Strategic terminal integration of game system and information resource consepts as a basis of analysis of energy active interaction of technogenic and ecological systems

Lubomir Sikora [1[0000-0002-7446-1980]], Natalia Lysa [1[0000-0001-5513-9614]], Rostislav Tkachuk [2[0000-0001-9137-1891]] Valentine Kunchenko-Kharchenko [3[0000-0002-8971-1217]],

Yurii Kryvenchuk [1[0000-0002-2504-5833]]

[1]Lviv Polytechnic National University, Lviv 79013, Ukraine
[2]Lviv State University of Life Safety, Lviv 790007, Ukraine
[3]Cherkasy state technological university, Cherkasy 18006, Ukraine
lssikora@gmail.com, lysa.nataly@gmail.com, Rlvtk@ukr.net,
itib@chdtu.edu.ua, yurkokryvenchuk@gmail.com

Abstract. Modern accelerated development man-made production structures let to the development of concentration of harmful emission and their volume in eco-environments (ground, water, atmosphere), also contamination of villages, cities and towns has increased. Complication of technological processes, growth of production capacities of thermal power plants, transportation, oil and gas industry, which includes energy – efficient objects, complicated the process and management, which led to a decrease in certain areas of their level of safety and increased the risk of accidents and catastrophies.

Keywords: system, game, information, strategy, control, data analysis, problem, risk

1   Introduction

Scattering of socially communicable and technogenic large structures carries a cyclic terminal character and is characterized by time power from month to years. According to the given tasks and the cycle of development and influence of factors on these structures we must coordinate their functional activity taking into account their hierarchical organization. Form their financial resource, information factors on these structures of direction leads to a mismatch of deliberate purposeful management to the emergence of conflicts in and between the system and between them and the risks of the emergence of conflicts in the hierarchy and the risks of emergencies. The level

of risks of accidents and man-made catastrophes depends on many systems and factors of system reliability.

Reliability and quality of projects of technogenic systems, model and algorithms of functioning.

Quality of structures, units, components, method of their installation.

Conformity of the constructed structures to the exact requirements, methods of their laying and testing for introduction into the exploitation.

Quality of strategies, algorithms for data processing and management decisions.

Quality of training (engineering, knowledge, practical, etc.) of production and practical personnel, as well as their positive and negative features.

Preparation of resources for the production process and their quality.

The ability to withstand resource and information attacks on a technogenic system.

Ability to withstand information and mental-psychological attacks on operational and management personnel when making management decisions.

All these aspects of risk assessment have both strategic and game character and determine the dynamics of processes in technogenic systems, as well as the level and nature of the impact on the environment.

Substantiate the method of minimizing the risks of the impact of technogenic systems on the eco-environment based on game, system and information technologies.

Research tasks: to solve the given problem we need to find the solution of the given tasks and methods:

- To analyze the problem of minimizing the risks of the impact of techogenic systems on the environment
- To carry out the analysis of literary sources in which this problem is considered.
- Justify the methods for solving problems
- To analyze the causes and factors of emergence of conflict situations, both technical and informative.
- To develop game models of management strategies.
- To develop the method of conflict resolution in technogenic systems.
- To develop the method of structuring of the system and its integration.
- To justify the system game and the way it is presented.
- To build a general scheme of interaction of technogenic systems that generate harmful emissions with the ecological and social environment of coordination strategies for eco-protection and technology of deep waste treatment.
- To justify new man-made characteristics and their nature and impact on the environment.

2   State of arts

According to the given tasks we are going to made an analysis of the literary sources for last period, which depict the state of the problem of environmental technogenic safety.

In this paper (1-3) are considered the problems of making automated process control system of new generation on the base of microprocessor structures and information technology and system analysis, in the directory is systematized information about the aggressive complexes of automated control systems, structural organization, methodology of system design without disclosing the psychology of management.

In this paper (4) is considered the theory of making decisions and the procedures of constructing equilibrium strategies in the case of mismatch of strategic interests of corporate players, methods of overcoming conflict situations on the basis of system analysis are considered.

In this paper (5-10) are considered the reasons of origins and ways of overcoming corporate conflict protection methods and activities in the face of threats based on the classical approach to situation analysis.

In this paper (11) situational management paradigm for the first time is developed as a method of managing complex systems of technical and organizational class using artificial intelligence theory of theory of knowledge of logic of decision making.

This monograph (12) describes the methods of discrete mathematics that are used to model complex systems of different nature. Was made the analysis of decision-making problems of group choice logic of strategic behavior of system methods and methods of situation description.

In this paper (13) is considered the problem selection of data as a basis for the sufficiency of information about the state of the object that is required for management decisions.

In this paper (14-19) is considered and outlines the basics and methods of assessing the quality of information for decision making in production systems. Also were made the methods of estimation of reliability of data on a condition of objects and methods of the description of dynamic models. The method of synthesis of data processing structures is substantiated.

In this paper (20) was made an analysis of ways of thinking when making decisions in different situations, formulating the concept of systematic thinking of the person.

Mathematical aspects of constructing model of purposeful behavior of a person at decision-making and psychology of actions are considered in the collection of works (21).

Monograph (22) is devoted to the study of the basic problems of logic of action, dynamic and static aspects of definition of action, semantics, game-theoretic models of processes of decisions on which the principles of management are formed.

The monograph (24) describes methods of analysis of reliability and safety of technical systems, analytical analysis and methods of probable modeling and methods of estimation of risks of emergencies.

The monograph (25) deals with theoretical systemic and logical-mathematical foundations of socially-territorial complex-formed and information-consistent structures, problems of interaction of society with nature and models of integration of sciences, theory of formation of structures is developed.

Monographs (26-27) are devoted to the methods of risk analysis and safety of industrial enterprises, the main causes of accidents, their consequences, risk analysis.

In monographs (28-37) are formed the main provisions of information-resource concept of analysis and synthesis of management systems of complex objects. Techniques for forming control strategies in the target space of the system under conditions of disturbance action based on game and resource-information concepts have been developed.

In works (38-39) the concept of creation of regional center for decision-making on ensuring the protection of the population and objects of life support from NPPs, hydraulic structures, earthquakes is substantiated.

In article (40) processes of destabilization of ecological systems under the influence of technogenic structures – pollutants are considered, strategies of sustainable development and process of destruction of mechanical systems and their information interpretation are considered.

In the fundamental work (41-42) the energy theory of stochastic signals is considered as a basis for the analysis of factors and methods of construction of laser systems based on it.

In works (43-46) methods of analysis of dynamics of behavior of complex systems, state control, detection of factors of active destruction of structure of technogenic objects, state control are considered.

3 Causal factors of man-made accidents

Causal factors of man-made accidents are mistakes which were made during designing, limited knowledge of the structure of technological systems and power systems, gaps in understanding information about the dynamics of the destructive processes that may occur during the operation of energy-active objects. Game concept of interaction (active factors – technogenic systems) is the basis for revealing the system, information and energy structure of processes of destruction of technogenic objects due to the imposition of unpredictable factors, which due to the limited knowledge of operators can not be taken into account and, accordingly, to predict.

On the basis of game and system models, as the basic principles of the analysis of the interaction of technogenic, ecological and social systems, it is necessary to build general schemes of hierarchical organization of regional society. The solution of this problem will allow to analyze the available resources for production and vital activity of the person and society, to assess the risks and the likelihood of conflicts in the allocation of resources. This approach which is addressing to the safety of life provides the basis for a thorough analysis of the interconnections of the production complex with resources and the eco-environment, as well as the opportunity to provide deep processing of hazardous waste.

Problematic tasks of management of technogenic systems with the energy-active objects are relevant as in energy, petrochemical industry, aviation, transport and social structures, because the level of pollution of the ecosystem of the regions in which they operate depends on the qualities of strategies for managing resources and objects. To solve the problem of improving the efficiency of production structures, to reduce the level of pollution, it is necessary to form an appropriate level of training of per-

sonnel, who would have knowledge of different levels – from technological to pre-system information technologies. The solution of this problem will allow to introduce long-term impact of harmless technical emissions in the eco-environment of the region where there are potentially dangerous objects. For system with a hierarchical structure of organization of management characteristic of cognitive system of operational personnel decision – making is the existing gaps in knowledge about the structure of objects, the processes of automatic and operational management, the system of selection and processing of data necessary for making both local and system decisions at the strategic level of the hierarchy, which minimize the risk of accidents due to a clear understanding of emerging crisis situations.

4   Analysis of risk minimization tasks

4.1   Systematic game of targeted technological structures in boundary models of resource allocation

Systematic game of targeted structures $Gr\left(CUS_1 \otimes CUS_2\right)$ is based on strategies of resource allocation and coordination of management actions and accordingly occurs at the managerial level according to the objectives of functioning (pic. 1) when fulfilling the conditions of the balance of material and energy resources.

Let's consider the basic schemes of interaction of participants of paired information of the game in the structure of technological system. The following structures of the game participants are set accordingly (28-33):

− $\left\{IVF \otimes CUS\right\}_P$ − perturbation factors of system parameters CUS source of interference IVF, which has channels of influence on the technological process;

− $\left\{CUS_1 \otimes CUS_2\right\}_{Str}$ − perturbation factor structure of the system CUS_2, as an adversary to the realization of the purpose of functioning (the break of the functional bonds);

− $\left\{CUS_1 \otimes CUS_2\right\}_{Strat}$ − perturbations of system strategies CUS_2, due to misinformation (in estimating the parameters of state trajectory);

− $\left\{CUS_1 \otimes IR\right\} \otimes \left\{CUS_2, IR\right\}$ − the struggle for resources between structures CUS_1 and CUS_2 (material, energetic, informational, financial);

− $\left\{ TБ_i \otimes TБ_j \mid Cus\left[Strat\, U \mid C_{TП}\right]\right\}$ − resource conflicts and races between technology blocks.

The state of the system is determined by the balance of resources in the research structure, with effective game strategies in place that determine their distribution based on load energy – efficient units (28-30).

$$\left[\sum_{i=1}^{m}\Phi_{вх_i}^{R}\left(U,\tau,\xi\right)-\sum_{j=1}^{m}\mu_j\Phi_{вих_j}^{PR}\left(t,\eta\right)\right]=\Delta\Phi\left(U,\xi,\eta,t\right),$$

$$\exists Strat U_{\Phi R}\left(C_i\right): \Delta\Phi(\ ) \subset I_{\Delta opt} \overset{\Delta}{=} \left[z_C - \varepsilon,\, z_C + \varepsilon\right]\mu_{FZ}, \quad \forall\left|\xi(t)\right| \le \alpha_0, \quad \forall\left|\eta(t)\right| \le \beta_0$$

де $z_C \in V_\varepsilon\left(C \mid R \times\right)$ – the target status of the technological system.
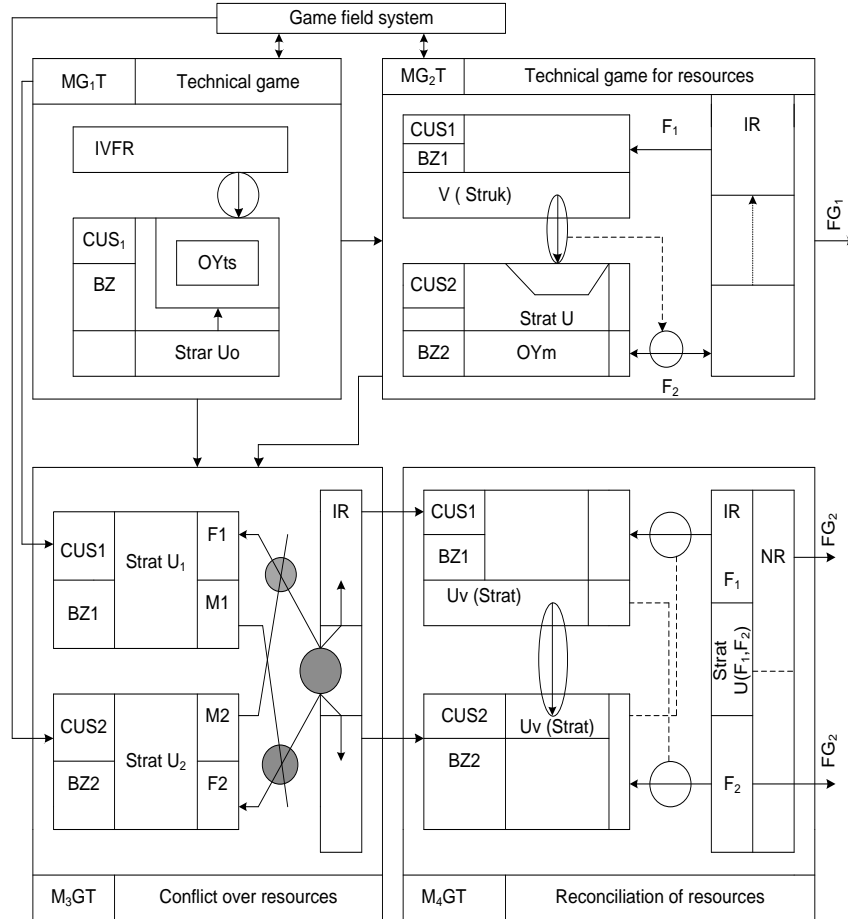
Fig. 1. Structural models of scenarios of co-operating systems interaction in paired play

where $Z(t) \in I_Z \subset R$ – implementation of the state trajectory; $\dim I_Z = \left[\max Z - \min Z\right]$ – the permissible limits of the status parameter interval; $GRAF\left(Z(t)\right) = \underset{Z,t}{E}\left\{\left(Z(t),t\right) \in I_Z \times T_n\right\}$ – a graph of the spatial structure of the trajectory in the state space $\left[I_Z \times T_n\right]$; Z_0 – the initial state of the system, $\left[I_Z \times I_{\frac{d}{dt}Z}\right]$ – phase space; CUSi – purposeful system; FG1,2 – field of game. Due to the actions development sceneries in this game will M1GT be a technological game in structure M1GT, M2GT – a model of interaction and distribution of resources, M3GT – a mod-

el of conflict and distribution of material and energetic recourses, MGn – a strategy of reconciliation of interests. The overall balance of material resources in the terminal management decision – making strategy according to the load regime is described by the behavior of a random process trajectory model, which is formed on the basis of interaction in the technological structure of local components of resource flows and reflects the dynamic state of the system through the trajectory of balance dynamics in the form of information situation functioning. Structure of target space is determined by the procedure (strategy) for solving the problem, models of state space and phase of the control object and its energy characteristics interconnected through isomorphic operators of object dynamics. Based on the study of the situational behavior of the level of the trajectory of the state OU, when the conditions of the balance of resources are fulfilled the procedures of classification of possible states of objects of management and the strategies of movement to the goal are formed (28-37, 46).

For impulse flows, the state trajectory model is determined on the basis of dynamics modeling according to the equation of (nonlinear) balance of resources, relative to the region of stable equilibrium, in the conditions of disturbances and constraints on resources:

$$GRAF\left[Z\left(t\,|\,T_n\right)\right] = Z_0 + \int_t^{t+T_n} A_{Z\Phi}\left(t,\theta\right)\left[\sum_{i=1}^m \Phi_{ex}\left(t,U_i\right) - \sum_{j=1}^m \Phi_{eux}\left(t,\xi\right)dt\right]$$

according to game models on two competing systems.

## 4.2   Dynamics of game flows and flows and balance strategies

For each participant who will take part in the game, like an intellectual system, that makes decisions which are directed to achieve the goal, a characteristic feature is the way to formulate management strategies based on the possible behavior of a competitor, based on the equations of dynamics that describe the behavior of players in the target space, both each player and in common. The dynamics of player interaction is determined by the joint solution of the system of equations over the interval of time (Tn) according to the distribution of available resources and goals (30-33) (pic. 2):

$$\begin{cases} \dfrac{dZ_1(t)}{dt} = F_1\left(x_1,U_1,t\right) + F_{12}\left(U_2,\xi_2,t\right), \exists U_! \in Strat\left(U/C_1\right), \forall t \in T_n \\ \exists PRPSyt\left(Strat\left(U/C_1\right) \xleftarrow{\ I_s\ } Strat\left(t/C_2\right)\right) \\ \dfrac{dZ_2(t)}{dt} = F_2\left(x_2,U_2,t\right) + F_{21}\left(U_1,\xi 1_2,t\right), \exists U_2 \in Strat\left(U/C_2\right), \forall t \in T_n \end{cases} .$$

Management strategies are based on conceptual models of situation classification, that is estimation of belonging of a trajectory of a state to the designated, by certain criteria, class of target space and selection of the command of management which removes the system in the corresponding target task class. Given the following structure of the division of classes, as n-dimensional sets: $\left\{K_i\right\}_{i=1}^m \times T_n \triangleq KL_I$ – invariant systematic classification of the partitioning of the space of goals in the continuous interval of time of functioning of the game structure; $\left\{K_i\right\}_{j=1}^m \times \left\{T_K\right\}_{K=1}^m \triangleq KL_{II}$ locally

invariant classification of partition of target space and states with respect of terminal control cycles.

The introduction of such a division of classes makes it possible to form the principles of synthesis of local and global behavior strategies based on the behavior of methods of their resource and situational management D. Pospelova (11).
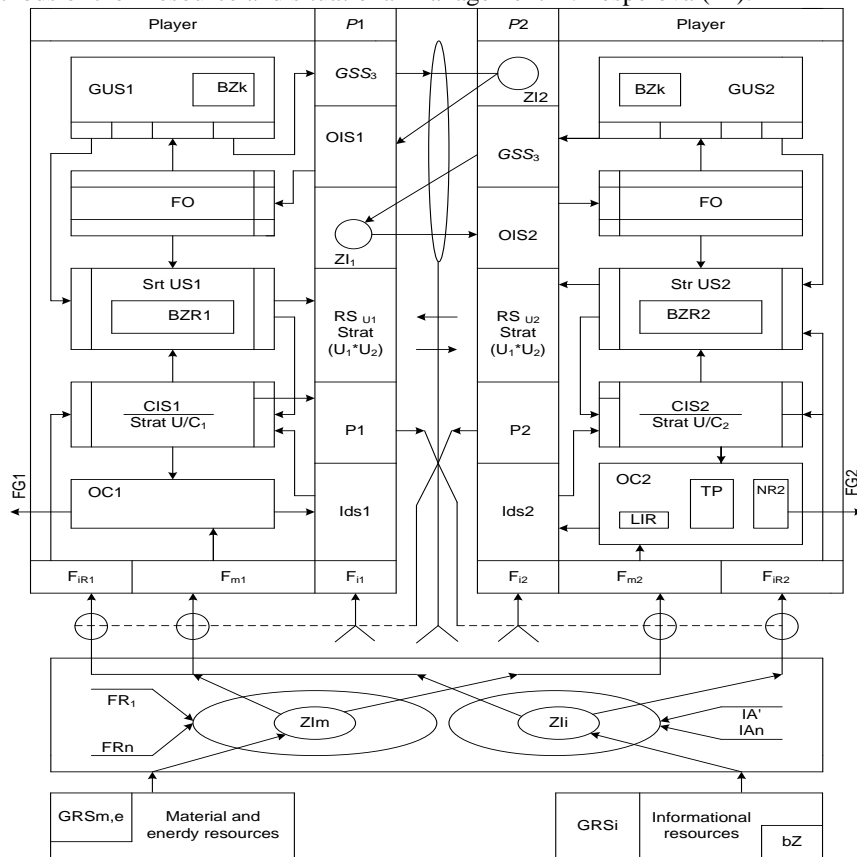
Fig. 2. Model of a gaming system that uses a common source of resources based on the coordination of conflict – free game strategies.

Where OISi – observational information systems; Idsi – images of the dynamic situation in the object of the game; FRi – factors of influence on resources; IAi – informational atacks; $\{GRS_{mi}\}$ – global resource delivery systems; P1, P2 – players; ZI – zones of interaction; FG1,2 – field of game; GSS3 – generation of sounding signals for data collection; RSi – resource steams; BLRi – base of logical rules; Fip – factors affecting resource and information flows; OC – object control; TP – technological process.

Methodology and systemology for analyzing the dynamics of the trajectory of the technological system, based on equations of the balance of resources, is based on the methods of parametric and non-parametric statistics; decision theory in uncertainty; of

estimations of statistics on the membership of images of dynamic situations in the present time to alternative classes of reference models of state space partitioning. Each class is matched by local decision-making strategies (which are elements of global politics), which allows the management team to move the system to the target area, that is to describe the procedure for solving the problem of resource allocation in the target space of the system and avoiding conflicts.

4.3   Adaptation and coordination of management strategies

In the case of a situation where the target problem is not solved, procedures (if available) are formed to adapt the strategies to achieve the goal of disturbance and interference, based on the additional study of the problem. This requires the creation of a new model of the problem and the target situation in the technological structure, the assessment of available resources, which leads to a change in the trajectory of movement and terminal time (13-22).

Synthesis of goal achievement strategies in a feedback management system, is based on refining the goal model and how to implement it with limited resources, as procedures of solving the goal.

Synthesis of behavior of the system, with a given structure of the conditions of perturbations and large-scale interference is based on the use of typical models of strategies to achieve goals, which are reflected through the lanes of the direction of possible trajectories in the target area. Estimation of threshold pollution, which lead to technological failure due to distortion of information on the state of the system in the mode of situation estimation and decision making, is the basis for the choice of cases of algorithms for signal processing with robust properties. Synthesis of strategies for correction of models and parameters of the system in the evolution of the control and control system is based on methods and procedures, algorithms for solving the target problem, which are verified by classes of reference solutions of problems.

Efficient estimation of strong obstacles and correction of optimal algorithms for signal processing and ensuring their robustness, as well as adequate filtering from obstacles from the point of view of obtaining the correct information for forming the image of the situation in the target space are the basis of decision making in the condition of uncertainty of the dynamic situation with respect to the target. Correction of data processing algorithms for dynamic pattern formation is based on procedures for evaluating the behavior of quality functionals in perturbation zones.

Correction of management object models and goal achievement strategies is carried out(in crisis conditions) based on the availability of problem of problem solving procedures, which requires a series of procedures [30-33].

Verification of conditions of achievement of goals and estimation of means and volumes of resources;

Assessment of availability and mobility of resources for the implementation of objectives in critical conditions;

Adjustments to target entry strategies and availability of resources at the time of conflict.

Optimization of the crisis management of the system is carried out taking into account knowledge of the structure, dynamics and purpose of the system and is based on the formation of quality functional, components of which will be indicator functions of saving resources, terminal time to achieve the goal, accuracy of maintaining the functional state. Optimization of signal processing algorithms and control strategies for each game participant in the technological structure is carried out based on the structure of the target task to study the statistical characteristics of the signal trajectory and interference, as well as on basis of checking the correspondence of signal models to the processing algorithms, the conditions for ensuring their robustness and information are fulfilled, subject to coordination of resource sharing strategies (7-11) (pic. 3).
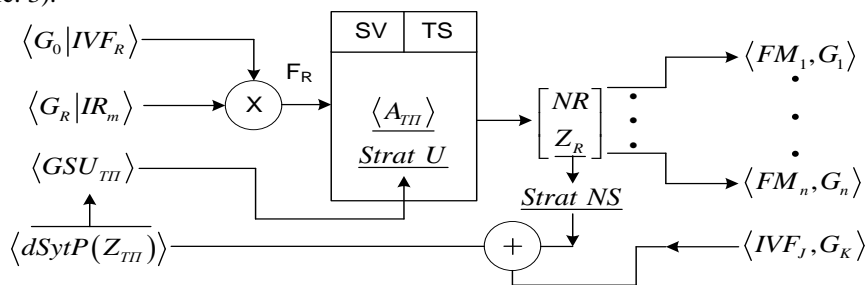

Fig. 3. Participants of the technological game

Where, TS – a technological system as a zone of interaction; G0 – player, who depicts perturbation factors of the flow of resources; GK – perturbation of informational channels; GR – model of source of resources, which provides a technological process; {G1…Gn/Fn} – forming machines (operated by third party operator); {GSUTΠ/Strat U, Strat NS} – process control system, as a coordinator of the guaranteed balance allocation mode with the selected class of observation and management strategies aligned with the target.

4.4   Method of solving conflict situations

The problem of solving conflict situations in technological structures, with the interaction of active and passive participants in the game, requires for its solution the creation of a complex of conceptual models, a well-organized intellectual knowledge base, containing blocks of interconnected models of structure and dynamics of control and optimization strategies. Models of synthesis procedures of automated process control system and on their basis synthesis of conceptual model of technological structure, its parameterization with respect to the target space of states, determination of boundary and emergency models. These parametrized conceptual models are tested on stability according to Liapunov theory under the influence of perturbations with standard probabilistic characteristics [7-11, 28-37].

The set of requirements for accuracy and stability of automated process control system and the estimation of the parameters of the response to the perturbation determine the degree of roughness and are the informational basis for the synthesis of

robust algorithms for detecting and processing signals, that circulate in information channels of automated control system. This concept is the basis for the synthesis of conflict-free strategies for resource allocation and information support [28-34].

Having constructed on the basis of a conceptual model $CM\left[SU_{TII}\right]_{B2}$ – a control system of i-class which is defined by an algorithm of the solution of a problem target task of a parametric model [28-34]. For this we need to build the next components of the system:

Model 1. SSZ – State space at intervals:

- $\left\{I_R = \left\{Z_U^-, Z_0, Z_U^+\right\}\right.$ – Normal mode;
- $I_m = \left\{Z_{max}^+, Z_{max}^-\right\}$ – Allowable emissions;
- $I_A = \left\{Z_A^+, Z_A^-\right\}$ – Aerial areas.

Model 2. $\Phi\Pi\left(Z_{TII}, \dot{Z}_{TII}\right)$ – Phase space with a set of Liapunov's stability regions $\left\{\left|Z_T^+, Z_T^-\right|, \left|\dot{Z}_T^+, \dot{Z}_T^-\right|\right\}$ dynamic mode that determine the area of operation under the action of perturbations and changes in the intensity of flows $\left\{F_{R_1}, F_{R_n}\right\}$ on the control machines;

Model 3. $\Pi Cds\left(\hat{Z}_T / T_n\right)$ – Target space $\left\{I_Z \times R_T\right\}C_{U_i}$ terminal basis control cycle $\left\{CU_i\right\}$ based on the resource balance model relative to the equilibrium state $\left\{Z_0\right\}_{SR}^{DS}$:

$$\hat{Z}_{TII}\left(t / T_n\right) = Z_0 + \int_{t_0}^{t} A_{TII}\left(Z, \dot{Z}, t, \tau, \theta\right) \times \left[F_{ex}\left(U\left(\tau\right), t, \xi\right) - \sum_{i=1}^{m} F_{eux}\left(t, \theta, \eta\right)\right]dt + Z_{\xi}\left(t\right)$$

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Model 4. Model of choice of game space and dynamic description of situations when performing control actions.

The model of the game 4 space is formed on the basis of the compression of the parameters of the terminal time(cycles), the intervals of the parameters(L1) in the boundary mode, the target region, then.

$$\left\langle T_{gi}, I_{\theta}, L_n^+, L_g^+, L_A, L_m\right\rangle \xrightarrow{gr} \left\langle \Pi S \cong T_{gi} \times I_{\theta}\right\rangle \rightarrow \Pi Gr\left(CUS_1 \otimes CUS_2 \big| \Pi S_z\right)$$

– model of the game on ΠS_z.

According to the purpose of the task, we can model the behavior of the trajectory of the TS, which reflects the change in the level of the mode and the state during the action of disturbances on the resource flows and information channels.

Accordingly, the strategy of game behavior in the region of the location of industrial technogenic systems depends both on the quality of waste disposal of each structure in particular, and on the level of eco-control and policy and administrative parameters. In non-constructive conflict behavior, the risks are heightened, which can

lead to a man-made catastrophe with the emission of harmful substances in the absence of infrastructure for their deep processing and disposal (pic. 4).

The structure of harmful products depends on the type of coal fuel, the depth of processing, cleaning and grinding. The degree of grinding of coal dust provides high-quality combustion of (20-60) microns, and complete purification of flue gas of combustion products. In the presence of coal in the rock concentrate the quality of the fuel decreases, and consequently the level of power regime decreases the risk of contamination and accidents. In the structure of the smoke stream will be not only the gas components of the combustion products (CO, $CO2$, N, S), but also the dust components of the rock, which create dust bands scattered throughout the atmosphere.

The scheme of formation of risk of influence of harmful products on the ecosystem reflects the hierarchy of the game which includes the following components [36]:

– $\{PTS_i\}$ – production technological system;

– SNR – sources of natural resources (energy, air, water, etc.);

– SI and E – social infrastructure and the environment;

– SA – the system of assistants in the structure of the eco-monitoring system (SEM);

– SALTES – the system for assessing the level of technological and environmental safety;

– SAS – state administrative structure that develops coordinating strategies for industrial complexes $\left(BTC_i / i = \overset{n}{} \right)$ of productive technogenic systems;

– SISS – system infrastructure of life support of society (population).

To find the necessary vehicle control strategy, it is necessary to simulate in perturbations and play the game in the state spaces, goals, resources on the model for different perturbation classes, determine on the basis of the interval Liapunov`s region in phase space, and beyond them – the parameters of the strategy correction (pic. 4).
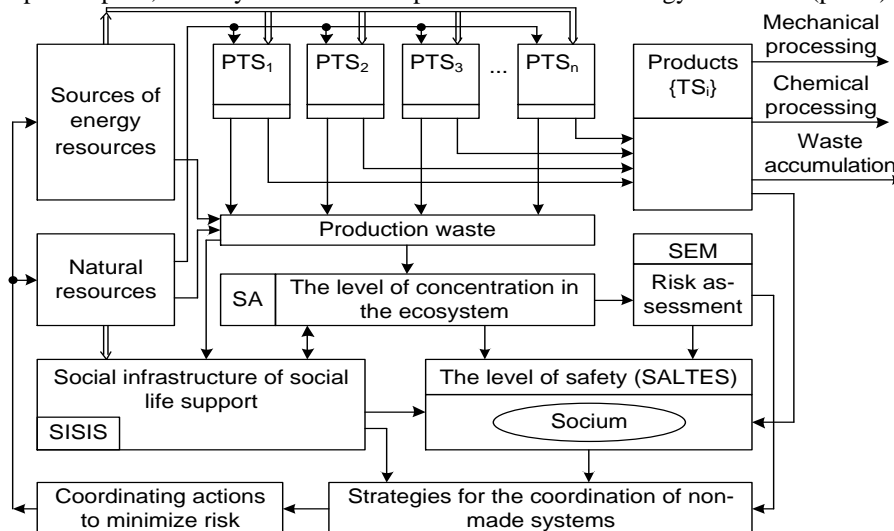
5   Results

At the TPP of Western Ukraine work was carried out using laser concentrates to control concentration of coal dust when fed to the boiler unit to improve the quality and energy efficiency of the combustion process, and at the same time to reduce the level of pollution by increasing the level of filtration depth.

Tabulated measurements are given.

Calculation of dust consentration in the power unit's pipelines №4

Pipeline A

	m_{i0}	$\sum m_i$	Δm_i	l_j	d_j	S_j	
1.	300	450	150	230	18	2,5	$C_k = \dfrac{\sum \Delta m_i}{Vt_i \times S}[\textit{г}/\textit{м}^3]$
2.	400	520	120	230	18	2,5	
3.	300	420	120	230	18	2,5	
4.	300	360	60	200	18	2,5	$C_k = \dfrac{0,74}{226 \cdot 10^{-4} \cdot 10 \cdot 10} = 3,2 \text{ g/m}^3$
5.	300	420	120	200	18	2,5	
6.	300	480	180	190	18	2,5	
			$\sum \Delta m_i$ 740,0			$\sum S_j$ 226 cm²	Flow rate $V_i = 10$ m/sec. Dust collection time $t_i = 10$ sec.

Pipeline B

	m_{i0}	$\sum m_i$	Δm_i	l_j	d_j	S_j	
1.	1320	1450	130	9	2,5	22,5	$C_k = \dfrac{\sum \Delta m_i}{Vt_i \times S}[\textit{г}/\textit{м}^3]$
2.	1380	1560	230	9	2,5	22,5	
3.	1450	1670	220	8,5	2,5	22,5	
4.	1040	1290	220	9	2,5	22,5	$C_k = \dfrac{1090}{135 \cdot 10^{-4} \cdot 10 \cdot 10} = 8,074 \text{ g/m}$
5.	1360	1480	120	9	2,5	22,5	
6.	1560	1610	50	9	2,5	22,5	
			$\sum \Delta m_i$ 200			$\sum S_j$ 135cm²	Flow rate $V_i = 10$ m/sec. Dust collection time $t_i = 10$ sec.

6   Conclusions

The analysis of the problematic situation of the interaction of technogenic and ecological systems with the aim of reducing the risks of harmful effects on the environment, based on the integration of gaming system and information technologies, showed that improving the efficiency of TPP operation is possible due to the

modernization of power units, methods of preparation of fuel, improving the efficiency of fractions combustion, optimization and coordination of operation of power unit models with other energy sources.

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