TEKA Kom. Mot. Energ. Roln. – OL PAN, 2010, 10, 405–416

PROBLEM OF EXPERIMENT PLANNING IN SPECIFIC AREAS - FACTOR SPACE IN THE IDENTIFICATION OF ENERGY-SAVING TECHNOLOGIES PARAMETERS

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Summary. Description technology is considered aiming at parametric and structured identification considering models with variable structure. Methods of the estimation of their parameters are offered. Experiments are planned in non-standard area of factor space to adapt the models.Topological mapping of factor-space of the image on the factor-space of the original is entered for this. Information-system models are introduced for the description of processes of the creation of technological complex.

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

INTRODUCTION

One of urgent issues nowadays is the optimum energy content and resource-intensity at designing various sorts of technological systems (processes). The optimization of power inputs, charge of resources etc., are 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 whose sanction is solved at the design stages and has a rather specific nature.

DESCRIPTION OF TECHNOLOGY AS AN OBJECT OF PARAMETRICAL AND STRUCTURAL IDENTIFICATION

In the above sense the process of technology and appropriate technical complex development can be considered as a process of identification (structural and parametrical) of a certain object (in particular, object of control) in a 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 = (S1,..., Sl). Concerning the projection problems, the perceived situation is controlled, that is S(U) = (S1(U),..., Sl(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* = (Z1*,..., Zk*), where Zi* is a requirement i to a state S, with a help of function ψi (S). Here: Zi = ψi (S) (i = 1,..., k), the functions ψi define connection of a state S and criterion parameter Zi. The purposes-requirements have a various character, and their form is unified and corresponds to one of the kind:

1. $Z_i' = \xi_i$ (fixed values);
2. $Z_i' \geq \eta_i$ (it is lower than some threshold value);
3. $Z_i' \rightarrow$ extr (accepts extreme value in the sense of maximum or minimum).

The majority of situations are reduced to such requirements, especially in scientific and technical sphere.

Point of area:

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

(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 on resources R:, $U \in R$ which determine power, material, temporariness 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 so that: to achieve a defined value Z* of objective function, and also to compensate drift, subject to parameters of environment S. Parameters of environment are meant as measurable parameters, actually as environment X and parameter of object Y, interacting with the environment. Then: $S = \langle X, Y \rangle$.

In most cases, connections of technological complexes with environment are rather strong and are of various character. That results in the necessity of the solving of an object identification problem, where for the given set of criteria {Z*} 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 as a character of relationship F to state Y from its inputs – uncontrolled X and controlled U:

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

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: $F = \langle St, \mathbf{b} \rangle$, where St is a structure of model F , b = (β1,…,βk) – 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 as well. The parametrical synthesis of a model is connected with the defining of parameter

$\mathbf{b} = (\beta_1, \ldots, \beta_k)$ of model $Y = F(X, U, \mathbf{b})$, 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 parameter $\mathbf{b}$. Depending on ways of reception of this information, it is possible to distinguish: identification and experiments planning.

ESTIMATION METHODS OF VARIABLE STRUCTURE MODELS' PARAMETERS

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: $J(t) = (X(t), Y(t))$. 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 are not influenced by the state of environment. For finding-out relationship of an object output Y from such parameters it is necessary to deliberately vary them, that is the experiment with an object is necessary, that automatically breaks a mode of normal functioning and it is not always desirable. In this case the experiment will be carried out with minimal perturbations of object and opportunity of reception of the maximum of information on the influence of varied output parameters of the 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 the 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 us consider dynamic processes, that is such processes, where the values of all variables are submitted by time series, and the functional relationship Ft(·) generally changes in time and is set by some vector of structural parameters. Assuming differentiability Ft(·) 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 on $\frac{dX_i}{dt}$, this ratio can be treated as linear model with varying structural coefficients.

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

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

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

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

where: Y is a vector of factor-function value (output); X is an 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 $\mathbf{M}\left[UU^{T}\right] = \sigma^2\mathbf{I}$ (here $\mathbf{I}$ is unit identity matrix of the appropriate order); T is a quantity of observations.

It would be incorrect to consider the coefficients of model (2) for dynamic processes constant during all the investigated period, that requires adaptation from the point of view of dynamics of the vector of structural parameters b. That is the model accepts the kind:

$$Y_t = X\mathbf{b}_t + U_t. \tag{3}$$

Such a problem can be solved in several ways. For example, it can be solved by representation of parameters of the model in an obvious kind as function of time or use of the 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 the statement a problem (3), is the representation of required parameters as stochastic quantities, submitting certain law of variation with time. Here generalizations of models of the given type demands use of ideas of the Kalman's filter [1].

Another well-known method – consequent shifting bases estimation and discovery on this base of "driftage" factor. Herewith the 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 the 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 correspond more 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 of decreasing weights, it is possible to define a vector of parameters reflecting connections at the end of the initial period. In a 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 the group of observations' results with maximal weight.

Let's consider a sequence of weighing matrixes, each of which corresponds to a 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: $\mathbf{b}_t = (X^{T}\mathbf{G}_tX)^{-1}\ X^{T}\mathbf{G}_tY$ is an approximation of the coefficients of model.

The set of coefficients $\mathbf{b}_t$ is determined by low distribution of weights for each of moment t. For 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 $\mathbf{b}_t$ the most essential are τ results of observation, we have a weight matrix of the kind:

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

Thus, we have a generalization of the 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:

$$g_{it} = g^{[(\tau-1)/2]-i}, \; i < t,$$
$$g_{it} = 1;$$
$$g_{it} = g^{i-[(\tau-1)/2]}, \; i > t, \qquad (5)$$

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 in a choice of small values of τ, that has an effect on the conditionality of matrix $(X^T \mathbf{G}_t X)$.

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 is the method of "crest" regression.

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

Structurally, an idea of the 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:

$$\mathbf{b}^0 = \mathbf{b}_t + U_t, \qquad (6)$$

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

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

$$Y = X\mathbf{b}_t + \delta_t$$

$$\mathbf{b}^0 = \mathbf{b}_t + U_t, \quad (7)$$

with estimation of vector:

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

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

According to the classical rule, as an estimation σ_t^2 is used:

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

In (9) choices of small τ will inevitably have the consequence of essential fluctuation of estimations of residual dispersion for various time intervals. Therefore, a more correct representation is needed of the assumption about uniformly precise models, estimated on each steps of the processing of adaptive algorithm. Processing from this, let us assume that residual dispersion σ_t^2 is identical to all t. Further it follows, that for all t the rest of model (8) is submitted to distribution, where $\mathbf{M}[\delta_t] = 0$, $\mathbf{M}[\delta_t \delta_t^T] = s^2 \mathbf{G}_t$. From here follows the dispersion of model $S_b^2 = S^2$ and $\frac{\sigma_t^2}{s_\beta^2} = \frac{\sigma^2}{s^2} = \sum_{t=1}^{n} g_t$.

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

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

The problem of estimation in the form (8) derivates the problem of the choice of best g and τ. The choice of these values is to some extent limited: it is not efficient to take such a size of "sliding period", for whose weights supplied at one of extreme observations, it becomes negligibly small. the value of g is determined by a number of parameters, estimated on everyone steps (by dimension of a vector b).

The variation of coefficients of a model near their average value is determined by both parameter of weighing and size of a sliding period. In this connection, the degree of spread of model coefficients values is expedient to be expected (at fixed τ) in relation to coefficients bt0, which are received with the help of the model under condition of g = 1.

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

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

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

(similarly generalized by the least square method).

The strict approaches to 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, the least square method, the noise-eliminated method results in the estimation formula:

$$\mathbf{b} = (X^{T}\,\mathbf{W}X)^{-1}\,X\mathbf{W}Y, \text{ where } \mathbf{W} = \begin{pmatrix} w_1 & & 0 \\ & \ddots & \\ 0 & & w_r \end{pmatrix}, \text{ with the weights } w_i = \frac{\Phi\left(\frac{y_i - x_i b}{s}\right)}{\frac{y_i - x_i b}{s}};$$

S which 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 by dynamic series of the first partial derivatives, it allows not only to estimate a measure of reaction of factor-function under a variation of factor-arguments of model, but also provides conditions for specifications of an initial kind of relation.

$Y = F(X_1,\ldots, X_n)$; the various preliminary hypotheses about a type of functions $Y = F(X_1,\ldots, X_n)$ 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, whose coefficients are exposed to adaptation, is essential. Nevertheless, as the experience of accounts shows, at operation by various variants of differential relationships the specified uncertainty is insignificant: the problem usually involves the choice of the suitable equation from two-three variants, which is always feasible.

PLANING AN EXPERIMENT IN THE SPECIFIC AREAS OF FACTOR SPACES

Multifactor statistical models are used mainly at creation and perfection of various complex systems. They are especially necessary, when opportunities of designing, manufacturing and operation 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 the processing of the results of passive (especially not organized) experiment.

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

Thus [4] the necessity is emphasized of permanent methods and algorithms, having transparent mathematical properties in the sense of optimality. One feature of a rather widely used least-square method is its instability if no additional assumptions are made, which are difficult to check [2]. Thus, at the solution of the applied problems, it is necessary not only to formulate a system of necessary preconditions, but also to ensure their control [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 actually carried out [9].

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

Here it is necessary to use some topological mapping of the original of factor-space in an image. Two systems $\mathbf{R}_{Or}$ and $\mathbf{R}_{Im}$ at a mutually unequivocal and mutually continuous mapping will be isomorphic. At consideration of topological mapping the metric properties of sets $\mathbf{X}_{Or}$ (original) and $\mathbf{X}_{Im}$ (image) are not used, and consequently $\mathbf{X}_{Or}$ and $\mathbf{X}_{Im}$ 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 $X_{ij}^{(Or)}$ on an image appropriate to them – values of levels of factors $X_{ij}^{(Im)}$ $(i = 1,\ldots,k; j = 1,\ldots,n)$ [9]. For this purpose a consideration is entered of the mappings:

$$X_i^{(Im)} = f_i(X_1^{Or}, \ldots, X_k^{Or}), \tag{10}$$

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

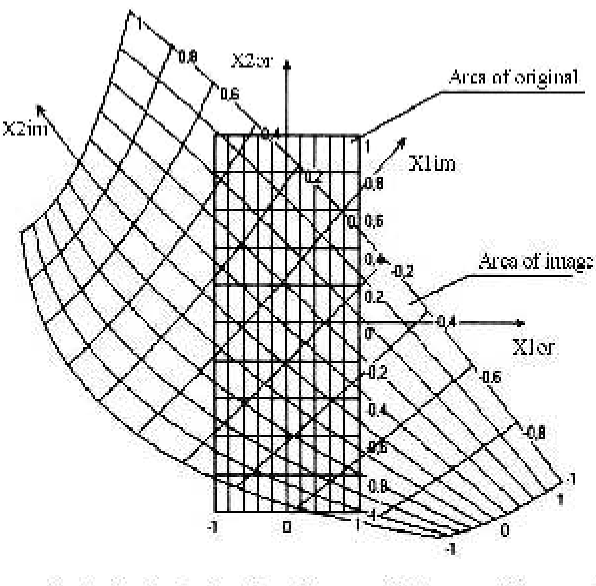

Fig.2. Systems of natural and coded by the authors coordinate areas of image and original at curvilinear boundary conditions of image ($k = 2$)

For nonlinear restriction of the form of an image they are used as boundaries of a line of the second order and surfaces, received on the basis of the structure of multifactor experiment 3^k or 3^{k-p}:

$(1 + x_1 + z_1)(1 + x_2 + z_2)\ldots(1 + x_k + z_k) \rightarrow n_C(n_p)$, where values of fictitious independent variable $x_0 \equiv 1$; $x_1, x_2, \ldots, x_k$ are linear orthogonal constants of factors $X_1, X_2, \ldots, X_k$; $z_1, z_2, \ldots, z_k$ are quadratic orthogonal constants of factors $X_1, X_2, \ldots, X_k$; k is a quantity of factors; $n_C(n_p)$ is a common quantity of structural elements which the 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 the least-square method.

The mapping of point of plan of experiment of original $X_{ij}^{(Or)}$ and point $X_{ij}^{(Im)}$ of image with the 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 Fig. 2.

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

The figures of the original $\mathbf{G}_{Or}$ and image $\mathbf{G}_{Im}$ concern the equivalence, thus the binary relations of equivalence are carried out for them. Figures $\mathbf{G}_{Or}$ and $\mathbf{G}_{Im}$ 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 issue. Here, it is important to build the so-called information-system model of the process of the making the technical system (the complex) with given parameters on energy- and resource-intensity, reliability etc. Structurally, such a model can be submitted as represented in Fig. 3.

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

Thus, the information-dynamic model of reliability appropriate to stage j of creation of technical system in a formalized kind is represented by the sequence :

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

where: PR_{ij} is a requirement on i parameter of reliability and on j design stage; $\gamma(PR_{ij})$ is fiducial probability; $R_j = (\rho_1^j,\ldots,\rho^j_{mj})$ is a vector of adequacy parameters; $\mathbf{I}_{input}\,\mathbf{j}$ and $\mathbf{I}_{input}$ ((**j**–**1**)–**j**) are input information of step j of design of technical system.

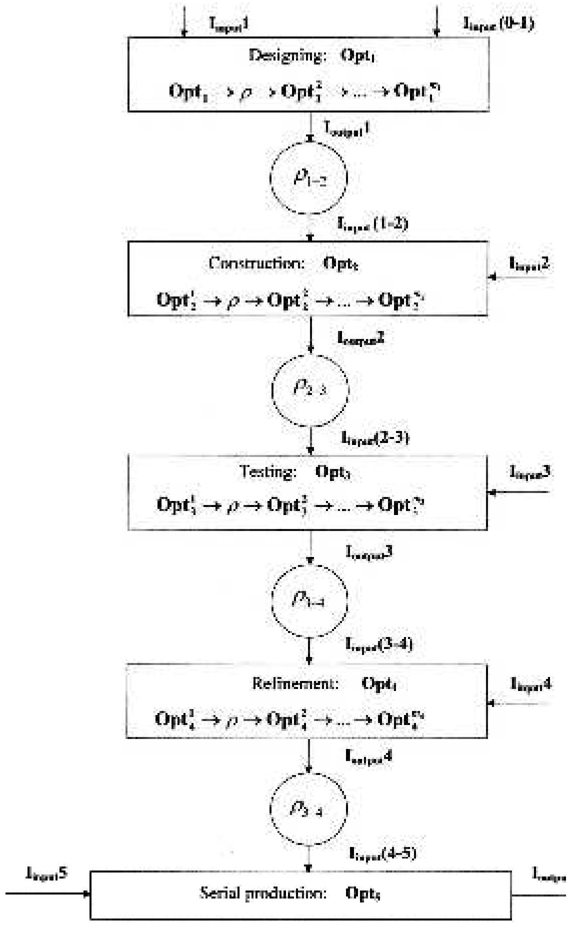

Fig. 3. The structure of information-system model of a process of creation of technological system

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

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

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

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

$$\begin{cases} \mathbf{C} \to \min \\ PR_{ij} \in \left(\alpha\left(PR_{ij}\right), \beta\left(PR_{ij}\right)\right)' \\ i = 1,\ldots,m_j,\ j = 1,\ldots,k \\ T \le T' \end{cases}$$

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

CONCLUSIONS

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. A program is formed of problems of the coordinated optimum.

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PROBLEM PLANOWANIA EKSPERYMENTALNEGO W OKREŚLONYCH OBSZARACH – PRZESTRZEŃ CZYNNIKA W IDENTYFIKACJI PARAMETRÓW TECHNOLOGII ENERGOOSZCZĘDNYCH

Streszczenie. Rozpatrzono technikę opisu mającą na celu identyfikację parametrów w modelach o zróżnicowanej budowie. Zaproponowano metody oceny parametrów. Zaplanowano eksperymenty w nie-standardowym obszarze przestrzeni czynników w celu adaptacji modeli. W tym celu naniesiono mapę topologiczną przestrzeni czynnikowej obrazu na przestrzeń czynnikową oryginału. Wprowadzono modele systemu informatycznego dla opisu procesów tworzenia zespołu technologicznego.

Słowa kluczowe: adaptacja, model systemu informatycznego, niestandardowy obszar przestrzeni czynnikowej, problem optymalizacji, optymalna zawartość energii, identyfikacja parametrów, intensywność zasobów, identyfikacja strukturalna, zespół technologiczny