СЕКЦІЯ 1
ТЕХНОЛОГІЧНІ ПРОЦЕСИ ТА СИСТЕМИ МАШИНОБУДІВНОГО ВИРОБНИЦТВА

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THE ANALYSIS OF TEST PLANNING OF FLEXIBLE PRODUCTION SYSTEMS

In our country, automatic production lines are widely used, combining complexes of aggregate machines and automatic machines that work automatically. The disadvantage is the narrow focus on the manufacture of a certain type of product. In this regard, such tools can be only used where production is massive and sustainable. In industrialized countries, large-scale and mass production is only 20%, and single, small-scale and mass production is 80% [1, 2, 3].

In order to resolve the contradictions caused, on the one hand, by the small-scale production facilities, and on the other, by the large scale of production itself, methods of group technology were developed. The next step in the automation of production is the development of programmable and, therefore, reconfigurable tools, that is, flexible equipment. These include CNC machines, machining centers, industrial robots and other equipment.

As a rule, test planning involves the fact that the product being checked, or some part of it, must be removed from the ready state for some time. This means that more frequent tests reduce the useful time during which the system is ready for action and expects only the occurrence of an accident or alarm, and, on the other hand, less frequent tests reduce the confidence in servicing equipment and, consequently, its ability to perform the resulting problems [4, 5]. In addition, test planning can significantly increase the failure rate of system equipment or lead to additional malfunctions, while in passive standby or storage, in many cases, the risk of failure is less.

Let the product in the ready state undergo tests which are carried out in a negligible time without creating the prerequisites for the appearance of additional malfunctions.

Hardware failures will be called malfunctions, emphasizing the fact that they are timely eliminated, they may not lead to a failure to perform some task [6, 7]. We believe that each testing has a fixed cost of C_1, and the stay of the product in a malfunctioning state for one hour is costed in C_2. Then a malfunction that occurs at any moment between some kth and $(k+1)$-th tests causes operational losses equal to:

$$\int_{t_k}^{t_{k+1}} \{(k+1)C_1 + C_2(t_{k+1} - x)\} dF(x), \quad (1)$$

where $F(x)$ is the distribution of time to the first fault. However, since a malfunction can occur after any test, to calculate the total expected operational loss, it is necessary to add (1) over all possible k from 0 to ∞:

$$M[C_э] = \sum_{k=0}^{\infty} \int_{t_k}^{t_{k+1}} \{C_1(k+1) + C_2(t_{k+1} - x)\} dF(x). \quad (2)$$

If the distribution $F(x)$ is continuous and has a moment, then there exists a sequence of non-negative numbers $\{F^*{}_k\}$ (which represent the moments of tests) that minimizes the total expected losses of the form (2). This sequence can be found for all k:

$$\frac{\partial}{\partial t_k}\left\{\int_{t_{k-1}}^{t_k}[kC_1 + C_2(t_k - x)]dF(x) + \int_{t_k}^{t_{k+1}}[(k+1)C_1 + C_2(t_{k+1} - x)]dF(x) + \right\} = 0 \quad (3)$$

or finally

$$t_{k+1} - t_k = \frac{F(t_k) - F(t_{k-1})}{\mathfrak{f}(t_k)} - \frac{C_1}{C_2}, \quad (4)$$

where

$$\mathfrak{f}(t_k) = \frac{dF(t)}{dt}|_{t=t_k}.$$

Using recurrence relation (4), the optimal values of the test moments $\{t^*_k\}$ are successively determined, but for this it is necessary to set the value t_1, on the basis of which all the other test moments are found [4-5]. Such verification strategies are called periodic to distinguish them from variable-interval verification strategies called sequential. If the form of the distribution law $F(t)$ is unknown, then the task of test planning is formulated somewhat differently.

The basic dependencies of test planning and repair under variable operating modes have been monitored and the ranges of existence of the system depending on internal factors and changes in working time, environmental characteristics and factors affecting the system have been obtained.

Several methods of mathematical test planning on the operability of the FPS equipment have been analyzed and developed, taking into account the impact of all possible negative factors on the system.

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ОСОБЛИВОСТІ ДЕФОРМУЮЧОГО ПРОТЯГУВАННЯ МАЛОПЛАСТИЧНИХ МАТЕРІАЛІВ

Для оцінки якості обробленої деталі слід використовувати параметр, що характеризує дефектність поверхневого шару, – ресурс використаної пластичності [1, 2]. Дослідження показників пластичності стає особливо актуальним при обробці пластичним деформуванням малопластичних матеріалів, в тому числі такого конструкційного