Problem Statement - Machine Failure Prediction

Business Context

System failure is a common issue across the manufacturing industry, where a variety of machines and equipment are used. In most cases, it becomes important to be able to predict machine failures by analyzing system data and taking preventive measures to be able to tackle them. This is known as predictive maintenance and with the rising availability of data and computational resources, the use of such data-driven, proactive maintenance methods has resulted in several benefits like minimized downtime of the equipment, minimized cost associated with spares and supplies, etc.

AutoMobi Engineering Pvt. Ltd is an auto component manufacturing company. The manufacturing facility of AutoMobi consists of numerous products machined on several CNC (Computer Numerical Controlled) machines. In an attempt to transition to a data-driven maintenance process, the company had set up sensors in various locations to collect data regarding the various parameters involved in the manufacturing process. Initially, they want to try it in an injector nozzle manufacturing shop where they are manufacturing fuel injector nozzles for automobile engines using various manufacturing processes (like turning, drilling, etc). The company has been collecting data on an hourly basis from these sensors and aims to build ML-based solutions using the data to optimize cost, improve failure predictability, and minimize the downtime of equipment.

Objective

AutoMobi has recently been encountering a problem with frequent equipment failure in the fuel injector nozzle manufacture unit, leading to disturbance in the manufacturing process. They have reached out to the Data Science team for a solution and shared data for the past three months. As a member of the Data Science team, you are tasked with analyzing the data and developing a Machine Learning model to detect potential machine failures, determine the most influencing factors on machine health, and provide recommendations for cost optimization to the management.

Data Dictionary

- **UDI:** Unique identifier ranging from 1 to 10000
- **Type:** The type of product consisting of low(60% of all products), medium(30%), and high(10%) quality corresponding to L, M, and H
- **Air temperature:** Ambient temperature (in the machine shop) measured in Kelvin
- **Process Temperature:** Tool tip temperature measured in Kelvin
- **Rotational Speed:** Rotational speed of the machine spindle measured in revolutions per minute (rpm)
- **Torque:** Torque acting on the machine spindle measured in Newton meter (Nm)
- **Tool wear:** Tool wear measured in micrometers (During the manufacturing process, continuous rubbing of the tool on the workpiece leads to the wearing of the tool material. The tool wear is measured as the amount of wear on the cutting face of the tool measured in micrometers)
- **Failure:** 0-No failure, 1-Failure

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