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DEFINITION OF MACHINABILITY MATERIAL IN PROCESS SYSTEMS

In most cases, the creation of diagnostic systems requires significant costs of money in purchasing expensive hardware and software for processing diagnostic results obtained, that prevents a widespread of these systems on most manufacturers in our country. The proposed method of diagnosing of processing for multi-machine improves the efficiency an automatic data collection and analysis of information for solving a determining task of the technical condition of a machining FMS during processing details, as well as early detection and localization of errors in processing for improving the reliability and efficiency of the machining. The above-mentioned advantages allow to reduce costs, so as to implement this technique there is no need to use the complicated expensive equipment. Also, a staff training process takes a little time, these advantages reduce an amount of defective details and the number of prematurely broken tools or malfunctioning equipment. Given all the advantages of this method of diagnosing machining process on the multipurpose machine composed of the flexible production lines, these reduce the cost of parts while increasing a precision manufacturing of parts.

An important task of instrument making is the automation of processes through the extensive use of machine tools with numerical control (CNC) and the organization on their basis of flexible manufacturing systems and flexible production units.

The feasibility of using CNC determined by the reduction in the number of workers, increased technological flexibility and capabilities of each workplace through enhanced versatility of these machines, saving production areas, improving the quality of manufacturing parts, and simplification of conditions. In addition, based on these tools is the ability to create flexible, quickly-adjusting production complexes, which is especially important in small-scale production. The use of flexible manufacturing systems based on new computers with the introduction of advanced automatic process control systems (APCS) and efficient technical systems of identification will potentially move to a fully automated production technology, hence, without a human being.

However, a widespread use of such promising multifunctional equipment and its efficient operation are being constrained by a number of significant reasons, including:

- The lack of high-quality software that takes into account all the technological characteristics of cutting its many parametric functional dependence between them.
- Low reliability of the machining process, which refers to a number of unreliable, cutting tool wear.
- The lack of such automated CNC feedback systems that are based on information about the progress of processing would increase the reliability of such technological treating systems (CBT).

The problem of improving the reliability of these machines can be solved by creating efficient automatic identification systems and process control treatment, receiving current information about the technical condition of the cutting process and issue the appropriate control action on the CNC machine.

Before we formulate the main goals and objectives of determining machinability, stop briefly on some of the concepts of reliability theory which are most involved in the subject of further discussion. Under *the object* will be meant system and its components that to be studied (study). Suppose further that at any time the facility is in one of two different, mutually exclusive conditions: performance or failure. *The efficiency* - this is a state facility at which it is able to perform specified functions, keeping values within defined parameters set by regulatory and technical documentation. Accordingly, under the refusal, it would be meant the violation performance of the object. It should be noted that the concept of failure (efficiency) is largely conditional and should be closely associated with features of construction and operation of the object.

The well-known reliability theory that reliability laid in the design, provided and supported in production when operating fully applies to those affected technical objects, which are detection system machinability materials in technological system, and which usually consist a large number of interacting components and subsystems and perform a wide range of critical functions in the management of complex flight conditions that are changing. In practice, the use of different techniques to improve reliability - creating strong elements that ensure favorable treatment of their work, and backup components and subsystems, creating circuits with reduced effects of failures and so on. One of the effective ways to improve the reliability of ACS is associated with the development and use of special equipment and controls that provide the ability to identify and eliminate failures which caused them adverse effects both during manufacture and in the operation of the equipment. We further understood by some set of machinability evaluation test, computational and logical operations on the results of the implementation of which can be judged the actual state of the controlled object and, therefore, take the necessary steps to manage. The most complete function evaluation of processing is realized with ACS, which performs the above operations and decision-making about the efficiency of the facility for timely action on it without the direct participation of the person (operator). The undoubted advantages of ACS include the possibility of managing girth control virtually any number of components and devices, expanding the test operation, high speed, high accuracy etc.

Depending on the purpose of managing their construction and features, not all of these problems of workability evaluation should be treated and resolved in the same volume. However, the effectiveness of solutions to each of these tasks largely depends on the understanding of the processes that occur in a controlled facility; how closely the methods and means of assessment related to the specific workability both of tasks to manage the data object.[1,2,5,10]

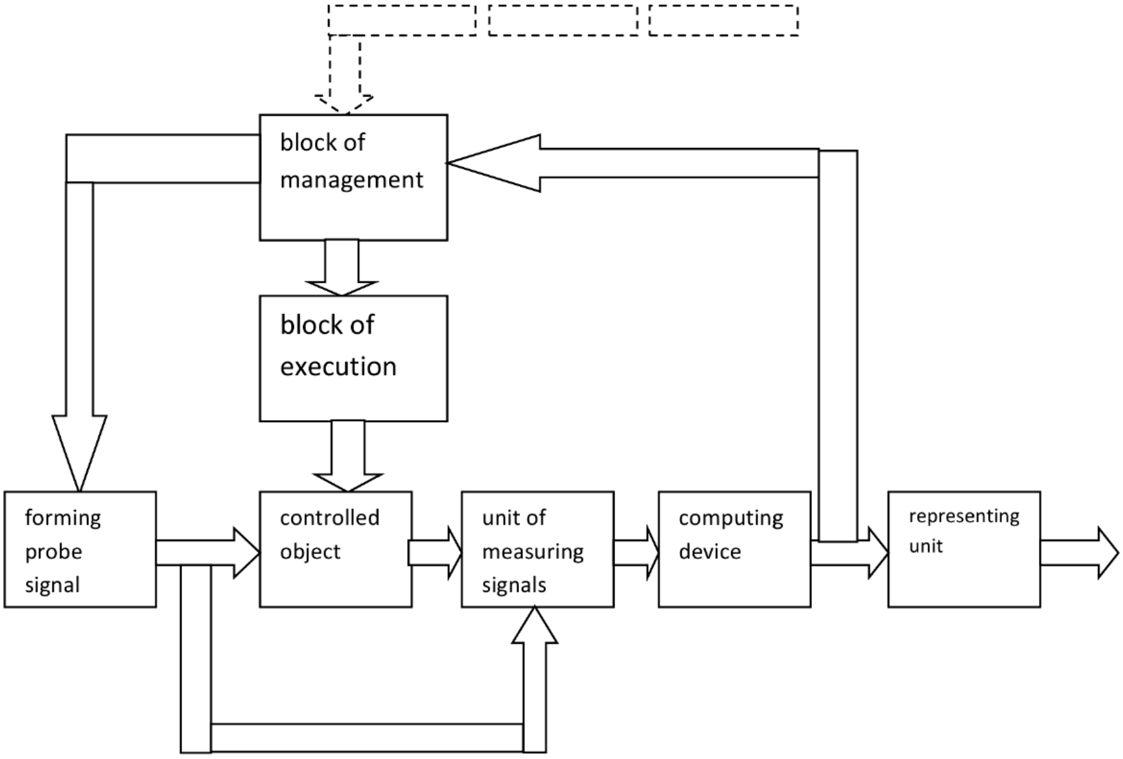


Fig. 1. Generalized structure of ACS

Just as the design of any ACS begins with a study equations that describe the job management object (a given part of the system), as a necessary step towards the construction of ACS is to obtain a mathematical model of a control object. Indeed, only by understanding the essence of the basic phenomena occurring in the facility, and having at least an approximate mathematical description of the controlled processes taking into account the mutual influence of the most essential factors, you can talk about the selection of informative parameters of object, rational task of needs to systems-

We will consider further that the object of control can be presented in the form of diagrams, present in Fig. 2. Here the $x_1, x_2, \dots, x_k$ input influences (probe signals), that determine the mode of operation of the facility and make a direct impact on the value of its output (controlled) coordinates $y_1, y_2, \dots, y_M$ .Turning to the matrix notation, it is more convenient to talk about vector input action $x = (x_1, x_2, \dots, x_k)^T$ and a vector of target coordinates of the object $y = (y_1, y_2, \dots, y_M)^T$, where the symbol t denotes the transpose operation vector-line. All of these quantities are generally a different physical nature, however it is important to emphasize the fact that constructive performance object, as a rule, allows to change all or some action $x_1, x_2, \dots, x_k$ by the appropriate law (for example, using special generators probe signals), and the original coordinates $y_1, y_2, \dots, y_M$. measure using appropriate gauges (measuring devices), largely due to the technical state of object controls and, therefore, can be used to analyze it. In Fig.2. is listed as influences ("error") $z_1, z_2, \dots, z_L$, which form a vector "error" $z = (z_1, z_2, \dots, z_L)^T$ and reflecting the impact of the environment, power supply, internal noise and other uncontrollable factors on the behavior of the object, and therefore to control outcomes.

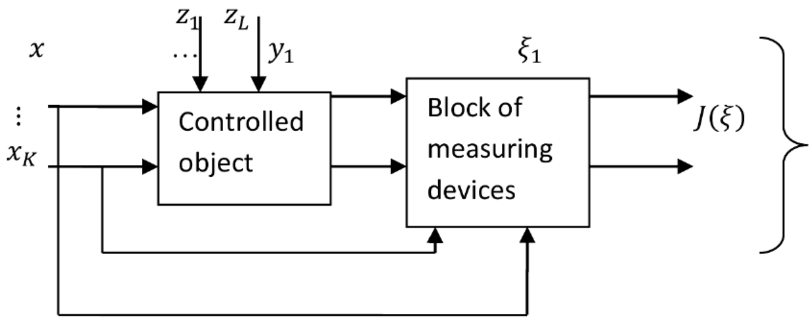


Fig. 2. The scheme of measurement of monitored parameters

The mutual relationship between the vectors x in and z, the components of which are functions of time, generally defined the operator equations

$$y(t) = A\big(x(t), z(t)\big) \tag{1}$$

This means that the operator A set of mathematical operations , in a result of certain vector function $x(t)$ and $z(t)$ is associated with some vector function $y(t)$. The most simple form A operator takes a linear object (system), since the latter can be written

$$y(t) = Ax(t) + A_z z(t), \tag{2}$$

where A and A_z- in turn, linear operators which obey the superposition principle. Examples of linear operators can bring the following ways of describing object:

a) in the time domain - using differential equations

$$\sum_{i=0}^{m} Q_i y^{(i)}(t) = \sum_{j=0}^{k} P_j x^{(j)}(t) + \sum_{h=0}^{l} V_h z^{(h)}(t); \tag{3}$$

b) using pulse transition functions

$$y(t) = \int_0^t \varphi(t-\tau)x(\tau)dt + \int_0^t \varphi_z(t-\tau)z(\tau)dt; \tag{4}$$

c) in the frequency domain - through matrix gear

$$\mathbf{Y}(s) = \Phi(s)\mathbf{X}(s) + \Phi_z(s)\mathbf{Z}(s) \tag{5}$$

d) using frequency characteristics

$$\mathbf{Y}(j\omega) = \Phi(j\omega)\mathbf{X}(j\omega) + \Phi_z(j\omega)\mathbf{Z}(j\omega). \tag{6}$$

The equations (3) ... (6), the following notations are used: Q_i,P_j and V_h - matrix of coefficients dimensions *M* × *M, M* × *K, M* × *L,* in accordance *t, k* and *l*- order derivatives for senior vectors $y(t)$, $x(t)$ and $z(t)$; $\varphi(t)$ and $\varphi_z(t)$ Pulse transition (weight) function of the object at the inputs *x* and *z;* $\mathbf{Y}(s)$, $\mathbf{X}(s)$, $\mathbf{Z}(s)$ - column vector images by Laplace output coordinate, input and revolting influences; $\Phi(s)$ and $\Phi_z(s)$ - TX Matrix object dimensions *M* × *K* and *M* × *L.* Equation (6) follows directly from (5) when substituted $s = j\omega$**.**

Note that the above descriptions herein are equivalent and can be easily obtained with each other. However, if the object of control has essentially nonlinear properties, then the use of equations (2) ... **(**6) for its mathematical description is possible only in cases when the subject is studied in the "small deviations", ie when the vector components *x,y, z* - deviations are small relative to some baseline (nominal) values.

Returning to Fig. 2, focus more on issues related to the peculiarities of the formation of the vector control parameters $\xi = (\xi_1, \xi_2, \dots, \xi_N)^T$ with a block measuring devices. The structure of the current vector includes the settings that fully cover the degree of efficiency of the object, and hence is very critical to the occurrence of certain failures (faults). These parameters can be either individual components of the vector of initial coordinates $y = (y_1, y_2, \dots, y_M)^T$ object control (ACS) and its intermediate position, describing the technical condition of the most critical elements (components and subsystems). The physical nature of monitored parameters $\xi = \xi_1, \xi_2, \dots, \xi_N$ also varies: some are meaningful levels of temperature, pressure, speed, etc. (Under the control Sula), others - levels of voltage, current, power, etc. (In fact the control electronic units ACS), others are generalized indicators of quality machinability materials (bandwidth, time control and so on.) And expressed in terms of value of output coordinates $y_1, y_2, \dots, y_M$ *and* input action $x_1, x_2, \dots, x_k$ object of control. Finally, controlled parameters can be considered as formal parameters describing a particular type of operator facility (eg ratios of its differential equations (3) or transmission matrices (4). In the latter part of the task of monitoring tasks is to identify the objects on the results of observations of vectors *x*, *y,* moreover, determination of these parameters is usually accompanied by a large volume of payments and is transmitted through a specialized computing device or CVM.

As repeatedly stressed, the object is workable if its basic characteristics meet the requirements, thus ensuring implementation of defined functions. In fact, these requirements must be considered as limiting the possible deviation of operator *AND* controlled object relative to a reference (model) operator $A_{ет}$, providing solutions object of his main tasks in settlement conditions. Geometrical conditions of performance can be interpreted as follows:

object is functional, if the current point with coordinates $(\xi_1, \xi_2, \dots, \xi_N)$ in N- dimensional space controlled parameters belongs to the domain of acceptable values (tolerance area) D:

$$\xi \epsilon D. \tag{7}$$

Failure to comply with condition (7) means disability object, ie its refusal.

Most simply limits of the permissible area D are determined when the controlled parameters $\xi_1, \xi_2, \dots, \xi_N$ object assumed independent. This area is hyper form with sides parallel to the coordinate axes and is defined by a set of inequalities

$$a_i \le \xi_i \le b_i, (i=1, 2, \dots, N), \tag{8}$$

and the control capacity of the facility is to write one comparison of the monitored parameters ξ_i with their limited values a_i , b_i . If monitored parameters $\xi_1, \xi_2, \dots, \xi_N$is statistically dependent (which is more or less true for all real objects), the form of admissible domain D can significantly be complicated. For a more precise description of this area it is necessary to have information about the law of distribution $\xi_1, \xi_2, \dots, \xi_N$ as a random function, and also about their mutual impact on the effectiveness of the functioning of the facility. This and other related issues are discussed in detail in the next section from the standpoint of the general theory of statistical classification. In practice, the permissible construction area D is often carried out on the results of mathematical modeling or a series of field tests controlled object.

Seems interesting the use for the control of so-called "generalized" parameter J which is introduced as a function of monitored parameters $\xi_1, \xi_2, \dots, \xi_N$ andGenerally speaking, may not have a specific physical meaning. The main requirement for the choice of the generalized parameter: it should simply be calculated, and its value must, if it is possible, accurately represent the actual stock performance of object [9]. As an example, the following expression will be represented

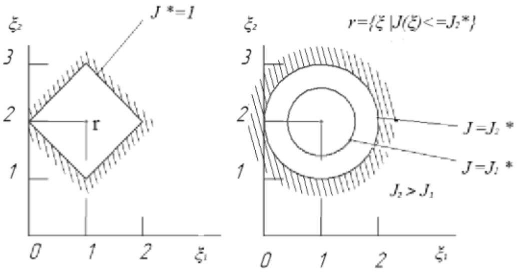
$$\mathrm{J} = \sum_{i=1}^{N} c_i |\xi_i - \xi_i^{\mathrm{norm}}| \tag{9}$$

where $\xi_i^{\text{норм}}$ - the nominal values of controlled parameters; c_i- weight (dimensional) factors that take into account the contribution of each parameter ξ_i the formation of a generalized parameter J. If the permissible area defined by

$$\mathrm{J} = \mathrm{J}\ *, \tag{10}$$

where J * - set (threshold) value of a generalized option *J*, It takes the form *N*- hyper dimensional space options $\xi_1, \xi_2, \dots, \xi_N$, Whose facets are not parallel axes. Thus, inequality (10) in $c_1 = c_2 = 1$, $\xi_1^{\text{норм}}$= 1, $\xi_2^{\text{норм}}$= *2, J* *= 1 sets the region shown in Fig .3, a. Another example - the expression

$$\mathrm{J} = \sum_{i=1}^{N} c_i (\xi_i - \xi_i^{\mathrm{norm}})^2 \tag{11}$$



a b

defines the so-called "elliptical" model of object performance indicator (if $c_1 = c_2 = = ...c_N$ This model becomes the "center"). Hypersurface of equaling levels corresponding values $J(\xi)=J^*$ representing hiperelipsoyidy placed in each other. If we take in (11) $c_1 = c_2 = 1$, $\xi_1^{norm} = 1$, $\xi_2^{norm} = 2$, then get a set of concentric circles (Fig. 2.4 b), one of which is below the tolerance area T on the plane (ξ_1, ξ_2). Thus, the control object on set parameters $\xi_1, \xi_2, \dots, \xi_N$ can be replaced the test execution is only of one condition (10). Moreover, watching the changing of the generalized parameter $J(t)$ In time for its size can predict the state of the controlled object at a future time, which is also one of the advantages of this approach.

Mathematical models of control objects discussed above are defined with continuous analytical dependencies between source (*in, ξ*) and incoming (*x, z)* variable and, therefore, often called analytical. In addition to this type of models, there are logical models in which vector components *x, y, z* can take only one of two integer values (0 or 1). The value of "1" indicates that the corresponding continuous variable (input or output object) is in the area of permissible values, and "0" - indicates that this variable has moved beyond the area. Relations between integer variables that create a logical model, expressed in terms of Boolean functions and is governed by the laws of the algebra of logic. Logical models used in solving problems of diagnostic control when focused on the qualitative analysis of the interaction of individual units that make up the object to identify the locations and causes of failure.

When making ACS for managing digital objects (we will primarily relate to these objects specialized digital controllers and control systems based on an onboard digital computer) must be borne in mind another characteristic circumstance. The information to be processed by means of these devices may be distorted as a result of certain hardware failures, and due to short-term disruptions caused by the influence of internal or external interference. At a sufficiently high level of reliability of equipment controlled intensity failures can significantly exceed a failure rate [2,3,5]. Thus, the ACS should provide not only the definition of the technical condition of the object, but also control of fidelity provided of this information, and in the presence of failures - the possibility of the elimination of their consequences. Identify the impact of failures can also be carried out in the framework of the tolerance control, i.e. with regard to the control of the relationship type (7), however, the correction of distortion in your information requires the use of special measures, based on software or temporal redundancy.

Research of mathematical model of the controlled object allows you to specify the most significant properties and characteristics of the ACS, reasonably set requirements for these characteristics, specify those quantitative indicators, which can be taken as a basis in the design stage of the ACS and used to assess the effectiveness of its operation. List further the main features of the ACS, accompanying them with the necessary short explanations.

1. The completeness (depth) of the control - shows which part of the equipment is seized by a control.

As an indicator of the completeness of control can be used, for example, the ratio of the number of monitored parameters *N* the total number of options N_0, that uniquely define the technical state of the object

$$F = \frac{N}{N_0} \tag{12}$$

or, similarly, the ratio of the probability of failure Q those elements whose state is manifested through ASA, the total probability of failure Q_0 of the control object

$$F = \frac{Q}{Q_0} = \frac{1-e^{-\lambda t}}{1-e^{-\lambda_0 t}} \approx \frac{\lambda}{\lambda_0} \tag{13}$$

where λ and λ_0 - accordingly, the failure rate of the controlled object and as a whole [4]. Obviously, completeness of control depends on technical capabilities that are arranged, ACS (the availability of sensors, a memory, and speed of computing device and etc.), and specific character of the object (the higher the price of failure is, the more amount of elements should be covered by the control).

2. *Accuracy* control is one of the main characteristics of ACS, reflecting the degree of confidence in the results obtained in the control. In other words, the accuracy of the control indicates that the degree is being accepted using the ACS solutions correspond to the actual state of the object of control.

On the reliability of the controls, various factors have the influence, including completeness of control, precision measurement of monitored parameters, especially the use of one or another method of control, reliability, and stability of the ACS and its individual units. Taking into account these factors, at any point in time, only one of the following 4 events may take place (S_1 ... S_4):

S_1 -the object is able-bodied and the ACS gives the positive signal, namely "fit";

S_2- the object is incapacitated, that is in a state of denial and ASA gives the signal "rejection";
S_3-the object is able-bodied, but the ASA gives the signal "rejection";
S_4 - the object is disabled, but the ASA gives the signal "fit."
Apparently, events S_1 and S_2 correspond to right, but events S_3 and S_4 - erroneous decision taken on the results of monitoring. It is usually assumed that the event S_3 ("False rejection") leads to the appearance of errors of 1st race, and event S_4 ("Undetected refusal") accompanied by mistake of 2nd race. Reliability control *D* can be defined as the probability of adopting a correct decision

$$\mathrm{D} = \mathrm{P}\ \{S_1\} \quad \mathrm{P}\ \{S_2 = 1\} - \mathrm{P}\ \{S_3\}\{S_4\} \tag{14}$$

where $R\{S_1\}$ - the probability of an event S_i. In order to calculate the reliability index *D*the initial data distribution of law controlled parameters must be owned at its disposal, error measurement devices, and controlled safety equipment.

Let α_i- conditional probability that managing records a violation of one of the relations (8), although in reality the object is functional and controlled setting ξ_i satisfies this ratio; that is a false denial on this parameter. Then, counting the inspection results for each parameter ξ_i; independent, you can find the probability of error of the 1st kind

$$\alpha = \mathrm{P}\{S_3\} = 1 - \prod_{i=1}^{N}(1-\alpha_i). \tag{15}$$

Similarly calculated probability of error of the 2nd kind

$$\beta = \mathrm{P}\{S_4\} = 1 - \prod_{i=1}^{N}(1-\beta_i). \tag{16}$$

Here β_i - a conditional probability that managing records relevant performance conditions (8) for the controlled parameter when in fact this condition is not observed (ie there are undetected failures). Formulas (15) and (16) are valid only when the control object covered all parameters that determine its technical condition. Reducing the completeness of control results in additional value growth α and β (And, thus, the reliability of control *D* decreases) as the ratio (8),thus, can not accurately reproduce the actual area performance G. decision of some problems associated with the formation requirements for ASA and its individual units, based on the reliability of a given control is discussed, for example, in [14].

3. ACS important characteristic that makes a significant impact on the reliability of test results is its reliability. From a quantitative point of view, a reliability of ACS conveniently assesses the following indicators:
mean time between failures (MTBF) T_0;
probability of failure of *R*(*t*) (Or probability of failure Q (*t*) Within a specified time *t*;
average recovery time $T_в$ (For renewable ACS);
availability factor $k_г = \frac{T_0}{T_0 - T_в}$.

Technically acceptable and deemed appropriate use of ASA, which probability of failure of the control equipment at least an order of magnitude is less than the actual probability of failure of the controlled object. This demand, in turn, requires rather severe restrictions on the level of complexity and weight and size parameters of the controlled devices. A Reduction of the effects of possible failures of ASA can be achieved by introducing additional means of control, providing performance check of the basic units of ACS with a slight increase in the total volume of the equipment or time control.

4. *Efficient* workability is a measure of the usefulness of control. In general, the effectiveness of control depends on the reliability and performance of ACS, costs of developing, manufacturing and operation, the purpose of the object of control.

For non-renewable ACS as an indicator of efficiency *E (t)* usually take the chance of the task

$$\mathrm{E}\ (\mathrm{t}) = E_0\ (\mathrm{T}) \cdot \mathrm{P}\ (\mathrm{t}), \tag{17}$$

where E_0 *(T)* - ideal probability assignment of the task in terms of reliability ACS, which does not require maintenance; *P (t)* - probability of failure of the control system. If during the operation of the ACS allowed individual breaks associated with the replacement or repair of items that failed, then the expression (2.17) for efficiency *E (t)* to include another factor is--coefficient of readiness $k_г$ that reflects the readiness of the ACS to the solution of the underlying problem. With this definition of efficiency, the main attention is paid to achieving a given end result using the ASC in terms of many (largely undefined) factors. However, this measure does not give the technical-economic evaluation of one or another variant of construction of the ACS, as totally ignores nested costs for the creation and operation of control systems.

From this lack of freely formulated a different definition, according to which the efficiency of control refers to the relative magnitude of the costs

$$E = 1 - \frac{C}{C_{los}} \tag{18}$$

where C -additional charges for creating a system of control, including the costs of control and possible wrong decisions made using the ACS; C_{los} the cost of losses to the wrong decisions in the absence of control. The amount C_{los} takes into account the inevitable loss (cost), which is related to the exploitation of the object of control, refused, or, on the contrary, unduly removal facility operating at its capacity. Thus, the effectiveness of the ACS higher than more material effect is achieved from its application, i.e. the more fully reveals the real opportunities of the controlled object.

5. *Performance* of the ACS is determined by the average time T_{contr} necessary to perform the operations control facility. This figure can be represented as a sum of terms that characterize the individual stages of control: connection object generator of probe signals, measurement of vector controlled parameters ξ, comparison of monitored parameters with the boundaries of tolerance fields, making decisions about the efficiency of the facility, the replacement of items that failed on the back, etc.

Depending on the nature of tasks, these terms can have different values and make different contributions to the overall assessment of the performance of ACS. So, while the dynamic control of most of the time occupied by the operation associated with the definition of generalized indices of quality of the ACS or any parameters of its mathematical models for the effects of long-term observations of vectors output coordinates *y (t)* and the incoming action *x (t)*−(see fig.3 and equation (3) and (6). Solution of problems finding the defect and predicted control of ACS and its elements are accompanied by a sharp increase in the volume of calculations and, consequently, makes increased demands on the performance of ACS and its individual components. Often these requirements are implemented by creating AUTOMATED SYSTEMS based on CVM, possessing, in addition to the high speed of information processing, and also along other flagged before advantages.

Conclusion. Content analysis of possible tasks workability evaluation and review of existing methods for constructing ACK indicates that these problems must be addressed and solved using various methods of automatic control. The basis of these methods is usually the same principle of tolerance control, whereby the control object is recognized workable if its essential parameters (characteristics) satisfy the relation of type control (7), which defines the limits of tolerance region (tolerance field). However, each of the workability evaluation methods has its own individual characteristics that reflect the specifics of a particular object, especially getting it monitored parameters and limits of tolerance region, the uniqueness of the decision-making algorithms, the possibility of technical implementation of regulatory assets.

Information sources

1. Solomentsev Y.M., Mitrofanov V. H., Protopopov S.P., & Rybkin I.M. (1980). *Adaptivnoe upravlenie technologicheskymy processamy* [*Adaptive management process*]- M .: "Engineering", p. 536. [in Russian].

2. Yampolsky L.S., Taranenko V.A., & Evdokimov V.D. (1975*). Sredstva I metody avtomaticheskogo upravleniya regimamy obrabotky metalov rezaniya* [*Means and methods of automatic control mode of metal cutting*] - Kyiv, UkrNINTI, p.60. [in Russian].

3. Ganin N.M., Katkovnik V.Y., & Polishchuk M.N. (1991). *Matematicheskie modeli avtomatizirovanyh proizvodstvenyh system* [*Mathematical models of automated production systems*] - Leningrad, p. 76. [in Russian].

4. Utkin E.F. *[The influence of heterogeneity of structure of alloys machining]* http://www.ostu.ru/conf/tech2002/ sect2 / utkin.html.

5. Republican Interdepartmental Scientific and Technical Collection (1987). *Adaptivnie systemy avtomaticheskogo upravleniya [Adaptive automatic control system]* - Kyiv "Technology", p. 23-27 .

6. Panov A.A., Anikin V.V., & others. (1988*) [Metal cutting: A Handbook technologist]*- M .: "Engineering", p.680. [in Russian].

7. Dashchenko A. I. (1991). *Avtomatizatsiya procesov mashinostroyeniya [Automation of engineering]*- M .: "High School" p.471. [in Russian].

8. Kotyuk A.F., & Tsvetkov E.I., (1970*). Spectralniy koreliyatseoniy analyz nestatsionarnyh slychainyh procesov [Spectral and correlation analysis of non-stationary random processes]* - M .: *[Publishing Committee, Standards of Weights and instrumentation]*, p.100. [in Russian].

9. Ostafievo V.A., Tymchyk G.S., & Shevchenko V.V. (1983).*Adaptivnaya systema upravleniya [Adaptive management. - Mechanization and automation management]* - Kyiv, №1,. - p. 29-32. [in Russian].
10. Zayets S. S., (2012). The system of forecasting of processes of machining / S. Zayets S.S, Maksymchuk I.V., & Pedko K.O. Scientific Herald KUEITU. [in Ukranian].

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ВИЗНАЧЕННЯ ОБРОБЛЮВАНОСТІ МАТЕРІАЛІВ В ТЕХНОЛОГІЧНІЙ СИСТЕМІ

В більшості випадків створення діагностичних систем вимагає витрати значних коштів на придбання коштовного обладнання і програмного забезпечення для опрацювання отриманих результатів діагностики, що не унеможливлює широке поширення даних систем на більшості приладобудівних виробництв нашої країни. Запропонований метод діагностування процесу обробки на багатоцільовому верстаті дозволяє підвищити ефективність систем автоматичного збору та аналізу інформації для вирішення задач визначення технічного стану механообробних систем в ГВС у процесі обробки деталей, а також своєчасне виявлення та локалізація похибок обробки для забезпечення підвищення надійності та ефективності процесу механічної обробки. Наведені вище переваги дозволяють зменшити витрати, так як для реалізації даної методики нема необхідності використовувати складне коштовне обладнання, процес навчання обслуговуючого персоналу займає мало часу, зменшується кількість забракованих деталей, а також кількість передчасно зламаного інструменту чи непрацюючого обладнання. Враховуючи всі переваги даного методу діагностування процесу механічної обробки деталей на багатоцільових верстатах в складі гнучких виробничих ліній зменшується собівартість деталей при підвищенні показників точності виготовлення деталей.

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ОПРЕДЕЛЕНИЕ ОБРАБАТЫВАЕМОСТИ МАТЕРИАЛОВ В ТЕХНОЛОГИЧЕСКИХ СИСТЕМАХ

В большинстве случаев создание диагностических систем требует затраты значительных средств на приобретение дорогостоящего оборудования и программного обеспечения для обработки полученных результатов диагностики, не исключает широкое распространение данных систем на большинстве приборостроительных производств нашей страны. Предложенный метод диагностирования процесса обработки на многоцелевом станке позволяет повысить эффективность систем автоматического сбора и анализа информации для решения задач определения технического состояния механообрабатывающих систем в ГИС в процессе обработки деталей, а также своевременное выявление и локализация ошибок обработки для обеспечения повышения надежности и эффективности процесса механической обработки. Приведенные выше преимущества позволяют уменьшить расходы, так как для реализации данной методики отпадает необходимость использовать сложное дорогостоящее оборудование, процесс обучения обслуживающего персонала занимает мало времени, уменьшается количество забракованных деталей, а также количество преждевременно сломанного инструмента или неработающего оборудования. Учитывая все преимущества данного метода диагностирования процесса механической обработки деталей на многоцелевых станках в составе гибких производственных линий уменьшается себестоимость деталей при повышении показателей точности изготовления деталей.