



REDUCE COSTS AND IMPROVE QUALITY WITH AI

Discover how AI reduces the cost of poor quality in industrial manufacturing through predictive analytics, unified data, and simulation-driven design.

```
20 READ BYTE
30 IF BYTE = -1 THEN BASE = BASE - 1 : GOTO 999
40 POKE BASE, BYTE
50 BASE = BASE + 1
60 GOTO 20
999 IF BASE = (50 + 32768) THEN SYS(32768 + 32) : END
1000 DATA 120
1010 DATA 169, 128
1020 DATA 141, 21, 3
1030 DATA 169, 45
1040 DATA 141, 20, 3
1050 DATA 88
1060 DATA 96
1070 DATA 238, 32, 208
1080 DATA 76, 49, 234
1100 DATA -1
```

SSP

PROCESSING
INPUT

MODE... AUTO
FREQ... 12371 Mhz..



63% automatic
34% calculated current load

```
10 BASE = 32768 + 32
20 READ BYTE
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```

Industrial manufacturers operate in a high-stakes environment where the machines they build are mission critical. When equipment fails in the field, customers face costly production downtime, while manufacturers shoulder warranty claims, potential recalls, and the harder-to-quantify—but far more damaging—reputational costs. In an industry where trust and reliability are paramount, even a single failure can have long-term consequences for your brand.

For many industrial organizations, the cost of poor quality amounts to 15 to 20 percent of total sales revenue. Manual processes, fragmented engineering data, and siloed systems often prevent teams from addressing quality issues proactively, leaving them to react to problems after they've already caused damage.

A new approach is necessary to overcome these challenges. By integrating artificial intelligence (AI) into core engineering and quality processes, industrial companies can prevent defects at the design stage, avoiding downstream costs speeding up time to market, and improving customer satisfaction.

THIS E-BOOK EXPLORES HOW AI TRANSFORMS QUALITY MANAGEMENT BY ENABLING YOUR ORGANIZATION TO:

- **Enhance product quality** by identifying potential design flaws early.
- **Optimize product performance and reduce costs** through simulation-driven design validation.
- **Ensure regulatory compliance** through automated traceability.
- **Build a unified digital thread** connecting engineering, manufacturing, and service teams.





THE HIGH COST OF REACTIVE QUALITY

Most industrial manufacturers manage quality reactively. Engineering, manufacturing, and service teams work in isolated silos without real-time collaboration. This fragmentation leads to design issues reaching production, manufacturing teams working from unclear specifications, and service teams lacking current information.

OVER 60 PERCENT OF QUALITY ISSUES ORIGINATE FROM DESIGN CHOICES MADE IN ENGINEERING.

These early decisions introduce flaws to the manufacturing, operation, and service stages of complex industrial assets. Identifying and fixing these issues downstream during production or field service costs significantly more than addressing them during the initial design phase.

When product requirements get lost or modified as designs evolve, companies lose clear traceability. If an engineering change occurs, the impact on downstream processes is rarely evaluated systematically. This results in costly rework, higher scrap rates, and delayed time-to-market.



0012 2636 1233 2636 0012 2636 1233 2636
3034 1259 0034 1259 3034 1259 0034 1259



HOW AI TRANSFORMS INDUSTRIAL QUALITY MANAGEMENT

Rather than functioning as a standalone tool, the best use case for AI is direct integration into the systems you already use to manage the product lifecycle. This approach transforms vast amounts of data into a strategic asset for proactive decision-making.

To operationalize AI effectively, organizations must embed AI agents directly into enterprise systems like [product lifecycle management](#) (PLM) software. These agents perform three key functions that augment human expertise and drive operational efficiency.

ADVISE: TURNING DATA INTO INSTANT INTELLIGENCE

AI agents act as an intelligent knowledge base, providing instant access to critical information within the user's workflow. This capability allows engineering teams to make informed decisions without searching across siloed databases.

For example, an engineer designing a new heavy equipment component can ask the AI agent to identify alternative parts that meet specific performance, cost, and compliance requirements.

The agent analyzes data on approved vendors, component lifecycles, and current supply chain risks. It then provides a data-backed recommendation in seconds. This ensures design decisions are optimized for quality and manufacturability right from the start.

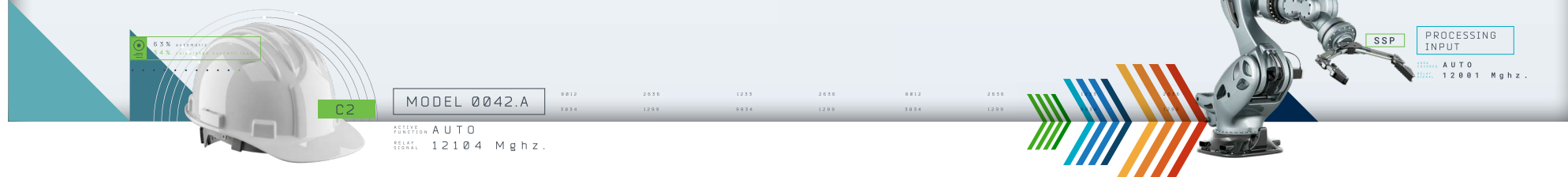
ASSIST: STREAMLINING COMPLEX WORKFLOWS

AI agents function as intelligent partners that assist users by completing specific steps within a larger process. This reduces manual effort, minimizes human error, and gives teams more time to focus on high-value innovation tasks.

During a design review, an AI assistant can automatically cross-reference a new component against the bill of materials, verify its compliance with regional sustainability legislation, and flag any potential conflicts. This streamlines the review process, improves accuracy, and ensures compliance without disrupting the pace of product development.

AUTOMATE: EXECUTING WORKFLOWS AUTONOMOUSLY

At the most advanced level, AI agents execute entire workflows with minimal human intervention.





By connecting systems, monitoring data, and driving outcomes autonomously, AI accelerates processes that were previously manual and time-consuming.

An AI agent can automate parts of the engineering change management process. When a change request is submitted, the agent analyzes its impact across the entire product structure, notifies all affected stakeholders, updates relevant documentation, and routes the change for approval. This level of automation accelerates decision-making and ensures all changes are fully traced and documented.

SHIFTING LEFT: HOW ENGINEERING DRIVES QUALITY AND REDUCES COSTS

[Read the White Paper](#)



4 PRACTICAL STEPS FOR IMPLEMENTATION

Adopting AI for quality and innovation is not a single event but a journey of strategic integration. For industrial manufacturers, the path to success requires a methodical approach that balances immediate gains with long-term scalability. To move from potential to performance, organizations must focus on building a robust foundation, selecting the right tools, and fostering a culture of data-driven collaboration.

This roadmap outlines the essential steps to incorporate AI into your quality and innovation strategies effectively.

STEP 1: ASSESS AND STRENGTHEN YOUR DATA FOUNDATION

AI is only as good as the data it consumes. Before deploying advanced algorithms, you must ensure your product data is accessible, structured, and reliable. In many industrial organizations, critical data is trapped in siloed systems or unstructured formats like spreadsheets and emails.

Audit Current Data Infrastructure: Begin by mapping where your product data lives. Identify the disconnects between engineering, manufacturing, supply chain, and service. Are your Bills of Materials (BOMs) consistent across departments? Is compliance data linked to specific components?



Establish a Single Source of Truth: Implement or optimize a PLM system to centralize your product record. This [digital thread](#) connects all data points—from requirements and CAD models to quality metrics and field service logs.

Contextualize Your Data: Raw data needs context to be useful for AI. Ensure that your data is governed and organized so that AI tools can understand the relationships between different product elements. A strong PLM foundation ensures that when an AI tool looks for “risk,” it understands the difference between a supply chain delay and a regulatory violation.

✦ **EMBRACING MODEL-BASED DESIGN (MBD)**

With MBD, the model becomes the source of all product and manufacturing information (PMI), which drives all engineering activities. This model may further be used downstream by suppliers and across organizations within an enterprise.

🟢 **STEP 2: SELECT SCALABLE AND RESPONSIBLE AI TOOLS**

Not all AI solutions are built for the rigorous

demands of industrial manufacturing. When evaluating tools, prioritize those that are purpose-built for industrial applications and offer enterprise-grade security and scalability.

Look for Embedded Capabilities: Rather than building custom AI models from scratch—which can be resource-intensive and hard to maintain—choose platforms with AI capabilities already embedded. Solutions like PTC's [Windchill](#), [Creo](#), [Codebeamer](#), and [ServiceMax](#) integrate AI directly into standard workflows, lowering the barrier to entry and reducing time to value.

Prioritize “Glass Box” AI: In quality-critical industries, you need to understand how an AI model reaches its conclusions. Avoid “black box” solutions that offer no transparency. Choose tools that provide explainable insights, allowing your engineers to trust and verify the AI's recommendations.

Ensure Security and IP Protection: Your intellectual property is your competitive advantage. Ensure that any AI tool you adopt respects data privacy and keeps your proprietary designs secure. Responsible AI deployment means retaining control over your data and ensuring it isn't used to train public models without your consent.



STEP 3: INTEGRATE AI INTO EXISTING WORKFLOWS

The most successful AI implementations are those that feel natural to the user. If an engineer has to switch between three different applications to get an AI insight, adoption will suffer.

Embed AI in Daily Tasks: Integrate AI assistants directly into the design and quality management environments your teams already use. For example, [Windchill AI](#) Assistant offers a faster way to access trusted information already in their PLM--less time searching, more time applying insights.

Start with High-Impact Use Cases: Identify specific pain points where AI can deliver immediate value. This could be automating parts classification to reduce duplicates, using generative design to optimize weight in heavy equipment, or applying predictive analytics to prevent failures in mission-critical components.

Automate Routine Processes: Use AI to handle repetitive, low-value tasks such as document retrieval, basic compliance scanning, or data entry. This frees up your highly skilled engineers and quality managers to focus on complex problem-solving and innovation.

★ VALIDATE DESIGNS EARLIER, REDUCE WASTE LATER

AI-powered generative design and simulation tools allow engineers to validate designs virtually before production. This proactive approach helps teams catch issues when they are least costly to address, improving first-pass yield and reducing scrap rates.

STEP 4: FOSTER CROSS-FUNCTIONAL COLLABORATION

AI helps break down silos, but technology alone isn't enough. You need to align your teams around a shared vision of quality and innovation.

Unify Quality and Engineering: Encourage a "shift left" mentality where quality and compliance teams are involved earlier in the design process, supported by AI insights. When a designer sees a supply chain risk alert in real-time, they can collaborate with procurement immediately to find a solution.





Upskill Your Workforce: Provide training on how to work alongside AI tools. Help your teams understand that AI is a tool to augment their expertise, not replace it. Show them how to interpret AI-generated insights and use them to make better decisions.

Establish a Feedback Loop: Create mechanisms for teams to provide feedback on AI performance. If an AI tool flags a false positive for a compliance risk, ensure there is a process to correct it. This continuous feedback loop helps refine the system and improves accuracy over time.

✦ **REAL-WORLD INSIGHTS THAT IMPROVE DESIGN AND SERVICE**

By systematically tracking field failures and enabling root cause analysis, engineers can identify design flaws that traditional testing missed. Service technicians also gain access to accurate 3D models and current specifications, improving repair accuracy and first-time fix rates.

By following these practical steps, industrial manufacturers can move beyond the hype and operationalize AI to drive tangible business outcomes. A disciplined approach—grounded in trusted data and focused on empowering people—will ensure that your AI investment leads to smarter products, faster cycles, and better quality.

PROVEN RESULTS IN INDUSTRIAL MANUFACTURING

Shifting quality earlier in the lifecycle delivers measurable business advantages. When companies move from inspection to prevention, they see tangible improvements in their key performance indicators.

- ✦ **VOLVO CE ACHIEVED UP TO A 30 PERCENT REDUCTION IN THE COST OF POOR QUALITY**
- ✦ **NIDEC REPORTED A 40 PERCENT DECREASE IN COSTS FOR NON-QUALITY DELIVERABLES.**
- ✦ **VAILLANT GROUP SAW A 53 PERCENT IMPROVEMENT IN FIRST-PASS SAMPLE APPROVAL AND A 16 PERCENT REDUCTION IN REWORK.**



NEXT STEPS FOR INDUSTRIAL LEADERS

Ultimately, the integration of AI leads to superior business results that directly impact the bottom line. For industrial companies, a quality failure is not just a warranty cost. It represents a loss of brand reputation, contractual penalties from customer downtime, and lost future revenue.

Integrating AI into your product lifecycle directly addresses these financial risks by predicting and preventing defects.

- **Improve first-pass yield:** When manufacturing teams have clear, associative 3D models and accurate bills of materials (BOMs), they can consistently adhere to engineering tolerances. This ensures parts fit perfectly on the assembly line, dramatically reducing internal failure costs like scrap and rework.
- **Reduce the cost of poor quality (COPQ):** Catching issues virtually in the design phase prevents them from becoming massive external failure costs in the field. Coupled with a stronger feedback loop from field service back to engineering, product iterations be informed by real-world performance.
- **Build resilient supply chains:** A centralized data foundation provides the visibility needed to anticipate supply chain disruptions. You can quickly regionalize supply chains or adjust component sourcing without losing configuration control or compromising on quality.

This holistic approach ensures compliance, fosters cross-functional collaboration, and drives a culture of continuous, measurable improvement across the enterprise.





BEGIN YOUR TRANSFORMATION WITH PTC

Embarking on an AI-driven digital transformation requires a partner with deep industrial expertise and a portfolio of solutions designed specifically for the complexities of heavy equipment, industrial machinery, and component manufacturing. PTC provides the foundational technologies and strategic guidance necessary to operationalize AI effectively across your entire value chain.

Our solutions are built on a bedrock of responsible, scalable, and enterprise-grade principles. We ensure your intellectual property is protected and the operational insights you gain are fully trustworthy.

By embedding AI directly into industry-leading platforms, PTC makes an intelligent product lifecycle accessible and highly practical:



- **Windchill (PLM):** Creates a unified, centralized repository with full traceability from design through quality management.



- **Creo (CAD):** Delivers model-based enterprise capabilities and AI-powered generative design to catch issues when they are least costly to address.



- **Codebeamer (ALM):** Connects customer requirements with designs, tests, and verification outcomes to build audit-ready documentation and identify risks early.



- **ServiceMax (SLM):** Captures field performance data and equips service technicians with accurate CAD models to improve first-time-fix rates.

Our approach allows you to augment your existing workflows, build on a strong product data foundation, and realize measurable value without overhauling your entire IT infrastructure.

The future of industrial manufacturing will be defined by those who can successfully harness the power of their product data to drive quality upstream. We encourage you to explore how PTC's intelligent solutions can help you navigate this transition, reduce operational costs, and build customer confidence through consistent, proven quality.

READY TO SEE THE BENEFITS OF INDUSTRIAL AI?

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