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DEVELOPMENT OF EXECUTIVE SYSTEM ARCHITECTURE OF THE CONVERTING CLASS

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Представлені результати досліджень, що були проведені з метою виявлення структури виконавчої системи перетворювального класу. Встановлено, що виконавча система перетворювального класу складається з технологічної підсистеми, підсистеми контролю, підсистеми обліку, підсистеми координації та підсистеми оптимізації. Встановлено, що особливості конкретної виконавчої системи перетворювального класу проявляються виключно в рамках особливості функціонування базового технологічного механізму

Ключові слова: система перетворення, підсистема координації, підсистема контролю, підсистема обліку

Представлены результаты исследований, которые были проведены с целью выявления структуры исполнительной системы преобразовательного класса. Установлено, что исполнительная система преобразовательного класса состоит из технологической подсистемы, подсистемы контроля, подсистемы учета, подсистемы координации и подсистемы оптимизации. Установлено, что особенности конкретной исполнительной системы преобразовательного класса проявляются исключительно в рамках особенности функционирования базового технологического механизма

Ключевые слова: система преобразования, подсистема координации, подсистема контроля, подсистема учета

1. Introduction

The category “system” is one of the central concepts of cybernetics as a science about general control principles. The analysis of steady patterns indicates that system objects are differentiated depending on solvable task: digestion system, heating system, crushing system, movement system etc.

It is logical to assume that all these system objects, providing transformation of physical products by interaction with other systems shall have the one internal architecture.

At the same time the studied system has not just to execute the own function, but execute it in the best way, that is optimally. It means that parameters optimization of input system products is its internal function.

Considering that every business connected with transformation of physical products includes a set of the interacting systems of the converting class, the synthesis of the internal structure of such systems is an important scientific task.

2. Literature review and the problem statement

Proceeding from general conceptions about the system as an indivisible essence, it is possible to present its structure in the form of subsystems. Each subsystem has to carry out one or several uniform functions. Nevertheless, these conceptual ideas are very often broken.

So, in the work [1] it is proposed to consider a subsystem as the part of the system, selected by some sign according to the purposes and research problems in which it can independently be accepted as a system.

If to adhere to the concept that system is something holistic, the definition of the subsystem as a system will cause the properties of the subsystem as a whole object will be different from the properties of the system from which the subsystem is selected. Therefore system allocation cannot be an arbitrary procedure, the algorithm of which is based on subjective approach.

In the work [2] the internal structure of the mobile robot is described. The structure of such a robot is presented in the form of six objects. Each object is defined by the concept system. The complex realizing control functions (the operating system) and the subsystem realizing movement function (system of movement) is a part of the systems.

Here it is necessary to focus on the concept "control system" that has developed historically [3]. As the control function is directed to setting the mode of interaction of systems, and, therefore, to the transformation process of system products as well, the control function is the built-in function of the system. Thus the "control subsystem" concept is correct concerning the conceptual formation approach of system objects.

Besides, the control subsystem is defined as a structure that has its own specific characteristics, depending on the rules and procedures established in it [4].

The task of the cybernetic system is transformation of input products to output products. Results of system operation implementation can be characterized by various indicators including using the categories interesting for researchers.

In particular, the cybernetic operation is considered successful if its output products expert estimation is higher than the input products expert estimation. The operation system indicators are: operation input products expert estimation (economic costs), operation output products expert estimation (the economic income) and operation added value (economic profit).

The authors form a kind of "classification" system by using the sign of intrasystem parameter or indicator. So, quality control systems are considered in [5]. But it is obvious that quality can`t be controlled. Operation process lasts until the quality of the transformation product reaches the predetermined level.

The similar problem concerns systems of cost control [6], profit control [7] and income control [8]. The authors use assessment indicators of technological operation as a sign of system identification, the process parameters of which they estimate. At the same time, estimative parameters can quite be internal output products of the control subsystem.

On the other hand, the authors use the term "subsystem" in cases when it comes to the system. So, each system for its functioning needs energy products. So the energy product is the same input system product as, for example, a raw product. As the products exchange is performed only between objects of one class, it is clear that the energy product is an output product of the system too. At the same time, in the work [9] the object providing giving of the energy product is determined as a "subsystem".

The serious terminological problem is connected with the attempt to identify objects that have a difficult structure. So, within the system, the independent system can also carry out a certain function. For example, the mailman who performs the function of message transfer is himself a system and carries out one of the control subsystem functions within other systems. However, the conceptual uncertainty of concepts "system" and "subsystem" leads to such situations when the systems which are carrying out functions within other systems are defined as "subsystems" [10].

The similar problem is connected with the concept "supersystem" [11]. According to the conceptual definition, the system is some indivisible entity. In this sense, the concept "supersystem" can be used in relation, for example, to systems, the output product of which is the object determined by the concept "purpose".

Uncertainty of the concepts "system" and "subsystem", and also lack of works in which the converting class internal systems architecture is described causes the need for research in this direction.

3. The aim and objectives of research

The aim of this work is development of the executive system architecture of the converting type.

For achievement of the research aim, the following objectives were solved:

– Development of the model of the technological subsystem;

– Development of the model of the control subsystem;

– Development of the model of the registration subsystem;

– Development of the model of the coordination subsystem;

– Development of the interface model of the optimization subsystem.

4. Synthesis of architecture of conversion system

The question of what is the system from the cybernetic point of view has been long and intensively discussed [12]. However, these discussions come to end at the level of general philosophical formulations. To generalize the essence of the proposed definitions, the system shall be represented as some integrity that is made up of interconnected elements.

Despite the lack of an accurate definition of concept "system", derivative concepts "supersystem", "complex system", "big system" and "subsystem" are actively used.

Nevertheless, creation of the objects that have all signs of cybernetic systems is solvable. Soda, coffee and other vending machines, make products and interact with the buyer, performing exchange operations. These machines are, in fact, the full-fledged entities, and, therefore, consist of systems.

Completely automated structure where each physical or program mechanism carries out a specific system function, is convenient to be investigated regarding the synthesis of the internal structure of any system.

The scientific task is to define classes of systems that use general principles of functioning and to synthesize their internal structure.

The program designer EFFLI [13] and a set of complete mechanisms [13, 14] have been developed for such research. A feature of designed mechanisms is that each of them performs one simple basic function.

With the use of the designed mechanisms, optimum systems of two classes have been created: transformation systems of physical products (TS) and buffering systems of physical products (BS). In the course of control systems creation, it has been established that the process optimization possibility for systems of the converting class can be received only if systems of this class interact with supply and consumption systems of technological products as buffering systems.

The created conversion system [13] provides object interaction with buffering systems that served as the supply and consumption of its system products.

Thus, access to the research of the converting system internal structure and allocation possibility of its subsystems has been got.

For definiteness, in this work, processes and objects of the heating system are considered as the converting system. This choice is connected with the fact that the heating process is inertial, and so there is no need to consider the dynamics of switching on of the heating element (starting process). The research has shown [15] that in optimization problems, generally, it is necessary to consider wear of the technological mechanism. It is connected with the fact that in case of performance improvement depreciation degree nonlinearly increases and has a significant effect on the total costs connected with carrying out the technological operation, and, therefore, and on optimum search results.

Generally, three types of physical products are fed at the converting system input: directed action product(s) (ADP) [14], energy product of ensuring the processes of the basic mechanism and energy products of ensuring the processes of service mechanisms. The supply of the intput products is provided by appropriate buffering systems.

Output products of the converting system are a finished product, accompanying product and by-product. Receipt system of the by-product is external environment.

The system of the reference graphic symbols based on the concepts of object-oriented systems representation is used. According to this concept, the system and every object have a port through which the objects interact with one another. Each port has an input section and output section (Fig. 1).

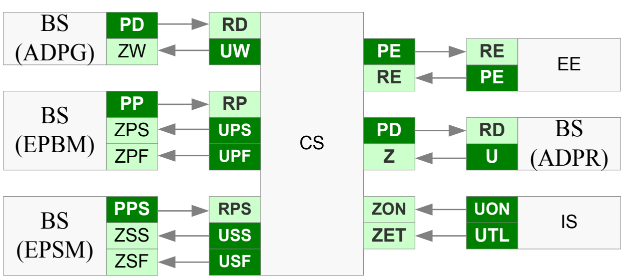

Fig. 1. The interface model of the controlled heating system

Here, PD – output section of ADP; RD – receiving section of input ADP; UW – signal section of ADP supply control; ZW – receiving section of command signal for ADP giving; PP – section of energy product giving out; RP – section of receiving power product; UPS – section of giving out control signal to supply energy product; ZPS – receiving section of command signal to supply energy product; UPF – section of giving out the control signal to supply energy product; ZPF – control signal receiving section for energy product supply; PPS – section of energy product giving out for the service mechanism; RPS – energy product receiving section for service mechanism; USS – control signal giving out section for service mechanism energy product supply; ZSS – receiving section of command signal for service mechanism energy product giving; USF – control signal receiving section to interrupt service mechanism energy product supply; ZSF – command signal receiving section to interrupt service mechanism energy product supply; UON – control giving out section at the first start of the converting system; ZON – command receiving section at the first start of the converting system; U – control giving out section for converting system basic function performance; Z – command receiving section for the converting system basic function performance; EE – external environment; IS – initialization system; BS(ADPG) – buffering system of directed action product giving out; BS (EPBM) – buffering system of energy product of basic mechanism; BS (EPSM) – buffering system of energy product of service mechanism; BS (ADPR) – buffering system of directed action product receiving.

So, the initialization system (IS) provides the initial start of the CS and establishes the threshold value of the output product quality. In case of receipt of a signal of a task from BS (ADPR), the converting system provides receiving ADP from BS (ADPG) and an energy product from BS (EPBM). Issue of the finished product is provided by giving of an energy product from BS (EPSM).

4. 1. Technological subsystem

The concepts "technological operation" and "technological process" are very widely used in scientific and technical literature. On the one hand, everything that is connected with these concepts seems intuitively clear. On the other hand, the accurate and standard definition of these cybernetic categories in authoritative sources is absent. Accordingly, there is no unified model of the technological subsystem.

In the work [14] it is established that the basic technological mechanism, generally, consists of the buffering mechanism, the action directed mechanism and the mechanism of finished product giving out. This means that for the observer who is inside the processing subsystem, the technological transformation of the products is provided by three simple operations. Performance of each simple operation is provided by a simple technological mechanism.

So, in the liquid heating subsystem these are: liquid buffering mechanism, heating mechanism, mechanism of heated liquid giving out, channel of heated liquid giving out and feeders of energy products (Fig. 2).

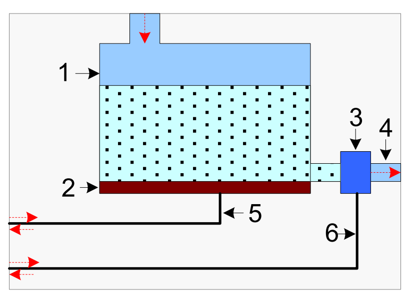

Fig. 2. The heating complete mechanism in the form of a set of simple mechanisms: 1 — buffering mechanism; 2 — heating mechanism; 3 — mechanism of heated liquid issue; 4 — channel of heated liquid issue; 5, 6 — mechanisms of movement of energy products

Therefore, in the subsystem the transformation of technological products is reasonable to determine by the "technological process" concept.

The sensors that determine the quantitative and qualitative parameters of technology products provide a number of processes aimed at the formation of intra-system information products. As each sensor is a complete mechanism (a set of simple mechanisms), transformation of the input technological product to the information product also is a technological process.

In relation to the technological subsystem, the converting process is a technological operation (Fig. 3).

On the entrance of the technological subsystem, two types of input technological products also arrive: action directed product (section of the port [RD]) and energy product (section of port [RP]). Also, the technological process, in one form or another, is affected by the environment products (section of the port [RE]).

Upon completion of the technological operation, the finished technological product (section of the port [PD]), and, sometimes, accompanying and by-products (section of the port [PE]) are transferred to the subsystem output.

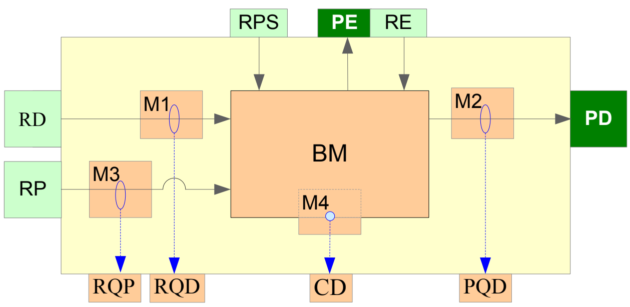

Fig. 3. Conceptual model of the technological subsystem with one action directed product

Here, RQP – section of energy product quantitative parameter receiving recording signal; RQD – reception section of quantitative parameter registration signal of the action directed product; PQD – section of quantitative parameters registration signal issuing of the finished product; M1–M3 – registration sensors of transformation products quantitative parameters (complete mechanisms); M4 – registration sensor of transformation product quality parameters (complete mechanism); BM – basic complete mechanism of technological subsystem.

In the conversion process, on the outputs of sensors (Fig. 4) the registration signals of quantitative and quality parameters of technological products are created: $rq_d(t)$ – registration signal of action directed product giving (section of RQD port); $rq_p(t)$ – registration signal of energy product giving (section of RQP port); cd(t) – signal of change of action directed product quality parameter (section of CD port); $pq_d(t)$ – registration signal of finished product issue (section of PQD port).

The initial condition of the system is determined by the temperature of the external environment which impact is considered by the introduction of the section of the RE port.

Heating of ADP is performed to the set level which moves on the section input of the ZET port of the control subsystem.

If to consider another system of the converting type (crushing, melting, synthesis, movement etc.), the model of the technological subsystem will change only relatively the internal device of the basic mechanism (BM). Also the quantity of action directed products, for example, in the system of mixing, can change.

– ADP quantitative parameters on the input and output of the basic mechanism;

– Quantitative parameters of the energy product;

– ADP qualitative parameters.

Thus, the conceptual model of the technological subsystem demands access only to one parameter that is connected with the features of the physics of the process of the basic mechanism – information about the ADP qualitative parameter.

However, as it will be shown further, this parameter is necessary only to determine the moment of completion of the energy product giving.

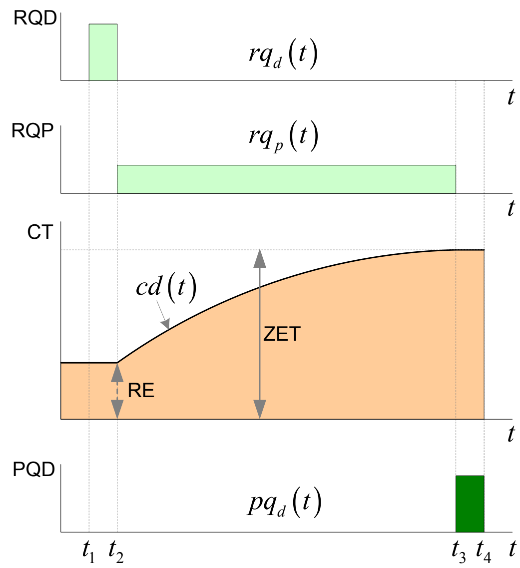

Fig. 4. Registration signals of internal products movement of the technological subsystem

Considering that in relation to the external observer the converting function of input technological products to output products is provided by one object – the technological subsystem, the converting process of the technological subsystem is provided by forming of the technological operation.

Input products of the technological subsystem are ADP and energy products.

External output products concerning the system are: the finished product, accompanying product and by-product.

Intrasystem output products of the technological subsystem are information products, displaying quantitative and qualitative parameters of technological products.

Thus, the internal architecture of the technological subsystem is determined by complete mechanisms, each of which provides the converting function of technological products.

Definition 1: The technological subsystem is an object of the converting system that provides transformation of input technological products to the finished product, accompanying product, by-product and information products that display quantitative and qualitative parameters of a technological process.

4. 2. Control subsystem

To provide the ADP supply, supply and interruption in supply of energy products, and also issue of the finished and accompanying products, it is necessary to control the moments of the beginning and completion of complete operations.

We will determine the object that provides transformation of information products (signals) of a technological subsystem to the information products, displaying the moments of the beginning and completion of operations of complete mechanisms by the "control subsystem" concept.

Combining complete mechanisms for determining the start or completion of complex operations in the subsystem of internal control is necessary because, as will be shown below, the output products of the internal control subsystem are used by all, without exception, information subsystems.

Registration signals of the technological subsystem get to the sections RQD, CD, PQD and the corresponding sections of the control subsystem (Fig. 5).

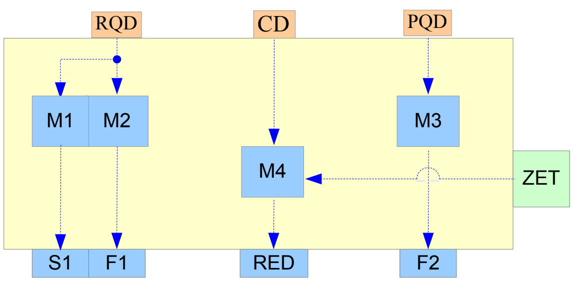

Fig. 5. Conceptual model of the control subsystem

Here, S1 – issuing section of the start moment registration signal of ADP feeding; F1 – issuing section of the completion moment registration signal of ADP feeding; RED – issuing section of registration signal of achievement ADP of the set quality; F2 – issuing section of the completion moment registration signal of finished product producing; M1 – signal formation mechanism of the beginning of ADP giving; M2 – signal formation mechanism about completion of ADP giving; M3 – mechanism of forming of signal of completion of finished product issue; M4 – signal formation mechanism about achieving conversion product a given quality; ZET – signal supplying section of heating temperature set point.

Mechanisms of this subsystem form the signals, registering characteristic timepoints (Fig. 6).

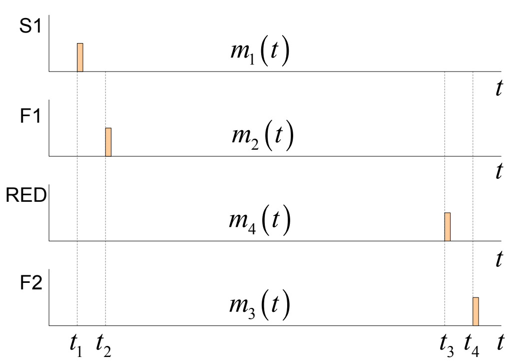

Fig. 6. Registration signals about products movement of the internal control subsystem

So, at the exit of the M1 mechanism, the pulse signal $m_1(t)$ of the moment of the beginning of the ADP giving is formed (the first ADP, if more than one). At the output of the M2 mechanism, the signal $m_2(t)$ about the completion of the ADP supply is formed (the last ADP, if more than one). At the output of the M3 mechanism, the completion signal $m_3(t)$ about issuing the final product is formed.

The M4 mechanism provides delivery of the registration signal $m_4(t)$ at the moment when the quality indicator of PNV reaches the level established in the section ETL.

Apparently, the processes of the internal control subsystem of the converting IS form the signals connected with registration of the characteristic moments for any system operation:

– Moment of the system operation start;
– Moment of completion of the ADP supply;
– The moment of achievement of the set quality of ADP;
– Moment of completion of the system operation.

Definition 2: The subsystem of internal control is an object of the executive system which provides the converting process of information products of a technological subsystem and the reference information product of quality to information signals of registration of the moments of the beginning and completion of internal complete operations of a technological subsystem.

4. 3. Coordination subsystem

Functioning of the converting executive system is ensured by its interaction with the consumption executive system and supply of necessary technological products. Functions of intersystem interaction are also provided by the coordination subsystem (Fig. 7).

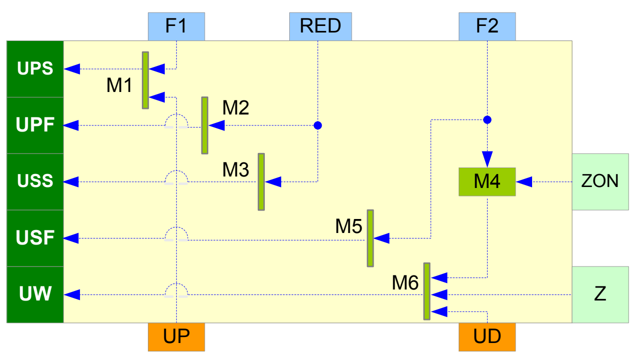

Fig. 7. Conceptual model of the coordination subsystem: UP – section of the signal displaying the intensity of the energy product supply; UD – section of the signal issue displaying the ADP supply amount

Except for the M4 mechanism providing the start of the executive system of the converting type, all remaining mechanisms of the coordination subsystem are represented by the objects that provide a function of synchronization and intersystem coordination. The M4 mechanism provides the OR function performance.

External input products of the coordination subsystem are: initialization signal of the functioning start and command signal from the consumer of the finished product of the converting system.

The first operation of the converting ES is provided by the start signal supply through the section ZON. Subsequently, the signals at the output of the M6 mechanism are generated when the finished product dispensing operation is complete.

In the section UD, a signal that determines the amount of the action directed product, required for the conversion system, is established. The command signal that comes to the section Z, leads to formation of the pulse signal at the output of M6 and transfer of it to the section UW. The control signal on supply in the converting system of a certain amount of the action directed product (ADP) $rq_D(t)$ (Fig. 8) is thus created.

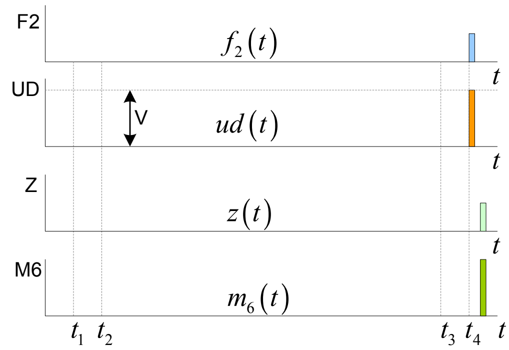

Fig. 8. The registration signals of products movement, connected with forming of control for the action directed product supply: $f_2(t)$ — a registration signal of the moment of completion of the finished product issue; V — amount of the ADP supply

As on one of the entrances of the M1 mechanism the signal of intensity of the energy product supply is established (section UP), the registration signal of the operation completion of the ADP supply (section F1) provides forming of the control signal at the M1 mechanism exit. This signal provides the process of continuous energy product supply in the executive system with the established intensity of $rq_P(t)$ (Fig. 9).

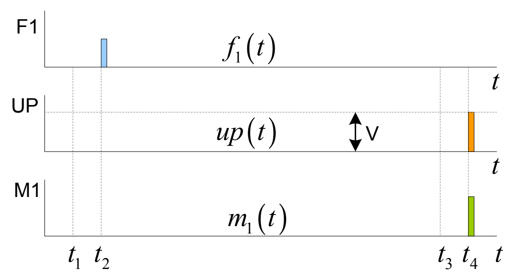

Fig. 9. The registration signals of products movement connected with control forming for the energy product supply in the basic mechanism: $f_1(t)$ — a registration signal of the moment of completion of the ADP supply; V — intensity of the energy product supply

The forming of the signal of achieving the desired quality of ADP in the section RED causes the signal to stop supply of the energy product in the basic mechanism and begin to supply the energy product to the service mechanism of the finished product issuance (Fig. 10).

Finally, the high level of the pulse signal in the F2 section turns off the power of the service mechanism (Fig. 11).

Mechanisms M2, M3 and M5 carry out only the function of intersystem coordination.

Thus, the subsystem of coordination carries out the functions of system interaction that are necessary for any system:

– Ensuring the ADP supply of the set volume;
– Energy product supply with the set intensity;
– Completion of the energy product supply;
– Start and stop of the service mechanism of the ADP issuance.

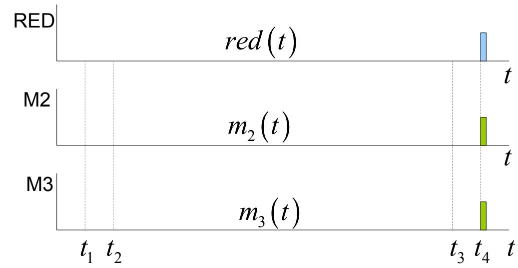

Fig. 10. The registration signals of products movement connected with stopping of the energy product supply in the heating mechanism and beginning of the energy product supply in the service mechanism

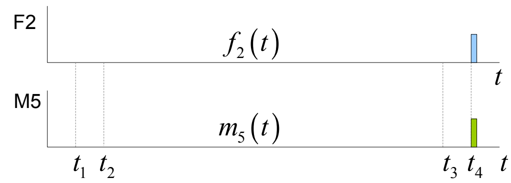

Fig. 11. The registration signals of products movement connected with interruption of the energy product supply in the service mechanism

Definition 3: The subsystem of coordination is an executive system object that provides the interaction of the converting system with external systems.

4. 4. Registration subsystem

The features of functioning of the mechanisms of the registration subsystem are connected with the need of basic functions receiving of input and output or the basic indicators of the target operation [15] that provide a possibility of numerical determination of basic indicators values. Collection and storage of basic indicators are necessary for calculation of the optimization criterion (Fig. 12).

And if the global optimum search procedure can be performed with the use of different methods of extremum determination, determination of such initial data for its search as an expert evaluation of input operation products (RE), operation time (T_{OP}) and an expert evaluation of output operation products (PE), is a standard procedure. For this reason, it is reasonable to allocate the complete mechanisms provide the issue of products in the form of global operation parameters, in the registration subsystem.

When the distributed parameters of resources consumption and resource productivity can't be neglected, instead of triple definition (RE, T_{OP}, PE), the input function and the output function shall be defined [14]. In that case, the registration subsystem won't contain the timer and integrators. Therefore, it is reasonable to allocate the complete mechanisms that provide forming of RE, TOP and PE output information products in a separate subsystem.

The mechanism F serves for the wear determination of the basic mechanism as a function of its operation intensity.

In the sections RSD, RSP, RSF and PS, the signals that display the cost estimates of the conversion products unit are given.

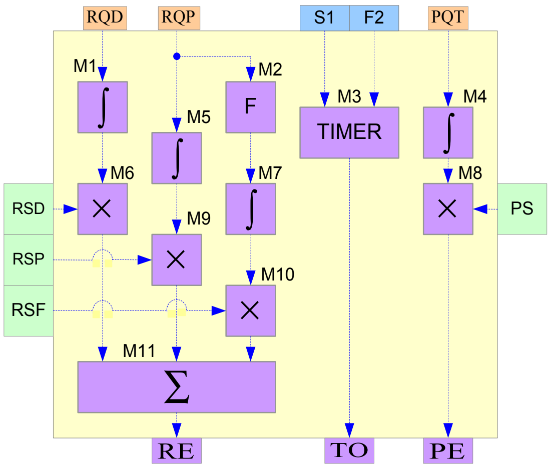

Fig. 12. Conceptual model of the registration subsystem: RE – section of producing a signal that displays the expert evaluation of input operation products; TO – section of producing a signal that displays the operation time; PE – section of producing a signal that displays the expert evaluation of operation output products

In this case, in the RE, TO and PE port sections of the registration subsystem, the basic indicators are created. Accordingly, the indicators display the operating costs assessment (RE), operation time (TO) and the cost assessment of the final product (PE) of the converting system.

The principle of functioning of the registration subsystem is considered in detail in [16].

Definition 4: The registration subsystem is an executive system object that provides the determination, collection, processing and storage of the data, determining the global parameters of the converting system in the form of the input function and the output function. In case, if the resources consumption and/or resource productivity distributed parameters can be neglected, the global parameters of the converting system can be presented in the form of the triple (RE, TOP, PE).

4. 5. Optimization subsystem

There is only one global extremum, if the basic mechanism of the technological subsystem carries out one function within the admissible controls (PE>RE) (in this example, heating of the portion of liquid to the set temperature) [15]. In this case, the optimization process can be based on, for example, using the successive approximation by the half-interval method. Then input products of the optimization subsystem are:

– The moment of the start of the technological operation (section S1);

– The moment of the finish of the technological operation (section F2);

– The estimate cost of the technological operation products (section RE);

– The technological operation time (section TO);

– The estimate cost of the finished operation product (section PE);

– The step of control changes (section S);

– The threshold value of the minimum step (section S_FIN);

– The initial sign (+/–) of control changes (section D_STR);

– The current sign (+/–) of control changes (section D);

– The lower limit on the control value (section U_MIN);

– The top limit on the control value (section U_MAX);

– The initialization signal of the optimization process (section CHG).

The output subsystem product is the control value that is directed in the section [UP] of the coordination subsystem (Fig. 13).

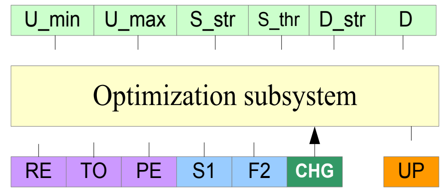

Fig. 13. Interface model of the optimization subsystem

Other ways to find the maximum optimization criterion value will lead to the change in the internal architecture of the optimization subsystem.

Definition 5: Optimization subsystem is the object of the executive system, the output products of which are parameters of the control signals that provide the maximum optimization criterion value within the set restrictions.

5. Definition of the executive system as an object structure consisting of subsystems

The research has shown that the converting system can be presented in the form of five subsystems: the technological subsystem, control subsystem, coordination subsystem, registration subsystem and optimization subsystem (Fig. 14).

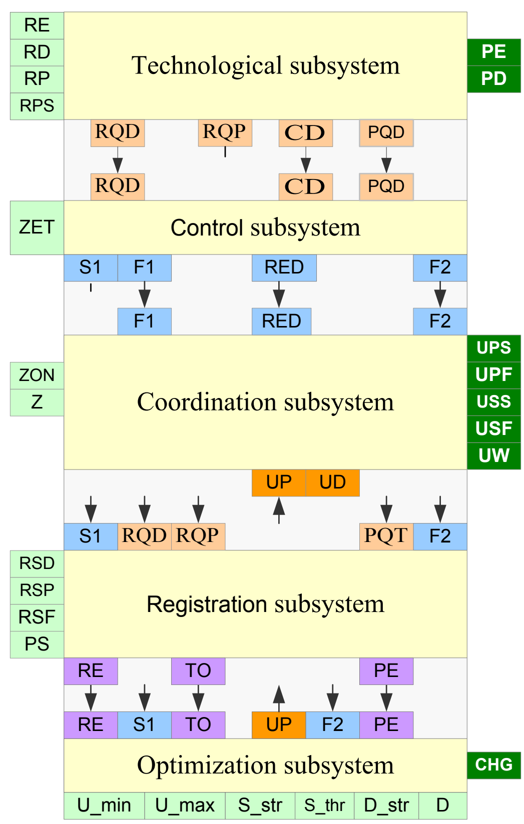

Fig. 14. The converting system in the form of subsystems

Each of these subsystems carries out the own system function.

The section of the UD port is obviously not connected with the optimization subsystem.

It is connected with the fact that the example of the system structure is given in the considered system, within which only energy consumption is optimized.

The volume of the ADP supply can be carried out, for example, manually. The ADP volume can be also practically optimized. It is one more reason for which the internal structure of the optimization subsystem wasn't considered. Considering the existence of the developed computer aids and the set of the fulfilled algorithms of multiple parameter optimizations, consideration of this issue is the subject of a separate research.

Definition 6. The converting system is an object structure representing a set of in a certain way interrelated channel-forming mechanisms and conversion mechanisms integrated with them.

The processes of the converting system are aimed at providing basic technological process, coordinated with the processes of the interacting supply systems, consumption of exchange products and naturally connected with the environment.

The exchange of the converting system with the environment is performed by means of an exchange of accompanying products of the converting process and the impact of the products of the external environment on the system.

6. Discussion of the results of the researches connected with development of the architecture of converting systems of physical products

The researches have shown that the converting system of the ADP of the physical nature can be presented in the form of five subsystems. Among these subsystems, there was no place for the control subsystem. It is connected with the fact that the functions of the object exercising control aren't defined. Of course, the control subsystem can be considered as all complete mechanisms that are not included in a technological subsystem. In that case, any system can be considered to consist of the technological subsystem and the control subsystem. But then there is a problem concerning division of the control subsystem into knots or modules.

The decision on allocation of such subsystems was based on the functional principle of the formed object. As a control, the principle of structural optimization was used. That is, if such information product as the moment of completion of the ADP issue, is necessary for the coordination, registration and optimization subsystems, its forming is provided within one subsystem.

Besides, the developed architecture of the system increases its "survivability". So, failure of any mechanism of the most complex registration and optimization subsystems turns the optimum system into a simple system (Fig. 15).

At the same time, the use of manual command of signals in sections of the UD and UP ports provides functioning of the system in the interaction mode without the optimum search process automation.

This factor is especially important in structures where the stop of the process leads to higher expenses, than a benefit from automatic optimization.

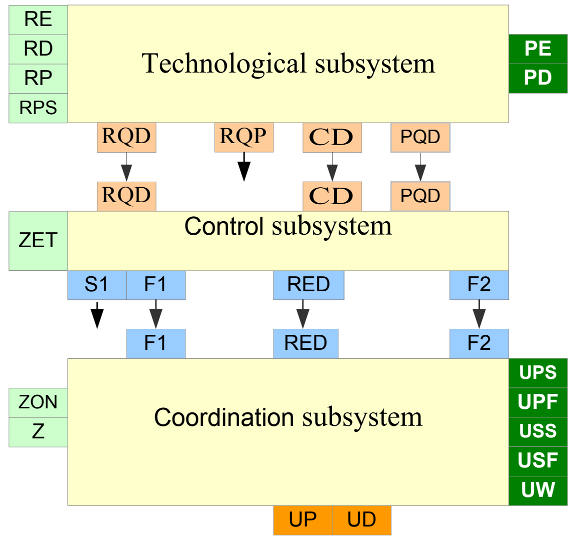

Fig. 15. Simple converting system

7. Conclusions

1. It is established that the converting system consists of the technological subsystem, control subsystem, registration subsystem, coordination subsystem and optimization subsystems.

2. Internal output products of the technological subsystem are registration signals of quantitative parameters of technological products and the quality parameter of the result of action directed products conversion. The model of the structure of the technological subsystem is created.

3. It is established that the input products of the control subsystem are the registration signals of action directed products of the technological subsystem, the finished product, the quality condition of action directed products and the set value of the quality level.

Output products of the control subsystem are: the moment of the beginning of the first ADP supply (the action directed product), the moment of completion of the last ADP supply, the moment of achievement of the set value of the quality process parameter and the moment of completion of the issue of the finished product.

The model of the structure of the control subsystem is created.

4. It is established that the input products of the coordination subsystem are output products of the control subsystem: the registration signal of the moment of the beginning of the first ADP supply; the moment of achievement the set quality by the transformation product; the moment of completion of the finished product issue.

The input products of external systems are: the command signal and the signal of initial initialization of the converting system. Input products of the optimization subsystem are: the amount of the action directed product supply and the intensity of the energy product supply. Output products of the coordination subsystem are the control signals for systems of the technological products supply. The model of the structure of the coordination subsystem is synthesized.

5. It is established that the input products of the registration subsystem are the output products of external systems

– the expert evaluations of technological products, quantitative parameters of registration signals of the technological subsystem and registration signals of the beginning of the ADP supply and completion of the finished product issue of the control subsystem. Output products of the registration system are the input function and the output function (target signature). The model of the structure of the registration subsystem is created.

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