

Risk-Based Maintenance Optimization of Production Tools in a Dynamic Environment

Flexible Manufacturing Systems (FMS) are systems where machines are equipped with multiple tools, allowing them to produce various products by switching tools. This setup has many advantages, but one downside is that it is more challenging to perform proper maintenance on such a system because the usage and condition of the tools are highly variable due to the flexible scheduling.

Risk-based maintenance (RBM) is a maintenance approach that prioritizes maintenance activities based on risk, applying the appropriate maintenance strategy in every situation, whether it be preventive, reactive, or another approach. Traditional approaches to risk-based maintenance of complex systems, such as fault tree analysis, would be difficult to apply to flexible manufacturing systems because modeling the entire system would require rebuilding the fault tree with every new production schedule.

Instead of the traditional approach, I focus on the maintenance of individual tools, as they are unique and simple, and I can perform reliability analysis based on their usage data. By combining the probability data obtained this way with the costs of maintenance and production downtime, I can create a risk-based objective function, which can form the basis of a population-based algorithm. Such an algorithm can provide a sufficiently good solution for determining when and what type of maintenance should be performed on a given tool.

In the case study, I create a model of a flexible manufacturing system in Python, generating usage data for the tools and assigning costs to maintenance events and production downtime. This allows me to obtain probability and severity data for the risk-based objective function, which will serve as the fitness function of a genetic algorithm.

The expected result is a maintenance model and algorithm applicable to flexible manufacturing systems, optimizing the scheduling of maintenance for individual tools.

keywords: Risk-based maintenance, genetic algorithms, flexible manufacturing systems, maintenance optimization