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Research on automated machine tool management model

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ABSTRACT

With the development of science and technology, the advancement of industrialization, automated production has been widely used, and automated machine tools are also favored as modern equipment for automation management coordination. This paper considers that the automatic lathe may fail during the process of continuously processing a certain part. Therefore, establishing the best inspection interval and tool replacement strategy for model design makes the automatic machine tool management more mature, and then promotes the modern development of production equipment.

Keywords: Automated management; Monte Carlo simulation, Industrial technology

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1. BACKGROUND

The automated machine tool is a machine tool model that can be automated and adjusted according to modern equipment and high technology. In an automated machine tool, the device has a program adjustment system that enables logic processing of programs that have control codes or other symbols, decodes them, and transmits them to the numerical control device via the information carrier. Then, the signal is sent out through the numerical control device to control the machine to run. Automated machine tools are ideal for machining precision parts and have reliable performance. They are an important development direction for modern machine control technology. Compared with traditional machine tools, automated machine tools have a number of advantages, such as high precision, adaptability, high work efficiency, etc. The emergence of automated machine tools has greatly promoted the modernization of production equipment[1].

When the automatic lathe is continuously machining a certain part, it will be faulty during the machining process due to the damage of the tool, etc. The occurrence of the failure is completely random, and the worker checks the part to determine whether there is a failure. The relevant cost parameters in the known production process are as follows: the cost of parts lost during the failure, the cost of the inspection, the average cost of recovering the fault to restore normality, and the cost of replacing a new tool when no fault is found. As a result, we have established the best inspection interval for the model design benefit the tool change strategy.

In this paper, it is assumed that the process faults are all tool failures. The parts produced in the event of failure are all non-conforming products. The parts produced in normal time are all qualified products. The tool fault records are accumulated. The number of completed parts is positively distributed when the fault occurs. It is now planned to replace the new tool regularly after the tool has been machined. Try to design the best inspection interval for this process (how many parts are inspected once) and the tool change strategy.

2. MODEL ASSUMPTIONS

(1) The time spent on inspection and fault repair is negligible.

(2) Equal opportunity for failure in the production of any part.

(3) The tool used to start production is new.

3. MODEL PREPARATION

Draw the sample figure normplot command in MATLAB. In the drawn sample graph, if all the sample values are distributed on a straight line, it indicates that the sample conforms to the normal distribution.

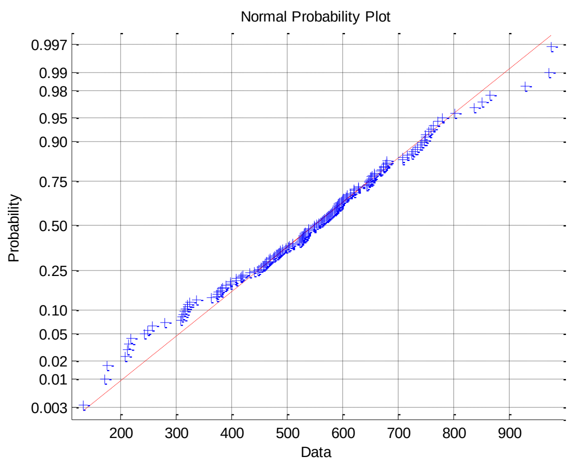

Fig.1 Normally distributed probability

The average number of pieces of tool produced is determined by the amount of tool produced. The curve of the probability distribution of the given data of the title is fitted and then integrated to obtain the average distribution of tool life. The average interval at which the tool will fail when the tool is replaced periodically:

$$\delta_a = \frac{1}{F(a)}\left\{\sum_{y=1}^{a-1} y\left[F(y)-F(y-1)+a\left(1-F(a)\right)\right]\right\}$$

Derivation of the continuous function to obtain the density function $f(x)$, substituted in δ_a:

$$\delta_a = \frac{1}{F(a)}\left[\int_0^a tf(t)dt + a\left(1-F(a)\right)\right]$$

The average fault interval of the process is equal to: $c=\delta_a$

The probability of producing a nonconforming product between inspections is:

$$\frac{(1-p)^{b-y}p}{1-(1-p)^b}(y=1,2,\cdots\cdots,b)$$

Then the mathematical expectation of the number of unqualified products produced in the middle of the inspection is:

$$E_{(b)} = \sum_{y=1}^{b} y\frac{(1-p)^{b-y}p}{1-(1-p)^b}$$

After simplification,

$$E_{(b)} = \frac{b+1}{2} + \frac{b^2-1}{12}\times p + O(p^2)$$

Which $p=\frac{1}{c}$ is very small, so $O(p^2)$ will be ignored, that is $O(p^2)=0$, there are:

$$E_{(b)} \approx \frac{b+1}{2}$$

4. THE MODEL

(1) The average cost of producing each product is equal to the cost of regular tool replacement, the cost of periodic inspections, the loss of nonconforming products caused by failures, and the average cost of repairing lathes:

$$S = S_1 + S_2 + S_3$$

(2) The cost of regular tool change is equal to the ratio of the cost of replacing the tool once and the period of time required to replace the tool:

$$S_1 = \frac{k}{a}$$

(3) The cost of periodic inspection is equal to the ratio of the cost of the tool inspection to the number of parts produced during the periodic inspection of the tool:

$$S_2 = \frac{t}{b}$$

(4) The loss caused by the non-conforming product is equal to the cost of repairing the tool and the loss of parts caused by the failure:

$$S_3 = \left(E_{(b)} f + d\right) p$$

$S_1=\frac{k}{a}, S_2=\frac{t}{b}, S_3=\left[\left(E_{(b)}+j\right) f + d\right] p, p=\frac{1}{c}, E_{(b)}=\frac{b+1}{2}$ will be brought into the objective function easily:

$$S=\frac{k}{a}+\frac{t}{b}+\frac{(b+1)\,f}{2c}+\frac{d}{c}$$

Optimize the function, given, and get, then the function is easy to get:

$$b=\sqrt{\frac{2ct}{f}}$$

In summary:

$$S=\frac{a}{k}+\frac{t}{\sqrt{\frac{2\delta_a t}{f}}}+\frac{(\sqrt{\frac{2\delta_a t}{f}}+1)\times f+d}{2\times\delta_a}$$

(5) Explanation:

a: The number of parts produced in one cycle when the props are replaced regularly.

k: The cost of replacing a new tool when no fault is found.

t: The cost of an inspection of the tool.

d: Found that the fault is adjusted to restore the normal average cost.

5. SIMULATION

The Monte Carlo method, also known as random sampling or statistical test method, belongs to a branch of computational mathematics. With the help of computer technology, Monte Carlo simulation achieves two major advantages: First, it is simple, and it eliminates the complicated number of journals. The calculation process makes the average person understand and master; the second is fast. Simple and fast, it is the technical basis for Monte Carlo methods to be applied in modern project management. The Monte Carlo algorithm indicates that the more samples, the closer the optimal solution is.

The Monte Carlo simulation image obtained by using MATLAB is shown in the figure:

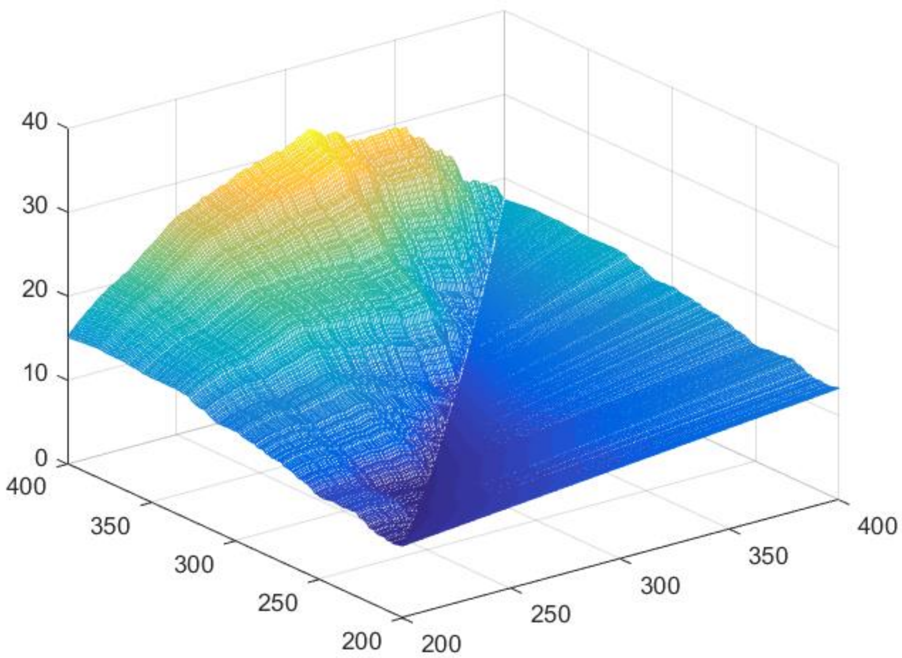

Fig.2 Monte Carlo simulation image

6. MODEL IMPROVEMENT

In the process of model establishment, we adopted the method of equidistance inspection. Although the model is simplified, it is deviated from the actual situation and increases the cost to some extent. Therefore, non-equidistant inspection and tool change method can be used for modeling. In the actual production process, there is less chance of failure after a period of production or tool change, and the machine is damaged after working for a period of time. The probability of failure increases gradually.

7. Conclusion

Based on bed management, a function aiming at the expected loss cost of each part is established, which has certain rationality and feasibility. It can be used not only for the processing of single-piece parts in a single process, but also for the production of complex lathes with multiple processes and multiple parts. In addition, it can be used for other resource arrangements and economic decisions. Therefore, this model has good application value and the automation machine tool management is more mature. It is worth promoting.

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