Tool Replacement Policy in a Machining Center

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Abstract

In most industry fields, automated machining centers have been widely used. They have high flexibility and efficiency so that they can produce multiple types of products using multiple types of tools and are suitable for satisfying various demands of customers. Operational effectiveness of a machining center is significantly affected by operational decisions such as a part sequencing and a tool replacement. In this paper, among the operational decisions, tool replacement problem in a machining center is considered. The tool replacement problem is a problem of determining time for tool changes due to tool wear or breakage. Machine tools play a major role in producing good quality workpieces economically. Proper tool replacement could give the benefit such as an improved product quality, reduced machine down time, and lower production cost. If a tool is replaced too early, the remaining tool life is lost and frequent tool changes take place and so the tooling cost is increased. On the other hand, if a tool is replaced too late, the probability of tool failure may be very high. Therefore, a penalty cost for the rejected workpiece takes place and the additional time to rework the rejected workpiece is required. The consequences of tool replacement decisions can affect system throughput both directly and indirectly.

For the problem, we develop a new tool replacement policy to minimize total production costs composed of tool related costs (replacement and breakage costs), material costs, and tardiness costs. In the suggested replacement policy, we compare expected additional costs when a tool is replaced and when a tool is not replaced at each time an operation is to be started. If the expected additional cost when a tool is replaced is less than the expected additional cost when a tool is not replaced, current tool is replaced with a new tool. In the replacement policy, such costs are estimated through simulation.

The tool replacement policy suggested in this paper was compared with other tool replacement policies that are used in practice or suggested in previous research for randomly generated test problems. Results of the computational tests show that the new replacement policy gives better performance than existing ones.