Process Control for the Manufacturer of the Future

Manufacturing companies generate vast volumes of data from their processes. Almost every aspect of the business has a data stream, from equipment sensors to process measurements to product tests. Most of this data indicates that assets and programs behave as expected, and no action is required. But if you can extract the essential, actionable nuggets of information from this blizzard of data, you might have a massive competitive advantage.

What is Process Control?

Process control is a simple way to achieve production-level consistency. When managers continuously monitor and control a process, they can ensure that it works at its full potential—resulting in consistent, quality manufacturing. But your factory can transform operations by shifting from detection to prevention. By constantly monitoring process performance, you can detect trends or slight process changes before performance is affected. Digital factory process control has a range of benefits:

- Reduce wastage and warranty claims
- Maximize productivity in a manufacturing unit
- Increase operational efficiency and sustainability
- Reduce the need for manual inspections
- Enhance customer satisfaction
- Control costs
- Improve analytics and reporting

Process Control in Action

The manufacturing industry widely uses control charts. They are the foundation of early warning systems that monitor key metrics, detect deviations from the baseline, and generate automated alerts. TIBCO supports many univariate and multivariate charts:

- Integrated limits generation
- Storage and deployment
- Rule selection to detect out-of-control points
- Tagging and annotation
- Management and operations dashboards
- Periodic or real-time alerts
- Process capability studies
- Root cause drill-downs

Statistical Process Control

It is easy to forget the challenge of deriving actionable insight from continuous streaming data is an "old problem." Still, statistical process control (SPC) was around in the early 20th century. Walter A. Shewhart is generally considered the inventor of modern statistical process control charting. He worked at Bell Labs in the 1920s and was concerned about the reliability of the emerging telephone transmission system. Interestingly, the business requirements behind the invention of statistical process control originated with early Internet of Things (IoT) technology.

Today, statistical process control methods are the foundation of almost all process control in manufacturing and elsewhere. They are mandated for all pharmaceutical and medical device manufacturers, required by automotive manufacturers, and an integral part of all automated high-tech manufacturing.

Monitoring Steady States

A widespread statistical model for monitoring individual data streams assumes a constant average or mean (median) value over time, with constant variability due to uncontrollable or noise factors. If a process is stable and working as desired, then a control chart can be constructed based on the estimate of the acceptable noise variability.

The control chart will consist of a center line that indicates the expected constant average value for a particular parameter and its control limits. When the observed values fall outside the control limits, the original steady-state model no longer fits the observed data. The process is "out-of-control."

Univariate Statistical Process Control

Univariate Statistical Process Control (UPC) is a method extensively used within the manufacturing industry to effectively monitor processes for a single-stream steady-state process characterized by a constant value (average, median) and some acceptable variability.

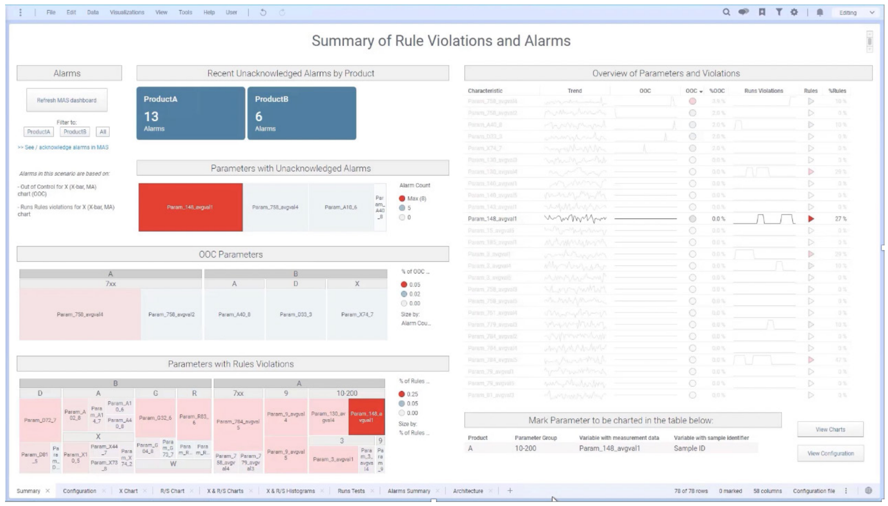

Figure 1. Process Control Summary with Drill-down to Control Chart

Multivariate Statistical Process Control Solutions

Multivariate Statistical Process Control (MSPC) was developed to monitor multiple variables simultaneously for a production process (biochemicals, cement, fertilizers, food, paint, perfume, pharmaceuticals, petroleum products, polymers, pulp, semiconductors, and the like).

MSPC can help users reduce product variability while increasing quality. There are several notable use cases for MSPC:

- Apply univariate and multivariate statistical methods for quality control, predictive modeling, and data reduction to complex manufacturing processes
- Determine the most critical process, raw materials, and environmental factors and their optimal settings for delivering products of the highest quality
- Monitor the process characteristics interactively or automatically during production stages, rather than waiting for final testing
- Build, evaluate, and deploy predictive models based on the known outcomes from historical data

Using AI to Detect Complex Anomalies in Time Series Data

In a dynamic manufacturing environment, it may not be adequate to look only for known process problems. It is also important to uncover and react to new, previously unseen patterns and problems as they emerge. Univariate and linear multivariate statistical process control methods have traditionally been used in manufacturing to detect anomalies. With increasing equipment, process, and product complexity, these more traditional methods may miss multivariate anomalies that also involve significant interactions and nonlinearities.

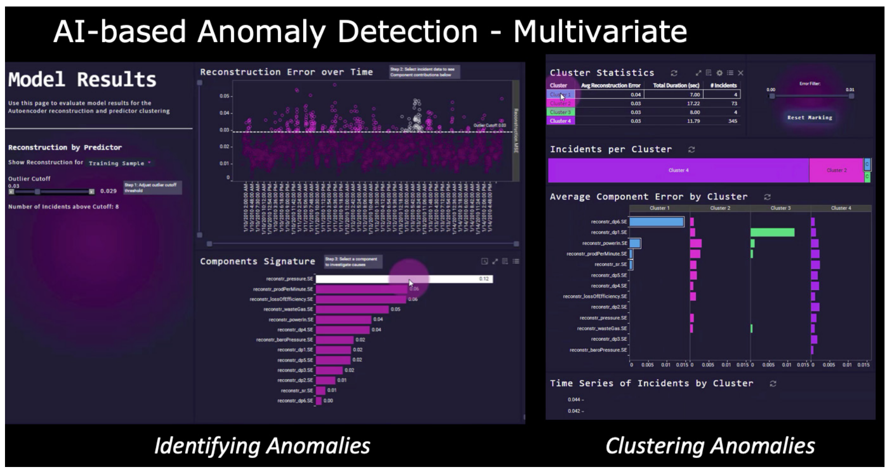

Figure 2. Anomaly Detection, Technology and Applications, TIBCO Community

Figure 2 shows a method for identifying complex anomalies using a deep learning autoencoder. Once the anomalies are detected, their fingerprints are generated so they can be classified and clustered, enabling investigation of the causes of the clusters. As new data streams in, it can be scored in real-time to identify new anomalies, assign them to clusters, and respond to mitigate potential problems. These tools are no longer the exclusive province of data scientists. After an initial configuration, engineers without deep data science expertise can routinely employ this method.

Advanced Process Control

Advanced Process Control (Figure 3) is an application of digital twin technology that involves using sensor and metrology data to implement real-time tuning and control of processes. This facilitates greater control of process variability than is achieved with the basic process control techniques above. Techniques include feed forward, feed backward, and predictive process modeling.

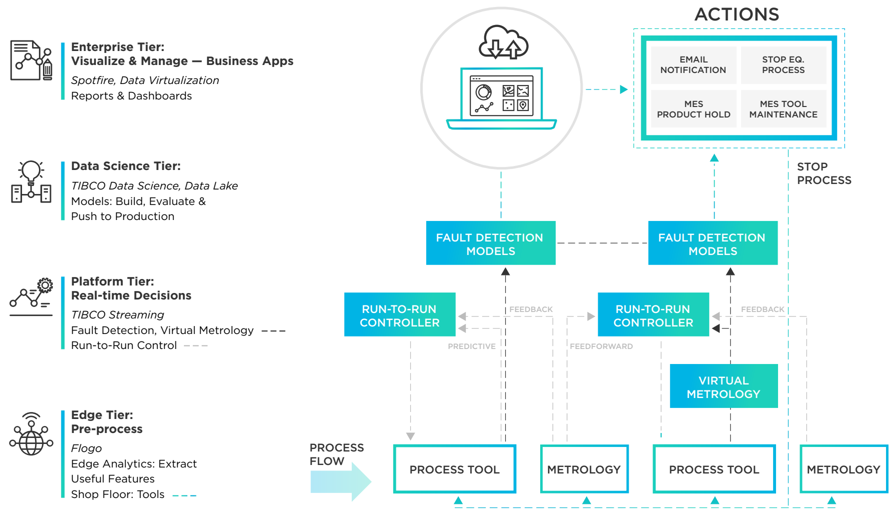

Figure 3. Advanced Process and Equipment Control

Manufacturing Process Control, Made Possible by TIBCO

Manufacturers and producers that focus on process improvement require real-time data from various systems to apply algorithms that derive metrics from process capabilities. Following the Six Sigma methodology, manufacturers then analyze this data and create predictive models. Manufacturers can miss opportunities to improve quality and reduce costs without timely and correct data.

TIBCO helps deliver proactive intelligence to detect early warning signs of abnormal events and failures and manage their outcomes. Smart data supports the design, implementation, and continuous optimization of key control systems and processes to ensure safe, efficient, and cost-effective production. Digital twin capabilities provide anomaly detection and advanced process control to intervene, optimize, and monitor in-flight processes.

TIBCO handles an extensive range of process control types and solutions:

- Univariate process control
- Multivariate process control (One variant of this is AI-based anomaly detection.)
- Advanced process control
- Basic process control where there's a simple distribution of data
- Detection of complex patterns in time series data and golden batch analysis
- Variations in the spatial distribution of failures

Depending on your specific needs, TIBCO can deploy different solutions, such as on the edge or in a streaming version.

Get Started Today with TIBCO

TIBCO provides the manufacturing intelligence necessary for the modern digital factory, enabling an automated and connected ecosystem. Our Connected Intelligence platform:

- Seamlessly connects data across processes, equipment, and IIoT devices
- Intelligently unifies data for greater access and control
- Confidently predicts the future to reduce costs, improve operations, and increase profitability.

Let us help you on your journey to create your digital factory. For next steps, visit https://www.tibco.com/solutions/manufacturing-intelligence/process-control.

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