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ABOUT A PROBLEM OF PLANING OF EXPERIMENTS IN SPECIFIC AREAS FACTOR SPACE AT IDENTIFICATION OF ENERGY-SAVING TECHNOLOGIES PARAMETERS

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Summary. Description technology is considered as object parametric and structured identification. It is offered consider the models such object as models with variable structure. For the reason adapting the models not specially organized experiments are planned in non-standard area of factor space, the topological mapping factor-space of the image on factor-space of the original is entered. Information-system models are introduced for description of processes of the creation technological complex.

Key words: adaptation, information-system model, non-standard area of factor space, optimization problem, optimum of energy content, parametric identification, resource-intensive, structural identification, technological complex.

INTRODUCTION

One of urgent questions is their optimum of energy content and resource-intensive at designing a various sorts of technological systems (processes). The optimization on power inputs, charge of resources etc., associated with parameters of criterion efficiency of system functioning in a spectrum of possible similar technological systems. That circumstance results to certain sorts of compromises between efficiency and optimality, the problem of which sanction is solved on design stages and has a rather specific nature.

DESCRIPTION OF TECHNOLOGY AS AN OBJECT OF PARAMETRICAL AND STRUCTURAL IDENTIFICATION

In above sense the process of technology and appropriate technical complex development can be considered as a process of identification (structural and parametrical) certain object (in particular, object of control) in space of situations.

It is obvious, that condition of object Y is determined by a condition of external environment X. Then the object is represented as the converter F of a condition of environment in a condition of object: $Y = F(X)$, where F is an operator of connection of input X and output Y describing specificity of its operations. External environment is understood as a finite or countable set of its parameters: $S = (S_1,..., S_l)$. Concerning of projection problems, the perceived situation is controlled, that is $S(U) = (S_1(U),..., S_l(U))$, where U is a control. The value of specified parameters forms a situation space. The natural drift of situations caused by evolution of environment results in displacement of points along some trajectory (see fig. 1.).

The criterion concepts are formulated as a vector: $Z^* = \left(Z_1^*, ..., Z_k^*\right)$, where Z_i^* is a requirement i to a state S, with a help of function $\psi_i\left(S\right)$. Here: $Z_i = \psi_i\left(S\right)(i = 1,...,k)$, the functions ψ_i define connection of a state S and criterion parameter Z_i. The purposes-requirements have a various character, and its form is unified and corresponds to one of the kind:

1. $Z_i^* = \xi_i$ (fixed values),
2. $Z_i^* \geq \eta_i$ (there is less some threshold value),
3. $Z_i^* \to \text{extr}$ (accepts extreme value in sense maximum or minimum).

The majority of situation is reduced to such requirements, especially in scientific and technical sphere.

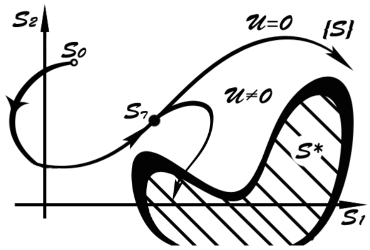

Fig. 1. The situation space

Point of area:

$$S^* = \begin{cases} \psi_i(S) = \xi_i, (i = 1,...,s) \\ \psi_j(s) \geq \eta_j, (j = s+1,...,s+p) \\ \psi_m(s) \to \text{extr}, (m = s+p+1,...,s+p+l) \end{cases},$$

(where: $s + p + l = k$) is a state of environment. Accessibility of such state of environment depends on a type of relation $S = S(U)$, and also from resources R: $U \in R$, which determine power, material, temporary and other opportunities.

Thus it is necessary to take into account possible drift of a situation, which assumes control such that $S(U,t) \in S^*$ (see fig. 1.).

Hence, the control U is necessary that: to achieve a defined value Z^* of objective function, and to compensate drift also, subject to parameters of environment S. Parameters of environment are meant measurable parameters actually as environment X and parameters of object Y, interacting with environment. Then: $S = \left\langle X, Y \right\rangle$.

In most cases, connections of technological complexes with environment are rather strong and are various. That results in necessary of the solving of an object identification problem, where for the given set of criteria $\left\{Z^*\right\}$ and resources R such variant of object, which will appear as most effective on criterion accessibility, is defined.

Generally, structure of a technology, as an object, is understood a character of relationship F of state Y from its entrances – uncontrolled X and controlled U :

$$Y = F\left(X, U\right), \tag{1}$$

where: F is defined by some algorithm, which specifies, how, under information about inputs: X and U , to define an output Y . In ratio (1) it is conditionally considered, that the model: F consists of structure and parameters: $F = \left\langle St, \mathbf{b} \right\rangle$, where St is a structure of model: F , $\mathbf{b} = (\beta_1, ..., \beta_k) -$ its parameters.

The structural analysis of a model means: defining of an object inputs and outputs, expert ranking of object inputs and outputs, decompositions of the model, and choice of structural elements of model also.

The parametrical synthesis of a model is connected with defining of a parameters $\mathbf{b} = (\beta_1, ..., \beta_k)$ of model $Y = F\left(X, U, \mathbf{b}\right)$, where the chosen structure St is reflected in operator F (on the basis of such categories as linearity, continuity, static character, determinacy, etc.).

The information on behavior of inputs $X(t), U(t)$ and output $Y(t)$ of object is necessary for the defining of the parameters $\mathbf{b}$. Depending on ways of reception of this information, distinguish: identification and experiments planning.

THE METHODS OF ESTIMATING OF PARAMETERS OF MODELS WITH VARIABLE STRUCTURE

The basic source of the information at identification, as a process of an estimation of numerical parameters value in a mode of normal functioning of object (without organization of special perturbations) is pair: $J(t) = \left\langle X(t), Y(t) \right\rangle$. It is obvious, that during normal functioning not all inputs of object (X and U) change. In particular, those parameters from U do not vary, which the state of environment does not influence. For finding-out relationship of an object output Y from such parameters it is necessary purposely them to vary, that is the experiment with object is necessary, that automatically breaks a mode of normal functioning and not always it is desirable. In this case experiment will be carried out with minimal perturbations of object and opportunity of reception of the maximal information about influence of varied output parameters of object.

Thus, the extreme limitations of opportunities of purposeful updating of the experimental data take place, on the basis of which the mathematical model should be identified. In turn small volumes of initial statistics result in use of rather primitive modeling designs. An urgent problem, in this plan is the presence of such receptions of processing of the limited arrays of the numerical data, which would allow overcoming simplicity of constructions following from traditionally used methods.

As an initial assumption we shall accept an opportunity of representation of simulated process as function connecting value of output (a result attribute) Y to quantity X . Let's consider dynamic processes, that is such processes, where the value of all variables are submitted by time series, and the functional relationship $F_t(\cdot)$ generally changes in time and is set by some vector of structural parameters. Assuming differentiability $F_t(\cdot)$ at each moment on all parameters, we shall write down for first partial derivative at the moment t:

$$\frac{dY}{dt} = \sum_{i=1}^{n}\left(\left(\frac{\partial F_t}{\partial X_i}\right)\left(\frac{dX_i}{dt}\right)\right) + \frac{\partial F_t}{\partial t}.$$

Because $\frac{\partial F_t}{\partial X_i}$ does not depend from $\frac{dX_i}{dt}$, this ratio can be treated as linear model with varying structural coefficients.

The accuracy of the initial data, as a rule, is those, that frequently only identification of first partial derivatives of model looks enough correct procedure. Defining of first partial derivatives values is most important in applied aspect also. Therefore, with the complete basis it is possible to assert, that, having developed procedure of construction of dynamic estimations of model, it is possible basically to solve the problem identification (in sufficient for practical use a kind) quantitative characteristics of connections between separate elements of simulated object.

The traditional methods of modeling are based on representation of investigated process as linear model with constant coefficients:

$$Y = X\mathbf{b} + U,$$

$$X = \begin{pmatrix} x_{11} & \dots & x_{1n} \\ \dots & \dots & \dots \\ x_{T1} & \dots & x_{Tn} \end{pmatrix}, \quad Y = \begin{pmatrix} y_1 \\ \vdots \\ y_T \end{pmatrix}, \quad \mathbf{b} = \begin{pmatrix} \beta_1 \\ \vdots \\ \beta_n \end{pmatrix}, \qquad (2)$$

where: Y is a vector of factor-function value (output); X is a observation matrix (factor-arguments or inputs); $\mathbf{b}$ is a vector of structural parameters; U is a vector of random deviations, for which under the assumption $\mathbf{M}[U] = 0$ and $\mathbf{M}[UU^{\mathrm{T}}] = \sigma^2\mathbf{I}$ (here $\mathbf{I}$ is unit identity matrix of the appropriate order); T is a quantity of observations.

It would be uncorrected to consider the coefficients of model (2) for dynamic processes constant during all investigated period, that requires adaptation from the point of view dynamization of vector of structural parameters $\mathbf{b}$. That is the model accepts a kind:

$$Y_t = X_t \mathbf{b}_t + U_t \ , \tag{3}$$

Such problem can be solved in serial ways. For example, it can be solved by representation of parameters of model in an obvious kind as function of time or use of model with switching of parameters (special case of this reception – use of special classes of functions, spline-functions etc.).

One more direction of development of statistical models resulting in statement a problem (3), is a representation of required parameters as a stochastic quantities, submitting certain low of variation with time. Here generalizations of models of the given type demands use of ideas of the Kalman's filter [1].

Other well known method – consequent shifting bases estimation and discovery on this base "driftage" factor. Herewith possibility of the building estimation is expected on separate interval inwardly main sample.

The estimations of parameters (2), received by standard methods reflected influence of some factors-arguments of model on factor-function on the average on all set of the initial data. However, if, for example, there is a problem extrapolating of factor-function value, then its accuracy can be raised, when the components of a vector will more correspond to character of information variables on a finite piece of an estimating interval. Hence, attributing the observation results concerning the more and more remote period decreasing weights, it is possible to define a vector of parameters reflecting connections at the end of the initial period. In more general case, as a result of giving to some groups of observation results of a various sequence of weights we shall receive approximation of a vector of parameters to the greatest degree appropriate to group of observations results with maximal weight.

Let's consider a sequence of weighing matrixes, each of which is corresponds to set of weights, allocating from an initial array of observation results one moment of time, which is

$$\mathbf{G}_t = \begin{pmatrix} g_{1t} & & 0 \\ & \ddots & \\ 0 & & g_{Tt} \end{pmatrix}, \quad \begin{matrix} g_{it} < g_{i+1t}, & i < t, \\ g_{it} > g_{i+1t}, & i > t. \end{matrix}$$

Vector of structural parameters: $\beta_t = \left(X^{\mathrm{T}} \mathbf{G}_t X\right)^{-1} X^{\mathrm{T}} \mathbf{G}_t Y$ is an approximation of the coefficients of model.

The set of coefficients $\mathbf{b}_t$ is determined by low of distribution of weights for each of moment t. From practical reasons, it is obvious, that here it is meaningful to consider one- or two-parametrical distributions.

For the moments enough removed from current t, weights $g_{it} \approx 0$. Believing, that for an estimation of vector $\mathbf{b}_t$ are most essential τ results of observation, we have a weight matrix of kind:

$$\mathbf{G}_t = \begin{pmatrix} 0 & & & & & & & & & 0 \\ & \ddots & & & & & & & & \\ & & 0 & & & & & & & \\ & & & g_{1t} & & & & & & \\ & & & & \ddots & & & & & \\ & & & & & 1 & & & & \\ & & & & & & \ddots & & & \\ & & & & & & & g_{\tau t} & & \\ & & & & & & & & 0 & \\ & & & & & & & & & \ddots \\ 0 & & & & & & & & & 0 \end{pmatrix}, \qquad (4)$$

Thus, we have a generalization of a method of “sliding periods”.

Let’s assume also, that inside each of intervals length τ the distribution of weights is formed as a geometrical progression:

$$\begin{aligned} g_{it} &= g^{((\tau-1)/2)-i},\ i < t, \\ g_{tt} &= 1; \\ g_{it} &= g^{i-((\tau-1)/2)},\ i > t, \end{aligned} \qquad (5)$$

where: g is a denominator of this geometrical progression.

Approximation of the coefficients of the model and ratio (4) – (5) theoretically allow at given g, τ to construct a sequence of vectors $\mathbf{b}_t$, being estimations of structural coefficients of model at each current moment of time. It is important to note, that the demand for more or less exact approximation of dynamics of the coefficients results to a choice of small values of τ, that has an effect for conditionality of matrix $\left(X^{\mathrm{T}}\mathbf{G}_t X\right)$.

There is developed and rather widely used the regularization method (A.N. Tikhonov’s method [2]) for the solution of ill-posed problem. With reference to a problem of estimation of regression model, the special case is known, which a method of “crest” regression is.

However, the difficulties of application of a regularization method in practice of estimation of models are connected with absence f the concrete recommendations about a way of a choice of parameters of a method, result that is, in particular, not uniqueness of a "crest" estimation.

Structurally idea o a regularization method within the framework of adaptive model can be realized as follows. Let's assume, that model (2) allows adequately to estimate the average values of structural parameters, and that for each current moment t the ratio

$$\mathbf{b}^0 = \mathbf{b}_t + U_t, \tag{6}$$

is fair, where $\mathbf{b}^0 = \left(X^{\mathrm{T}} X\right)^{-1} X^{\mathrm{T}} Y, \quad \mathbf{M}[U_t] = 0, \quad \mathbf{M}\left[U_t U_t^{\mathbf{T}}\right] = \Psi$.

Then the problem of estimation of adaptive model will accept a kind:

$$\begin{aligned} Y &= X\mathbf{b}_t + \delta_t \\ \mathbf{b}^0 &= \mathbf{b}_t + U_t \end{aligned}, \tag{7}$$

with estimation of vector:

$$\mathbf{b}_t = \left(X^{\mathrm{T}} \mathbf{G}_t X + \sigma_t^2 \Psi^{-1}\right)^{-1} \left(X^{\mathrm{T}} \mathbf{G}_t Y + \sigma_t^2 \Psi^{-1} \mathbf{b}^{\mathbf{0}}\right). \tag{8}$$

It is necessary to note, that (8) and estimation on a method of "crest" regression can be represented as a particular cases of more general method of mixed estimation [3].

According to a classical rules, as an estimation σ_t^2 use

$$s_t^2 = \frac{1}{\tau - m} \left(Y - X\mathbf{b}_t\right)^{\mathrm{T}} \mathbf{G}_t \left(Y - X\mathbf{b}_t\right). \tag{9}$$

In (9) choices of small τ will have by an inevitable consequence essential fluctuation of estimations of residual dispersion for various time intervals. Therefore more correct represent the assumption about uniformly precise of the models, estimated on each steps of processing of adaptive algorithm. Processing from this, let's assume, that residual dispersion σ_t^2 is identical to all t. Further follows, that for all t the rest of model (8) submit to distribution, where $\mathbf{M}[\delta_t] = 0, \ \mathbf{M}\left[\delta_t \delta_t^{\mathrm{T}}\right] = s^2 \mathbf{G}_t$. From here the dispersion of model $s_{\mathbf{b}}^2 = s^2$ and $\dfrac{\sigma_t^2}{s_\beta^2} = \dfrac{\sigma^2}{s^2} = \sum_{i=1}^{n} g_i$.

At the mode assumptions the estimation of multiple regress with variable parameters can be represented as an iterative procedure (at given g and τ):

1. we believe $s_{\mathbf{b}}^2(0)=0$ and we find initial estimations of vectors $\mathbf{b}_t(1)$,
2. the received estimations of structural parameters give a new estimation for $s_{\mathbf{b}}^2$, equals to $s_{\mathbf{b}}^2(1)$,
3. the procedure of estimation repeats with a new value $s_{\mathbf{b}}^2(1)$, and so up to convergence of a process.

The problem of estimation in the form (8) derivates a problem of a choice best g and τ. The choice of those magnitudes is to some extent limited: it is not meaningful to take such size of “sliding period”, for which weights supplied one of extreme observation, becomes negligibly small. Magnitude of g is determined by number of parameters, estimated on everyone steps (by dimension of a vector $\mathbf{b}$).

The variation of coefficients of model near their average value is determined both parameter of weighing and size of a sliding period. In this connection, the degree of spread of model coefficients values is expedient to expect (at fixed τ) in relation to coefficients $\mathbf{b}_t^0$, which are received with the help of model under condition of $g=1$.

Thus, the criterion of choice g can be written down as optimization problem:

$$\frac{1}{s^2}\sum_{t=1}^{T}\left(y_t - x_t\mathbf{b}_t\right)^2 + \sum_{t=1}^{T}\left(\mathbf{b}_t - \mathbf{b}_t^0\right)\Psi^{-1}\left(\mathbf{b}_t - \mathbf{b}_t^0\right) \rightarrow \min,$$

$$s^2 = \frac{1}{T-m}\left(Y - X\mathbf{b}\right)^{\mathrm{T}}\left(Y - X\mathbf{b}\right),$$

(similarly generalized least square method).

The strict approaches of estimation of regression model in conditions of presence of crude errors in the initial data are based on application of noise-eliminating methods [4]. As against a traditional one step by step least square method, the noise-eliminated method results in the estimation formula: $\mathbf{b} = \left(X^{\mathrm{T}}\mathbf{W}X\right)^{-1}X\mathbf{W}Y$, where: $\mathbf{W} = \begin{pmatrix} w_1 & & 0 \\ & \ddots & \\ 0 & & w_T \end{pmatrix}$, with the weights $w_t = \dfrac{\Phi\left(\frac{y_t - x_t\mathbf{b}}{s}\right)}{\frac{y_t - x_t\mathbf{b}}{s}}$; s is an average measure of scatter of the residual for a given regression model.

The kind of function $\Phi(\cdot)$ determines a variant of noise-eliminated method.

Received as a result of application of an adaptive method dynamic series of first partial derivatives allow not only to estimate a measure of reaction of factor-function under a variation of factor-arguments of model, but also provide conditions for specifications for specification of an initial kind of relation $Y = F(X_1,..., X_n)$; the various preliminary hypotheses about a type of functions $Y = F(X_1,..., X_n)$ can be checked up proceeding from the analysis of dynamics of the appreciated values of its differential characteristics. A choice of a kind of “basic” mathematical model, which coefficients are exposed to adaptation, is essential. Nevertheless, as shows experience of accounts, at operation by various variants of differential relationships the specified uncertainty is insignificant: the speech usually goes about a choice of the suitable equation from two-three variants, which is always feasible.

PLANING AN EXPERIMENTS IN THE SPECIFIC AREAS OF FACTOR SPACES

Multifactor statistical model are used mainly at creation and perfection of various complex system. They are especially necessary, when opportunities of designing, manufactures and operation, which based on traditional physical principles, result to inexpedient large expenses.

Here, at reception of models, it is necessary to use methodology of the theory of planning of experiments [5, 6]. The known traditional methods of experiment planning assume the forms of factor spaces as a multidimensional simplex. In non-standard areas of factor space the search of the best conditions of reception of models in a general view is unknown; except for the already marked regularization method. Usually such problems are reduced to numerical methods.

To the reasons of occurrence of non-standard areas of factor space can be related situations, when: the parameters of technical and technological objects are connected by relationship close to linear [7]; processing of experiment provided that the level of the factors can not be precisely enough sustained on a matrix of the experiment plane, and also at processing results passive (specially not organized) experiment.

In such area the correlation a factor and, consequently, their main effect and interaction at building of the models take place. Multicollinearity of effects (its mutual conjugacy) complicates or makes impossible steady defining of structure and coefficients of the regress equation, substantial interpretation of causal and structural connections between effect and simulated response. At significant multicollinearity of effects the problem is ill-posed.

In [4] it is underlined necessary of steady methods and algorithms, having transparent mathematical properties in sense of optimality. Feature of a rather widely used least-square method is its instability if not to make of any additional assumptions, which are difficulty checked [2]. Thus, at the solution of applied problems, it is necessary not only to formulate system of necessary preconditions, but also technique of their checks [8]; stability of the preconditions and method of reception of models to rather small infringements of the accepted conditions; the system of actions, if the preconditions are not carried out actually [9].

Using methods of experiments planning, in original it is always possible to find statistical models with the best characteristics. The any area of factors space which is not appropriate to the standard form, is accepted for an image of factor-space $\left(\mathbf{R}_{\mathrm{Im}}\right)$. If in it the models with the best characteristics by traditional methods are not obviously possible, then the method of transition from given badly-caused factor-space $\mathbf{R}_{\text{Im}}$ of an image to well-caused factor-space $\mathbf{R}_{\text{Or}}$ of an original, in it is necessary to solve a problem.

Here it is necessary to use some topological mapping of the original of factor-space in an image. Two systems $\mathbf{R}_{\text{Or}}$ and $\mathbf{R}_{\text{Im}}$ at a mutually unequivocal and mutually continuous mapping will be isomorphic. At consideration of topological mapping the metric properties of sets $\mathbf{X}_{\text{Or}}$ (original) and $\mathbf{X}_{\text{Im}}$ (image) are not used, and consequently $\mathbf{X}_{\text{Or}}$ and $\mathbf{X}_{\text{Im}}$ can have the different metrics.

The methods of orthogonal representation of correlated factors are realized by mapping of points of the original – values of levels of factors $X_{ij}^{(\text{Or})}$ on appropriate to them of an image – values of levels of factors $X_{ij}^{(\text{Im})}$ $(i=1,...,k;\ j=1,...,n)$ [9]. For this, purpose is entered in consideration the mappings:

$$X_i^{(\text{Im})} = f_i\left(X_1^{\text{Or}},...,X_k^{\text{Or}}\right), \tag{10}$$

which are forming a group. Here, functions f_i and inverse functions f_i^{-1} should be continuous. For a case of linear restriction the form of an image are set as a structure of complete factor experiment 2^k: $(1-x_1)(1-x_2)...(1-x_k) \to n_C$.

For nonlinear restriction of the form of an image are used as boundaries of a line of the second order and surfaces, received on the basis of structure of multifactor's experiment 3^k or 3^{k-p}: $(1+x_1+z_1)(1+x_2+z_2)...(1+x_k+z_k) \to n_C(n_F)$, where value of fictitious independent variable $x_0 \equiv 1$; x_1, x_2, …, x_k are linear orthogonal constants of factors $X_1, X_2,..., X_k$; $z_1, z_2,..., z_k$ are quadratic orthogonal constants of factors $X_1, X_2,..., X_k$; k is a quantity of factors; $n_C(n_F)$ is a common quantity of structural elements accordingly equals to 2^k, 3^k and 3^{k-p}; p is a fractional replicate.

The coefficients of mapping functions f_i are defined by least-square method.

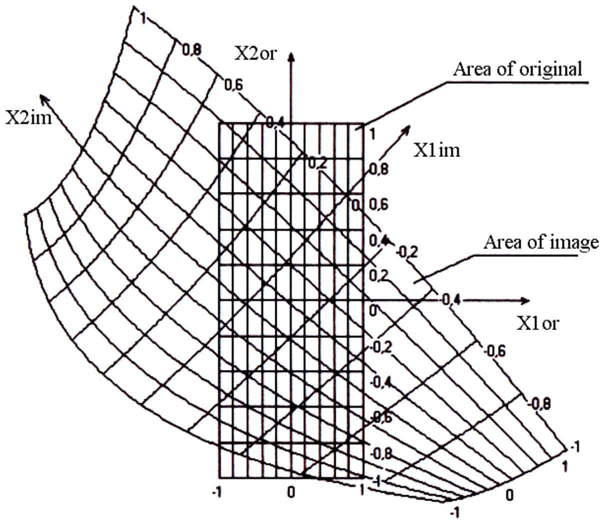

Fig. 2. Systems of natural and own coded coordinate areas
of image and original at curvilinear boundary conditions of image
$(k = 2)$

The mapping of point of plan of experiment of original $X_{ij}^{(\mathrm{Or})}$ and point $X_{ij}^{(\mathrm{Im})}$ of image with use of mapping functions (10) actually represents reception of the plan of experiment in an image under condition of use in the original and image of the own coded systems of coordinates. Graphically it looks, for example, as is represented in a fig. 2.

Agrees to lemma of T. Andersonn [10], the necessary properties of estimations of the coefficients of statistical models in original area and its uniqueness are kept at a topological mapping in image area too.

The figures of the original $\mathbf{G}_{\mathrm{Or}}$ and image $\mathbf{G}_{\mathrm{Im}}$ are concerning equivalence, thus as for it's the binary relations of equivalence are carried out. Figures $\mathbf{G}_{\mathrm{Or}}$ and $\mathbf{G}_{\mathrm{Im}}$ are isomorphic.

INFORMATION-SYSTEM MODEL OF CREATION OF TECHNICAL COMPLEXES

In the problem of designing of technological systems and appropriate technical complexes as purposeful search of final variant, the process of removal of indeterminacy can be considered as information technology. Here, it is important building so named information-system model of the process of the making the technical system (the complex) with given parameter on energy- and resource-intensive, reliability etc. Structurally, such model can be submitted as, represented on a fig. 3.

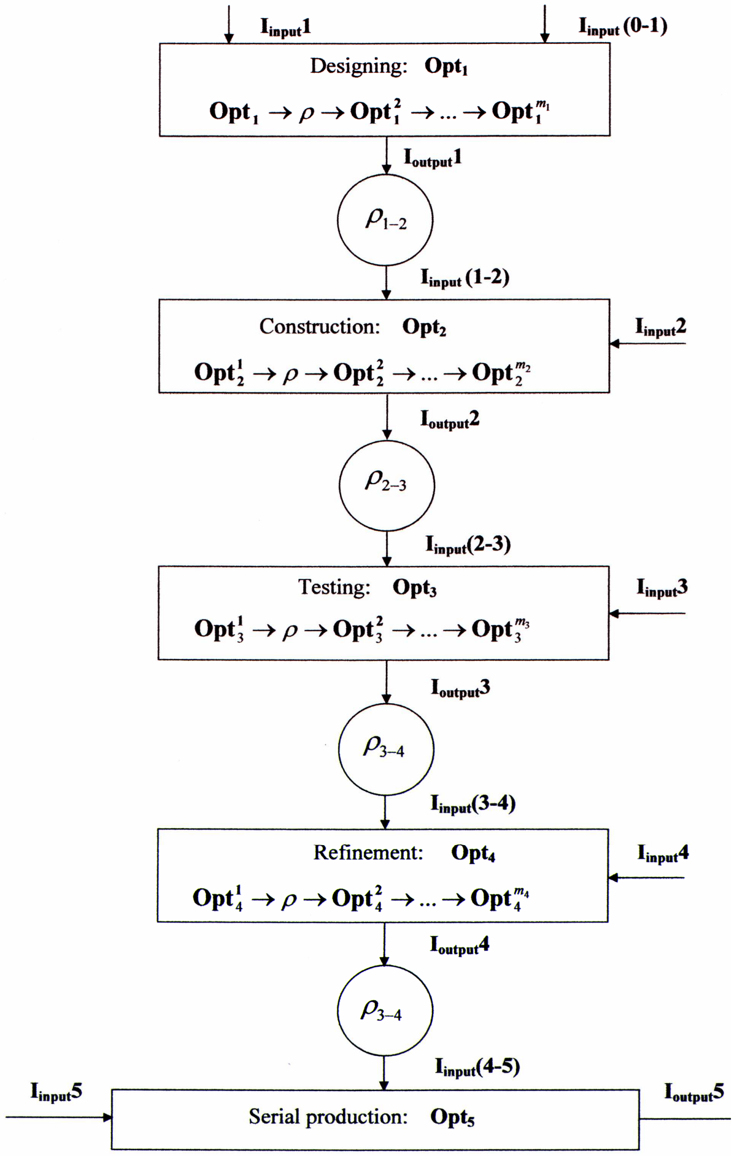

Fig. 3. A structure of information-system model of process of creation of technological system

From the descriptive point of view, each of stage of creation of a technological system is accompanied by necessity of solution of a number local optimization problems $\mathbf{Opt}_{\mathbf{j}}^{\mathbf{i}}$ with check of adequacy ρ_j $(j=1,2,...)$. The output information of the current design stage is the input information of next stage (that is obvious) – intersystem information flow $\mathbf{I}_{\mathbf{input}}(\mathbf{j}-(\mathbf{j}+\mathbf{1}))$. Obviously also presence of the non-systemic input information $\mathbf{I}_{\mathbf{input}}\mathbf{j}$, coming from outside.

Thus, the information-dynamic model of reliability appropriate to stage j of creation of technical system in formalized kind represents a train:

$\mathbf{IDmodel}_j = \left\langle PR_{ij}\,(i=1,...,n); \gamma(PR_{ij}); R_j; \mathbf{I}_{\mathbf{input}}\mathbf{j}; \mathbf{I}_{\mathbf{input}}((\mathbf{j}-\mathbf{1})-\mathbf{j}),\, j=1,...,m_j \right\rangle$ where:

PR_{ij} is a requirement on a i parameter of reliability on j design stage; $\gamma(PR_{ij})$ is fiducially probability; $R_j = \left(\rho_1^j,...,\rho_{m_j}^j\right)$ is a vector of adequacy parameters; $\mathbf{I}_{\mathbf{input}}\mathbf{j}$ and $\mathbf{I}_{\mathbf{input}}((\mathbf{j}-\mathbf{1})-\mathbf{j})$ are input information of step j of design of technical system.

The procedure of statistical estimation of informatively of the current stage of design at known PR_{ij} and $\gamma(PR_{ij})$ is based on a ratio:

$$\mathbf{I}_{\mathbf{output}}\mathbf{j} = \gamma(PR_{ij})\lg\frac{\gamma(PR_{ij})}{1-\alpha(PR_{ij})} + \left(1-\gamma(PR_{ij})\right)\lg\frac{\left(1-\gamma(PR_{ij})\right)}{\alpha(PR_{ij})},$$

where $\alpha(PR_{ij})$ is a lower bound of fiducially intervals $\left(\alpha(PR_{ij}),\beta(PR_{ij})\right)$ up to $i=1,...,m_j$.

The account of topology of complex of technical system, and also an information-logical formalism in a representation of system of designing allow to carry out a general statement of optimization problem of reliability: $\left\{C_j; R_j\right\} \rightarrow \mathbf{opt}_j$ $(j=1,...,k)$, where C_j is a vector of step-by-step expenses. This problem is a problem of multicriterion optimization with restrictions on reliability: $PR_{ij} \in \left(\alpha(PR_{ij}),\beta(PR_{ij})\right),\, i=1,...,m_j,\, j=1,...,k$ and time: $T_j \le T_j^*$ $(j=1,...,k)$. In general case, generalized problem will accept a kind:

$$\begin{cases} \mathbf{C} \rightarrow \min \\ PR_{ij} \in \left(\alpha(PR_{ij}),\beta(PR_{ij})\right), \\ i=1,...,m_j, \quad j=1,...,k \\ T \le T^* \end{cases}$$

where: $\mathbf{C}$ is a vector criterion of optimization. Its solution is among the Pareto-optimal solutions, the technology of which searching is reduced to methods of consecutive concessions (compromises).

CONCLUSION

Thus, the perfection of the technological procedures of design stages of technical systems is carried out under the programs generalizing experience and new approaches in technical development. Program is formed of problems of the coordinated optimum.

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О ЗАДАЧЕ ПЛАНИРОВАНИЯ ЭКСПЕРИМЕНТОВ В СПЕЦИФИЧНЫХ ОБЛАСТЯХ ФАКТОРНОГО ПРОСТРАНСТВА ПРИ ИДЕНТИФИКАЦИИ ПАРАМЕТРОВ ЭНЕРГОСБЕРЕГАЮЩИХ ТЕХНОЛОГИЙ

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Аннотация. Рассматривается описание технологии как объект параметрической и структурной идентификации. Предложено рассматривать модели таких объектов как модели с переменной структурой. С целью адаптации моделей вводится топологическое отображение фактор-пространства образов на фактор-пространство оригиналов при неспециальной организации экспериментов в нестандартных областях факторного пространства. Информационно-системные модели вводятся в рассмотрение для описания процессов создания технологических комплексов.

Ключевые слова: адаптация, модель информационной системы, проблемы оптимизации, , параметрическая идентификация, структурная идентификация, технологический комплекс.