TIBCO

Continuously Improve Manufacturing Process Control with Real-time Insights and Predictive Capabilities

A current trend in manufacturing is towards tailor-made products in smaller lots with shorter delivery times. This change may lead to frequent production modifications, resulting in increased machine downtime, higher production cost, and the need to rework or scrap faulty products produced by processes that are unstable or not optimized.

To satisfy the customer demand behind this trend, manufacturers are moving quickly to new production models with a lower lead time but without compromising quality. Therefore, quality assurance and process control are critical areas that IT must support.

At the same time, product traceability becomes central to compliance and quality. Traceability can be achieved by interconnecting data sources across the factory, breaking down multiple data sources, analyzing historical and real-time data for insights, and taking immediate action to control the entire end-to-end process. Doing so can lead to noticeable cost reductions and gains in efficiency, process reliability, and speed of new product delivery. Additionally, data science helps manufacturers find the best setups for machinery.

The Digital Factory

When transforming into a digital factory, you will aggregate, analyze, and act on all your data. Sensors, equipment, people, applications, and processes are part of a connected ecosystem, providing:

- Increased uptime, reduced downtime
- Minimized waste and defects
- Better yields
- Reduced cost due to better quality
- Fewer deviations and reduced non-conformance
- Energy efficiencies
- Traceability and transparency in the manufacturing processes

Modern manufacturing operations are highly complex, and industrial control systems must manage in-flight processes within precise limits—responsible for delivering efficient, productive, reliable, and safe operations. But they are often not integrated, exposing manufacturing processes, operations, and production to risk.

Manufacturing CIOs can leverage new digital technologies that empower manufacturers to embrace a digital transformation path:

Process Optimization

With process optimization, manufacturers can identify bottlenecks in production, expensive quality problems, excessive energy consumption, and failure points. Process optimization analyzes historical data to detect opportunities for time, cost and quality improvement. It may also include identifying suppliers and materials that do not matter to final product quality, resulting in more significant savings.

Proactive Process Monitoring

Traditional process monitoring focuses on parameters one at a time, using quality control charting to monitor key metrics, detect deviations from the baseline, and generate automated alerts or actions. This methodology allows manufacturers to verify that parameters are “in control” and consistent with design specs. But with today’s complex processes and products, manufacturers may need multivariate methods such as AI-based anomaly detection to detect more subtle anomalies that degrade product quality and reliability. Data science solutions have enhanced Six Sigma practices to improve businesses’ efficiency and competitiveness.

Process Digital Twins

Advanced Process Control is a form of digital twin technology that involves the use of sensor & metrology data to implement real-time tuning and control of processes. These solutions involve a digital twin that predicts the output of a process,

while it is still in-flight, and adjusts the process recipe, in real time, to hit the desired target. This facilitates greater control of process variability than is achieved with the after-the-fact process control techniques above.

Better Quality, More Loyal Customers, Higher Margins

Manufacturers achieve robust quality when the variability of raw materials, ambient weather, supplier variability, or fuels do not affect the quality of the final product. For example, a car must perform reliably and without variation, even in extreme road and weather conditions. Additionally, this car must perform well despite any uncontrollable variability in supplier part quality, raw materials, or other manufacturing conditions.

Next-generation Process Control Capabilities

Using the methods and technologies above, every manufacturer can implement digital factory practices: root cause analysis, operations monitoring, process control, and predictive maintenance to boost overall equipment effectiveness (OEE). With advances in cloud computing, real-time analytics, data science, and other technologies, cheaper and more scalable factory solutions are available, allowing every organization to digitally transform, develop future-ready strategies, and capitalize on opportunities.

Root Cause Analysis

The first phase of a manufacturing program is to identify the root cause of product quality problems. Manufacturers may analyze simple linear correlations between end-product quality measurements (yield, defects, and returns) and upstream product, process, equipment, component, material, or environmental measurements. They can perform analysis of variance (ANOVA) equipment studies to identify the individual process steps and factors (machine, recipe, operator, and others) that produce a bad product. Similarly, manufacturers can identify component commonality analysis to identify outsourced component sources and process factors responsible for the faulty product.

After identifying the most evident causes of product-quality problems, manufacturers may have additional problems more difficult to diagnose. These are often due to complex non-linear effects and interactions between predictors not detectable with the techniques used during the first phase of analysis. Gradient Boosting Machine (GBM) modeling, a machine learning algorithm, can help uncover these complex relationships to solve the next phase of quality problems. (By using GBM from the beginning, combining both quality improvement phases to accelerate the ramp-up to mature production is possible.)

Predictive Maintenance

Predictive maintenance involves gathering targeted data for AI-driven analysis, which will help anticipate potential failures and increase OEE. Prescriptive actions can be triggered based on the prediction and make multiple recommendations to plant supervisors. Companies can then schedule maintenance at times that have minimal impact on operations, avoiding unexpected equipment and product waste downtime.

Operation Monitoring

Having end-to-end visibility of data helps manufacturers get insights from control charts for early warning systems that monitor:

- Key performance indicators
- Deviations from baseline

Process control raises automated alerts. Knowing if manufacturing processes are in a state of control is critical to minimizing production costs.

Harness the Complexity and Power of Your Data with TIBCO

TIBCO delivers AI-infused process control methodologies and digital twin capabilities to help global manufacturers deliver safe, efficient, and cost-effective production. Proactive intelligence detects early warning signs of abnormal events, automatically intervening if needed and managing outcomes in real time.

TIBCO's Process Control Solution:

- Delivers fit-for-purpose processes that support product quality and uniformity
- Reduces major accident hazard (MAH) exposure, near-misses, and health, safety, environment (HSE) risks
- Supports asset integrity
- Improves environmental, social, and corporate governance (ESG) and sustainability reporting—decreasing waste, emissions, and resource usage
- Maximizes profit and efficiency while reducing working capital
- Increases productivity and reduces cycle time
- Identifies the best equipment configuration parameters
- Improves reliability and process capability (CPK)
- Delivers predefined data models to build a single source of information

TIBCO Connected Intelligence for Manufacturing

Manufacturers compete with siloed, disconnected systems that do not leverage key data sources or address end-to-end enterprise touchpoints—reacting to problems after they have significantly impacted processes and products. To combat data challenges, TIBCO's Connected Intelligence platform connects any application or data source, unifies data for greater access, trust, and control, and predicts outcomes in real time and at scale.

Interconnected Data for Real-time Awareness

Using AI-driven intelligence, you can integrate all data sources from diverse endpoints—equipment sensors, financial systems, system logs, and social media—and enable intelligent engineering, operations, maintenance, and management. The TIBCO platform can implement decision-making and action-taking in the moment and at the point of greatest impact. And it allows you to scale complex, computationally intensive workloads in the cloud at a lower cost. You can analyze and visualize streaming factory data with historical data on a single dashboard and proactively trigger actions in case of anomalies.

Breaking Down Data Silos to Increase Factory Efficiency

Scattered and disconnected data sources prevent you from having a holistic understanding of your factory floor and business performance. By breaking down siloed data, manufacturers can gain business insights in real time. TIBCO can unify data sources by providing all data, on-demand, in a single logical layer that is governed, secure, profiled and serves a diverse community of users to have a true 360-degree view on all factory data.

Advanced and Historical Analysis

Data science capabilities are a perfect complement to traditional analytics. ML algorithms can uncover the hidden relationships between manufacturing variables, product yields, and quality, even if traditional data correlation doesn't find strong signals. Manufacturers have successfully implemented GBM models with a data function that uses the R generalized boosted regression model package. Data scientists have created a reusable template that accepts categorical and continuous data for predictors and responses. Analysts can use the template without special knowledge of statistics or machine learning.

TIBCO has out-of-the-box operations monitoring and process control. It supports Shewhart charts, also known as control or process behavior charts, used to determine if a manufacturing process is in a state of control. Our solution for manufacturers also supports continuous process verification (CPV), shelf-life analysis, and 21 CFR Part 11 used in the pharmaceutical industry for government-regulated manufacturing.

More and more manufacturers are looking into process mining to represent a product's production process. They can model a product as an entity and its processes as edges. This model allows a deep understanding of the manufacturing process. Combined with technologies such as AI/ML, the model helps identify and resolve bottlenecks, discover excessive lead times, and resolve interprocess conflicts. Some use cases include product traceability, simplified information sharing, parts management, supply chain automation, and payments.

Build Your Digital Factory with TIBCO

Becoming a data-driven manufacturer means unlocking data silos, increasing agility, integrating systems, and understanding how to turn your data into practical, profitable action. Let us help you on your journey in creating your digital factory.

For the next steps of your journey, please visit https://www.tibco.com/solutions/manufacturing-intelligence.

Global Headquarters
3307 Hillview Avenue
Palo Alto, CA 94304
+1 650-846-1000 TEL
+1 800-420-8450
+1 650-846-1005 FAX
www.tibco.com

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