A quality monitoring application in personal care manufacturing

Operationalizing a digital twin to continuously evaluate batch quality, compare predictions, and detect deviations in a single interface

Basetwo

Problem

Personal care manufacturers must tightly control viscosity and particle size distribution (PSD) to ensure consistent product texture, stability, and performance. Yet most mixing workflows still depend on manual experimentation, offline lab tests, and iterative troubleshooting. This creates several challenges:

- **No predictive insight** into viscosity or particle size development during mixing.
- **High experimental load** during process development and scale-up.
- **Inability to simulate process scenarios,** such as alternative equipment or formula tweaks.
- **Difficulty transferring learnings** between products, formulas, and mixer types.

Without a digital framework to model and monitor mixing behavior, teams struggle to improve reliability, accelerate development, and maintain consistent quality at scale.

Basetwo Solution

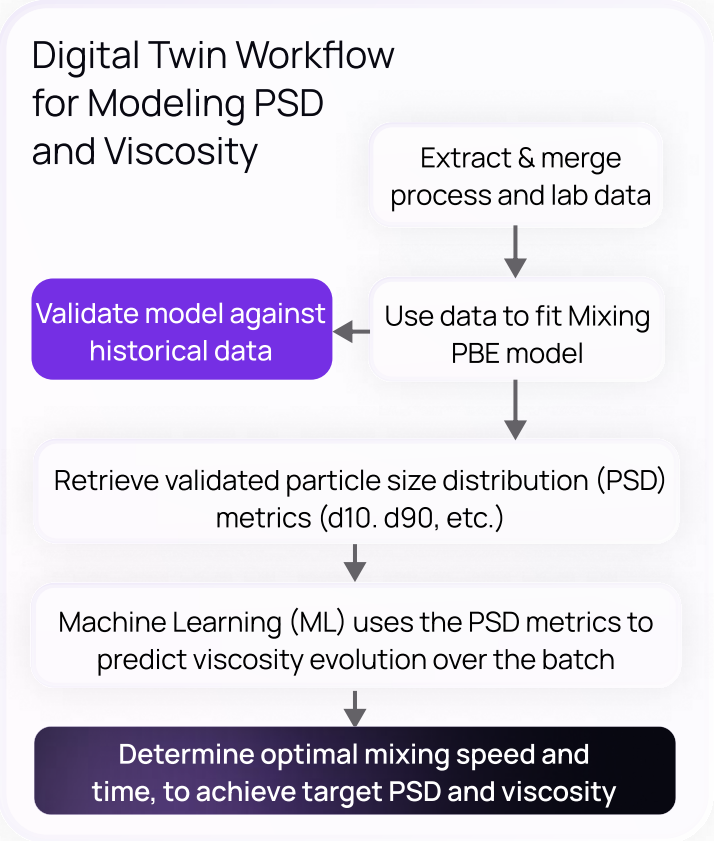
To address these challenges, personal care manufacturers use Basetwo to build hybrid digital twins that predict and monitor key quality attributes throughout the mixing process. This digital foundation supports data-driven decisions and powers scalable quality monitoring applications.

Data Ingestion:

Manufacturers first unify and transform historical and real-time data from process historians, ELNs, and LIMS systems, including process parameters, formulation details, and equipment specifications.

Digital Twin Development and Validation

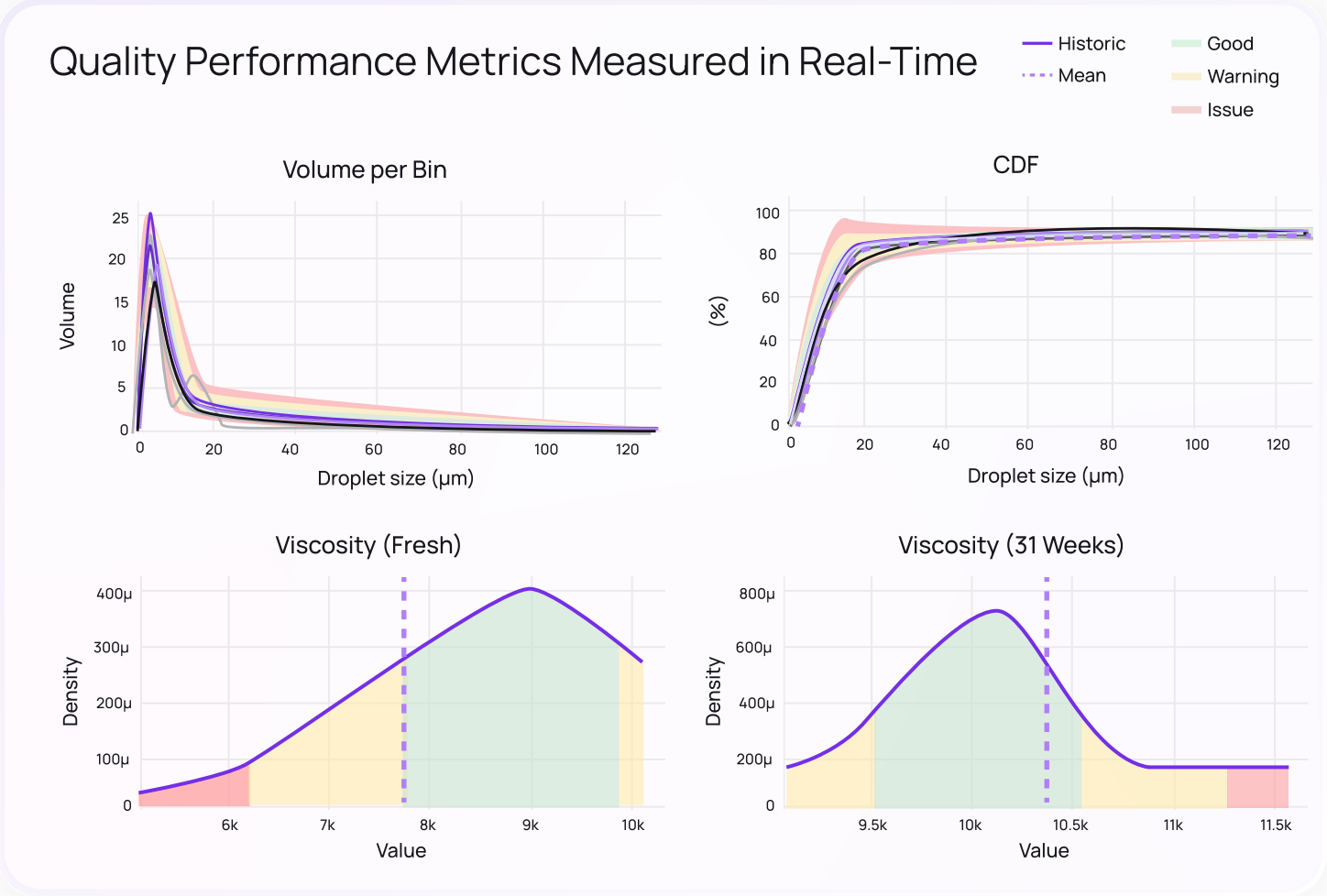
A hybrid digital twin is then developed by combining a mechanistic PBE model—used to simulate how PSD evolves under different mixing conditions—with a machine learning model that predicts viscosity from PSD metrics. This approach captures how process settings, equipment design, and formulation characteristics shape final product quality.



Model Application

Deviation Detection

Once the digital twin is developed and validated, it can be used to continuously verify that each batch is progressing within expected ranges for key quality attributes such as viscosity and PSD. The model compares predicted quality trajectories to incoming batch data, enabling early identification of deviations that could impact final product quality.



The above figure shows the comparison of real-time metrics to historical performance within the Basetwo platform. The green standard-deviation band represents the normal operating window. The yellow region indicates a warning zone where the process begins to drift, and the red region marks the issue zone where values fall outside acceptable limits and may signal a quality or process deviation.

Together, this visualization enables operators to quickly determine whether temperature, PSD distribution, remain within safe and optimal limits.

Workflow Feature

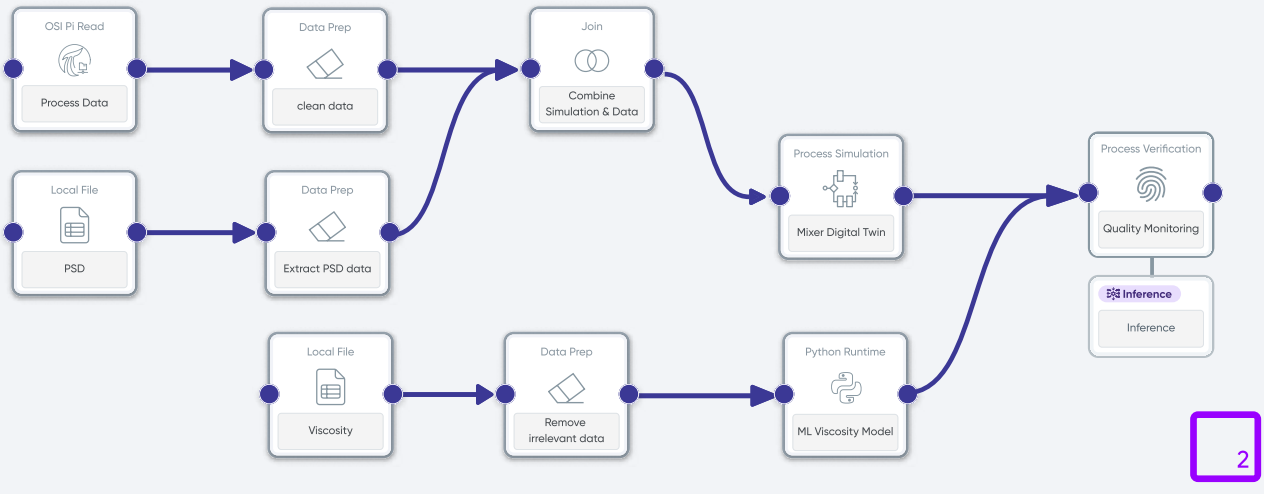
Application View

Once validated, this workflow is deployed through Application View, enabling teams to upload batch files, run the full digital twin pipeline automatically, and visualize predicted quality attributes, deviations, and batch health in a single decision-ready interface.

Application View bridges the gap between advanced workflow design and day-to-day execution, enabling non-technical users to run the digital twin with their own batch data—without needing to understand or recreate the underlying modeling pipeline.

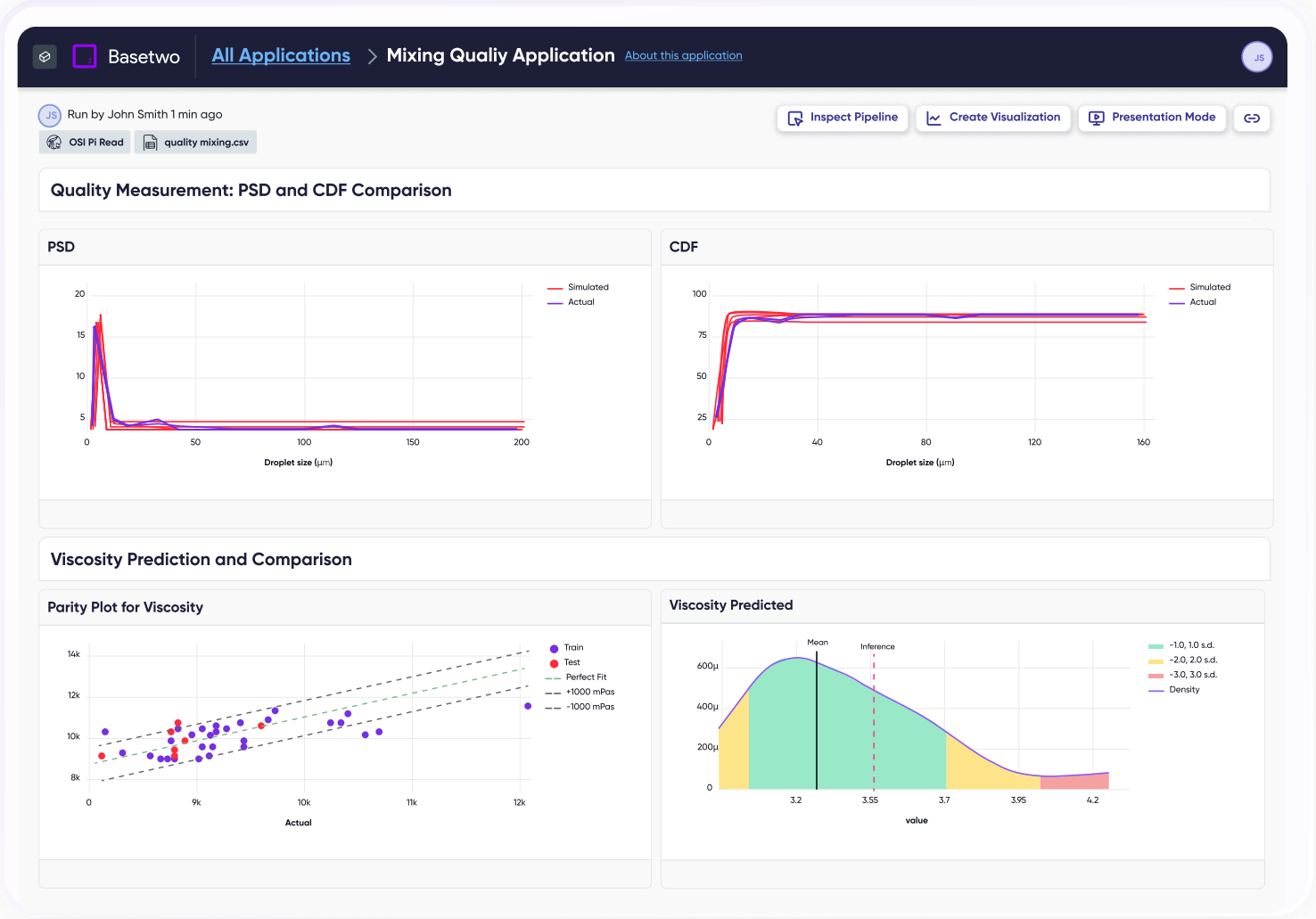
1. The complete digital twin workflow can be deployed as a standalone application, incorporating:

- ✓✓ Data ingestion (batch data, RPM, BTOs, etc.)
- ✓✓ Data preparation (mixing start, outlier handling)
- ✓✓ Mechanistic modeling for (PSD prediction)
- ✓✓ ML viscosity model
- ✓✓ Sensitivity analysis
- ✓✓ Process verification outputs



The deployed application consolidates key PSD and viscosity insights into a single, intuitive dashboard. After uploading new batch data, teams can quickly assess model performance, predicted quality attributes, and overall batch health, enabling faster and more confident decision-making.

2 Operators can upload new batch files and run the entire pipeline in a single click, giving the whole team a decision-ready interface for routine use.



The application dashboard illustrates how quality insights are presented to users. Typical views include viscosity prediction and comparison plots that show how closely model outputs align with measured values, along with indicators that highlight when a batch is operating within normal, warning, or out-of-range conditions.

The dashboard may also include comparisons of simulated and measured particle size distributions, such as PSD and cumulative distribution functions, to validate how well the model captures particle size behavior.

Together, these views provide immediate visibility into batch quality, model reliability, and process behavior. By surfacing deviations early and reducing reliance on manual lab analysis, the application equips R&D and process teams with consistent, data-driven insight that supports broader digitalization and scale-up objectives.

Basetwo Solution

Impact of Quality Monitoring

With the deployment of Basetwo's hybrid digital twin and the operationalization of the workflow through Application View, beauty and personal care manufacturer now have a scalable, data-driven framework for quality monitoring and batch reliability.

Earlier detection of quality drift through continuous comparison of predicted and observed batch behavior

Improved batch reliability and consistency by monitoring viscosity and PSD against expected operating ranges

Reduced reliance on manual testing and rework through automated, model-driven quality assessment

A Platform Built by Engineers for Engineers

- Rapid cloud-based deployment in weeks.
- Intuitive, drag-and-drop interface; for simplified simulation, monitoring, and optimization.
- Live process models deployed as reusable, scalable workflows

Explore digital twins for consistent and reliable quality throughout your personal care processes

Reach out today →

www. basetwo.ai