Paper 08: Performance Drift Detection & Decision Framework: Redesign vs Process Fix

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Abstract:

Industrial products often fall out of performance limits over time due to cumulative process variations, even when the original designs remain unchanged. This paper introduces a versatile, industry-agnostic framework that detects these deviations early and evaluates the economic trade-offs between two corrective strategies: design modification and process improvement. The approach combines Statistical Process Control (SPC) with capability analysis for monitoring stability, multivariate and time-series analytics to attribute deviations and predict compliance breaches, and a risk-adjusted financial model using Net Present Value (NPV), ROI, and payback period to compare solutions under uncertainty. The framework is illustrated through a case study of a 5HP 4P NEMA Induction motor demonstrating how process variations result in motors of the same design failing to meet efficiency limits. By parameterizing performance metrics, specification limits, cost models, and risk factors, the framework adapts to various manufacturing sectors, enabling data-driven decisions that optimize energy efficiency, lifecycle performance, and economic goals.