The AI Guide for Manufacturers:

Improve Uptime, Throughput, and Quality

AZO. | NorthWind

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Introduction

AI is everywhere. While industries from finance to logistics embrace AI at scale, manufacturing leaders remain understandably cautious. Plant environments are complex. Downtime is expensive. And quality, safety, and compliance leave no room for guesswork. AI may promise efficiency and insight, but most manufacturers still struggle with a basic question: **Where do we start?**

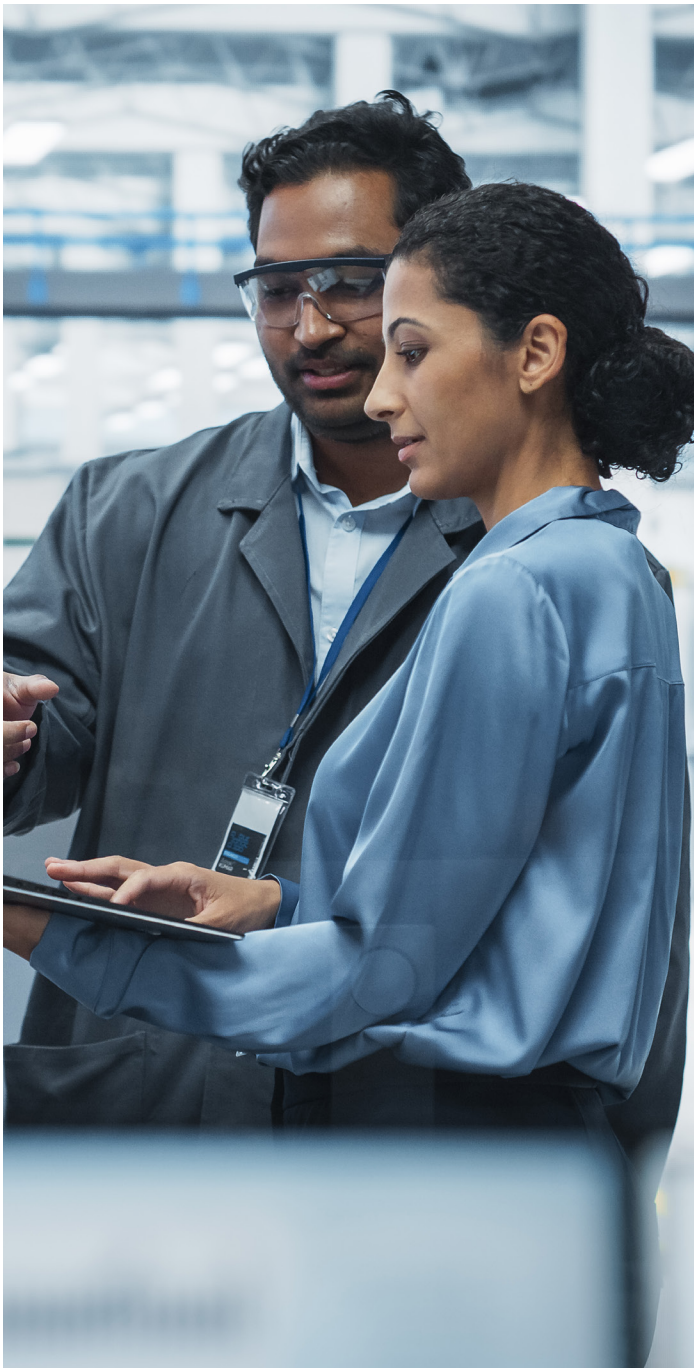
> Start where the value is clear. Scale when the team is ready. And let AI become a force multiplier for people and processes you already trust.

Many companies face a gap between AI's hype and their day-to-day reality. Fragmented systems, institutional knowledge, labor shortages, and outdated documentation all make transformation harder than it looks from the outside. Meanwhile, skilled workers are retiring faster than replacements can be trained. Plants are under pressure to do more with less while still hitting throughput, quality, and safety targets.

That's where AI can help, but not through futuristic, automated autonomy or overnight disruption. The real opportunity lies in something more practical: augmenting human expertise, capturing what your best people know, and scaling it through systems that support better, faster decisions.

AI already offers real impact inside plants when deployed deliberately and with the right partners. We at AZO and NorthWind have seen it because we're partners with these plants in developing accessible solutions.

As your company explores AI implementation, here's what you should know to make informed, grounded decisions not just about what's possible, but what's practical.



Smart Scheduling & Inventory Optimization

Material waste in manufacturing often signals deeper issues: gaps in visibility, poor systems integration, or process drift that isn't caught in time. Whether it's dosing inaccuracies, scheduling misalignment, or avoidable cleanouts, these losses quietly erode margins. AI helps manufacturers see these patterns and take meaningful action to prevent them.

AZO General Manager Casey King named four common causes of ingredient waste that stand out across industries in material handling:

Off-spec batches due to dosing errors.
A small deviation in a critical ingredient — like a vitamin — can compromise an entire batch, especially in high-compliance sectors like pet food, pharma, or nutraceuticals. AI can detect dosing anomalies as warranted or flag patterns of over- or under-delivery that indicate calibration, maintenance, or control issues.

Spills or accidental discharges.
These may occur during process upsets, like a valve opening at the wrong time or a poorly timed cleaning cycle. These events are often triggered by upstream system issues, something AI is especially effective at detecting.

Inefficient material use.
Poor forecasting can result in raw material sitting in inventory too long, which ties up cash and sometimes even causes material waste due to expiration, which is especially detrimental for sensitive or high-cost materials. "A lot of that is still human-driven today," King said. "If you don't optimize your inventory and material use, you're tying up valuable operational cash and physical space." Integrating delivery schedules from your ERP with your AI tool promotes optimization.

Cross-contamination and manual scheduling decisions.
Cross-contamination with unplanned downtime and manual scheduling decisions that overlook optimum batch sizes or run orders also increase ingredient waste. Machine learning can reduce these risks by learning consumption patterns, identifying reorder points, detecting usage anomalies, and optimizing production to prevent overproduction and scrap.

Scheduling Optimization With Machine Learning

Few plant teams operate on a fixed, stable schedule. “Most plant schedulers I know are redoing the schedule at least several times per week,” King said. “They’re not making it once a month and sticking to it.”

Production teams are in constant motion, responding to equipment issues, material delivery delays, last-minute customer orders, or formulation changes. AI-powered scheduling tools help stabilize this chaos. They ingest real-time constraints to anticipate impacts across shifts, and can re-optimize on the fly:

- **Minimize allergen-related cleanouts** by intelligently grouping compatible SKUs
- **Reduce silo or bin changeovers,** improving throughput and lowering cleaning downtime
- **Respond to late or missing material deliveries,** rebalancing available resources in real time
- **Prevent contamination risks** by intelligently sequencing production runs and scheduling cleaning cycles

Machine learning can also factor in more complex constraints: changeover times, lead times, storage limitations, and labor availability. One of its biggest contributions is speed: what once took hours of spreadsheet updates and cross-checks can now happen in minutes.

REAL-WORLD EXAMPLE

AI Saves Hours and a Shutdown

Two sister facilities operate across town. At one, a key ingredient ran short and threatened to stop production, but the other facility had capacity to make the product. It took schedulers five hours to put together their schedule for this facility, and now the production schedule needs to be totally reworked.

Using AI, the plant optimized their schedule within minutes to add the emergency order. The system accounted for current inventory, changeover times, truck ETA, and available staff, offering a workable plan. Gifted schedulers who know where to look could do this, but AI tools can do it faster.

Real-time Inventory Analysis Starts With Clean Data

For AI to optimize scheduling or inventory, it needs reliable information, but real-time visibility is often limited.

Common data problems include:

- Disconnected ERP, MES, SCADA, and warehouse systems
- Manual entries and lagging receipts
- Inconsistent material master data (UoM conversions, packaging, substitutes)
- Missing or unreliable lot tracking and expiration dates
- Shop-floor activity that isn't captured, like partial bins, returns, or yield loss
- Clock drift across systems, causing timestamp misalignment
- Weak barcode or RFID discipline
- Gaps in supplier delivery data or recipe change documentation

When these issues go unaddressed, on-hand inventory levels drift from reality, especially during changeovers or in high-mix production environments.

AI becomes valuable as an orchestration layer. It integrates information such as delivery schedules from ERP, production activity from MES, and equipment status from SCADA or historian systems. This enables insights, such as flagging low-stock ingredients before they halt production, or predicting when a key material will fall below safety stock based on usage.

That said, integration has its challenges. Data formats, real-time connectivity, and custom configuration work are common barriers. Current platforms, such as Palantir Foundry, address these constraints by offering flexible, secure tools that integrate across fragmented architectures.

A couple best practices for keeping your data safe and traceable include:

- **Use read-only connectors** into operational technology where possible, segment plant networks, and enforce least-privilege access with audit logging.
- **Keep customer data siloed** and avoid training external models on plant data.

Workforce Transformation & Training

When you start talking about implementing AI in your plant, a common fear will inevitably surface: *Will AI take my job?*

Here's our take.

> AI won't eliminate the need for plant personnel, but it *will* shift required skill sets.

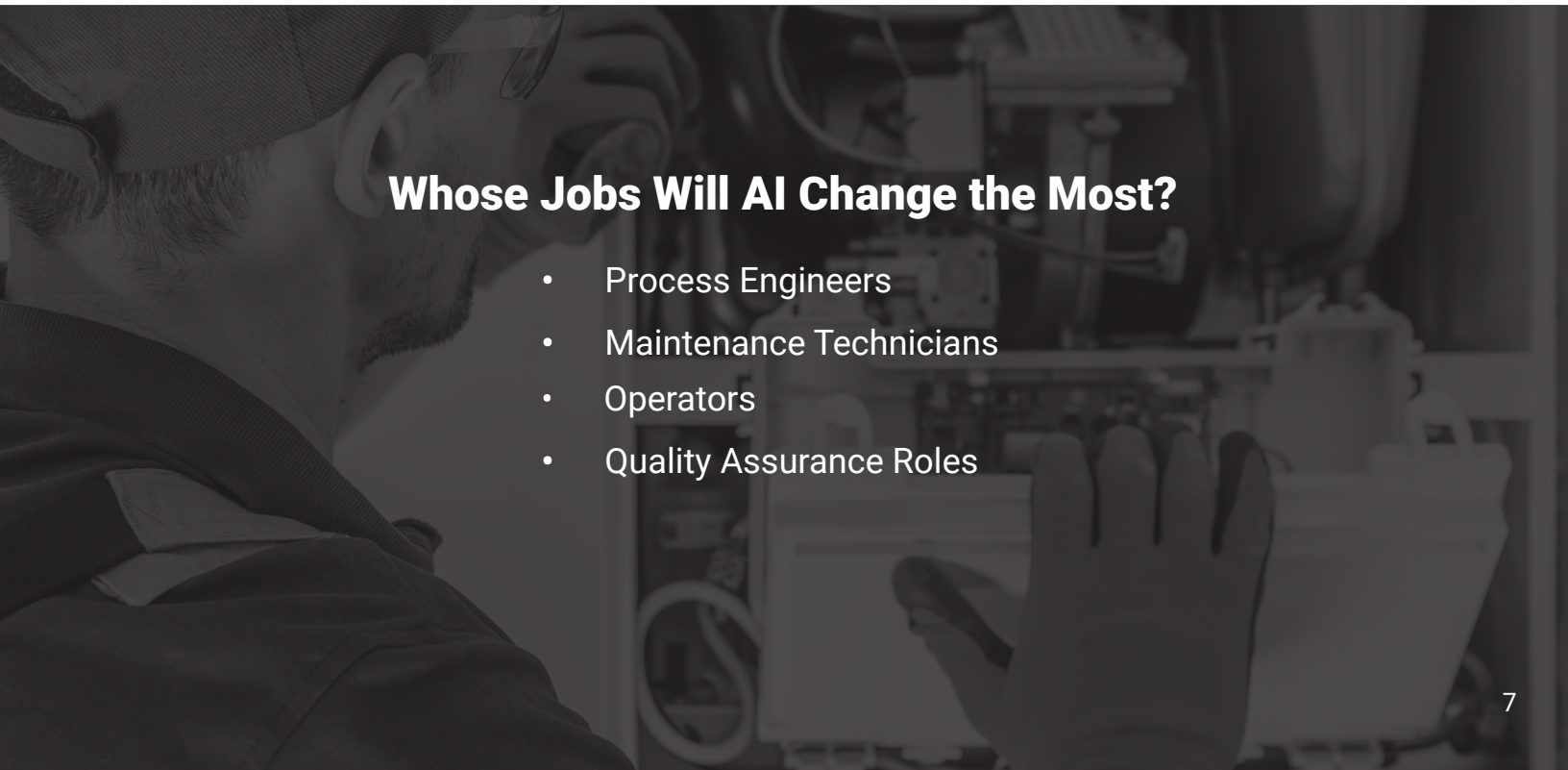
Mechanical, electrical, and controls technicians will remain essential, especially for complex repairs and novel faults. At the same time, teams will need employees who can interpret AI outputs, manage data infrastructure, and understand system behavior at higher levels. Routine monitoring may become less of a focus, but situational awareness and troubleshooting expertise must increase.

Fear of replacement, skepticism about new tools, and bad early experiences (inaccurate recommendations or "hallucinations") undermine trust. Once trust is lost, adoption slows or stalls.

Successful implementation requires more than training. It calls for internal champions who understand the technology and the plant culture, and who can demonstrate value early, support their peers, and build confidence over time.

> Often, changing the culture to accept AI is more challenging than the technical implementation.

Vendors also play a role. Sustained support beyond initial deployment helps teams get over the learning curve and see AI as a partner, not a threat.



Whose Jobs Will AI Change the Most?

- Process Engineers
- Maintenance Technicians
- Operators
- Quality Assurance Roles

4 Compelling Reasons Why AI Benefits Your Workforce

1 Preserves Institutional Knowledge

AI can act as a collective think tank of all your employees' experiences. Your most seasoned operators often carry decades of know-how that isn't written down, like their intuition for what to check when things go wrong or how to tweak a process for better yield.

When paired with a well-organized foundation of your plant's operating manuals and documentation, AI tools can respond to simple questions like, "How do I run the extruder?" and deliver relevant, plant-specific guidance. As operators interact with the system, their inputs and problem-solving steps enrich the knowledge base, creating a feedback loop of expertise that benefits the next generation.

2 Faster Training, Shorter Onboarding

AI can significantly reduce onboarding time and accelerate training for new and cross-trained employees. Instead of shadowing experienced staff for weeks, operators can use AI to access documentation, historical troubleshooting records, and step-by-step instructions as they need them.

Going from brand-new to seasoned employee is now a practical goal. With AI systems pointing to the right procedures and surfacing context from past events, inexperienced staff can operate more confidently.

3 Lifting Mental Burden While Preserving Skill

AI reduces cognitive load by analyzing alarms, surfacing relevant documentation, and guiding users through troubleshooting. This frees up operators and technicians to focus on higher-value tasks, especially during shift transitions, when issues may be inherited without context.

But this support comes with a caveat. If users rely too heavily on AI without understanding the reasoning behind its suggestions, foundational skills will erode over time. Plants must make sure that AI tools don't become black boxes. Recommendations should be explainable, with clear logic and references to design intent, so operators continue to build their own critical thinking abilities.

4 AI-Driven Scheduling and Resource Optimization

AI also supports workforce planning by analyzing production patterns, skill availability, and operational constraints. It can optimize shift handovers, balance workloads, and predict when specific expertise will be required.

In environments where skilled labor is scarce, AI-assisted scheduling becomes especially valuable. Plants can ensure coverage for operations while making the best use of limited human resources.

Automated Process Tuning

Considering that AI can make any change to your processes with no technical limitations, the bigger question remains: **What are you willing to let AI do?**

In nearly all cases of AI adoption in manufacturing, we recommend keeping a human in the loop. Meaning, AI makes the recommendations, the operator determines whether the recommendation is actionable.

In this way, AI doesn't replace human judgment or someone's job. After all, the best troubleshooters notice things instruments don't capture well: a motor's "off" hum or a mixer's change in feel. Those cues — plus an understanding of risk and production priorities — are where human intuition shines.

AI adds the other half of the picture. It correlates and checks behavior against how the system is designed to work using P&IDs, OEM manuals, wiring diagrams, and device hierarchies.

Instead of a long hunt, operators get a short list of likely causes with "start here, then check this" guidance and links to proper procedures. The human still makes the call; AI offers greater context and surfaces options faster.

> "AI can supplement your workforce so they can do their jobs better and more efficiently," said Ben Bosworth, AI Product Manager at NorthWind, "and hopefully get rid of the tasks they don't want to do — or get them done faster — so they can do the things they like doing."

Setting Your AI's 'Temperature'

Large language models (LLMs) include a 'temperature' setting that typically ranges from 0 to 1.

- **If set toward 0,** your AI will be more **deterministic**: literal, factual, more precise. It won't deviate greatly from the instructions you give it.
- **If set closer to 1,** the AI will be **non-deterministic**. Think free-flowing, brainstorming, and producing more creative answers.

The temperature you choose depends on your application's needs. In general, manufacturing AI systems intentionally lean toward deterministic with specific prompting to keep risks low. AI tools can suggest changes — like increasing a motor speed or reducing feed time — but they operate within preset thresholds. Final approval is still the operator's, reducing liability while maintaining flexibility.

REAL-WORLD EXAMPLE

AI Excels at Correlation and Diagnostics

AI is already delivering value by diagnosing root causes in complex systems. In one case, NorthWind's AI identified a high blower pressure fault even though the issue wasn't with the blower itself. By tracing connected equipment upstream and downstream, AI uncovered the root problem: plugged end-of-line filter bags.

Another example involved a cooling valve that had been manually closed by an operator. No immediate fault occurred, but the extruder overheated and shut down. The AI traced the shutdown to the earlier valve closure.

Because AI understands the entire system topology — what's connected to what and how — it can identify relationships a human might miss.

Your First AI Use Case

The fastest win with AI starts with your plant's documentation. Start by digitizing and organizing P&IDs, OEM manuals, SOPs, wiring diagrams, and device hierarchies so operators and techs can ask a question and land on the right page in seconds. That alone reduces hunt time, standardizes procedures, and shortens onboarding.

With that foundation in place, layer in basic alarm and tag context: when a fault occurs, the system points to the relevant sections of the manuals and SOPs and suggests the first checks. It's a low-risk, high-utility starting point that uses data you already trust, and it sets you up for deeper analysis as your team gets comfortable.

How To Adopt AI for Process Tuning

Here's how to strike the right balance between autonomous correction and human review.

1. **Start with "suggest-only."** The system shares likely causes, proposes checks, and cites procedures and documentation so operators can act confidently.
2. **For routine, low-impact adjustments,** allow tightly bounded autonomous corrections that are reversible, monitored in real-time, and automatically rolled back if they drift outside limits.
3. **For anything that touches safety, product quality, or regulatory compliance,** keep humans firmly involved. Wrap this in governance to retain an audit trail.

To avoid process disruption, recognize where tuning is beneficial versus where it could introduce instability. Plants are finding value by targeting repeatable, measurable, and high-impact areas, such as batching systems, feeder timing, and material transfer speeds. Small improvements in these areas add up when scaled across hundreds of batches or multiple lines.
When AI is used to flag deviations from expected discharge times, abnormal cycle durations, or feed inconsistencies, operators can make more informed decisions without slowing down production. It's a shift from reaction to orchestration while retaining human oversight.

Predictive Maintenance & Downtime Prevention

Predictive maintenance could be a compelling application of AI in manufacturing. The opportunity is clear: anticipate equipment issues before they cause unplanned downtime. But for most facilities, this reality is more fragmented than futuristic.

"The plants that are doing this the most have a problem that they're already trying to solve," said NorthWind CEO Michael Bosworth. Predictive AI is typically used to investigate root causes after they happen rather than anticipate them. As Bosworth noted, "AI is most effective where failure leaves a measurable trail before it becomes obvious."

Places where AI can help include:

- **Rotating equipment** such as motors, conveyors, and mixers often show early warning signs through changes in vibration, current, load, or temperature.
- **In batch or recipe-driven processes,** small deviations in timing, weight, or temperature signal quality or consistency issues.
- **Coupled systems.** When upstream and downstream devices are monitored together, AI can detect cascading faults operators might miss.
- **Utility systems (compressed air, steam, or chilled water.)** Pressure drift or minor leaks often show up in alarms or historian tags before affecting performance.

Effective predictive maintenance gives operators fast, evidence-based insight. By combining alarms, historian data, and production context with design documents like P&IDs and device hierarchies, AI can identify likely faults and suggest what to check first. This is work that orchestration teams rarely have time for.

When deeper investigation is needed, AI supports structured root-cause analysis, initiates work orders, and captures fixes for future reference. The goal is reducing unplanned downtime and keeping critical knowledge in the system, not just with the person on shift.

> Predictive maintenance works best when AI connects alarms and process data with system design so operators know what failed, why it happened, and what to do next.

But for AI to properly help with predictions, it needs consistent signals from equipment.

Sensor and Signal Limitations

Successful predictive maintenance requires high-quality signals with data that indicate when something is about to fail. For many facilities, those signals are scattered or simply unavailable. It's not easy to gather, even before you get to AI analysis.

In practice, plants typically reserve predictive technologies for high-cost equipment where failure is catastrophic. Think large motors or blower packages with long lead times, not the dozens of smaller assets scattered throughout a plant. As AZO's Director of Marketing & Sales Mike Miller said, "We're not going to put a sensor to detect when a seal wears out in every place in the plant."

What should sensors track? The strongest early signals emerge when you pair a plant's "digital vital signs" with its "memory," anchored by design and equipment documentation.

Digital vital signs

- HMI/SCADA alarm logs
- Historian tags
- Condition-monitoring data (vibration, temperature, motor current)

Memory

- CMMS/ERP work orders
- Service tickets
- Spare-parts usage
- Operator notes

When combined with production context (recipes, setpoints, speeds, changeovers) and up/downstream equipment events, these sources reveal patterns earlier than humans typically can. But until plants invest more broadly in instrumentation, predictive AI will remain limited in scope, especially in legacy environments.

Micro-Downtime Events Add Up

While major failures capture attention, the more frequent threat comes from "micro-downtime," minor issues that disrupt flow, delay batches, or require manual resets, sometimes dozens or hundreds of times a week.

> The most common hidden downtime comes from: 1. Slow performance drift in rotating equipment, 2. Ingredient variability, and 3. Cascading faults that don't trigger an alarm.

REAL-WORLD EXAMPLE

AI Diagnoses a Hidden Micro-Downtime Issue

A plant experienced persistent weighment faults. Operators grew accustomed to pressing the reset button and moving on. When NorthWind's AI tool reviewed the system, it found the root cause: the tolerance was set to zero. "You never hit a perfect weighment," Bosworth explained.

The tolerance should have been changed, but operators grew numb to the alarm rather than considering why it kept firing. Knowledge gaps and shift changes exacerbated the issue.

Interruptions like this may only cost seconds or minutes at a time; but, across a shift, a week, or a month, they will compound into real production losses.

AI and Surfacing Patterns

This is where AI excels. Not in preventing a single catastrophic failure, but in identifying repeated, perhaps unnoticed behavior.

"AI tools help because they're able to surface problems and get them to the right people to pay attention to them," Bosworth said. For instance, a valve that intermittently fails due to plant air pressure dropping below a threshold isn't malfunctioning. But it is misbehaving, and AI can correlate those instances with upstream faults to trace the cause.

AI should provide answers about persistent patterns on the production floor. As Miller described, "Not all situations are going to be solvable with sensors and AI analysis," but when used strategically, AI buys back time by keeping engineers ahead of the curve on failures and inefficiencies.

A Hidden Variable: Operator Attention

Good predictive maintenance takes into account both operators and machinery. Operator decisions, workarounds, and fatigue all contribute to unplanned downtime. When operators are flooded with nuisance alarms or inconsistent systems, attention bandwidth gets depleted. They become desensitized. And that's when real problems get missed.

AI can serve as an attention amplifier, not by replacing operators, but in escalating persistent issues to someone with capability to take action: a supervisor, an engineer, or even a maintenance manager. Nothing improves unless information AI collects is utilized.

> "It's like a distracted driver. Maybe you didn't have a wreck, but certainly the risk goes up with all those distractions. And it's the same thing on the plant floor."
>
> —Michael Bosworth, CEO, NorthWind

Early AI Adoption Risks

Mitigate these risks by keeping a human in the loop to set guardrails on what systems can do.

- **Over-reliance on AI recommendations** without context leads to unnecessary fixes.
- **Loss of human troubleshooting skills** may occur if teams defer too often to automated decisions.
- **Data quality issues** like inconsistent tags, missing histories, or siloed systems skew results and undermine trust.
- **Cybersecurity and governance concerns** grow as analytics tools connect to plant networks and operational systems.
- **Model drift and limited explainability** complicate understanding or validating AI guidance over time, increasing risk of untraceable decision-making.

AI-Driven Quality Control & Anomaly Detection

In most manufacturing environments, the costliest quality issues go unnoticed until it's too late. Whether it's a batch that goes off spec, mislabeled packaging, or a failure in allergen segregation, the result is often scrap, rework, or worse: product recalls and compliance violations.

Among the most critical risks to monitor:

- **Allergen cross-contact,** especially in high-mix food or nutraceutical lines
- **Foreign material contamination,** often introduced during handling or transfer
- **Packaging integrity failures,** such as leakers or weak seals
- **Labeling and coding errors,** which compromise traceability and regulatory compliance
- **Thermal deviations and moisture/water activity drift,** affecting safety and shelf life
- **Weight/specification drift,** leading to giveaway, waste, or noncompliance
- **Genealogy errors,** where batch traceability is lost

Pairing AI With QC Expertise

False alarms can occur during changeovers, ingredient lot changes, or environmental shifts, and are all scenarios where human intuition still adds value. That's why the best quality systems are hybrid by design. AI offers data analysis, while human operators provide contextual awareness and final decision-making, reducing false positives and missed defects.

Moving Quality Control (QC) Upstream

Most quality checks rely on post-process sampling and fixed lab schedules. AI can reduce that dependency by spotting problems during production, not after.

"There's a push toward more visual analysis rather than stopping the batch while it's sampled and sent to the lab," said King. For example, NorthWind has codeveloped a quality control kibble station where a photo, weight, and size is fed to AI to instantaneously analyze kibble.

While it's not a replacement for QA protocols, this approach may help:

- Reduce unnecessary testing
- Focus lab resources on high-risk situations
- Flag suspect lots faster
- Lower chances of releasing non-compliant product

REAL-WORLD EXAMPLE

How Is My Plant Running Today?

Data lives across dozens of reports, but operators only see pieces of the picture and supervisors rarely have time to review it all. With AI, a simple prompt like "How is my plant running today?" generates a clear summary across production, quality, and equipment. Instead of chasing data, managers get immediate insight and can act faster by walking the floor with specifics, not assumptions. That's how alarms get addressed and productivity improves.

Conclusion

The most successful AI implementations in manufacturing support, not supplant, people on the floor. When AI tools are used to augment human judgment by surfacing insights, preserving institutional knowledge, and reducing repetitive tasks, plants can move faster, train better, and maintain higher standards of quality and safety.

The key is knowing where to start. Proven, low-risk use cases — digitizing SOPs, optimizing scheduling, or identifying recurring faults — offer quick wins and build confidence. From there, capabilities can grow as infrastructure matures and teams gain trust in the system. But success isn't about the algorithm alone. It depends as much on data quality, cybersecurity, governance, and cultural readiness.

That last point is the most underestimated. Resistance to change is still a primary barrier. Technical rollout may take weeks, but cultural adoption takes sustained effort.

Companies that invest in training, internal champions, and strong vendor partnerships will see the greatest long-term value.

In many ways, the irony is clear: the best-performing plants will adopt AI faster. Not because they need it most, but because they're already skilled at managing change. And that's what AI requires: a willingness to rethink routines, make workflows more transparent, and build systems that share knowledge rather than silo it.

The real promise of AI isn't autonomy. It's decision support. It offers teams more clarity and context in how they respond to complex or unfamiliar problems. Done right, AI becomes a tool that lifts less experienced staff while sharpening seasoned teams' skills.

Manufacturing will always need human judgment. But with the right approach, AI can help preserve, scale, and put it to work in smarter ways.

Put AI to Work in Your Facility

About the Authors

AZO

Combining German engineering with American service, AZO custom designs reliable bulk material handling solutions. From small processing lines to high volume, 24/7 operations, AZO builds each system with comprehensive, engineering-centric design and support. By partnering with Automation and AI specialists like NorthWind, AZO delivers comprehensive solutions that support the hands-on guidance required for successful AI adoption and state of the art manufacturing.

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NorthWind Technical Services

NorthWind is an automation company with extensive process experience, in addition to programming and design expertise in a wide range of industries. They are also on the cutting edge of AI in industrial automation and serve as a trusted advisor that bridges manufacturing operations and AI capabilities for manufacturing facilities throughout the world.

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