Chapter 85
Big Data Analytics for Predictive Maintenance Strategies

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ABSTRACT

Maintenance aims to reduce and eliminate the number of failures occurred during production as any breakdown of machine or equipment may lead to disruption for the supply chain. Maintenance policy is set to provide the guidance for selecting the most cost-effective maintenance approach and system to achieve operational safety. For example, predictive maintenance is most recommended for crucial components whose failure will cause severe function loss and safety risk. Recent utilization of big data and related techniques in predictive maintenance greatly improves the transparency for system health condition and boosts the speed and accuracy in the maintenance decision making. In this chapter, a Maintenance Policies Management framework under Big Data Platform is designed and the process of maintenance decision support system is simulated for a sensor-monitored semiconductor manufacturing plant. Artificial Intelligence is applied to classify the likely failure patterns and estimate the machine condition for the faulty component.

INTRODUCTION

Maintenance can be defined as all actions which are necessary to retain or restore a system and a unit to a state, which is necessary to fulfill its intended function. The main objective of maintenance is to preserve the capability and the functionality of the system while controlling the cost induced by maintenance activities and the potential production loss. Correspondingly, failures can be defined as any change or anomaly in the system causing an unsatisfactory level of performance. Although only certain

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failures will cause severe risk in productivity and safety, most failures lead to disruptive, inconvenient, and expensive breakdowns and loss of quality. Maintenance plans are designed to reduce or eliminate the number of failures and the costs related to them.

There are two broadly accepted methodologies aiming at continuously enhancing maintenance excellence, with different focuses. As a human factor management oriented policy, total productive maintenance (TPM) involves all employees, especially the operators, in the maintenance program in order to achieve optimality in overall effectiveness and zero breakdowns. Through the operators' participation in maintenance, such as through inspections, cleaning, lubricating and adjusting, early detection of hidden defects, before service breakdown. TPM aims to diminish and eliminate six significant losses of equipment effectiveness – i.e. breakdowns, setup and adjustment, idling and stoppages, reduced speed, defects in process, and reduced yield (Jardine & Tsang, 2013).

Reliability-centered maintenance (RCM) is another approach to strengthening the system's reliability, availability and efficiency which focuses on design and technology. RCM program is based on systematic assessment of maintenance needs after a complete understanding of the system function and the types of failure causing function losses.

Types of Maintenance

Maintenance activities can be categorized into three types:

1. Reactive or corrective maintenance,
2. Preventive maintenance (PvM), and
3. Predictive maintenance (PdM).

The following terms are also respectively used for the above three categories interchangeably as:

1. Breakdown maintenance or unplanned maintenance,
2. Planned maintenance, and
3. Condition based maintenance (CBM) or prognostic and health management (PHM).

Reactive or corrective maintenance follows the run-to-failure methodology, which is the repair and/or replacement work after an equipment outage has occurred. This primitive maintenance approach, which has been applied in industry for decades, and is still considered the best maintenance policy for non-critical components with short repairing time in the system. However, in most cases, an equipment failure can lead to unexpected production delay and lower the production efficacy rate, or more seriously, cause severe damage to other components and/or injury to people. One goal of a proactive maintenance plan is to reduce the overall requirement for reactive maintenance and to apply PvM and/or PdM strategies on any feasible occasion.

Preventive maintenance is performed based on a certain periodic interval to prevent and correct problems before breakdown without considering the actual health condition of a system. Basic preventive maintenance, including inspections, lubrication, cleaning and adjustment is the first step to be undertaken. After that, rectification or replacement can be undertaken only for components identified with defects and/or considerable risk of failure. Generally, most PvM actions can be implemented by operators with basic training.