***Joint* IMEKO TC-1 & XXXIV MKM Conference 2002**
Wrocław, 8 - 12 September 2002

Madiar ZARIPOV*
Irina PETROVA
Victoria ZARIPOVA

PROJECT OF CREATION OF KNOWLEDGE BASE ON PHYSICAL AND TECHNOLOGICAL EFFECTS

In the new millennium the change of technological and technique generations occurs in a temp unprecedented earlier. Therefore in order to train high-qualified engineers able to quickly, efficiently react to society's new needs it is necessary for them to upgrade their knowledge permanently.

Indicators consumption increase both in quantity and in nomenclature needs an acceleration of production rate owing to automation of design process. The problem is that a description of various physical processes on which the principle of indicators action is based, is being carried out with the use of physic-mathematical apparatus, appropriate to this class of phenomena. It hampers the design process automation, increases new indicators development time and their cost. The article considers a united system approach in the field of sensitive elements theory, invariant to the physical nature of phenomena and processes used and in the field of methods and instrumental means of these elements structural designing with following process automation.

Keywords: sensitive elements, theory, energy-information model.

1. INTRODUCTION

Various physical properties which are the base of different sensors action principles are being described by means of physic-mathematical apparatus adequate to the given concrete class of phenomena. It hampers design process automation, increases new indicators development time and cost.

* Department of Technological Processes Automation, Institute of Information Technologies and Communications, Astrakhan State Technical University, 414025 Tatischev str. 16, Astrakhan, Russia, e-mail: irina@astu.astranet.ru

Decrease of the cost of indicators – as a final product may be achieved by wide introduction of new information technologies, especially during preliminary “searching” design, because this stage has the most science-consumption.
The main problems of this stage are synthesis and choose of design solutions of indicators, it requires analysis and comparison of a lot of alternative variants.

Elaboration of automated system of technical solutions search in the field of indicators is difficult because of the following reasons:

1 Absence of united generalized model for full description of processes of information receiving and processing in indicators using different physical principles;

2 Available databases of physical effects, and based on them systems of automated design (for example TechOptimizer 3.0 of Invention Machine Corporation, Boston, MA, USA) are intended for synthesis of widespread purposes technical devices. The result of such systems work is: synthesis of action principles of technical device having form of chain of consecutive transformations from input towards output. Such systems don’t allow to make mathematical model relating input and output values of a sensor and to estimate it’s sensitivity and other operating characteristics.

Analysis of various system approaches [1, 2] to the development of control systems sensitive elements theory showed a necessity to elaborate a method, combining:

- mathematical simulation of processes in a technical device being invariant to the physical nature of these processes;
- possibility of registration of physical effects and phenomena which are beyond the model's strict frames;
- possibility of structural description of device action physical principle.

2. ENERGY-INFORMATION MODELS OF CIRCUITS OF A VARIOUS PHYSICAL NATURE

The development of conceptual model of knowledge systematization of physical phenomena and effects for new sensitive elements synthesis is based on principles of non-balanced thermodynamics (works of L.Onzager, D.Gibbs and C. de Groot, I.Prigozhin) because they enable to get the full system of transfer equations and other regularities, not revealing their molecular mechanism. The authors suggested energy-information models of processes of various physical nature (EIMC) on the base of phenomenological equations of non-balanced thermodynamics, gave the main definitions of EIMC.

The main definitions of this model (EIMC) as well as quantities and parametres were given in [3]. These quantities and parametres are related with equations named "EIMC criteria" by the authors.

They are given in [3] for a simple case of concentrated parametres systems.
Principles of action of many modern indicators are based on the processes of self-

oscillation, parametrical amplification, and others with different physical nature parametres changeable in time. Therefor the authors introduced additional quantities characterizing speed of main EIMC quantities change, and enlarged a set of main criteria for the systems with changeable in time parametres (parametrical systems) and for systems with parametres distributed in space (tab. 1).

Table 1. Criteria of EIMC

Criterion's name	Equation
Energetical	$U \cdot I = N$, where N – is power [Wt]
Statical	$I \cdot L = P$ or $P \cdot D = I$
	$U \cdot C = Q$ or $Q \cdot W = U$
	$I \cdot R = U$ or $U \cdot G = I$
	$I' \cdot R = U'$ or $U' \cdot G = I'$
Dynamic	$U = \frac{dP}{dt}$ or $P = \int U dt$
	$I = \frac{dQ}{dt}$ or $Q = \int I dt$
	$U' = \frac{dU}{dt}$ or $U = \int U' dt$
	$I' = \frac{dI}{dt}$ or $I = \int I' dt$

3. APPARATUS OF PARAMETRICAL STRUCTURAL SCHEMES

The authors suggested an apparatus of structural-formalized description of physical processes proceeding in sensitive elements - apparatus of parametrical structural schemes (PSS). It allowed to develop sensitive elements analysis and synthesis methods invariant to physical nature, and to elaborate complex of algorithms and programs.

The work of control systems sensitive elements is based on interaction of various physical nature circuits. So in any technical device one can distinguish sectors with several consecutive elementary transformations of the same physical nature. These sectors are related between each other by means of inter-circuit physical-technical effects. Thus sensitive elements may be presented as an aggregate of inter-dependent transformations of one physical quantity into another quantity or parameter, which form parametrical structural scheme. The main kinds of elementary links of parametrical structural schemes were considered in the work [3].

All diversity of inter-communications between values and parametres inside a circuit of one physical nature may be presented as a graph named "topogram of intro-circuit dependences" in the work (fig.1). Introduction of "topogram of intro-circuit dependences" identical for circuits of various physical nature allows to simplify significantly the algorithm of searching of sensitive elements action principle.

4. AUTOMATED SYSTEM OF SYNTHESIS OF SENSITIVE ELEMENTS ACTION PRINCIPLE

The authors have elaborated principles of building of flexible interactive dialogue systems of synthesis of new technical solutions, composition of databases and principles of information organization in bases on the basis of energy-information models of circuits (EIMC) and of parametrical structural schemes apparatus. Composition of databases of this system is described in the article [3].

Parametrical structural schemes topogram [PSS] reflecting possible principles of action of a synthesized sensitive element represents a complex graph (fig.1). Tops of the graphs are the values of circuits of various physical nature, and verges are parametres or effects. The target functions of an algorithm is to define possible variants of physical principle of action according to given input and output values of a sensitive element (i.e. ways on the graph), and to choose the most optimal among them according to an aggregate of requirements to operating characteristics.

So the defined problem is focused to the problem of full sorting out using strategy of return. Reduce in calculation range is achieved due to following features of EIMC and PSS:

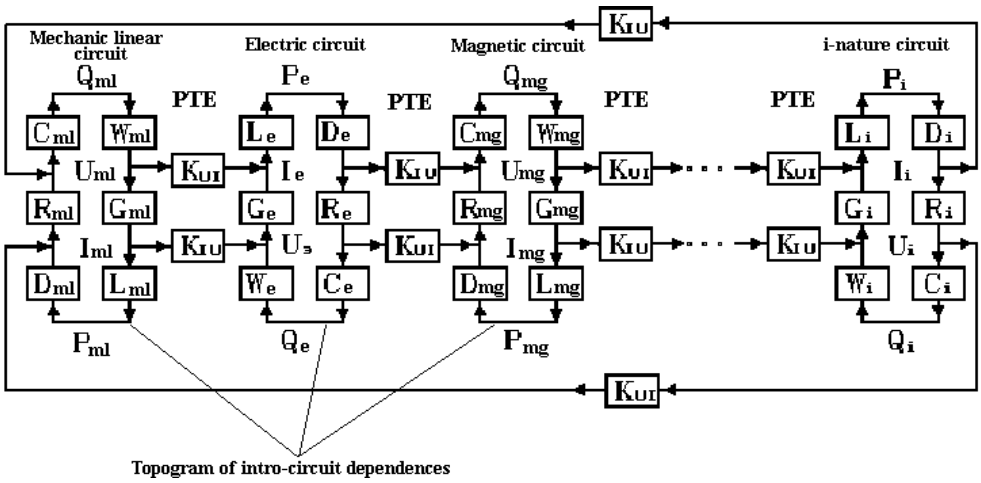

Fig. 1. Parametrical structure

- There are “parallel physico-technical effects (PTE)” i.e. effects coinciding in their pares of input and output quantities, that leads to coinciding of ways synthesized for this and that PTE,
- If synthesized PSS has a quantity, which was involved in previous variants of PSS, then synthesis of this quantity is not carried out again, but a previous experience is used,
- Introduction of topograms of intra-circuit dependencies identical for circuits of different physical nature allows to model (to simulate) all intra-circuit connections beforehand and to use them during synthesis of parts of intra-circuit dependencies independently of their physical nature.

The first stage of new technical solutions synthesis is ending by searching variants of PPA of sensitive elements (SE) according to the totality of operating characteristics. An additive form of generalized criterion of effectiveness is used for searching –“ranging”. The effectiveness generalized criterion for a i-th variant has a look:

$$K_{ief} = \sum_{k=1}^{N} \zeta_k \tilde{Э}_{ik} \ ,$$

Where $\tilde{Э}_{ik}$ - relative value of the k-th criterion of effectiveness, i.e. of the k-th operating characteristic (sensitivity, cost, error, reliability etc.); it is defined as $\tilde{Э}_{ik} = Э_{ik} / Э_{max\,ik}$ ratio of the k-th operating characteristic of the i-th PPA variant to the maximum value of this characteristic in the set of variants of given technical solution PPA; ζik - weight coefficient which characterizes importance of the k-th operating characteristic.

The target function of the second stage algorithms is an elaboration of variants of constructional realization of each element link (on morphological matrix database) for variants of sensitive elements PPA chosen in the first stage; and choose of the variant optimal according to operating characteristics requirements totality.

Totality of existing and supposed constructional realizations of each PTE makes a morphological set of this effect, and is characterized by morphological features. The set N of descriptions of PTE technical realization variants may be represented as Decart multiplication of the sets N = k1, k2…, kj,…kn, where ki(1,2,…n) – is a set of values of the i-th feature. In result one can make a matrix of morphological features values.

Creating not technical devices themselves but databases of PTE morphological matrix allows to increase several times the number of variants of technical device (indicator) building, and to choose the best meeting the requirements among them. Morphological matrix of PTE has a property of insertness that provides connection of knowledge about constructional realizations of effects (existing and possible). During morphological synthesis the characteristics specific for each PTE may be taken into

consideration in addition to main characteristics involved in the search of variants of transformers' PPA, it reduces probability of synthesis of unproductive technical solutions not able to work.

5. CONCLUSIONS

Statements of general theory of analysis and synthesis of SE for control systems information transformers are elaborated on the base of suggested generalized conceptual model for description of processes in circuits of different physical nature – EIMC.

Distinctive features of EIMC are:

- Decomposition of complete physical processes proceeding in SE on processes in circuits of different physical nature,
- Systems of concentrated, distributed and changeable in time parameters – analogues (resistance, capacity, inductance, and their derivatives) for description of features of material medium in which physical processes take place,
- Systems of criterion – equations relating quantities-analogues with parameters-analogues for describing processes of definite physical nature having concentrated, distributed and changeable in time physical-and-chemical quantities and parameters.

The PSS apparatus is suggested for structural-formalized description of physical processes in SE; its distinctive feature is the introduction of elementary links of PTE, that reflect influence of a quantity on parameter of a chain of the same or different physical nature.

The received theoretical results became a basis for principles of building a flexible interactive dialogue system of new technical solutions synthesis, databases composition, and information organization. It allows to improve the quality of designing due to considerably more number of simultaneously synthesized variants of action principles, possibility of their constructional elaboration, and quantitative comparison of their total operating characteristics.

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