The predictive quality for manufacturing guide

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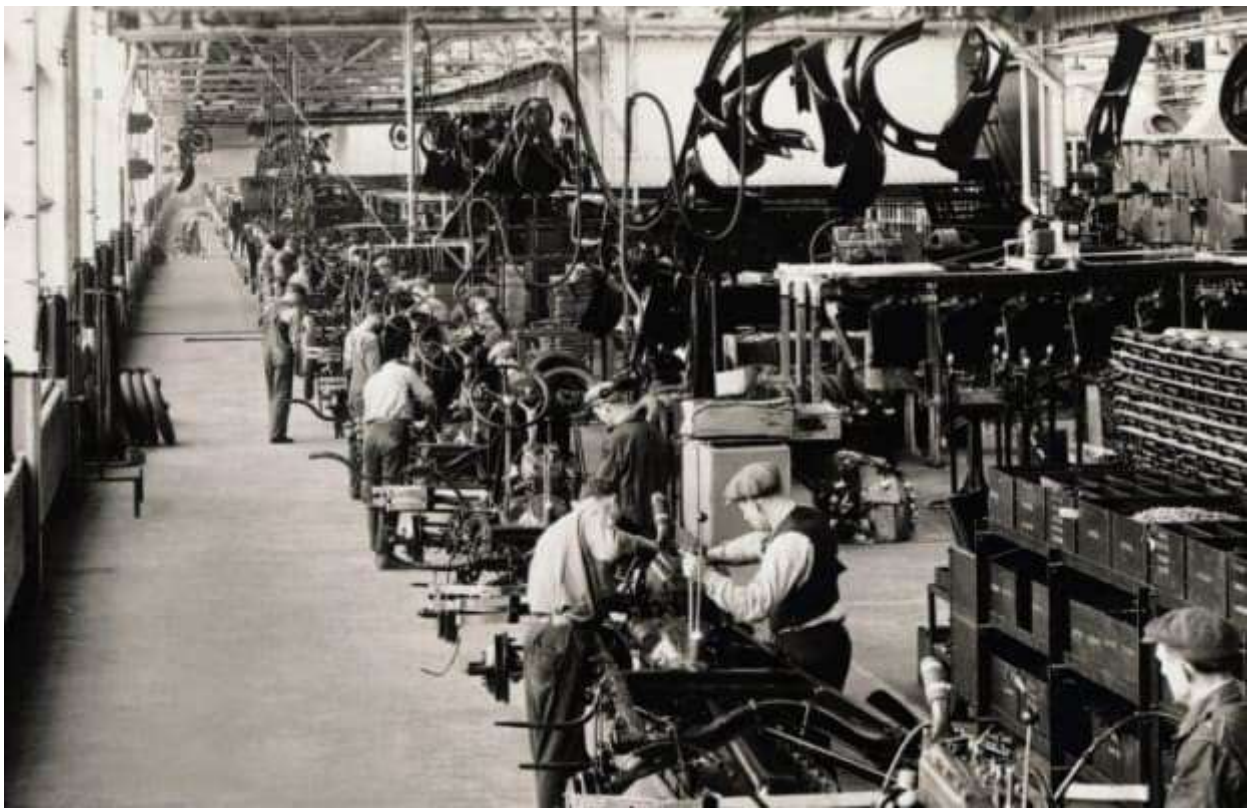
Since the early days of Henry Ford's Model T manufacturing lines, managing quality has been one of the main levers that industry leaders have used to improve throughput, profitability, and speed to market. Yet process optimizations based on traditional methods have pushed the expectations for quality to the limits.

Today, the concept of predictive quality analytics pushes the quality threshold even higher, due to revolutionary technologies such as cloud computing, artificial intelligence and machine learning.

Due to increased competition in the manufacturing landscape, now is the perfect time to get familiar with and adopt predictive quality.



Henry Ford's Model T manufacturing assembly line

What is predictive quality?

Predictive quality (or predictive quality analytics) is the application of advanced data analysis, machine learning, and statistical modelling techniques to predict quality issues proactively, before they occur in the manufacturing process. It involves analyzing historical data, real-time sensor data, and other relevant information to identify patterns, trends, and potential anomalies that could affect product quality.

By leveraging predictive quality analytics, manufacturers can proactively identify and address quality concerns before they impact production.

Where is predictive quality used?

Predictive quality solutions and software are employed in manufacturing facilities where quality control and process optimization are critical. They can be deployed on a single line or station, or multiple lines or stations. The same solution can even be employed across different facilities, so that corporate executives have access to company-wide quality information all in one place.

What are the benefits of predictive quality to manufacturing?

Predictive quality will improve product quality, even for manufacturers who have iron-clad manufacturing processes and are already achieving high quality output. In addition to increasing quality itself, predictive quality also provides other benefits to a manufacturer, including:

Benefits to manufacturing production

- **Shortened testing time**: Predictive quality enables manufacturers to gain insights into the key factors affecting product quality, enabling them to optimize testing efforts by focusing on critical areas, resulting in an ability to shorten testing cycles and accelerate time-to-market.
- **Less waste:** With the ability to predict and prevent quality issues, manufacturers can minimize waste generation, including material waste, energy consumption, and resource utilization, contributing to improved sustainability and cost reduction.
- **Improved first time through (FTT):** Through the implementation of a predictive quality solution, manufacturers can achieve a higher rate of successful production runs without defects or rejections, reducing the need for rework, optimizing resources, and enhancing operational efficiency.

Benefits to quality and engineering teams

- **Better insight into factors affecting quality:** Machine learning provides manufacturers with deeper insights into the factors influencing product quality, enabling them to identify correlations, trends, and even identify the root causes of quality issues, facilitating targeted improvements and more consistent production outcomes.
- **Reduced manual effort:** The beauty of machine learning and AI is that it crunches massive amounts of data in seconds. By automating data analysis with anomaly detection and quality control processes, predictive quality software reduces the reliance on manual efforts, freeing up resources while improving efficiency and accuracy.

Benefits to the end customer

- **Less risk of quality spills or warranty issues:** By proactively detecting and addressing quality issues before products reach the end of the line (or worse yet, go to market), manufacturers can significantly reduce the risk of warranty claims and associated expenses, leading to cost savings and improved profitability.
- **Improved customer satisfaction:** Implementing a predictive quality analytics solution ensures that products consistently meet or exceed quality expectations, resulting in

provide transparency to customers by sharing information about quality control efforts, demonstrating a commitment to delivering high-quality products, and fostering trust and confidence.

All of these benefits can also lead to higher-level business objectives such as enhanced profitability and overall operational efficiency.

How does predictive quality work?

The benefits sound appealing, but how do these results actually come about?

For predictive quality to generate accurate quality predictions, a number of steps must take place. The actual implementation and intricacies of predictive quality may vary depending on the specific manufacturing context, data availability, and the complexity of the quality issues being addressed. Here are the general steps:

1. Collecting manufacturing data

Predictive quality starts right on the shop floor. A manufacturer collects relevant data from various sources such as machines, production systems, quality control checkpoints, and historical records. This data could include information about process parameters, machine performance, environmental conditions, and quality measurements, depending on the manufacturer's unique goals. The data is often stored in a centralized database or data warehouse for further analysis.

2. Data preprocessing

the data, such as deriving statistical measures, creating derived variables, or aggregating data across time intervals.

3. Training and validating machine learning models

Machine learning algorithms are trained using historical data that includes both good and defective product instances. The models learn patterns and relationships between input variables and quality outcomes. The training process involves splitting the data into training and validation sets, optimizing model parameters, and evaluating model performance. Various machine learning algorithms, such as decision trees, random forests, or neural networks, can be employed depending on the specific requirements of the predictive quality solution. Models will need to be monitored and re-trained periodically.

4. Predicting real-time quality

Once the machine learning models are trained and validated, they can be deployed to make real-time predictions on new data as it becomes available during production. The predictive quality solution continuously monitors incoming data, compares it against the models, and generates alerts or warnings when outliers or anomalies are detected. Based on these insights, manufacturers can take immediate action to prevent quality issues, such as adjusting process parameters, implementing maintenance procedures, or inspecting products.

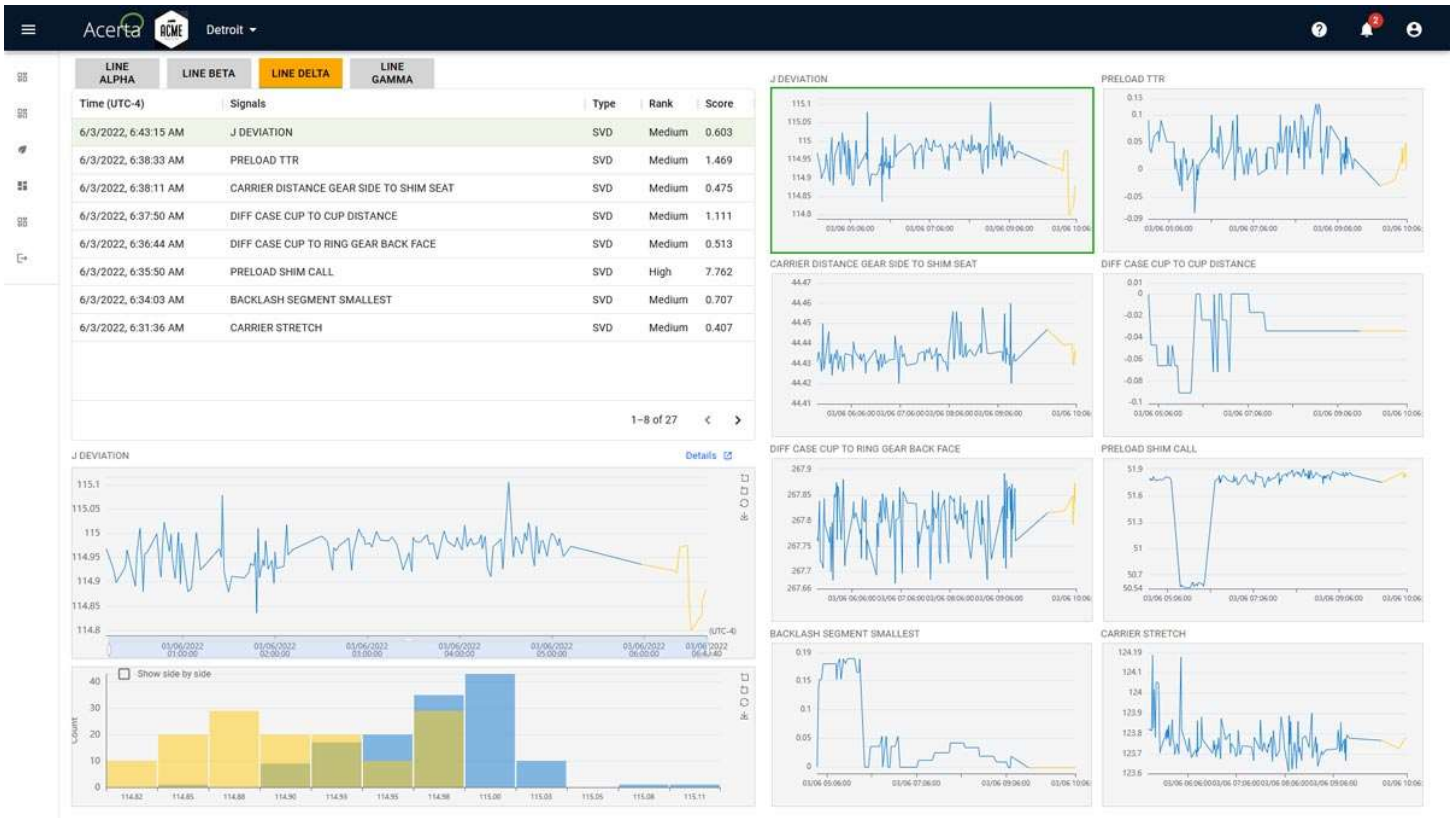
5. Leveraging advanced quality insights

Because the manufacturing data has been analyzed and visualized using the predictive quality solution, it can be shared among stakeholders and customers in order to provide transparency into the process and observe overall trends. Predictive analytics provides immediate, real-time and actionable insights that can greatly improve the ability to perform root cause analysis and

Key features of predictive quality solutions

Centralized dashboard

A centralized dashboard presents real-time and historical data visualizations, key performance indicators (KPIs), and quality metrics in one place. Manufacturers can monitor quality performance, track trends, and identify areas of concern, enabling data-driven decision-making and quick identification of quality improvement opportunities.



The LinePulse predictive quality dashboard

determine whether a variable has moved beyond specification limits. With single-variate anomaly detection, machine learning is used to identify outliers in individual data variables. By comparing data points against historical patterns or statistical thresholds, the software can detect outliers and potential quality issues associated with specific variables, such as temperature, pressure, or vibration.

Multi-variate anomaly detection

Machine learning algorithms expand anomaly detection to analyze multiple variables simultaneously, enabling manufacturers to uncover complex quality issues that involve interactions between different data dimensions. By analyzing correlations and dependencies across multiple variables, manufacturers gain a holistic view of quality deviations and can identify patterns that may not be evident in single variate analysis.

Predictive quality alerts

The predictive quality solution generates notifications when there is a risk of a parameter exceeding predefined thresholds, enabling manufacturers to act quickly. These alerts can be customized and sent to relevant stakeholders, such as quality engineers or production managers, to trigger immediate investigation.

Automated root cause analysis

When a product fails an in-process or end-of-line test, a predictive quality tool can be used to narrow down the cause of that failure based on patterns the algorithm can detect in the upstream data. By starting with a list of the most statistically likely signals to be related to the failure, a root cause analysis investigation can be done in minutes and hours, not weeks and months.

Predictive quality in a manufacturing plant would be used by various stakeholders involved in quality control, production management, and process optimization. Here are some key roles that would typically utilize a predictive quality analytics software solution:

- **Quality Engineers:** Quality engineers and managers utilize predictive quality to monitor real-time quality metrics, detect anomalies or deviations, and proactively address potential quality issues on the shop floor. They can also leverage it to enable more thorough root cause analysis, identify process improvements, and optimize quality control measures.
- **Production Managers/Supervisors:** Production managers and supervisors use predictive quality to monitor production data, track quality trends, and ensure compliance with quality standards.
- **Senior Personnel:** Senior management within the manufacturing environment leverage predictive quality software to gain a holistic view of quality performance and operational efficiency in their plant. They will find value from insights into quality metrics, key performance indicators, and can assess the impact of quality on business outcomes.

Predictive quality in a nutshell

In summary, predictive quality is a method for manufacturers to improve quality using machine learning and statistical modelling to analyze manufacturing data and generate predictions during the production process. Predictive quality is widely becoming the standard for quality control among the most cutting-edge manufacturing facilities, and its adoption is expected to increase as time goes on.

We're glad you asked. Our LinePulse product is the only predictive quality analytics software solution powered by machine learning and artificial intelligence (ML/AI) and purpose-built for precision manufacturers in the automotive and off-highway industries.

Fill in this quick form and one of our product experts can show you how you can use LinePulse to improve quality and first time through, reduce scrap and rework, avoid bottlenecks, and simplify quality in your plant.

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Enter your contact details to open the calendar and easily book a 30 minute LinePulse demo.

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