Group Maintenance Strategy of CNC Machine Tools Considering Three Kinds of Maintenance Dependence and Its Optimization

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Abstract

Unreasonable maintenance strategies will increase maintenance costs and reduce the efficiency of CNC (Computer Numerical Control) machine tools. Therefore, not only the degradation state of components but also their coupling effect should be considered to obtain a scientific and reasonable system-level maintenance strategy because of the dependence among different components of CNC machine tools. This study proposes a group maintenance strategy of CNC machine tools considering economic, structural, and stochastic dependence among critical components and optimizes the group maintenance strategy. The model of group maintenance of CNC machine tools is composed of four sub-models: sub-model of component degression, sub-model of group maintenance decisions, sub-model of imperfect maintenance, sub-model of maintenance cost. Utilizing the model of group maintenance of CNC machine tools, the time, objective, and measures of maintenance can be decided according to the degression state and failures. And then, the cost of each maintenance can be calculated. In the group maintenance model, economic dependence and structural dependence among components are quantified by cost, while stochastic dependence is quantified by failure intensity. On that basis, the Monte Carlo method is used to simulate the machine tool operation process and the long-term maintenance cost of CNC machine tools corresponding to a certain failure intensity threshold is calculated. Finally, Genetic Algorithm is used to optimize the failure intensity thresholds of preventive and group maintenance. A numerical example verifies the effectiveness of the proposed optimization method for group maintenance strategy.

Full Text

Due to technical limitations, full-text HTML conversion of this manuscript could not be completed. However, the manuscript can be downloaded and accessed as a PDF.

Figures

Figure 1

The whole model of group maintenance of CNC machine tools

Figure 2

Failure intensity curve considering degradation acceleration factor

Figure 3

Failure intensity curve considering service age regression factor

Figure 4

Failure intensity curve considering degradation acceleration and service age regression factors

Figure 5

Flow diagram of Monte Carlo simulation

(a) spindle

(b) feeding component

(c) lubricating component

(d) cooling component

(e) tool storage component

Figure 6

Failure intensity curves of critical components under different maintenance strategies