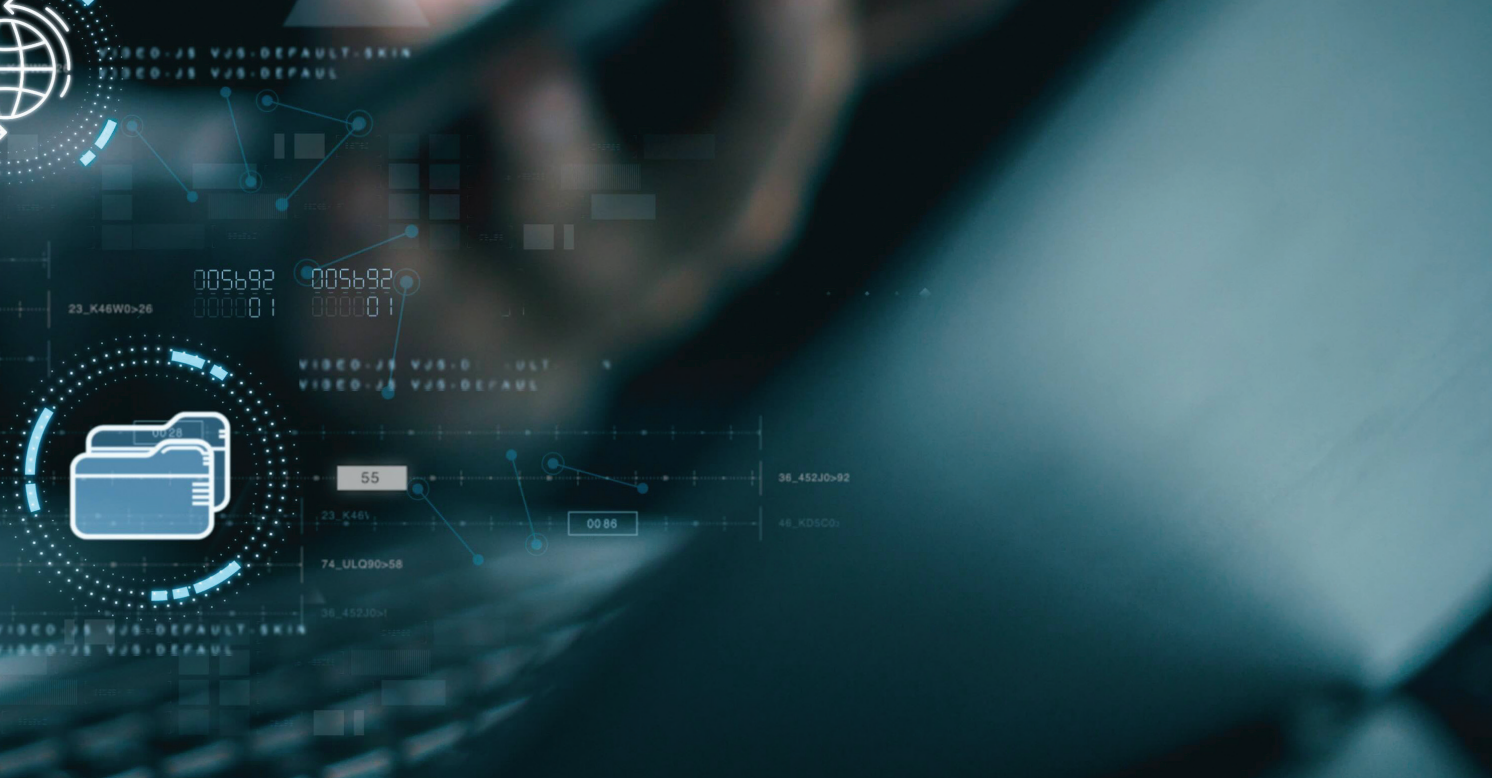
Legacy tools under strain

Traditional tools built on signature updates or static rules were never designed to match the pace or instability of modern attacks. AI alters code constantly and reshapes its own signals in ways that unsettle tools which depend on stable, recognisable patterns.

Automated scripts test weak points at high frequency and generate rapid chains of intrusion attempts that leave teams sifting through alerts. This creates a landscape where familiar tools still have value yet struggle to provide the confidence

that many organisations need when adversaries no longer work at human speed. In engineering and manufacturing environments, this pressure is often intensified by a mix of legacy systems, specialist equipment and networks that were never designed for constant exposure.

Recent analysis from security researchers reports “78 per cent of CISOs now admit AI-powered cyber-threats are having a significant impact on their organisation”, which reinforces the growing limitations of traditional controls.



Rising impact in Britain

Across the UK the impact is already visible. The Cyber Security Breaches Survey 2025 shows that organisations reporting a breach face a mean cost of £3,550 for their most disruptive incident, while a government-commissioned study places the wider economic impact of cyber attacks at around £14.7 billion each year. These figures show that routine incidents still carry weight for organisations across the UK. They also reveal a shift in how attacks unfold.

Automated probing shortens the gap between an initial scan and a serious attempt to breach a system, which forces incidents to gather pace and draws heavily on operational teams. As this tempo increases, older tools struggle to keep their footing and leave practitioners working with less room to anticipate the next stage of an intrusion. For manufacturing and engineering teams, this compression of response time can sit alongside production demands and safety considerations, adding further strain during active incidents.

AI reshapes monitoring

A further challenge appears once AI begins to influence how organisations monitor their environments. Automated tools now scan networks and endpoints for unusual activity, although their outputs often need human context before teams can trust what they see. These systems can present signals that sit close to normal operational patterns, which makes it harder for practitioners to judge whether a change in behaviour deserves closer attention.

Attackers also use AI to produce misleading indicators that mimic trusted activity or disguise a malicious sequence inside ordinary network traffic, which makes early recognition far harder for automated systems. Without oversight, teams risk either ignoring subtle signals or chasing false leads that drain resources during busy periods.

Building stronger visibility

Security therefore rests on a blend of clear visibility and confident human judgement, supported by processes that help teams act without

hesitation. UK engineering and manufacturing organisations benefit from monitoring that builds a steady picture of system behaviour under routine conditions.

Lifecycle planning also supports this picture by keeping endpoints current and reducing the presence of devices that sit outside managed oversight. These adjustments give teams a steadier view of network activity, even as automated tooling produces a heavy flow of alerts. With a clearer picture in front of them, practitioners can step into developing incidents earlier and guide responses with more confidence.

Sharper social threats

Another pressure on security teams comes from the steady rise in social-engineering attempts. Recent global research notes that in 2024 “there was a sharp increase in phishing and social engineering attacks” and that “Generative AI is augmenting cybercriminal capabilities”. These messages often pass through standard filtering and reach staff who may not expect them.

Automated tools can support the screening process, although their outputs need human review to avoid misjudging messages that share traits with legitimate correspondence. As these attempts grow more polished, organisations benefit from awareness training and monitoring practices that keep pace with the evolving character of these attacks.

AI-driven intrusion methods continue to advance, yet organisations can adjust their thinking to meet this change. Traditional tools still hold value, although their protective strength relies on how they sit alongside real-time monitoring and the routine maintenance that keeps systems predictable enough for practitioners to read them with confidence. For engineering-led organisations, maintaining this balance is increasingly part of operational resilience rather than a standalone IT concern.

www.oryxalign.com



AI-driven intrusion methods continue to advance, yet organisations can adjust their thinking to meet this change.



Why Manufacturing's Next Leap Depends on Physical AI

By Alex de Vigan, CEO & Founder, Nfinite.



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The missing piece is structured, spatial data, 3D representations rich enough for machines to learn geometry, material behavior, and real-world physics.

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Manufacturers have spent the past decade wiring their operations for automation, connecting sensors, deploying robots, and digitizing production lines. Yet even as factories become more networked, many remain fundamentally blind to the physical world they operate in. Machines execute with precision, but they don't truly perceive.

The next frontier is Physical AI: systems trained on high-fidelity 3D data that can understand, predict, and act within the real world. It's the layer that bridges the digital twin and the real world, and it's quickly moving from R&D to return on investment.

When "Smart" Systems Aren't Seeing Clearly

Most AI deployed in manufacturing today is built on 2D or textual data, perfect for language and analytics, less so for spatial reasoning. The result is narrow intelligence: robots that follow scripts rather than adapt, inspection tools that flag anomalies but can't contextualize them, and digital twins that stop at visualization rather than simulation.

The missing piece is structured, spatial data, 3D representations rich enough for machines to learn geometry, material behavior, and real-world physics. Without that, AI can't meaningfully connect design, production, and maintenance.

Physical AI: The Bridge Between Model and Machine

Physical AI trains systems not just on what things look like but how they exist and interact. Think of a welding robot that learns from millions of accurately modeled joints, or a maintenance AI that can "see" the difference between corrosion and shadow.

High-fidelity 3D data enables this by anchoring machine learning in spatial truth. Once trained on such data, AI systems can predict tolerance drift, automate quality control, and simulate new production scenarios before a single prototype is made.

In short, Physical AI turns static digital twins into operational infrastructure, live, learning systems that improve with every cycle.

Why This Matters for Industry 4.0 Leaders

Within manufacturing today, many face a similar tension: the need for adaptability without sacrificing precision. Physical AI directly addresses that.

- **Reduced downtime:** Simulated environments can let teams test line changes virtually, reducing commissioning or cutting retooling time by up to 75% in some industrial deployments.
- **Improved first-time-right rates:** AI trained on realistic 3D assets reduces false defect flags and improves consistency.
- **Cross-domain collaboration:** Engineers, designers, and maintenance teams work on the same digital twin, one that reflects reality in millimeters.

These are not speculative gains. Automotive, aerospace, and consumer-goods companies are already piloting 3D-driven AI pipelines to optimize factory layouts and robotic manipulation. The ROI is visible in faster iteration, safer environments, and data that compounds in value over time.

From Retail Visuals to Industrial Intelligence

Retail was one of Physical AI's first proving grounds. Global retailers needed scalable, photorealistic 3D visuals to sell millions of products online. That required automating the generation of accurate, physics-based digital twins at industrial scale.

Those same data pipelines now serve manufacturers and robotics teams. Whether training warehouse robots to navigate cluttered aisles or building simulation-ready models for autonomous systems, the principle is the same: quality 3D data is the new raw material of real world intelligence.

The Path Forward

The shift toward Physical AI won't happen overnight. It requires rethinking data infrastructure: how spatial data is generated, stored, and shared across suppliers and systems. But the groundwork is forming fast. Nvidia calls it "world-modeling." Fei-Fei Li, 'the godmother of AI', describes it as the key to "AGI with spatial understanding." Whatever the term, the signal is clear: the physical world is becoming a dataset.

For manufacturing leaders, the question is no longer whether to invest, but how to start. The practical entry points are clear:

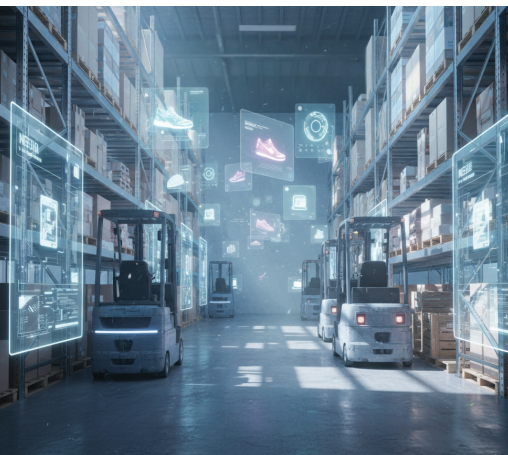
1. Audit existing 3D data assets: CAD, scans, digital twins, for quality and consistency.
2. Build a shared spatial data layer accessible across design, production, and maintenance.
3. Train AI systems on real-world variability, not just ideal conditions.

Those who take this seriously will own the next decade of industrial innovation.

Closing Thoughts

Automation made factories efficient. Physical AI will make them perceptive. And when machines can finally see the world as we do, industry can stop guessing, and start understanding.

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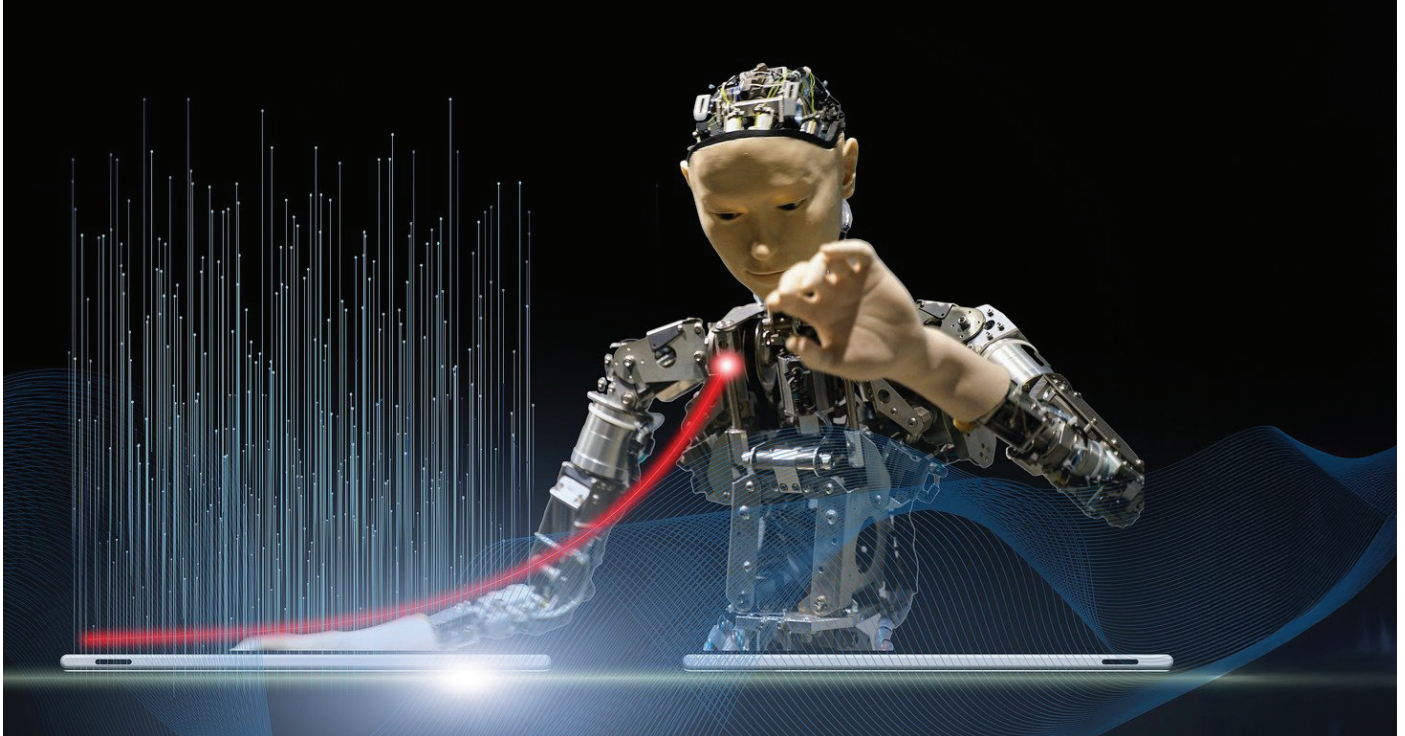
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Taking the guesswork out of demand forecasting: A deep-dive into the predictive power of machine learning

By Chris Butcher, Data & AI Presales Solution Architect, Columbus.

Every manufacturing company has one main goal – to produce exactly the amount of product to meet demand. No more. No less. This requires manufacturers to maintain proper stock levels, address seasonality sales, all the while ensuring available equipment and appropriate personnel. It's a tall order but AI-powered demand forecasting brings it down to size and delivers the results.

“

Here's where real-time data integration can enable manufacturers to gather and analyse data for more precise forecasting that can better handle the “unknowns”.

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Yet there remains a notable gap in the adoption of AI technologies such as machine learning (ML) within the manufacturing industry. McKinsey reports that a significant 73% of enterprises continue to rely on manual or outdated forecasting methods. But when the cost is high, manufacturers can no longer hold off taking the AI plunge with demand forecasting. Chris Butcher, Data & AI Presales Solution Architect at Columbus explains how ML technology can address these issues, and importantly how manufacturers can decide where and when to use it to get most success.

Everything from optimised production and inventory levels to flexible pricing, budgeting and hiring rely on accurate decision-making. But factors such as capacity, demand and cost aren't always known parameters, especially when influenced by natural disasters or geopolitical tensions. Variations in supplies,

transportation and lead times only add to these uncertainties, which can greatly influence supply chain performance with widespread effects on production scheduling and inventory planning.

What can technology offer to address this challenge?

Here's where real-time data integration can enable manufacturers to gather and analyse data for more precise forecasting that can better handle the “unknowns”. ML plays a crucial role in this by improving the accuracy of demand forecasting, especially when it comes to avoiding the traditional challenges associated with planning such as long delivery times, high transport costs, and high inventory and waste levels. With assistance from ML technologies, manufacturers can increase their value generation, heighten customer satisfaction and sustain a competitive edge.

The common pitfalls of traditional demand forecasting

- Time-consuming forecasts that limit quick adjustments
- Inaccurate forecasts that cause costly overstocking or understocking
- Failure to factor in external events and market changes, which reduces the ability to adapt to unforeseen circumstances
- High costs of maintaining a demand planning team and expensive forecasting tools

To live the impossible dream!

ML, when integrated into supply chain management systems, addresses all of these issues by leveraging advanced algorithms, data analytics and pattern recognition to provide more precise and actionable insights for manufacturers to navigate uncertainties.

ML-based forecasting can substantially reduce errors by up to 50%, allowing manufacturers to do the impossible – anticipate demand with enough time to manufacture the right stock and get as close as possible to producing the exact amount needed to meet future demand.

So how can manufacturers get started on their AI journey?

1. Build resiliency into supply chains with strategic partnerships

Effective demand forecasting is vital for procurement and supplier management. For instance, manufacturers can use ML-generated insights on future demand patterns to collaborate closely with suppliers and ensure the timely availability of raw materials and components.

This minimises lead times, reduces the risk of production delays due to shortages and allows for negotiation of favourable terms with suppliers. This can help manufacturers, especially those looking to regionalise their operations, create more resilient supply chains. Accurate forecasts also enable organisations to order materials in appropriate quantities, which can prevent overstocking and reduce carrying costs.

2. Trim waste to boost savings

Yet it's not just carrying costs where ML-based forecasting can bring financial reductions. Accurate forecasts enable efficient resource allocation, meaning raw materials, labour and equipment are used effectively, which can minimise waste and allow manufacturers to maintain efficient production processes.

The numbers don't lie! According to McKinsey, applying intelligent forecasting to supply chain management can reduce errors by between 20% and 50% – and translate into a reduction in lost sales and product unavailability of up to 65%. But that's not all. Continuing the virtuous circle, warehousing costs can fall by 5 to 10%, and administration costs by 25% to 40%.

3. Don't forget the untapped revenue opportunities

ML-based demand forecasting can be a vital way for manufacturers to grow revenue. By aligning production with anticipated demand, manufacturers can strike a balance between holding enough stock and meeting customer

requirements. This can significantly help improve cash flow and operational efficiency. But that's not all.

ML-based demand forecasting ensures products are available when customers are ready to purchase. This optimised product availability can capture more sales opportunities and maintain high customer satisfaction levels. Additionally, accurate demand forecasting allows manufacturers to plan for peak demand periods, optimising sales even during seasonal trends and holidays.

Are you data ready? Laying the data groundwork matters

Before AI can deliver results, manufacturers need to get themselves data-ready. Many organisations believe their processes are in order. In reality, shortcuts and workarounds exist. Unless these are identified and fixed, technology may end up reinforcing inefficiency rather than solving it.

It can be tricky to collect sufficient historical data and ensure its quality, particularly for new products or emerging markets. But even well-established companies and products often do not have historical data, or this data is not reliable and accessible. The same applies to KPIs, as activity isn't the same as purpose. Organisations need the right KPIs to track meaningful outcomes. But that's not the only hurdle. Choosing the right ML algorithm and optimising its parameters can be complex, while the interpretability of these models may be limited.

Before you start, dig deep for quick AI wins on the factory floor

Production lines aren't playgrounds, they're where the work is done. So the key is to start small and focus on use cases that may not directly affect production itself but still impacts workers.

Manufacturers can take the time to ask the right questions upfront to understand where the business value is. Organisations can look at where they can take cost out of the business or tackle issues that cause downtime, delays or wasted effort. It might be something as simple as making time recording more efficient.

Manufacturers that start with relatively low-cost, quick wins, can show that AI works in practice. It might be a slow approach at the beginning, but it ensures organisations are able to speed up later. A small proof of concept not only tests readiness for AI but also builds trust amongst the workforce which is key to securing buy-in.

Turn predictive insight into manufacturing advantage

It might not be a crystal ball but demand forecasting with the support of machine learning gives global supply chain leaders the accuracy and flexibility they need to stay one step ahead of customer demand. Amid demand uncertainties, using a machine learning model has the greatest influence on supply chain performance and can make the difference in today's competitive manufacturing landscape.

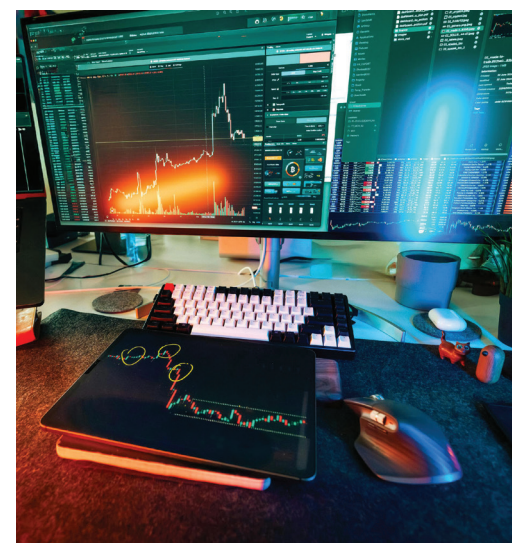
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Manufacturers that start with relatively low-cost, quick wins, can show that AI works in practice.

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INTRALOGISTEX

IntraLogisteX 2026

Discover Smart Warehousing, Manufacturing and Logistics

By John Thornton, Editor-in-chief, Logistics Manager Magazine.

More than 11,000 logistics, warehousing and manufacturing professionals are expected to attend IntraLogisteX 2026 at the NEC Birmingham on 18-19 March, as the UK's most established warehousing and logistics exhibition returns with its most ambitious edition yet.



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For Industry 4.0 audiences, the co-located structure mirrors real-world operational challenges, where robotics, data, sustainability and workforce considerations must be addressed simultaneously rather than in isolation.

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As digital transformation accelerates across manufacturing and distribution, logistics operations are increasingly recognised as a critical enabler of Industry 4.0 strategies. From intelligent automation and robotics to real-time data visibility and sustainability-driven infrastructure, the modern supply chain is undergoing rapid, technology-led change.

Against this backdrop, IntraLogisteX 2026 returns to the NEC Birmingham on 18–19 March, positioning itself as the UK's most comprehensive showcase for logistics, warehousing and supply chain innovation.

Now in its 11th year, IntraLogisteX has evolved beyond a traditional warehousing exhibition into a national platform that connects technology, strategy and real-world implementation across the end-to-end logistics journey.

From Warehouse Operations to End-to-End Supply Chain Visibility

Organised by Akabo Media, publisher of Logistics Manager magazine, IntraLogisteX has steadily expanded its scope to reflect the increasing complexity of modern logistics operations. The 2026 edition will bring together every major component of the

logistics ecosystem under one roof, from warehouse automation and intralogistics systems to fulfilment technology, freight forwarding, last-mile delivery and supply chain visibility platforms.

This end-to-end focus is particularly relevant for Industry 4.0 practitioners, as logistics environments increasingly mirror smart factory principles: interconnected systems, real-time data flows and automated decision-making. Rather than viewing warehousing as a discrete function, IntraLogisteX frames logistics as an integrated, technology-enabled network that underpins manufacturing, retail and e-commerce performance.

More than 300 exhibiting brands will be showcasing solutions spanning:

- Warehouse automation, robotics and intralogistics systems
- Fulfilment-floor technology, picking and packing
- Supply chain digitisation, data platforms and analytics

- ESG tracking, energy efficiency and sustainable infrastructure
- Freight forwarding, transport management and last-mile delivery

By consolidating this breadth of technology and expertise into a single venue and set of dates, the event offers a practical benchmarking environment for organisations evaluating investment decisions and digital roadmaps.

Co-Located Events Reflect Industry Convergence

One of the defining features of IntraLogisteX 2026 is its co-location with three complementary events: Robotics & Automation, the Sustainable Supply Chain Exhibition, and the newly launched Fulfilment & Last Mile Expo. Together, the four shows create a holistic supply chain and logistics management ecosystem, reflecting the convergence of automation, sustainability and customer-centric fulfilment models.

This integrated format enables visitors to explore how emerging technologies intersect across the full logistics lifecycle. For Industry 4.0 audiences, the co-located structure mirrors real-world operational challenges, where robotics, data, sustainability and workforce considerations must be addressed simultaneously rather than in isolation.

Real-World Operational Pressures

The timing of IntraLogisteX 2026 is significant. UK logistics and supply chain operations continue to face intense pressure from e-commerce growth, persistent labour shortages, rising energy costs, tightening ESG requirements and ongoing global supply chain volatility. These challenges are forcing organisations to rethink traditional operating models and accelerate adoption of intelligent, automated systems.

Rather than positioning technology as a theoretical aspiration, IntraLogisteX is designed as a practical forum where logistics leaders can see solutions operating in realistic environments, engage directly with solution providers and pressure-test ideas with peers facing similar constraints.

Visitors will be able to explore technologies such as:

- Robotics and automated systems aimed at increasing throughput while improving ergonomics and workforce safety
- ‘Warehouse of the future’ concepts, including space-optimised mezzanine designs, high-density storage and IoT-enabled inventory management
- Sustainability-focused infrastructure, including low-energy conveyors, advanced lighting systems and eco-efficient storage solutions

These technologies reflect a broader shift toward smarter, more resilient logistics operations that align closely with Industry 4.0 principles of connectivity, efficiency and adaptability.

Knowledge Sharing Through Conferences and Live Demonstrations

Alongside the exhibition floor, IntraLogisteX 2026 will feature a comprehensive conference programme and multiple seminar theatres

focused on real-world deployment of innovation. More than 60 sessions are planned, featuring case studies and insights from retailers, manufacturers and logistics operators already implementing automation, digital platforms and new fulfilment models at scale.

Visitors will be able to hear sessions such as:

- “From Process Automation to Intelligent Automation: Why Most Organisations Get It Wrong” by Promise Akwaowo, Process Automation Analyst – Royal Mail
- “Navigating the RPA Journey: Overcoming Challenges and Unlocking Potential” by Meritxell Corbeto Gonzales, RPA Project Manager – Bayer Global
- “How Innovate UK Drives Robotics Adoption: Funding, Ecosystem Building and Industry Engagement” by Agnes Wamagui, Knowledge Transfer Manager – InnovateUK
- “The connected supply chain: when collaboration becomes an advantage” by Carl McInerney, Regional Commercial Director – Connected Load Carrier

For technology leaders and engineers, this content provides valuable insight into deployment strategies, integration challenges and return-on-investment considerations, areas that often determine the success or failure of digital transformation initiatives.

Live demonstrations across the show floor will further enhance the learning experience, allowing visitors to see technologies operating side by side in realistic intralogistics scenarios. This hands-on approach enables meaningful comparison between competing solutions and facilitates informed discussions with engineers, systems integrators and implementation partners.

Visitors will be able to see the latest innovations from companies such as:

- SAP – End-to-end digital supply chain platforms
- Rockwell Automation – Industrial control, digital manufacturing, and connected operations
- Bosch Rexroth - Smart automation, motion control and factory integration
- Boston Dynamics - Mobile robotics and intelligent automation platforms
- Toyota Material Handling - Automated trucks, connected intralogistics and smart fleets
- Swisslog - Robotics, software and healthcare/logistics automation

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This hands-on approach enables meaningful comparison between competing solutions and facilitates informed discussions with engineers, systems integrators and implementation partners.
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The future of business is human-led

By Michael DeMaria, Director of Product Management, Fluke Reliability.

For 70% of companies, the promises of digital transformation are falling flat. This is according to data from McKinsey on digital transformation and leadership goals. However, this sobering statistic is not due to any technological faults – rather businesses are failing to acknowledge their most valuable assets, their workers. Unless organisations focus on empowering these teams, no amount of tools and data will create meaningful change. Digital transformation is failing because leadership teams aren't restructuring organisations to use this critical resource intelligently.

Until human capability is redesigned to match system capability, transformation will remain surface-level, wasting investments and crippling the potential to achieve more.

The birth of Industry 5.0

Industry 5.0 is shifting the established operating model for organisations. Instead of new technology replacing workers, smarter, more autonomous technology has made the human element even more vital. It's requiring us to move beyond the automation of Industry 4.0 into adaptive, resilient, and collaborative systems.

It's redefining our entire value system. Instead of prioritising efficiency and control, it focuses on building a workforce of people capable of adapting when they receive new information. It's enabling employees to take intelligent actions grounded in context and collaboration with new ways to use the tools they have.

Without human capabilities, organisations stay rooted in Industry 4.0, favouring automation over integrated, human-led strategy. To stay competitive in an era of constant changes, organisations need to design and enable environments that empower workers, where insight, authority, and action are connected at every level.

Industry 5.0 isn't about sidelining people. It's about making the loop more intelligent, distributed, and human-centric, empowering people to solve complex challenges better and faster than ever.

But the need to act is urgent: delays in digital transformation erode competitiveness and squander investments. To unlock the value of digital tools, leaders must empower frontline teams with faster, decentralised decision-making. This shift enables workers to anticipate disruptions, minimise downtime, and act on real-time insights, replacing reactive firefighting with proactive strategies that drive efficiency and resilience.

Building the human-centric model

Across every domain, the risks are compounding. The growing skills gap is leading to a loss of institutional knowledge, increasing the need for intuitive, trustworthy systems that help people make sound decisions without expert oversight.

Supply chain volatility demands rapid, distributed responses and teams that are empowered to act, not just report. Regulatory pressure is intensifying the demand for traceability and human accountability. And rising cyber threats are making human oversight more critical than ever, as system compromises threaten not only data but operational continuity.

Failure to adapt is failure to compete, but technology alone won't solve what are now deeply human and global challenges. Our attempts to centralise have resulted in bottlenecks that throttle progress and tie decision making up in red tape. Instead, we need distributed intelligence: empowered teams that are equipped with data and trusted to act on it. In this landscape, resilience depends on people enabled by tools, not replaced by them.

Steps to empowerment

There are three actionable steps leaders must take to eliminate the execution gap and empower their teams to act.

The first is building governance that enables velocity without compromising accountability, using clear guiding principles instead of bureaucratic approval processes. This empowers workers to make quick decisions while remaining aligned with organisational goals. It shifts the focus from asking for permission to acting with confidence, clarity, and shared responsibility.

The next step is addressing the gap between data overload and actionable insight. This means investing in data storytelling, context-rich interfaces, and role-specific views that deliver the right information to the right people at the right time. When data is presented with clarity and purpose, it stops being noise and starts guiding meaningful action.

The final step is to create models of collaborative intelligence that use data to enhance, not replace, human judgment and decision-making. Instead of trying to fully automate everything, use AI and data to support and amplify human reasoning in complex or uncertain situations. This type of reasoning is what humans do best, and by allowing people to focus on interpreting nuance, weighing trade-

offs, and applying context, organisations can make better decisions faster, without sacrificing accountability or adaptability.

The future belongs to organisations willing to rethink what success looks like, shifting goals from efficiency to resilience, from oversight to enablement, and from alignment to autonomy. A truly human digital strategy means more than simply putting more workflows on screens. It's a full transformation in how your organisation thinks, decides, and moves.

Efficiency may keep you afloat, but resilience, agility, and growth will carry you forward.

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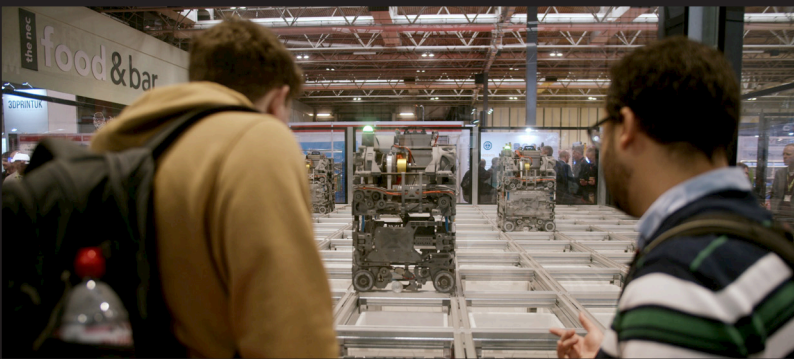
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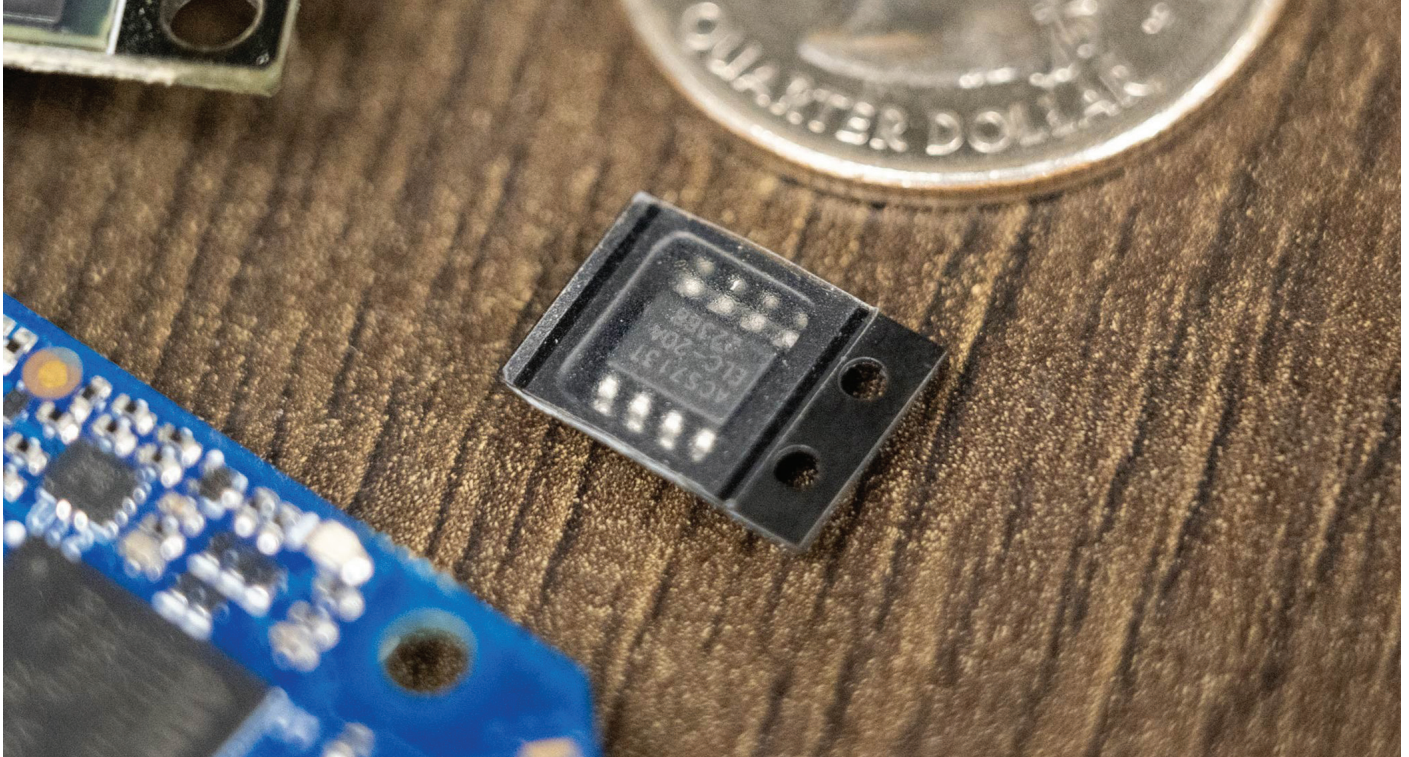
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The Role of Microcontrollers in the Next Generation of Low-power, Intelligent Edge Systems

By Padraic Heberlein, Embedded Systems and Software Engineer, Custom Electronics, Inc.

Microcontrollers (MCU) have long been the unseen backbone of modern electronics, from simple home appliances to advanced industrial systems. In the modern age, there has been a rapid evolution of MCUs as industries turn toward automation, connectivity and artificial intelligence. The next wave of development lies at the intersection of low power consumption, intelligent decision-making and real-time operation for intelligent edge systems.

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At the high-end, MCUs can be used for real-time learning for Internet of Things (IoT) and Edge technologies by enabling devices to interpret complex data without cloud dependency.

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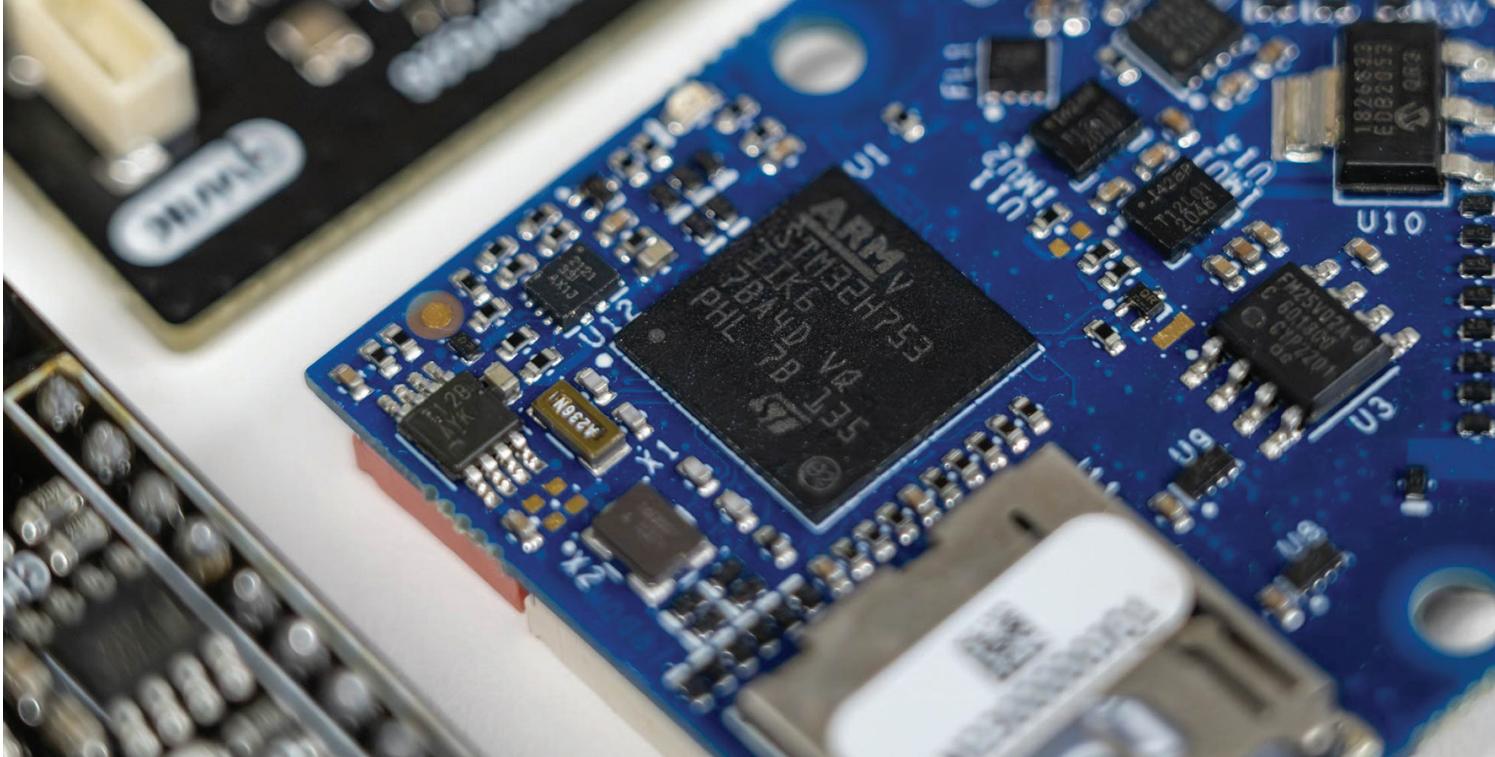
MCUs come in a variety of formats, sizes and capabilities, each tailored to specific applications. For battery-operated sensors and wearable devices, ultra-low-power MCUs help conserve energy, while mid-range MCUs offer a higher processing power that's suitable for complex motor control and advanced signal processing. At the high-end, MCUs can be used for real-time learning for Internet of Things (IoT) and Edge technologies by enabling devices to interpret complex data without cloud dependency.

At Custom Electronics, Inc. (CEI), we've built our reputation on energy, first through capacitors, then through battery systems. Recently, we've started expanding that expertise into embedded systems for intelligent power solutions. As part of CEI's research and development team, my work focuses on the ways in which we can integrate MCUs to enable more efficient, autonomous and resilient designs, whether in defense applications or advanced battery management systems.

Why Low Power Matters More Than Ever

Power consumption is a universal concern, no matter the industry. For connected devices, like those in remote or battery-operated environments, every milliwatt counts. Traditionally, large amounts of sensor data were sent to the cloud for analysis before any decisions could be made, resulting in significant power and time spent on data transmission.

With the increasing computational power and shrinking power consumption of MCUs, designers and programmers can now shift much of that processing directly to the devices, allowing them to analyze data and make decisions locally. This reduces latency and strengthens system resilience, especially in defense and IoT applications, where reliability is critical. In short, low-power MCUs enable smarter systems that can act faster and last longer.



Integrating Intelligence Into Energy Systems

At CEI, much of our exploration with MCUs begins with battery management and motor control. A properly embedded MCU can transform a conventional battery pack into a smart energy node, one capable of monitoring cell health, balancing loads or responding dynamically to environmental conditions.

We're also seeing tremendous value in pairing MCUs with advanced sensors to process data directly where it's collected. Whether for robotic motion, environmental monitoring or defense applications, the ability to process sensor input in real time, at the device level, eliminates inefficiencies and creates new possibilities for fully autonomous systems.

Even in our capacitor products, MCUs play a supportive but essential role, helping to regulate and stabilize power delivery within embedded designs. As I like to say, you can't really build a modern circuit without them anymore — they've become the "brains" behind even the most traditional power components.

Navigating Supply Chain and Design Challenges

Like many in the electronics industry, CEI continues to navigate ongoing supply chain constraints that affect component availability. These challenges have pushed our design teams to rethink our development approach by incorporating longer lead times and validating alternative components with well-curated lists of acceptable substitutes for every project.

Ensuring long-term reliability of MCUs is also a crucial factor to consider, especially in applications where maintenance or replacement might be difficult. Things like operating temperature, clock speed, voltage fluctuations and rate of use can affect the lifespan of a device. To combat this, there are some techniques that can be put in place to help extend operational life, such as low-power sleep modes, thermal management and dynamic frequency scaling. This is especially useful for battery-powered or IoT devices that need to be always turned on for the necessary tasks of computing or transmitting data.

In industrial and defense applications, MCUs are typically embedded in a system with power management systems, passive and active components that help mitigate power spikes and maintain stable operation — usually across years of service. Comprehensive tests, such as accelerated stress test, thermal cycling and real-time usage simulations, are key to verifying the reliability of MCUs in demanding operational conditions.

The Future: Smaller, Smarter and Closer to the Edge

The trajectory of microcontroller technology points to smaller, smarter and more integrated devices. The smallest MCUs available today are barely larger than a grain of rice, yet they can handle surprisingly complex tasks with minimal energy draw. Meanwhile, the ongoing adoption of embedded design, supported by accessible tools and open-source platforms, is making innovation possible for a wider range of engineers and applications. Additionally, advanced processing capabilities continue to help reduce power consumption and increase performance.

As MCUs continue to blend with sensors and AI accelerators, I foresee a new era, with devices that don't just connect — they think. The expansion of edge AI and real-time analytics means that MCUs can be integrated for more than just traditional control applications, for a more autonomous decision-making process. From defense to agriculture, industrial automation to health devices, the potential is virtually limitless. Security is also emerging as a top priority, with hardware-based encryption and trusted environments integrated directly into MCU architecture.

For CEI, it's a natural evolution. We've always been in the business of managing energy; now we're helping that energy make decisions.

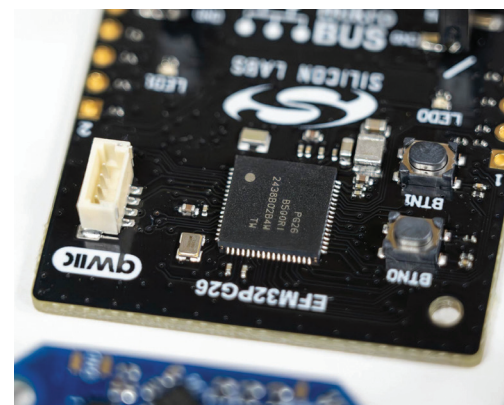
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As MCUs continue to blend with sensors and AI accelerators, I foresee a new era, with devices that don't just connect - they think.

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Top 3 robotic trends for 2026

By Oliver Selby, Head of Sales, FANUC UK.



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Through voice-controlled operation, adaptive motion control, safety-aware human-robot collaboration, and virtual commissioning via digital twins, AI is transforming industrial automation.

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The industrial automation landscape is rapidly evolving. Across manufacturing, a growing number of sectors are investing in robotics to boost efficiency, ensure consistent product quality, address labour shortages and enhance health and safety. As robot manufacturers such as FANUC work to make automation accessible to businesses of all sizes – from small-scale food producers to tier-one automotive suppliers – advanced technologies like AI are playing an increasingly important role. Against this backdrop, we highlight three key robotic trends for 2026 that are set to take industrial automation to the next level...

1. AI-driven robotics

Artificial intelligence is making robots smarter, safer and faster to deploy. Through voice-controlled operation, adaptive motion control, safety-aware human-robot collaboration, and virtual commissioning via digital twins, AI is transforming industrial automation.

One of the most significant benefits of AI is its ability to accelerate deployment. By assisting with code generation, AI makes it easier and quicker for companies to implement robotic systems. Non-specialists can use natural language to programme robots to perform tasks, reducing the engineering burden on manufacturers and delivering a faster return on investment. AI-enabled robots will also allow existing production lines to be retrofitted without extensive modifications, further speeding up the rollout of automation.

AI also expands opportunities for collaborative applications. With AI-driven voice control, robots can interpret spoken instructions and autonomously generate the code needed to execute tasks. This will enable robots to work more flexibly alongside human operators, adapting in real time to changing requirements.

In addition, AI will enhance robot safety and enable closer human-robot collaboration. For example, integrated vision systems allow robots to detect obstacles in their environment. AI can then instantly recalculate motion paths in three-dimensional space, ensuring safe and efficient operation around people and equipment.

2. Smart and scalable automation

Automation is becoming increasingly adaptable. Smart, scalable robotic solutions that can evolve alongside changing business needs are enabling manufacturers to de-risk automation investments without compromising on quality or reliability.

Smaller, more agile automated systems are also helping manufacturers address labour challenges, particularly for low-skill or repetitive tasks such as picking, placing and palletising. At the same time, suppliers are prioritising ease of deployment through simplified teaching methods, AI-enabled voice control and intelligent technologies such as vision and force sensing. As a result, the path to automation is now faster and more accessible than ever before.

Alongside these technological advances, end-users' attitudes towards return on investment are shifting. Rather than focusing solely on upfront purchase price, manufacturers are increasingly considering total cost of ownership (TCO), factoring in long-term considerations such as maintenance, downtime and energy consumption when making a purchasing decision.

As a result, automation solutions are becoming more flexible, affordable and user-friendly than ever. These smart and scalable systems are set to help more manufacturers overcome labour shortages, enhance product quality and consistency, and drive meaningful gains in productivity.

3. Open ecosystems and partnerships

The future of industrial automation is collaborative. Open platforms and partnerships between hardware and software providers are enabling more flexible, integrated solutions that accelerate innovation and adoption.

At FANUC, we are actively collaborating with leading technology partners bringing AI solutions to market, including NVIDIA, helping to unlock the potential of physical AI. A key step in this journey is our support for the open-source robotics platform ROS 2, which enables programming via Python. By lowering the barrier to entry, this allows developers, researchers and companies to build AI-driven robotics applications on FANUC's proven industrial hardware.

One important benefit of this openness is a smoother transition from education into industry. ROS 2 and Python are widely taught in colleges and universities, and making these tools available on industrial equipment will allow more young engineers to apply familiar skills directly in real-world manufacturing and automation environments.

More broadly, open platforms such as ROS 2 and Python will help to stimulate a new wave of innovation, enabling companies to build, customise and scale AI-augmented robotics solutions while leveraging their own software expertise on top of FANUC's hardware and NVIDIA's advanced simulation infrastructure.

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In a medical operating theatre, a hand-held surgical device, powered by a miniature BLDC motor, needs precise control to optimize the success of the procedure.

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Inductive encoders: a robust solution for precise motion feedback

By Sayali Shinde, Design Engineer,
Portescap.

An inductive sensor, also known as an inductive encoder, provides fast and precise feedback of motor speed and position. Compared to optical and magnetic encoders, they can optimize the reliability of feedback for miniature motion applications. However, their specification for motion design requires careful consideration, especially for different operational and environmental conditions.



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This direct interaction
between the field and
the object enables
real-time detection
and feedback.
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In a medical operating theatre, a hand-held surgical device, powered by a miniature BLDC motor, needs precise control to optimize the success of the procedure. Alternatively, a robot handling a tool for precision manufacturing needs accurate control to achieve micron-level position adjustment.

In both these examples, an encoder is an essential feedback device that measures the speed or position of the shaft of an electric motor. The encoder communicates this information to the controller, which calculates the discrepancy between the setpoint and the actual speed or position. The controller then sends a corresponding signal back to the motor to correct any error. With this process operating continually at high speeds, this creates a closed loop system essential to precise speed or position control.

Encoders can operate on an optical principle, using a disk with patterns and optical sensors to detect position or rotation, yet dirt or dust can impact the reading. Alternatively, magnetic encoders, which rely on a magnetized disk and magneto resistive sensors to detect magnetic field changes can be used. However, these devices are more affected by stray magnetic fields, leading to errors in environments with high electromagnetic interference (EMI).

Electromagnetic principle

Other options include encoders based on electromagnetic induction, which are impervious to contamination but also less susceptible to magnetic fields. Unlike magnetic encoders, the performance of an inductive encoder doesn't diminish over time.

An inductive sensor operates on an electromagnetic principle, and signals speed and position changes by utilizing the interaction between its electromagnetic field and a motor



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With inherently robust features, integration within the motor housing, and lack of mechanical components, this gives inductive encoders a long service life.

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shaft. An inductive coil is the main sensing element of an inductive sensor, and when an alternating current (AC) flows through it, the coil generates an electromagnetic field. A motor shaft within the proximity disturbs the field, which induces eddy currents, which are loops of current induced within a conductor when exposed to a changing magnetic field. These eddy currents create a secondary magnetic field, which interacts with the primary field of the sensor, and this interaction alters the inductance of the sensor's coil, causing a change in its output signal. As the motor shaft rotates, the inductance changes periodically, and the frequency of these changes corresponds to its speed. Alternatively, the sensor can determine its precise angular position by tracking the exact phase of the inductance variations as the shaft rotates.

Advantages of inductive sensors

Typically, adding an encoder adds length to the motor, and for flat or pancake-style BLDC motors, this extended length may negatively impact the motor-encoder assembly. However, inductive encoder technology also proves advantageous as the encoder elements and the commutation Hall sensor are situated on the same printed circuit board (PCB), maintaining the overall motor length compared to a standard encoder setup.

Inductive sensors achieve fast response times. Changes in position or speed cause immediate alterations in the induced eddy currents, which directly affect the inductance of the sensor coil. This direct interaction between the field and the object enables real-time detection and feedback.

These devices also enable high precision sensing, and inductive encoders can achieve high resolution due to their ability to detect even small variations in the inductive signal. As the motor shaft rotates, its interaction with the sensor's electromagnetic field causes measurable changes in the inductance of the coil, which are directly proportional to

the position or speed of the object. Accurate measurement of these variations provides precise motion feedback.

With inherently robust features, integration within the motor housing, and lack of mechanical components, this gives inductive encoders a long service life. Free of mechanical components such as optical disks, inductive encoders can also achieve a more compact design. These devices also typically have low power consumption, making them energy-efficient and suitable for battery-powered or portable power tool applications. Their relative simplicity also makes them easier to install and set-up, and for control system integration they can output various signal options such as PNP, NPN, or analog.

Support in specification

An inductive sensor can still be affected by magnetic interference, and the presence of nearby metallic objects can interfere with the accuracy and reliability of inductive sensors, leading to false readings or inconsistent performance. Inductive sensor operation can also be compromised by EMI generated by nearby electrical devices or equipment. Some inductive encoders may also be unsuitable for sterilization environments, such as surgical applications, as they can suffer damage.

While the integration of inductive sensors into miniature motion systems can be advantageous, their use requires appropriate specification according to operational and environmental considerations. Expert support in the selection of the right feedback sensor technology is useful to achieve long-term application success, as well as faster speed of development.

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The role of DevOps in enhancing automation systems

Why open architecture is the key to industrial DevOps

By Beth Ragdale, Software Business Manager, Beckhoff UK.

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At its core, DevOps is a cultural and technical approach that breaks down the traditional divide between software development and operational teams.

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Manufacturers today face greater pressure to adapt quickly. Product variation is rising, schedules shift often and machines must deliver increased performance with less downtime. As automation becomes increasingly software-driven, engineering teams are looking to the IT department for guidance. One methodology in particular, DevOps, is beginning to shape how automation systems are developed and maintained. Here, Beth Ragdale, Software Business Manager at automation and control specialist Beckhoff UK, explains how DevOps can transform industrial environments and why the openness of the underlying control platform determines its success.

At its core, DevOps is a cultural and technical approach that breaks down the traditional divide between software development and operational teams. In the IT world, DevOps enables rapid iteration, continuous testing and smooth deployment. These practices have changed how digital products are built and maintained, allowing teams to release updates frequently and improve quality with automated validation.

Industrial automation is now facing many of the same pressures that originally led to the emergence of DevOps. Machines are expected to evolve faster, integrate more advanced functions and operate more reliably. However, the engineering workflows behind them often remain siloed and heavily reliant on manual intervention.



When DevOps practices are combined with an open automation platform, development cycles become faster and more predictable.



The challenge is that industrial environments cannot simply copy and paste the IT model. Traditional PLC-based systems tend to be closed and proprietary, limiting the ability to integrate tools such as version control, automated build systems or virtual testing environments. When engineering teams cannot access these, processes become slower and less collaborative. A small modification to a machine might require manual code merging, extensive on-site testing and prolonged shutdowns. In these circumstances, the principles behind DevOps — continuous improvement, reliable iteration and rapid deployment — become difficult to achieve.

This is why openness is so important for DevOps. To benefit from DevOps, automation systems need an architecture that welcomes integration with mainstream IT tools. Standard communication protocols, open development environments and support for common programming languages all play a crucial role. When machine control is built on open foundations, engineering teams can work with familiar tools, share code more easily and establish repeatable processes for building and testing automation software.

Beckhoff's PC-based control platform is designed with exactly this in mind. Because TwinCAT runs on standard PC technology and supports a wide range of languages and interfaces, it naturally aligns with DevOps-style engineering.

The benefits of this openness can already be seen across a range of industries. In packaging, for example, software-defined motion has replaced rigid mechanical designs, allowing systems to adapt instantly to changing formats. Tetra Pak, a Swedish multinational food packaging and processing company, uses capping technology that demonstrates this clearly. It uses software-driven control and modular motion systems, which have enabled exceptional flexibility, reliability and throughput.

In the energy sector, open control architectures have proven essential for managing the demanding conditions of hydrogen production, storage and fuelling, where real-time data, safety functions and connectivity must operate as a single, integrated environment.

In both cases, the ability to develop, test and update control software rapidly has been instrumental in meeting complex performance requirements.

When DevOps practices are combined with an open automation platform, development cycles become faster and more predictable. Engineering teams can trial changes in simulations rather than using live equipment, reducing commissioning time. Operators can receive regular improvements without lengthy shutdowns because deployments follow established, well-tested procedures. Quality improves as issues are identified earlier in the development cycle, rather than during commissioning. Collaboration becomes smoother because every team works from a single, controlled codebase. Even cybersecurity can be improved, as updates and patches can be applied consistently and transparently throughout a facility.

Perhaps the most significant shift is cultural. Instead of viewing automation software as something that remains static once commissioned, engineers can approach it as a living system — one that evolves throughout the lifetime of a machine. This mirrors trends in software-intensive industries and offers manufacturers a powerful new way to compete. Machines no longer need to be replaced or mechanically reworked to support new production requirements. Instead, they can be enhanced and optimised using iterative software updates.

DevOps is set to play a much greater role in how automation systems are engineered. However, its true impact depends on the technology beneath it. An open, PC-based architecture provides the foundation upon which DevOps can thrive, giving manufacturers the flexibility to innovate continuously without compromising reliability or safety.

For companies looking to improve responsiveness, reduce engineering bottlenecks and build smarter, more adaptable machines, industrial DevOps offers a compelling path forward. And with an open platform at the centre of their automation strategy, that path becomes far easier to follow.

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Building traceability and control in battery manufacturing

By Mark Rutherford, CEO,
Alexander Battery Technologies.

Battery manufacturing is a well-established discipline but the operating environment has changed significantly in recent years. Battery manufacturing programmes are larger, applications are more diverse and the level of scrutiny applied to OEMs and their supply chain partners has increased, not only from regulators but from customers, insurers and auditors who want greater confidence in how products are designed, built and controlled over time.

In practice, this has shifted the conversation away from whether a battery meets its functional requirements and towards how consistently those requirements are delivered across projects, production batches and product lifecycles. Traceability, evidence and repeatable process control have become central to that discussion, particularly as batteries move into more critical and regulated applications.

Regulatory initiatives such as the EU Battery Passport reflect this wider change in expectations but they are not the sole driver. Although many battery manufacturers and their customers are not yet directly in scope, similar requirements are already being applied through contractual and quality frameworks. Serialised packs, auditable production records and verified material data are increasingly treated as standard expectations rather than future obligations.

The challenge for manufacturers is rarely a lack of technical capability. More often, risk emerges as projects evolve. Battery programmes almost always change between early builds and production, whether through component substitutions, process improvements identified on the line or adjustments driven by customer feedback.

Without structured control, those changes can introduce disconnects between approved designs, authorised component lists and the build taking place on the line.

At Alexander Battery Technologies, managing that reality means accepting that change is inevitable while ensuring it remains visible and controlled. Projects are structured with defined stage gates and budget release points, while engineering change is reviewed and approved within a single system so that updates are reflected accurately across production and quality records. The objective is not to constrain development but to ensure that design intent and manufacturing reality remain aligned as programmes progress.

For manufacturers without structured systems in place, informal tools become harder to sustain as volumes increase and programmes

scale. Spreadsheets and local workarounds tend to proliferate, creating fragmented records across engineering, procurement, production and quality. The solution is an ERP system that provides a single, authoritative source of information across those functions, supporting consistency without removing the judgement and experience that sit on the shop floor.

This becomes particularly important when managing materials and suppliers. Battery performance and safety depend on tight control of components, from cells through to mechanical structures and electronics. Approved materials, qualified suppliers and traceability back to batch and lot level reduce exposure to unplanned substitutions and provide a clearer response when supply constraints arise. Where alternatives are required, they can be assessed and approved in a controlled way, with a full understanding of impact.

On the production side, manufacturing execution systems (MES) capture how each pack is built and link that activity to a unique serial number. Process data can then be monitored using established techniques such as statistical process control (SPC), while measurement systems are validated where appropriate through Gauge R&R studies to ensure consistency.

These are long-standing manufacturing practices, but their importance has increased as expectations around evidence and auditability have risen.

Quality management benefits from the same integration. When inspections, non-conformances and corrective actions sit within the core production record, issues are identified earlier and addressed with less disruption. End-of-line testing still has a role, but it functions as confirmation rather than first detection, reducing rework and uncertainty later in the process.

There is sometimes a perception that tighter process discipline adds overhead but experience tends to show the opposite. Clear planning, accurate inventory control

and consistent records reduce wasted effort and the time spent reconstructing events after issues arise. Those efficiencies support lean manufacturing and make delivery more predictable for both manufacturer and customer.

For OEMs selecting a battery partner, these disciplines are increasingly part of the assessment. ERP-led process control supports smoother qualification, greater confidence during scale-up and clearer answers when questions arise months or years into a programme. It also means that readiness for initiatives such as the Battery Passport follows naturally, rather than being treated as a separate compliance exercise.

The industry is not being asked to rethink how batteries are made. It is being asked to demonstrate control, consistency and transparency at a higher level than before.

Manufacturers that have invested in structured, ERP-led foundations are better placed to meet those expectations while supporting efficiency, scale and long-term trust.

Alexander Battery Technologies partners with OEMs to design and manufacture battery pack solutions that meet demanding technical, regulatory and production requirements. Operating from the UK, the company supports battery programmes through development, scale-up and long-term manufacture, with a strong focus on traceability and controlled delivery.

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Why supply chain resilience is critical in the wiring sector

By Jeff Wood, Sales Director, WireMasters.

In 2025, average global shipping costs have surged by approximately 12 percent, driven by freight delays, port congestion and geopolitical friction, pressure points that directly affect the cost and availability of critical wiring materials like copper and prefabricated cables. In this context, resilience in the wiring supply chain is an operational imperative that determines whether projects move forward or stall altogether. Here, Jeff Wood, Sales Director at wiring specialist WireMasters, examines the importance of supply chain resilience and what can be done to achieve it.

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It begins with visibility, but true resilience is about anticipating vulnerabilities before they translate into shortages.

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Resilience in the wiring supply chain does not emerge from a single dimension of planning. It begins with visibility, but true resilience is about anticipating vulnerabilities before they translate into shortages. Distributors operate at the intersection of global manufacturing, logistics and end-user demand, which means that their role is not simply to source and ship, but to predict where the next point of friction might occur.

Strategic stocking as an insurance policy

In the wiring sector, just-in-time inventory models often fail to account for the long lead times, strict compliance requirements and limited substitutability of components. When delays occur, particularly in defence, aerospace or transport applications, there is often no fast workaround. Strategic stocking offers a more resilient alternative, but only when implemented with precision.

Rather than increasing inventory across the board, a risk-based approach allows distributors to focus on components that are both hard to replace and critical to customer operations. This may include cables with long manufacturing cycles, parts with few approved suppliers or items tied to specific certification standards. These decisions should be based on procurement data, usage trends and an understanding of where previous supply constraints have caused delays.

Stocking strategies must also be flexible enough to adapt to changing demand patterns. Digital inventory tools can help flag emerging risks, such as increased order frequency, extended lead times or regional instability, allowing for more responsive adjustments. In parallel, working closely with manufacturers to secure long-term supply agreements or advanced production slots



ensures that inventory planning is aligned with real-world constraints.

Sustainability as a source of stability

Sustainability is becoming a practical requirement for long-term operational continuity. In the wiring sector, where materials such as copper, fluoropolymers and specialty alloys are under growing environmental scrutiny, demonstrating responsible sourcing has shifted from a reputational concern to a business-critical function. New legislation in the EU and North America is tightening expectations on everything from carbon footprint disclosure to labour practices in the raw materials supply chain. Suppliers that cannot comply are likely to be phased out, either through enforcement action or loss of buyer confidence.

For distributors, aligning procurement strategies with sustainability criteria is now a way to build stability into their networks. This doesn't only mean avoiding non-compliant sources, it also means favouring manufacturers with robust ESG reporting, resilient energy supply chains and circular economy initiatives that reduce long-term exposure to raw material volatility. These suppliers are more likely to remain viable during regulatory shifts and market disruptions, making them stronger long-term partners.

Partnerships as shock absorbers

No supply chain is purely technical. The wiring sector, in particular, depends on longstanding relationships built on transparency, responsiveness and shared accountability. While systems and forecasts provide a useful foundation, it's the quality of collaboration between manufacturers, distributors and end-users that determines how effectively disruption can be managed.

When supply chains are under pressure, whether due to a sudden export restriction, a certification delay or a production shortfall, there is no substitute for having established lines of communication and mutual trust.

Distributors that maintain close contact with both ends of the supply chain are better positioned to anticipate customer needs, negotiate priority allocation and escalate issues before they reach critical stages.

WireMasters has built its reputation on this kind of partnership-led resilience. With decades of experience supporting high-stakes sectors like aerospace and defence, the company offers not only a robust product portfolio, but also the infrastructure, technical expertise and customer-first mindset needed to navigate volatility. Whether it's securing long-lead items, coordinating multi-site deliveries or advising on qualified alternates, WireMasters helps its customers stay ahead of supply chain risks and focus on delivering what matters most.

As wiring systems become more integrated into critical infrastructure and high-performance applications, the pressure on supply chains will only increase. Building resilience is an essential part of delivering on time, maintaining quality and meeting compliance standards. By taking a proactive approach to stocking, aligning sourcing with sustainability and investing in strategic partnerships, companies can reduce exposure to disruption and support long-term customer success.

www.wiremasters.com



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As wiring systems become more integrated into critical infrastructure and high-performance applications, the pressure on supply chains will only increase.”



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With private wireless, manufacturers will benefit from greater reach, performance, scalability, control, and the flexibility to support all services cost-effectively, even as more assets and people are connected.

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Unlocking Smart Factories with 5G Private Wireless and Open Ecosystems

By Tom Richter, Head of Enterprise Campus Edge Manufacturing, Nokia.

Rising costs, supply chain uncertainty, and the shifting political landscape are just a few issues keeping manufacturers awake at night. According to Deloitte's 2025 Smart Manufacturing and Operating Survey, 92% of respondents believe smart manufacturing will be the main driver of competitiveness over the next three years. Additionally, 85% believe that smart manufacturing processes will transform how products are made, improve agility, and help attract new talent.

As industrial enterprises continue their digital transformation, attracting talent and training existing workers to help them adapt to new tools and technologies are becoming priorities. While some manufacturers have already started connecting their operations, the transition to a smart factory won't be enabled by connecting machines, assets, and sensors alone.

They should take a holistic approach when selecting a digital platform, leveraging an open application ecosystem and ensuring that it not only supports their immediate priority use cases but also provides flexibility and scalability to meet future needs.

Beyond Connectivity

Wireless connectivity is vital even as manufacturers begin connecting assets. Wi-Fi is great for non-mission-critical application support, but even Wi-Fi 6 or 7 cannot close the connectivity gaps around a plant which, for example, is filled with metal structures. With private wireless, manufacturers will benefit from greater reach, performance, scalability, control, and the flexibility to support all services cost-effectively, even as more assets and people are connected.

Autonomous mobile robots (AMRs) are an example of the need for critical control. They

must experience continuous pervasive real-time connectivity across the factory floor to receive and execute scheduling instructions and immediately respond to re-routing requests for safe, productive operations. Robust connectivity is required to facilitate an uninterrupted data flow between these and other connected assets, including conveyor systems, vision inspection cameras, real-time monitoring sensors and robotic arms for predictive maintenance, indoor tracking and positioning, remote production line or lone worker monitoring in a smart factory.

5G private wireless provides this, with not only pervasive connectivity and low latency but also the inherent scalability and security to support the focus and pace of each manufacturer's digitalization journeys.

Connecting people and assets is a great starting point for the smart factory. However, manufacturers must be able to make the operational (OT) data they gain from doing this available to teams across the business, allowing workers to make better decisions about customer needs, product and quality management, future technical implementation, and more.

For example, with real-time visibility into inventory levels, production status, and supplier data, procurement teams can be alerted when a critical component is unavailable from a supplier. They can use this information to alert teams to adjust production schedules, to reallocate materials, or more rapidly source a component from an alternative provider to reduce the risk of downtime.

AI's effectiveness in industrial settings depends on high-quality, real-time data, which is increasingly supported by on-premise edge technology and private wireless networks. As more assets connect, the industrial edge becomes vital for managing applications, providing centralized visibility, and processing data locally. This data is then sent to centralized lakes, enabling AI and analytics tools to generate insights that enhance efficiency, safety, and sustainability, while reducing downtime, cutting costs, and driving innovation.

The Complex Connected Smart Factory Ecosystem

Infrastructure, software and connectivity providers, device manufacturers, network operators, cloud hyperscalers, systems integrators, and regulatory bodies are among those that must play a part in the smart factory ecosystem. Each brings essential capabilities to the table: the devices to connect people and assets; the software that enables the new Industry 4.0 capabilities such as predictive maintenance or automation; the expertise to design and manage the network, ensuring it aligns with the manufacturer's goals; and the regulatory framework to maintain security and quality.

Collaboration between these players and the seamless integration of technology are vital to providing benefits beyond connectivity and enabling the true smart factory.

The connected 5G ecosystem in practice

Digitalization remains a priority for millions of manufacturing plants globally. The process often begins by connecting workers through ruggedized industrial devices—such as tablets, smartphones, or smart helmets—that support hands-free communication even in noisy

environments or while wearing PPE. Wearables can track vital signs, detect hazards like gas leaks or rising temperatures, and potentially save lives.

While Wi-Fi alone can be unreliable, 5G private wireless ensures constant connectivity, enabling real-time access to data, instructions, and team communication. Advanced software solutions—like push-to-X communication, geofencing, and object recognition—further enhance safety by enabling situational awareness, enforcing PPE compliance, and triggering alerts for unauthorized zone access.

A seamless flow of operational data can be leveraged by a mix of smart factory use cases, including predictive maintenance, optimizing productivity, or maintaining regulatory compliance. Geofencing, for example, can also be used for tool management, alerting workers when a tool is incorrectly placed to ensure the right ones are used, maintaining product quality, worker productivity, safety, and regulatory compliance. Worker training can be augmented using AI, virtual reality applications, and OT data.

Remote monitoring using connected cameras and object recognition software can also be implemented to identify quality issues at the production line and alert maintenance teams, before those issues can significantly impact costs. Using operational data in this way won't just improve productivity and reduce costs but will also help to reduce the energy spikes associated with malfunctioning equipment, with this data feeding into sustainability reports and supporting broader carbon reduction and efficiency goals.

How to implement the smart factory ecosystem

The case for 5G private wireless in smart factories is strong, with implementation shaped by each manufacturer's goals and use cases. Success depends on the digitalization platform and the strength of the ecosystem behind it. Partnering with providers that collaborate across system integrators, device makers, application vendors, and regulators offers flexibility and speed. A robust digital backbone—powered by 5G and an ecosystem-neutral industrial edge—enables rapid integration of third-party solutions, turning OT data into actionable insights that drive safety, productivity, sustainability, and long-term competitiveness.

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Second sourcing is moving back into focus, not as a cost-cutting exercise but as a form of risk management.



What rising raw material prices mean for electronics

Why upstream volatility is no longer abstract for design and procurement teams

By Chris Withers, Sales Director, Zel Components.

If you feel like you're paying more for your electronic components, you're not imagining it. Thanks to upstream pressures, rising prices for key commodities used across electronics and manufacturing are filtering down into everything from copper-heavy printed circuit boards (PCBs) to metal-backed passives. Here, Chris Withers, Sales Director at Zel Components, an alternative electronic parts supplier, explains how engineers can respond more quickly to market volatility.

On the London Metal Exchange (LME), copper reached record territory in early January 2026, pushing above \$13,300 per tonne. That's more than 20 per cent higher than the late 2025 average as stock tightness and strong industrial demand combined.

That matters because copper isn't just a metal you read about in commodity news. It's used extensively in printed circuit boards, internal connectors and wiring, as well as across many power and signal paths in electronics. As a result, movements in copper pricing directly influence the cost of the boards and assemblies engineers design and build.

Precious metals are also impacting pricing dynamics. Gold recently surged above \$5,000 per ounce, reaching a series of record highs in the first few weeks of 2026 amid market volatility and safe-haven demand. While gold isn't in every bill of materials, it's used in contact plating and specialist components where performance meets reliability.

Likewise, aluminium has traded firmly above \$3,000 per tonne on global benchmarks and is forecast to remain well supported given current market dynamics. Even when commodity analysts suggest prices might ease later in the year, the near-term story is volatility, which introduces risk.

When inputs move

Engineers regularly buy copper foil, laminates and boards priced off copper's movement. Over 2025 and into 2026, manufacturers of copper-clad laminate — the base material for almost all FR-4 boards — began issuing public price adjustments directly linked to rising raw materials.

Some supplier notices describe increases of up to 30 per cent across all thicknesses of copper-clad laminate and prepreg, driven by higher copper prices, glass cloth costs and processing expenses.

This is the kind of upstream movement that doesn't stay upstream. It filters through every layer of a PCB quotation, especially in multi-layer designs where copper and prepreg content is higher.

The wider passive component landscape tells a similar story. Industry analysis shows price increases across capacitors, inductors, ferrite beads and related passives. These range from single digit to double-digit percentages for early 2026 deliveries, often citing metals and process cost inflation among the drivers.

This doesn't mean you should panic buy every part in your current bill of materials (BOM). However, it does mean that the old "wait-and-see" strategy is getting riskier, particularly if you're dependent on a single branded source for key sections of your design.

Alternative sourcing

Second sourcing is moving back into focus, not as a cost-cutting exercise but as a form of risk management. Pin-for-pin alternatives, for instance, allow engineering teams to maintain electrical and mechanical compatibility while reducing dependence on individual manufacturers, whose pricing or lead times may be more exposed to raw material volatility.

This approach is particularly effective for widely used regulators, discretes, interface devices and passives, where functional equivalence is well understood and validation cycles are manageable. As volatility increases, having approved alternatives already mapped can significantly reduce disruption when prices shift or allocations appear.

When suppliers combine local stock with extended inventory and effective cross-reference tools, response times improve. During a time of uncertain input costs, that flexibility is as valuable as unit price, provided performance remains consistent.

Prices might ease at some point, but it's difficult to predict when. Volatility isn't going away, and when raw material costs feed into electronics pricing, it's the teams that design and source with flexibility in mind that are better positioned to respond when conditions change.

www.zelcomponents.co.uk



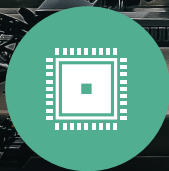


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AI in 2026: Beyond the Hype, Toward Efficiency and Agency

By Alexia Pedersen, SVP International, O'Reilly

The discussion around AI has been dominated by some dramatic figures this year: trillion-dollar market caps, record-breaking fundraising rounds, and projected power demands that rival the consumption of entire nations. The growing concern about whether we are experiencing a speculative AI bubble is completely understandable. Yet some of the most eye-catching claims may be performative; less about securing actual investment, and more about shaping perception.

This raises a critical question: if so much of the growth story is forward-looking, what happens when one of the dominant firms falters? The interconnectedness of today's AI ecosystem means that failure won't happen in isolation. While it's not guaranteed that the AI bubble will burst, 2026 or 2027 may be a time where rhetoric and reality are forced to converge.

A divergence in global AI strategy

In the U.S., headlines continue to centre around building ever-bigger AI models, but we're seeing a different approach taking shape in other markets. In China, for example, recent launches like DeepSeek OCR, Minimax M2, and Kimi Linear are deliberately optimised rather than oversized. These models focus on delivering strong performance at much lower compute and energy cost, proving that you don't need to scale endlessly to make meaningful progress.

This reflects two contrasting philosophies: growth through scale versus growth through optimisation. In a world where energy infrastructure is strained and sustainability pressures continue to mount, the advantage may ultimately shift to the systems that deliver more intelligence per watt. The next era of AI competition may be won not by the biggest models, but by the most efficient.

From experimentation to implementation

It's no surprise to see AI investment reaching record levels in the UK. Surveys consistently show that AI is now a central strategic focus for organisations, not an experimental side project. On the supply side, the ecosystem of tools has expanded, ranging from start-ups to established enterprise vendors and major cloud platforms. On the demand side, the skills and knowledge required to build solutions have become more accessible. Usage patterns on the O'Reilly learning platform reflect this shift: from 2023 to 2024, engagement with generative AI content grew 289%, while interest in AI principles and governance grew even faster, at 386%. This suggests organisations are no longer just curious, they are preparing to deploy at scale, responsibly.

There has also been significant progress in applying AI to specific functional areas. Computer vision, speech technologies, and natural language understanding are maturing rapidly. Traditional analytics workflows, recommendation, forecasting, personalisation, and anomaly detection, are being re-architected with AI at their core. Importantly, organisations can now point to real case studies, not just proofs of concept, with measurable impact on efficiency and decision quality.

As we enter this implementation phase, advantage accrues to companies with two critical assets: access to meaningful data and leaders who can rapidly build and iterate. This highlights a national challenge. The UK will need to remain open to technical talent and entrepreneurial leadership to maintain momentum. Competition for that talent is intensifying across Europe, and research shows that 71% of UK technology professionals believe the skills gap could slow national progress toward AI leadership. Innovation alone is not enough; the conditions for scaling innovation must also be in place.

The rise, and limits, of agents

The rise of AI agents was one of the defining developments of the past year. These systems can plan, take multi-step actions, and operate with varying degrees of autonomy. In 2026, we will see broader enterprise adoption, particularly in areas where workflows are repetitive, procedural, or knowledge-retrieval-heavy.

Greater delegation brings new responsibility, sending an agent to automatically execute complex financial tasks, for example, requires clarity around oversight, accountability, and error handling. Differences between models matter here - reasoning, reliability, and interpretability are not uniform across systems. The coming year may test how comfortable organisations really are with allowing AI to think and act on their behalf.

Unlocking enterprise knowledge through multimodality

Another major area of progress will be multimodal AI. While public attention often focuses on generative video and image creation, the enterprise use case is more pragmatic. The majority of organisational knowledge does not exist in neatly structured text, it is buried in slide decks, PDF manuals, video recordings, and shared drives. Multimodal systems will enable companies to search, summarise, and operationalise this data for the first time at scale.

This is less about novelty, and more about releasing trapped value.

The case for smaller, embedded AI

2026 and 2027 are set to be the year small, embedded AI systems gain meaningful traction. These models run locally on devices without needing to transmit sensitive data externally. They support privacy-preserving applications, reduce infrastructure dependency, and lower operational costs.

After years of centralising intelligence in the cloud, we are beginning to distribute it back outward - into the objects, tools, and environments of daily life.

What's next?

The story of AI in 2026 will not be defined by scale alone, it will be shaped by efficiency, agency, accessibility, and the strategic choices made in how, and where, intelligence is deployed. The next phase is less about building the biggest system, and more about building the right one, and to get the most from AI, organisations must supercharge their people with new skills and training to fully realise the value of their AI investments.

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Reducing risks in mould tools

By **Chloe Maine**, Business Development Manager, Business Development Manager.

Tooling plays a crucial role in the precision, quality, and efficiency of injection moulded components. Its success depends on specialist expertise, smart material choices, and reliable access to technical support.



“However, when precision and close control are critical, managing the toolmaking process in-house helps to maintain quality, flexibility and speed.”

Business Development Manager at MGS Technical Plastics Chloe Maine explores how processors can reduce their tooling risks and shares tips on how to ensure the highest quality tooling support.

How does a mould tool work?

A mould tool is a high precision, engineered assembly that manufactures complex parts in high volumes by forming molten plastic into specific shapes. Each mould tool is custom designed for a specific part or product family to meet detailed design specifications. Typically comprising two primary halves: cavity (A-side) and core (B-side). When clamped together in a moulding machine, these two halves form a hollow space - or cavity - that precisely replicates the product shape.

Additionally, the mould tool performs several critical roles during the moulding cycle. It manages the controlled flow and distribution of molten material into the cavity via sprues, runners and gates. It incorporates thermal regulation systems, such as internal cooling channels, to precisely control the rate of material solidification. Once the part has cooled and solidified, the tool uses mechanisms like ejector pins, plates, or even custom lifters to eject parts cleanly and reliably.

What is a multi-cavity tool?

Mould tools vary significantly in complexity depending on the application. One of the most efficient formats for high-volume production is the multi-cavity tool. Unlike a single-cavity tool that produces one part per cycle, a multi-cavity mould includes multiple identical cavities within the same tool. This allows several parts to be formed simultaneously during each cycle. The benefits include increased throughput, reduced costs per unit, and improved manufacturing efficiency.

3. How does a family tool differ?

Similar in format, a family tool instead produces different parts simultaneously within the same mould. Each cavity in a family tool corresponds to a distinct component - often parts that will be assembled together later, e.g. a container and its lid, or various components of a single product.

Family tools offer excellent efficiency for assembly-based production lines, reducing handling time and tooling costs. However, they present greater design and process challenges due to varying sizes, volumes, and cooling characteristics. Careful balance must be achieved to ensure all parts fill and cool properly within the same cycle. Gates, runner sizing, and cooling circuits must be meticulously designed to avoid inconsistencies in quality or cycle time.

What are the benefits of each?

Single-cavity tools provide high precision and are ideal for large, complex parts or low-volume runs, including prototyping. Multi-cavity tools instead increase output and efficiency by producing multiple identical parts per cycle, lowering costs. Family tools produce different parts in one cycle, reducing tooling and handling costs while streamlining production and ensuring part compatibility.

5. Will tooling material affect the quality of moulded parts?

Steel types used play a crucial role in the quality, consistency, and longevity of the parts the mould tool produces. Factors such as durability, surface finish, thermal conductivity, corrosion resistance, and machinability all depend on the steel grade selected. High-quality mould steel ensures precise cavity dimensions, smooth surface finishes, faster cooling times, and longer tool life.

6. Is it more cost efficient to use external companies to manufacturer tools?

Choosing in-house or outsourced toolmaking depends on the scale, complexity, and specific requirements of each project. For larger-scale projects or when multiple tools are needed, outsourcing can often be more cost-effective and time-efficient. However, when precision and close control are critical, managing the toolmaking process in-house helps to maintain quality, flexibility, and speed.

In either case and regardless of where they are built, applying Design for Manufacture (DFM) principles early in the development process is essential for precision and efficiency, maintainability and scalability.

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When AI Turns Inspection into Process Control

By Brent A. Fischthal, Head of Global Marketing Communications, Koh Young Technology.

A production line does not need another dashboard. It needs fewer surprises.

Most SMT teams can describe the same daily pattern: a yield drop that appears without warning, a printer that was stable yesterday but drifts today, a placement trend that only shows up on one product family, a backlog of calls waiting for review, and engineers spending too much time sorting data instead of improving the process. The pressure is not simply speed. It is stability in a world of tighter tolerances, higher mix, and less margin for variability.

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That is why the Industry 4.0 conversation is shifting. The goal is no longer just connectivity for reporting. The goal is connected production that supports continuous improvement. Data should not be collected simply because it can be collected. Data should shorten the distance between what the line is doing and what the team decides to do next.

This is where AI earns its place. Not as a concept, and not as a layer added on top of existing problems, but as practical tools that reduce repetitive effort and make process behavior easier to control.

Koh Young AI strategy is built around that standard. Koh Young has spent decades establishing measurement-based inspection as a reliable reference for the line. Today, Koh Young is extending that foundation with AI tools that help manufacturers move faster during NPI, cut false calls, shorten troubleshooting cycles, and apply closed-loop optimization where it matters most.

This article focuses on tools already in use on real production lines and the workflows they support: KAP Auto Programming, Smart Review, KSMART, and KPO for both printer and moulder optimization. Each tool addresses a specific pain point. Together, the tools support a more connected, more repeatable approach to continuous improvement.

Industry 4.0 on the Factory Floor

While the industry framed in many ways, manufacturers tend to judge Industry 4.0 it by outcomes:

- Is the line more stable through changeovers?
- Can teams identify drift earlier and react faster?
- Are improvements repeatable across shifts and sites?
- Does performance improve without adding complexity?

Those outcomes depend on a simple loop that every factory recognizes, even if it is not written down: measure, decide, act, and confirm. Continuous improvement is that loop repeated at speed, with fewer delays between each step.

The challenge is that most factories still run that loop with friction. Measurement is available, but interpretation takes time. Decisions are made, but actions are not always connected back to the process quickly. Confirmation happens, but often too late, after rework has already accumulated.

AI can reduce that friction, but only when AI is embedded in daily workflows and grounded in reliable data. That is where Koh Young is focusing: AI that strengthens the improvement loop rather than creating a separate system to manage.

Start with Measurement You can Trust

Connected production does not begin with connections. Connected production begins with trustworthy signals.

AI needs dependable input. If the data is inconsistent, the conclusions will be inconsistent, too. Koh Young advantage starts with True 3D measurement-based inspection, which captures quantitative values such as height, volume, area, coplanarity, and shape rather than relying only on image interpretation.

That distinction matters because many process shifts are subtle. Many process shifts may not look dramatic in a 2D image, especially when change happens gradually. Quantitative 3D data provides a consistent reference that supports two things continuous improvement depends on:

1. Comparability over time: trends become meaningful when the measurement method is stable.
2. Actionability: teams can react with confidence when the signal has clear physical meaning.

With stable measurement, AI becomes more than pattern recognition. AI becomes a way to interpret process behavior and drive practical actions that keep the line under control.

Why AI has Become a Manufacturing Requirement

Electronics assembly is not getting simpler. The reasons are well known, but the combined effect is shaping how lines must be managed:

- Designs are denser and more sensitive to small shifts.
- Product mix continues to rise, and changeovers are more frequent.
- New materials and miniaturization reduce the process window.
- Speed expectations keep increasing, while time for training is limited.

In this environment, traditional approaches break down. Rules and thresholds struggle with real-world variation. Manual review scales poorly. Root cause analysis becomes a recurring time sink, especially when issues are intermittent or linked to multiple upstream variables.

AI can help, but only when AI turns manufacturing data into decisions that make the process more stable. The goal is not automation for its own sake. The goal is consistency, made faster, with less manual burden.

KAP Auto Programming: Make NPI faster and more consistent

For many manufacturers, the first bottleneck is not line speed. The first bottleneck is the ramp.

Inspection programming can absorb significant time. The work is detailed, repetitive, and often dependent on a handful of experienced people. As product mix grows, that approach becomes hard to sustain. The result is familiar: longer NPI cycles, inconsistent program quality across sites, and valuable engineering time spent on tasks that do not directly widen the process window.

KAP Auto Programming was created to change that balance. Instead of building inspection programs entirely by hand, engineers can use AI-driven recognition and a growing internal knowledge base to automate much of the setup. The system identifies components and features, recommends parameters, and accelerates the creation of programs that would otherwise require significant manual effort.

From a connected production perspective, KAP Auto Programming contributes to continuous improvement in a practical way. KAP Auto Programming standardizes the starting point. When programs are created consistently, downstream data becomes more consistent. That improves comparability across shifts, across lines, and across plants.



The value shows up in three ways:

1. **Speed during NPI:** Programming work that used to take hours can be completed far more quickly, helping teams move from first build to stable production faster.
2. **Consistency across operations:** When program logic is generated through a standardized approach, outcomes become less dependent on individual style or experience. That matters when manufacturers run multiple lines, multiple plants, or global operations.
3. **Better use of engineering time:** Engineers can focus on validation, tolerance development, and process control rather than repetitive setup tasks.

KAP Auto Programming does not eliminate the need for expertise. KAP Auto Programming removes the repetitive portion of the workload so expertise can be applied where it creates the most leverage.

Smart Review: Reduce false calls and increase inspection usefulness

False calls do more than slow production. False calls change behavior. When operators see frequent alarms that do not correlate to real issues, trust erodes. Review becomes an issue. Production teams begin treating inspection as friction rather than feedback. Over time, that undermines both throughput and quality because attention shifts toward noise.



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Feature Continued...

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The value is not the dashboard itself. The value is time recovered in troubleshooting and the ability to make decisions faster with higher confidence.

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Smart Review targets this directly by applying AI to the review workflow. The intent is straightforward: reduce the time and inconsistency of manual verification while prioritizing what truly needs attention. In practice, Smart Review supports connected production in two important ways:

- Smart Review keeps the improvement loop moving. When review is faster, real issues are confirmed sooner and corrective action happens earlier.
- Smart Review improves the quality of the signal. When fewer false calls distort the picture, trends and correlations become more reliable.

Smart Review helps deliver:

- Fewer low-value decisions
- More consistent judgments across shifts
- Better flow with fewer unnecessary interventions

The result is a quieter line in the best sense: fewer distractions, fewer interruptions, and more attention focused on real process shifts that need action.

KSMART: Turn inspection results into continuous improvement insight

Many factories already have data. The challenge is turning that data into clarity.

When teams are chasing intermittent issues, teams often work from a mix of inspection logs, alarms, screenshots, repair notes, and individual experience. That can work when the problem is obvious. That is much harder when the symptom is inconsistent or when multiple variables interact.

KSMART fills that role by helping teams see trends, correlations, and recurring patterns across time. KSMART supports the continuous improvement loop by reducing the time between measurement and understanding.

A few examples illustrate the point:

- A drift in placement that seems random board-to-board may become a clear trend when viewed across a shift, a product family, or a specific machine.
- A print variation that only appears on certain panels can become visible when correlated with stencil conditions or paste behavior.

- A recurring defect that triggers rework in multiple areas can often be traced upstream when the data is organized and compared consistently.

From an Industry 4.0 perspective, KSMART helps connect what is happening on the line to decisions that can be made with confidence. KSMART does not need to become an IT project. KSMART supports the practical work engineers already do, but with better speed and context.

The value is not the dashboard itself. The value is time recovered in troubleshooting and the ability to make decisions faster with higher confidence. When engineers can find the true signal sooner, the line stabilizes sooner.

KPO Printer: Close the loop where defects often begin

Printing still defines the outcome of much of SMT assembly. The printing stage influences opens, shorts, insufficient solder, bridging, and rework that is expensive to diagnose downstream. Even small deviations can cascade quickly.

KPO Printer supports a prevention mindset. KPO Printer uses 3D SPI feedback to detect subtle shifts in print behavior and support corrective action before defects multiply.

This is where connected production becomes real. Instead of treating inspection as a checkpoint, data becomes feedback that drives control.

In practice, KPO Printer helps teams:

- Identify early signs of drift linked to stencil conditions, paste performance, or setup imbalance
- Reduce the time needed to stabilize after changeovers
- Lower downstream troubleshooting by preventing marginal conditions from becoming full defects

Continuous improvement is difficult when teams are reacting. Closed-loop optimization shifts it to prevention.

KPO Moulder: Extend closed-loop control into placement stability

Once printing is under control, placement becomes a major driver of variation. Offsets, rotations, polarity issues, and machine-to-



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This is a practical Industry 4.0 model. It connects measurement to decisions, decisions to actions, and actions to results.

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machine differences can gradually build into defects, especially in high-mix production where setups change frequently and lines are expected to run with minimal interruption.

KPO Mounter applies the same closed-loop philosophy to placement. Using feedback from post-placement inspection, KPO Mounter helps identify emerging trends and supports corrective action to keep placement stable.

The practical outcomes include:

- Earlier detection of drift before it becomes visible as failures
- More consistent behavior across equipment
- Improved resilience in high-mix conditions

This contributes directly to connected production goals. The line becomes easier to manage because correction is informed by consistent measurement, not by trial-and-error adjustments made under time pressure.

A Continuous Improvement Cycle, Supported by AI

Each of these tools can stand alone, but the greater value comes from how the tools reinforce one another within a simple continuous improvement cycle:

- Standardize and accelerate the launch with KAP Auto Programming
- Reduce disruption and protect flow through Smart Review
- Find root causes faster using KSMART to surface patterns and trends
- Prevent defects at the source with KPO closed-loop optimization

This is a practical Industry 4.0 model. It connects measurement to decisions, decisions to actions, and actions to results. This model does not require a separate architecture conversation to be valuable. This model meets the factory where it is and improves the parts of the workflow that consume time, create inconsistency, and slow improvement.

What Proven AI Looks like on Real Lines

Manufacturers do not measure AI success by technical language. They measure AI success by outcomes they can see:

- Less time spent on repetitive programming and setup tasks
- Shorter queues for defect review and fewer unnecessary interventions
- Faster root cause identification when issues appear
- More stable production through changeovers
- Higher yields and fewer defects reaching downstream operations

That is why Koh Young AI direction is intentionally pragmatic. AI is not positioned as a replacement for engineers or operators. AI is positioned to reduce low-value manual work and support faster, more consistent decision-making. The result is a team that spends more time improving the process and less time managing noise.

A Practical Definition of AI Leadership in Connected Production

AI leadership in electronics manufacturing is not about who announces the most. AI leadership is about delivering tools that work under real constraints: high mix, variable conditions, tight staffing, and constant throughput and quality pressure. Koh Young AI portfolio reflects a clear approach:

- Build on quantitative 3D measurement so AI starts with reliable input
- Focus AI on workflows that consume time and introduce inconsistency
- Use inspection feedback to support closed-loop action so stability improves, not just reporting

Connected production is ultimately about shortening the gap between what the line is doing and what the team needs to do next. When that gap gets smaller, continuous improvement becomes easier to sustain. With practical AI tools designed for production use, Koh Young is helping manufacturers make that shift in a way that supports daily stability and long-term performance.

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