A white Paper on concepts, model attributes that drive interfacing Artificial Intelligence in Tooling Industry using MoldPredict™

Biju Jose bjose@predilyticsinc.com

Syrita Maria smjoe@predilyticsinc.com

Celes John cjohn@predilyticsinc.com

Abstract

We present MoldPredict™, Aritficial Intelligence platform designed to predict asset overhaul timing, cost, and risk using advanced statistical modeling and machine learning.

This white paper discusses concepts employed in the system design that bridges the gap between traditional maintenance heuristics and modern predictive analytics, by combining survival analysis, power-law hazard modeling, and gradient-boosted learning into a practical, production-ready decision tool.

We believe MoldPredict™ platform provide insight to enable manufacturers to act early rather than react, reducing downtime, cost overruns, and unexpected failures.

1. Problem Statement.

Industrial molds/ tooling are high-capital assets with nonlinear degradation behavior. Traditional maintenance strategies rely heavily on fixed-cycle overhaul, line-down inspection, and/or just attained wisdom of the operational team that involved at a given moment. These approaches often remain siloed in the industry, leading to unequal production performance among suppliers of the product/ component of projects, no matter how small or big those are. As a result, organizations face either premature overhauls (wasted capital) or delayed interventions (catastrophic failures) of tooling equipment involved. Existing CMMS and predictive maintenance platform often lack domain-specific modeling of frailty or wear dynamics.

It is not uncommon to see OEMs relocate production lines globally, often wanting to reshore to developed industrial economies, but shuns away due to angsts of not accounting for underlying variability across tooling performance strategies that impact raw material usage, production intensity, and operational success.

2. System Overview.

MoldPredict™ is presented as an end-to-end predictive maintenance platform focused on tooling lifecycle intelligence. The system consists of:
- A feature-engineered data pipeline capturing equipment usage dynamics, raw material characteristics, and operational signals observed

- A modeling layer capable of regression, classification, and survival-based hazard estimation
- A local-first deployment model with optional cloud-backed licensing and authentication
- A user-facing dashboard for prediction, scenario analysis, and risk visualization

The architecture is modular, allowing models to be swapped or upgraded without rewriting the backend.

3. Modeling Approach.

At the core of MoldPredict™ is a hybrid modeling strategy.

First, survival analysis and power-law hazard models are used to estimate time-to-overhaul behavior. These models are well-suited for degradation processes where failure risk increases nonlinearly with usage cycles.

Second, gradient-boosted models/architectures are employed for regression and classification tasks, such as:
- Predicting expected overhaul cost
- Classifying high-risk vs low-risk assets
- Estimating probability of overhaul within a given horizon

Frailty and shared-risk proxies are incorporated in the model to generalize across groups while still learning asset-specific behavior.

4. Calibration and Adaptability.

MoldPredict™ supports user-driven model calibration through a controlled workflow:
- Users download a standardized training template
- Historical shop-floor data is populated locally
- The model is recalibrated using the customer's data
- Predictions immediately reflect site-specific behavior

5. Deployment and Security Model.

MoldPredict™ is delivered as a standalone application with optional cloud integration. All sensitive operational data remains local by default. This enables higher accuracy without exposing proprietary production data to external servers.

Cloud services are used only for:
- Licensing and subscription enforcement
- Authentication and access control
- Optional analytics and updates

Row-level security, strict API boundaries, and key rotation practices are enforced for enterprise readiness

6. Business and Industry Impact.

By shifting from reactive maintenance to predictive intervention, MoldPredict™ aims at:
- Reduce unplanned downtime
- Improve capital allocation for overhauls
- Increase confidence in maintenance scheduling
- Provide actionable risk visibility for engineering and operations teams

The platform is intended to align with Industry 4.0 initiatives while remaining practical for real-world manufacturing environments.

7. Conclusion.

MoldPredict™ represents a new class of domain-specific predictive maintenance tools. By combining statistically sound hazard modeling with modern machine learning and a local-first philosophy, the platform delivers actionable intelligence without compromising data ownership or operational simplicity. The result is a scalable, secure, and explainable system that empowers manufacturers to make better decisions, earlier.