Information and Logic Cognitive Technologies of Decision-making in Risk Conditions

Lubomir Sikora [1[0000-0002-7446-1980], [IEEE 40217863]], Rostislav Tkachuk [2[0000-0001-9137-1891]],
Natalia Lysa [3[0000-0001-5513-9614]], Ivanna Dronyuk [4[0000-0003-1667-2584]]
Olga Fedevych [5[0000-0002-8170-3001]]

[1,3,4,5] Lviv Polytechnic National University, 12, Bandera str., Lviv, Ukraine
lssikora@gmail.com, lysa.nataly@gmail.com,
ivanna.m.dronyuk@lpnu.ua, olha.y.fedevych@lpnu.ua
[2] Lviv State University of Life Safety, 35, Kleparivska str., Lviv, Ukraine
rlvtk@ukr.net

Abstract. The article deals with the problem of decision-making in terms of risk and conflict situations in the presence of terminal restrictions on the time of crisis resolution in the structure of managing a complex system.

The analysis of the concepts and principles of terminal logic, which are used to describe the thinking process of the operator when high speed is needed to make decisions and determine the image of the situation, risk indicators, factors of active influence on the operation of the technogenic system. With the insufficient pace of decision-making by the operator the risk of accidents increases.

Key words: logic, information, data, strategy, management, term of time, rate of cognitive speech.

1 Introduction

Experimental situations that arise in technogenic systems due to the active factors of influence on their resource management, information structures require rapid decisions by the operator. Such a study causes mental and intellectual tension in the operational and command staff, acting as an intellectual agent, who makes targeted decisions about the management of the elements of the objects and the technogenic system in general in terms of risk in the process of eliminating threats and preserving the life of the population and staff.

An important element of the intellectual behavior of operational staff is his mental and intelligent stability for the duration of the operational management of a system or object during emergency management. These problems are relevant in terms of ensuring the functional stability of the systems for both command and control groups. To ensure effective decision-making, the following personal characteristics are required to be taken in an emergency response high level of intelligence, psychological and physiological resilience, psychological and physiological resilience in stress situations, ability to adapt effectively in changing situations; ability to learn and to summarize knowledge and experience; purposefulness and determination in achieving the stated goal, ability for internal goal orientation and adaptation.

The technogenic environment model contains the following components in the knowledge base information about changes in environmental elements and relationships between objects that are characteristic of this class of problems, and information about possible perturbations and models of influence.

Information that is in the model of a problematic energy-active environment is reflected through the structure of the technogenic system, and its process of operation and is evaluated by the conscious "I- system" of the operator, which is necessary for the construction of appropriate procedures and decisions during emergencies. If only heuristic decision-making procedures are used to complicate situations, then such conditions are no longer sufficient for action planning.

The use of logic to describe events and decision-making processes provides the constructiveness of computational procedures and processes for the formation of patterns of situations and statements about them, as well as sequential action scenarios. But if only heuristic decision-making procedures are used at this stage, then in complicated situations they may not be sufficient to plan adequate actions.

Problem and research methods. The problem of human operator activity in complex technological systems and emergencies in the conditions of a challenge has been investigated by many scientists. Despite the active interest in this type of human activity in the field of technological and information development of society, the problem of optimization of training and work of human operator in complex hierarchical technogenic systems and the success of its functioning during the assessment of crisis and risk situations of boundary states of objects remains unsolved, management that provides an effective procedure for emergency response over the required time interval, which is an urgent problem at present a new stage of production activation.

Development of information technology for the training of operational personnel for work in emergency situations using the general theory of systems, system analysis, methods of modeling of energy-active processes, methods of terminal logic, information technologies for selection and processing of data taking into account the individual, and cognitive abilities of operational staff is a topical scientific issue.

The aim of study – development and justification of the method of integration of logical procedures and information technologies with the use of cognitive models of the decision-making process in the case of emergencies in technogenic structures with the limitation time for management actions.

Object of researching – process of intellectual processing of data by the cognitive system of operator-management at limitation of term of execution of decisions.

Subject of research – models, methods of information technologies of situation estimation by the cognitive system of the operator taking into account intellectual and temporal characteristics in the process of management logical methods of structure analysis for the construction of applied theories are considered.

Analysis of literary resources

In work [1–3] the methods of decision planning, logic- cognitive models of activity, and multi-step decision-making are grounded in the work.

In monograph [4] logical theories of temporal contexts as grounds for constructing terminal logic in a cognitive control system are described.

In works [5–6] are discussed the methods of logic in the processes of formation and decision-making in control system at risk conditions.

In works [7] This comprehensive text provides a modern and technically precise exposition of the fundamental theory and applications of temporal logics in computer science.

In works [12–13] logical and cognitive formation of managerial decisions in conditions of risk and conflict are substantiated.

Article [14] deal with information technologies of data processing, logic-cognitive temporal characteristics of decision-making, energy activity of objects and emergence of conflict situations, logical and cognitive models of operational activity.

2 Analysis of the problem of intellectual activity (managers) of operators in the face of threats

Analysis of literary sources showed that today powerful tools have been created for management activity, mathematical and systematic apparatus for solving problems of managing complex objects has been developed and theoretically grounded [1–3]. But at the same time the employee is positioned as an intelligent agent with integrated decision-making functions without cognitive analysis of his/her activity [4, 6, 8].

Analysis of the problem of occurence of emergency and boundary situations in technogenic structures and the choice of strategies for managing energy-active systems in critical production situations showed that the problematic creation of effective methods of synthesis of strategies for conflict resolution consecrated a large number of works that consider certain aspects and components: functioning of hierarchical goal-oriented systems with a certain level of integration of technological processes with coordinated management; operational management at different levels of integration, in accordance with requirements for providing technological processes on the basis of clear data; object; inter-level conflicts; human resources management according to the requirements of production technologies and functional management based on ability testing. But, at the same time, these methods do not take into account the peculiarities of the cognitive sphere of the individual for managing energy-active systems in critical production situations showed that the problematic creation of effective methods of synthesis of strategies for conflict resolution consecrated a large number of works that consider certain aspects and components: functioning of hierarchical goal-oriented systems with a certain level of integration of technological processes with coordinated management; operational management at different levels of integration, in accordance with requirements for providing technological processes on the basis of clear data; object; inter-level conflicts; human resources management according to the requirements of production technologies and functional management based on ability testing. But, at the same time, these methods do not take into account the peculiarities of the cognitive sphere of the individual [5, 9–10].

In accordance with the concept of strategic management, a balance of mutual requirements should be fulfilled, which would ensure the conflict-free functioning of the automatic control system (figure 1):

– the higher hierarchy provides staff with an adequate level of social security, prospective growth and advanced training;

– executive staff perform their duties to ensure the effective functioning of the hierarchical structure in accordance with regulatory strategies.

The crises and risks that arise in such systems are of the offensive nature of external active systems that would like to capture positions at the hierarchy nodes. With adequate training, such attacks are not possible except through deliberate interference with the system (figure 1).

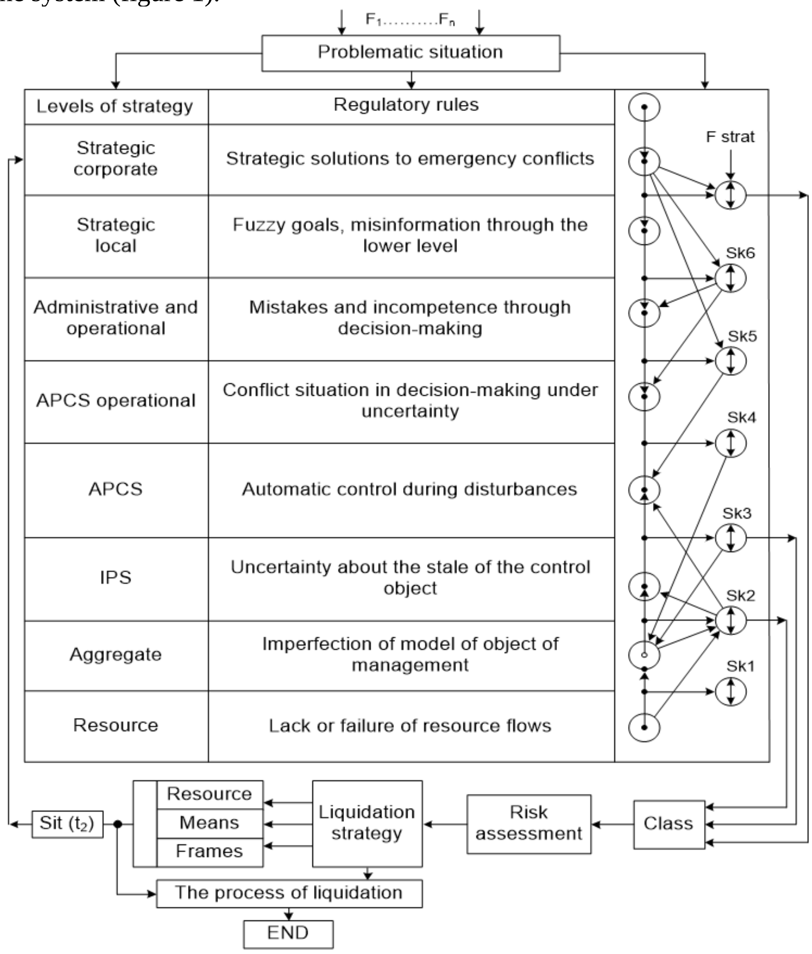


Fig. 1. Systemic risk factors, the failure of which leads to accidents: IC — information choices; APCS — automated process control system; $\{Sk_i\}$ — the sequence of the risk situation change

The problem of developing conflict management strategies has a complex structure that encompasses the components that form the basis of decision-making rules aimed at eliminating threats in technogenic topics: systemic(object structure, control systems, enforcement mechanisms, resource transportation and management systems); system-target(methods of formation, representation of the purpose in the target space of the management system and the means of its implementation); information (selection and processing of data about the state of the object, their evaluation, reliability, methods of formation and presentation of situations, their recognition, classification, interpretation); cognitive(knowledge component of management), logic-mathematical method of describing the the tactics of movement in the field of goal representation in the target space, logical-structural methods of decision-making on object management(management processors, their software and mathematical support of computational processes for all levels of the structure of the hierarchy; system dynamics to describe possible changes in the state of an object as a result of the use of selected strategies, risk assessment after their use [7, 13–14].

Analysis of methods of emergency response in technogenic energy-active systems was conducted, which showed that prevention of technogenic emergencies is extremely important and at the same time difficult. The operation in the territory of our country of numerous high-risk objects mainly in areas with high population density dramatically increases the risk of major man-made disasters, complicates the implementation of rapid response and implementation of measures to eliminate the consequences of natural and man-made emergencies [8–9].

Ukraine`s annual casualties are measured by hundreds of human casualties, millions of damage and irreparable damage to the environment.

The state of technogenic safety and dynamics of emergencies in recent years testifies to the increasing danger of threats to the life of the population, the economy and the environment.

The primary role in solving the problems of effective response to emergencies is played by the state policy in the field of civil protection, which is actively implemented in the state through unconditional implementation of the laws of Ukraine, decrees of the President and similar regulations of the Cabinet of Ministers of Ukraine and other normative documents.

Experience shows that only where emergencies are confronted with a clear organisation, clear, thoughtful measures of specialized rescue units, the use of advanced technologies and modern emergency equipment, coordinated and skilled actions of the services of the region and the population, which knows how to behave in extreme situations, can be achieved in arrogance in the protection of human life and health and preservation of property.

3 Logic-cognitive procedures for the formation of managerial decisions

Processes of solving problems and problems are the basis of the subconscious and conscious components of intellectual activity, and therefore it is important to formulate the concept of identifying mechanisms of mental(intellectual) activity of a person (figure 2).

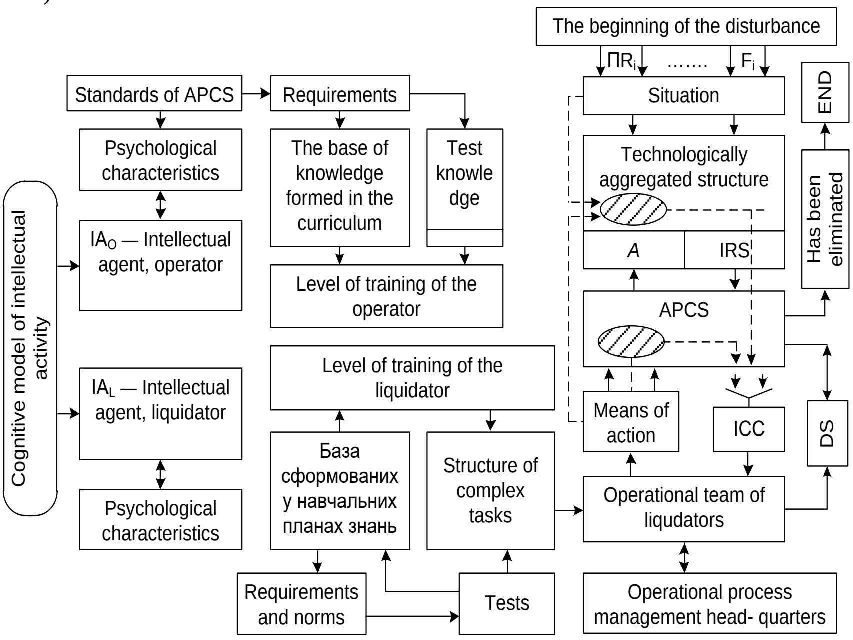


Fig. 2. Structural and functional model of decision-making by an operational employee based on the model of intellectual activity: *F — perturbation factors; APCS — automated process control system; A — actuator; IPS — intelligent perception system; DS-database system*

Accordingly, the development of an information concept for logical-cognitive models of intellectual activity in the context of risk is an important component of the creation of tests to assess the professional suitability of operational staff.

A functional system acts as a set of elements and processes in it with the appropriate organizational structure and strategy of behavior, which causes the appearance of the target result in solving problems and problems of a certain class [10, 13–14].

Basis elements and characteristic properties of a person-intellectual agent (IA) in decision-making: invariance of the structure of the system in the process of functioning; afferent synthesis as a generalization of information flows; goal-orientation in the process of structuring a task; problem-solving solutions; model of action results (action acceptor) in evaluating the process of solving the problem; feedback and control of local results and actions at the level of consciousness [2, 11, 14].

Construction of hierarchical models of the system is to justify the multi-level organization of the structure of the detection of resource flows, information channels for the selection of data transmission and management commands at each level (strategy) and between the levels of the hierarchy of identifying successive stages of formation and implementation of strategic management strategies (figure 3).

An important feature of hierarchical systems are the factors influencing the targeting during the terminal time of management cycles of management structures: different interests of levels of hierarchy leading to conflicts, mismatch of professional training of decision-making staff at other levels through incorrect strategies and low level of knowledge; vertical subordination of levels to form strategies [13–14].

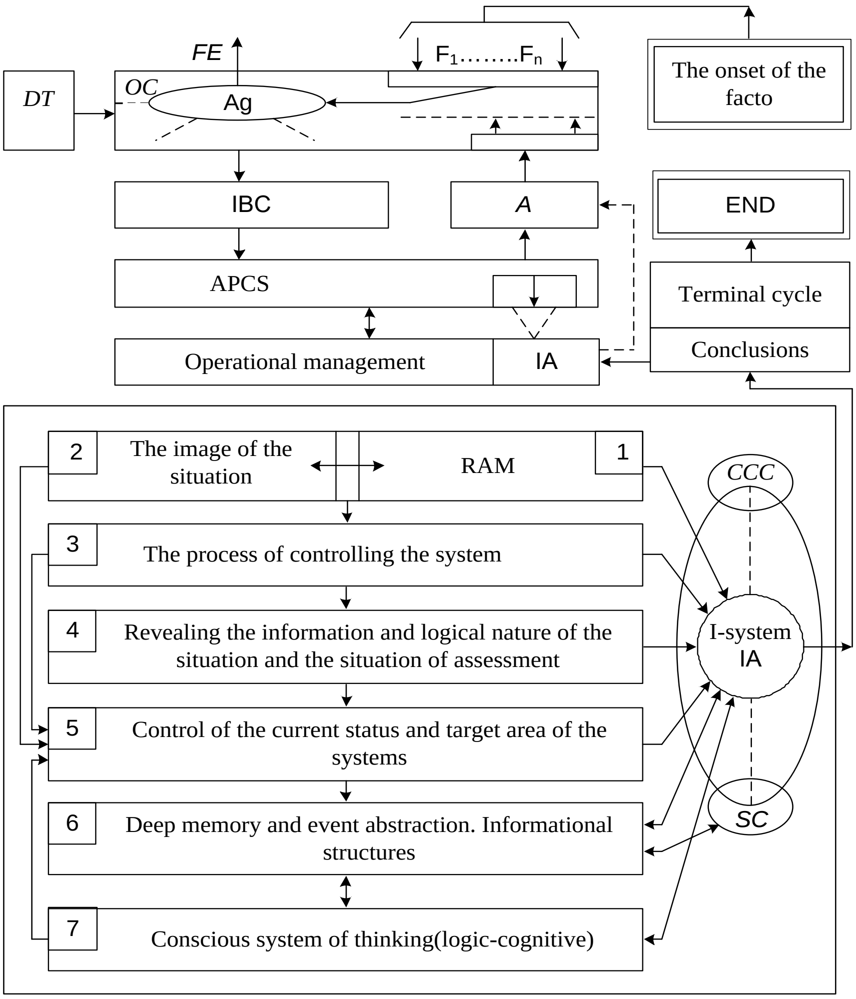


Fig. 3. Logic-cognitive model of event perception by the operative employee: FE — field of action; DT — decision tree; OC — object control; Fi — factors of influence; Ag — agents; IMS — information measuring system; APCS — automated process control systems; IA — intellectual agent; CCC — conscious cognitive component; SC — subconscious component; A — actuator

Logical-cognitive temporal processing of data by the operative employee in the process of assessment of the situation in the technogenic systems is considered on figure 4.

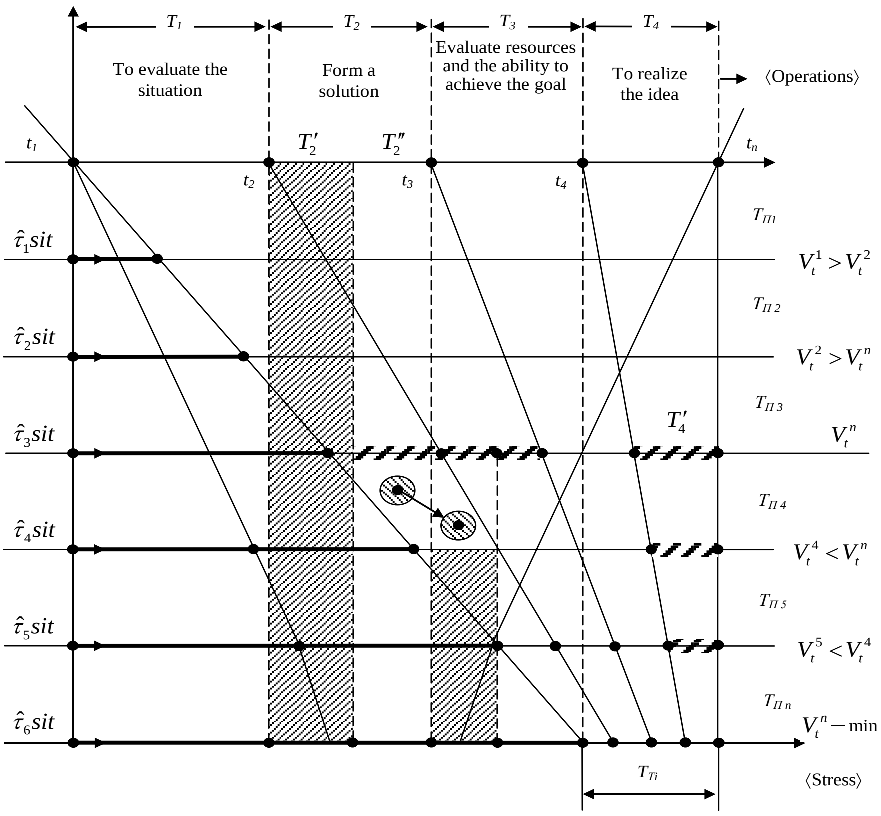


Fig. 4. Temporal structure of time to make the necessary structural decisions: *Tl — temporal layer; ti — time interval; Id — interval of decision-making*

According to the concept of intellectual data processing by the cognitive system of the operator in the mode of temporal reality, a functional and structural scheme of the cognitive model of data processing on the state and dynamics of the energy-active system has been developed (figure 5) [14].

According to the strategies, a logic of decision-making is formed based on an assessment of the situation from the flows of data obtained from IPS-APCS, is built as a rule [3, 12]: 1) $\prod_{UK}^{+}: \frac{A \Rightarrow B, A}{B}$; $\prod_{VK}^{-}: \frac{A \Rightarrow B, \overline{B}}{\overline{A}}$, which we interpret so: “If the situation A is related to the situation B (regime changes) and A has come, then there is a transition to a state that reflects the situation B”.

If you have as a parcel of judgment, then the truth of a categorical statement can be proved on the basis of a purely conditional conclusion according to the rules:

2) $\prod_{UK}^{+}: \frac{A \Rightarrow B, B \Rightarrow C}{A \Rightarrow C}$; $\prod_{UK}^{-}: \frac{A \Rightarrow B, \overline{A} \Rightarrow B}{B}$.

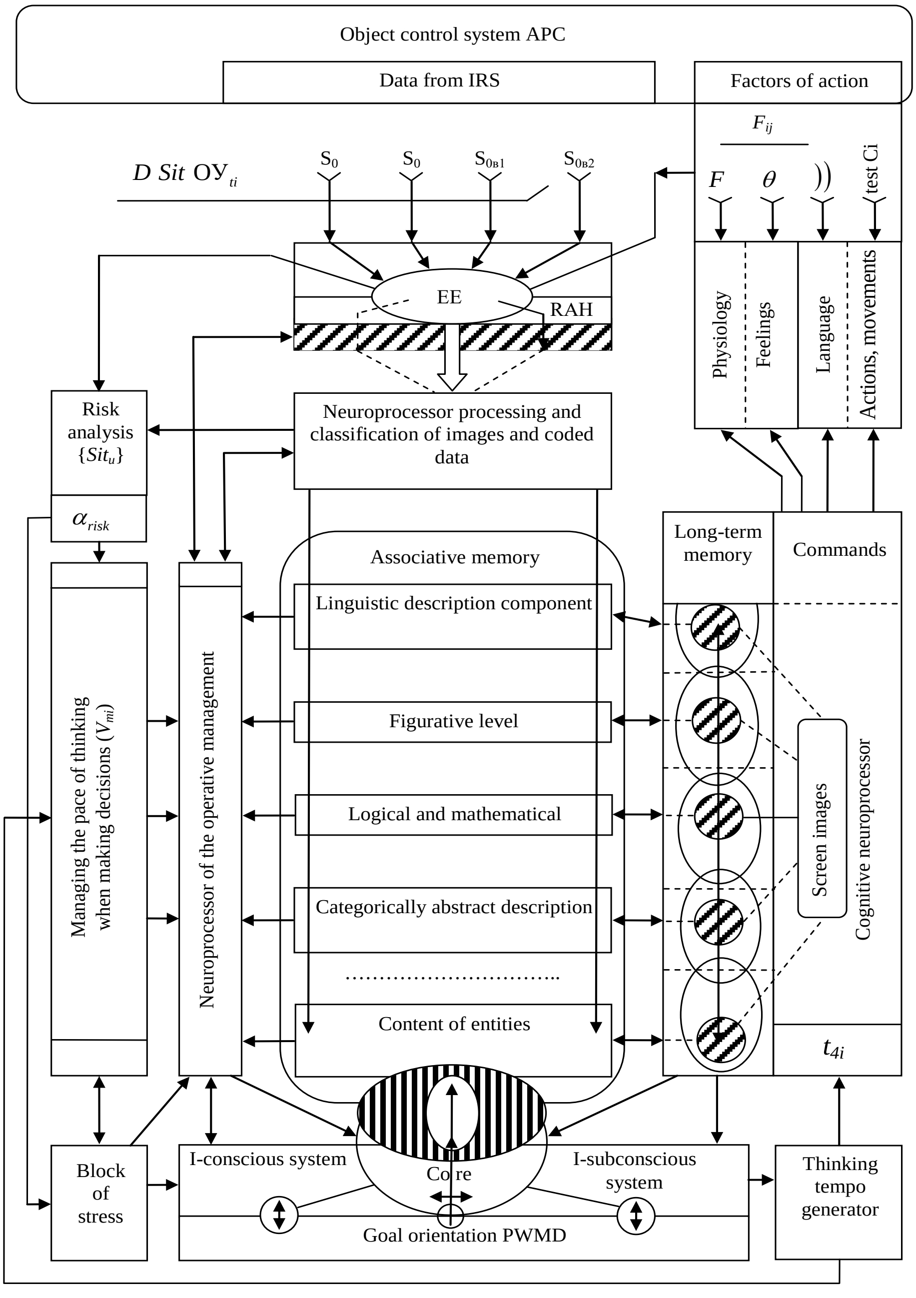


Fig. 5. Functional and structural diagram of a cognitive model of intellectual processing of temporal reality data by an operative worker of APCS. ICS — information-computing system; Sit — operative situation; OM — object of management; RAH — rank situations; Sn — system states; EE — emergency event; EE — an extraordinary event

The scheme of the affirmative-negative mode of the separate-categorical output follows from the rule (clauses 3–6), which on the basis of the data flows at a certain point of time $|t_i|$ during the terminal time $\{\tau_\kappa\}$ is the basis for drawing a conclusion about the situation $\left\{\forall t_i \left|_{i=i}^{m}, \exists \tau_{\kappa i}\right.\right\}$, according to concept [4, 14].

3) Integration of terminal situation data $\prod_{SV}^{+}: \frac{A \vee B, A}{\overline{B}}$; $\prod_{SV}^{-}: \frac{A \vee B, \overline{A}}{B}$.

According to the rules, we nave their interpretation:

4) $\prod_{VR}^{+}: \frac{A \Rightarrow B, A}{B}$; $\left(A^F \to SitB\right) \Rightarrow A^F : \left(SitB \xrightarrow{\psi} SitB'\right)$.

5) $\prod_{VK}^{-}: \frac{A \Rightarrow B, \bar{B}}{\bar{A}} : \left(A^F \to SitB\right) \Rightarrow A^F : \neg\left(SitB \to SitB'\right)$, then A^F — did not happen.

6) $\prod_{UK}^{+}: \frac{A \Rightarrow B, B \Rightarrow C}{A \Rightarrow C}$; $\left(A^F \Rightarrow SitB\right) \wedge \left(B^F \Rightarrow SitC\right) \Rightarrow \left(A^F \Rightarrow SitC\right)$.

If factor *A* leads to the situation *B*, then if case *A*, happen, situation *B* will change:

If factor A^F causes the situation $Sit\ B$, and from situation $Sit\ B$ happens situation $SitC$ under the influence B^F, then factor A^F causes $Sit\ C$.

7) $\prod_{UK}^{-}: \frac{A \Rightarrow B, A \Rightarrow \bar{B}}{B} : \begin{pmatrix} A^F \to SitB \\ A \to \bar{S}itB \end{pmatrix}$, then the state of the object does not change because A^F does not change its state of the object.

4 Temporal reality in the formation of management decisions by the operator under risk conditions

In times of crisis and pre-emergency situations occurring in technogenic systems during failure of models of functioning of energy-active units, it is necessary to take into account both the time cycles of data processing and the norms of time for performing emergency actions when making decisions. Cognitive disorientation in the estimation of the time intervals can lead to the fact that management and coordination actions will not be able to prevent an emergency situation if the operational management team is disoriented in time (figure 6). The system APCS has a block of automatic management and data processing, and the mode correction is performed by an operative employee, it is necessary to terminate the terminal condition at the time of decision making and situation assessment [4, 7, 12].

And the situation itself is that the operative employee, within the allotted time, assesses the possible threat and promptly takes precautionary measures:

$\left\{\tau_c^d \ll T_{r1} < T_{r2} < T_{r3} < T_{r4}\right\}$; $\left\{T_{r4} \le T_{s5} \le \tau_{ik}\right\}, \left\{T_{ki} \le \tau_{ik}\right\}$, where $\{T_{ri}\}$ — cycles of data processing for a minimum time allowed; $\{T_{s5}\}$ – time to correct decision-making strategies in the face of threats;

τ_{ik} — maximum interval of data processing cycle and automated decision-making when decisions are made in pairs (PWMD-APCS); $\{T_{ki}\}$ — cognitive time of an operative employee in the management team according to the classification he/she received in the APCS maintenance instructions. and during which time he/she is required to evaluate the situation, make a decision and perform a managerial or anti-emergency action [14].

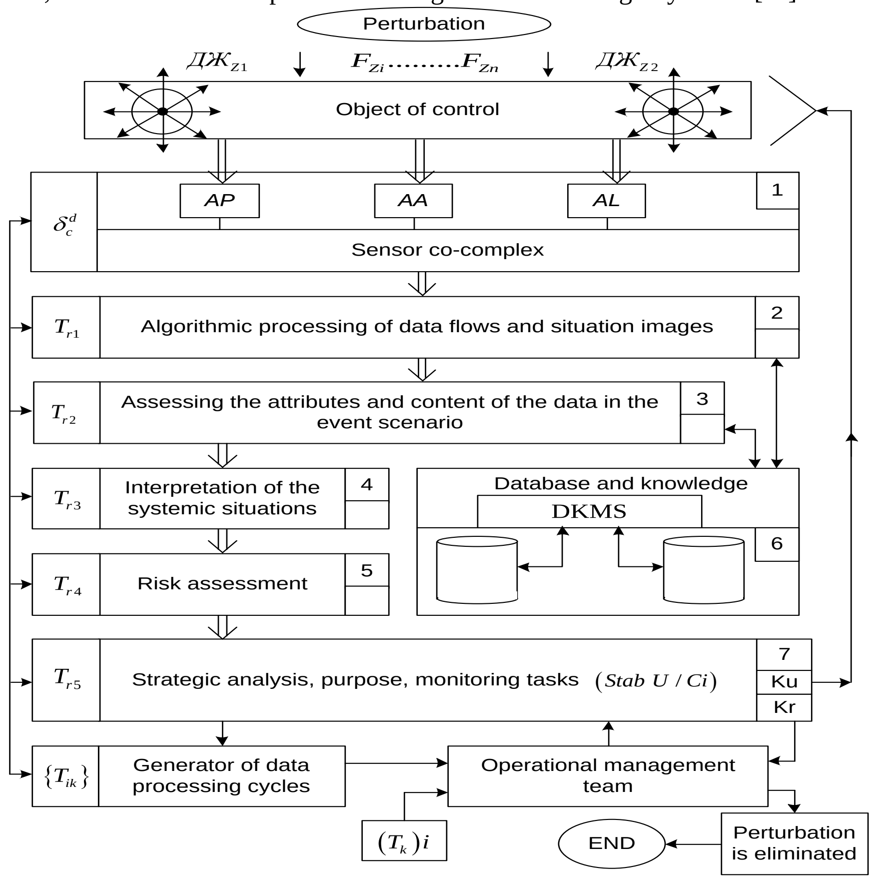


Fig. 6. Block diagram of information technology of data collection and their intellectual and systematic interpretation in the hierarchy of monitoring system structure: *{OPR} — sources of risk in the facility; {Fzi} — external influencers; block 1. {AP, AA, AL} — the system of active, passive, laser sensors for data acquisition, necessary for assessing the state of active objects; block 2. processing of sensory data obtained during the control process of ICS; block 3. intelligent processing of data and images of dynamic situations; block 4. interpretation of situations by operating personnel displayed on the control panel and multimedia system; block 5. intelligent risk assessment system when changing modes; block 6. an orderly database and knowledge; block 7. integrated intelligent systems of strategic analysis (*DSS*);* K_r, K_u *— correction of models and management actions to overcome crisis and extreme situations in man-made situations; DKMS — database and knowledge management system*

The structure of situations and events is analysed [3, 4, 7].

Enter: 1) *(TR)* — terminal structure;

2) $T = \{t_{i=1}^{n}\}$ — time set;

3) R — binary relation on T;

4) S — interpretation of knowledge about the state of the control object;

5) $f : T \to S$ — interpretation of the state of knowledge in the process of functional transformations;

6) $F_i = \langle F_{f(t)} \rangle$ — a set of basic functional transformations;

7) $[f(t) = f(t')] \equiv (t \neq t')$ — equivalence of knowledge during transformations;

8) $R_{tt'} : F_t \to F_{t'}$ — ratio of correct formulas that represent through $\{F_i\}$;

9) g — operational employee $[$«*always will be*» $gA \in F_t' \leftrightarrow A \in F'{]}_t$ — event confirmation;

10) H — operational employee $[$«*always was*» $HA \in F_t' \leftrightarrow A \in F_t']$ — confirmation in the past;

11) $S : E \to \{0,1\} \leftrightarrow \{F_t'\}\, t \in T$ — automatic interpretation of situation knowledge;

12) $\forall f \forall t \in T\left(M \subset F'_{f(t)} \to A \in F'_{f(t)}\right) \triangleq (M \models A)$ — automatic interpretation on the interval of time $T \subset T_m$.

Properties of terminal logics, which are the basis for constructing the rules of output in the procedures of formation and decision-making.

If $A \in F_t', t \in T, tA$ — indexed set, then M — set on logic $\langle TR \rangle$, for which we have characteristic features of event binding $t \in T$:

1. $t \sim A \in M \to tA \notin M$;
2. $t \sim\sim A \in M \to tA \in M$;
3. $t(A \supset B) \in M \to t \sim A \in M \vee tB \in M$;
4. $t \sim (A \supset B) \in M \to tA, tB \in M, \forall t'\ Rtt'$;
5. $tgA \in M \to t'A \in M, \forall t'\ Rtt'$;
6. $tH \in M \to t'A \in M, \forall t'\ Rtt'$;
7. $t \sim gA \in M \to t'A \in M, \exists t\ Rtt'$;
8. $t \sim HA \in M \to t' \sim A \in M, \exists t'\ Rt't$;
9. $tA \in M \to \exists t'A \in F_t'$,

where $t \in T$ — time set; TR — terminal structure of events in time; g, H — time conversion operators; $(\sim, \to)$ — operations; R — operator on the time axis.

On the set of indexed formulas N_3 by a carrier $T\ (N)$ we have the following rules of inference and number ratio A — T which underlies the logic of action at the time when the strategies of crisis management are formed:

$$\Pi_1)\ \frac{t \sim\sim A}{tA}\ \ \frac{tgA}{t'A}\ \ t' \in T(N),\ Rtt'\quad \overset{t}{\bullet} - \to - \overset{t'}{\bullet} -$$ (direct transition);

$$\Pi_2)\ \frac{t(A \supset B)}{t \sim A / tB}\ \ \frac{tHA}{t'A}\ \ t' \in T(N),\ Rtt'\quad \overset{t'}{\bullet} - \leftarrow - \overset{t''}{\bullet} -$$ (reverse);

$\Pi_3)\ \dfrac{t(A \supset B)}{tA,\ t \sim B}\ \dfrac{t \sim gA}{t' \sim gA}\ t' \notin T(N),\ Rtt'\ \ \overset{t}{\bullet} - \to - \overset{t'}{\bullet}$ – (statement);

$\Pi_4)\ \dfrac{t \sim gA}{t \sim HA}\ \dfrac{t \sim HA}{t' \sim A}\ t' \in T(N),\ Rt't\ \ \overset{t}{\bullet} - \leftarrow - \overset{t'}{\bullet}$ – (denial).

Dependent of the branches of output on the decision tree $(\exists t \in \neg A \in T) \Rightarrow tA$, if $(t \sim A)$ is included in the branch, describes the course of events according to the route in the decision tree.

Let $\langle TR \rangle$ — A closed table for the construction of action plans, then based on the decision tree is built a specific route of implementation of operational actions in accordance with the spatial and temporal structure of the technogenic system and the emergency object. According to $(\forall t \in T, (tA_1 ... tA_n,\ t \sim B))$ we have if T' — set of indices of a branch, $R' \subset R''$ then,

$[(A_1 ... A_n,\ |\!\to B) \Rightarrow (tA_1 ... tA_n,\ t \sim B)] \Rightarrow (\{A_1 ... A_n \sim \mathrm{B}\} \in F_t'),$ so $(A_1 ... A_n \models \mathrm{B})$ we output from the available values about the object.

In the procedures of output on the thermal (time) axis, the definition of temporal operators is based on the statement: let us have "always be A" — unknown, if there is an unknown future element A, then $\left(gA \in F_t^2 \leftrightarrow A \in F_t^2,\quad \forall t'\ Rtt'\ \ \overset{t}{\bullet} - \to - \overset{t'}{\bullet}\ (\mathit{temporal\ connection})\right)$. [4, 14] Let (XBR and XBΠ) — be the dynamic set then we have defining the basis properties for time dynamics:

$ДB_1\ t\neg(gA \in M) \to t'\neg(A \in M);\quad \exists t'\ Rtt'\ \ \overset{t}{\bullet} - \to - \overset{\exists t_1'}{\bullet}$ direct transition;

$ДB_2\ t\neg(HA \in M) \to t'\neg(A \in M);\quad \exists t'\ Rt't\ \ \overset{t}{\bullet} - \leftarrow - \overset{\exists t_1'}{\bullet}$ reverse;

$ДB_3\ \forall t(gA \in M) \to \forall t'(A \in M);\quad \exists t'\ Rtt'\ \ \overset{t}{\bullet} - \to - \overset{t'}{\bullet} - \bullet - \bullet - \bullet$ direct chain;

$ДB_4\ \exists t(gA \in M) \to \exists t'(A \in M);\quad \forall t'\ Rt't\ \ \overset{t}{\bullet} - \leftarrow - \overset{t'}{\bullet} - \bullet - \bullet - \bullet - \bullet$ turn into the past;

The spreadsheet rules look like this:

$\Pi B_S^T 1\quad \Pi_1 : \dfrac{t\neg(gA),\ t' \in T(N),\ Rtt'}{t'\neg A}\ \ \overset{t}{\bullet} - \to - \overset{t'}{\bullet}$ direct conclusion;

$\Pi B_S^T 2\quad \Pi_2 : \dfrac{t\neg(HA),\ t' \notin T(N),\ Rt't}{t'\neg A}\ \ \overset{t}{\bullet} - \leftarrow - \overset{t'}{\bullet}$ casual connection;

$\Pi B_S^T 3\quad \Pi_3 : \dfrac{\forall t(nA),\ t' \in T(N),\ Rtt'}{t'A}\ \ \overset{t}{\bullet} - \to - \overset{t'}{\bullet}$ incomplete conclusion;

$\Pi B_S^T 4\quad \Pi_4 : \dfrac{\exists t(HA),\ t' \notin T(N),\ Rt't}{t'A}\ \ \overset{t}{\bullet} - \leftarrow - \overset{t'}{\bullet}$ search for reasons.

The logic of systemic anti-crisis solutions in the elimination of threats is the basis for developing strategies and contingency plans.

5 Risk of management strategies

Modern production is a complex integrated man-machine controlled systems management strategies that are integrated into the structure of APCS and the base of knowledge and professional skills of the human operator.

In the hierarchy of the system of the human operator are entrusted with the following tasks: control of the dynamic state; formation of coordination actions to support the targeted functioning of the system; management and regulation of lecture-logical processes in normal modes and emergencies [12–13].

Purposeful activity of the operator is based on information technology of data processing and a cognitive model of formation of situational decisions in accordance with the cognitive functional structure of purposeful activity of the operator (figure 7) [11, 14].

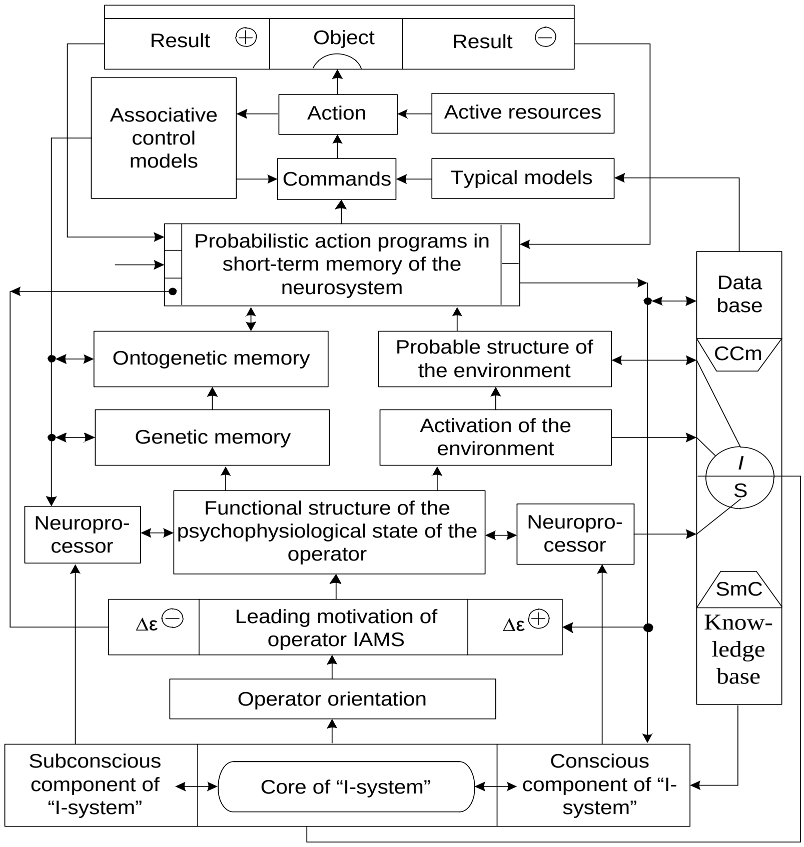


Fig. 7. Cognitive functional structure of purposeful operator activity: CCm — conscious component of memory "I — system". SmC — subconscious memory component; (C-S) — core of the cognitive memory management system; IAMS — intellectual automatic management system

It also reflects the stages of deliberate action to eliminate emergencies. Taking into account the scheme of forming a logical-cognitive model of perception of the structure and content of the object on the basis of operational data plans and teams of actions are taken, which take into account the temporal characteristics of the person during the perception of the situation and take actions to eliminate emergency situations.

6 Experiments, Results & Discussions

Based on the results of the research, a control experiment to verify the obtained theoretical conclusions was conducted.

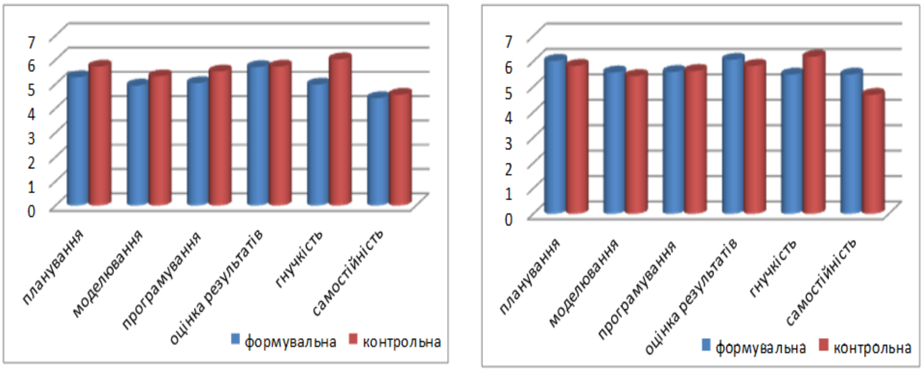
The representative sample size was 100 people: 50 in the experimental and 50 in the control groups and was selected from among cadets and students whose future professional activities involve work in extreme and stressful conditions.

The study of the two groups, both in the formative and in the ascertaining stages of the experiment, was carried out using the same set of specially selected psychodiagnostic techniques, which covered various aspects of personality activities (self-regulation, motivation, thinking, volitional sphere, etc.).

Here are some of them.

1. Methodology of style of self-regulation of behavior of V. Morosanov (SSBM) [15].

Comparing the indicators of the study before and after training to activate cognitive abilities, positive changes in the style of self-regulation of behavior in the formative group compared with the control can be seen (figure 8). Such changes occurred in most parameters (scales): planning, modeling, programming, evaluation of results, independence. In other turn, this contributes to the development of individual self-regulation of the individual and his profile, which is extremely important in working with a high degree of risk, scattered information, time lag and high cost of error.



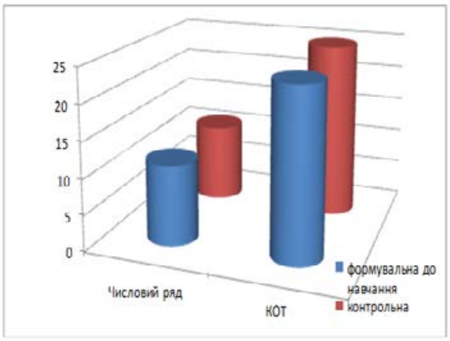
a) b)

Fig. 8. Comparison of the style of self-regulation of behavior at the ascertaining (a) and formative (b) stages of the experiment

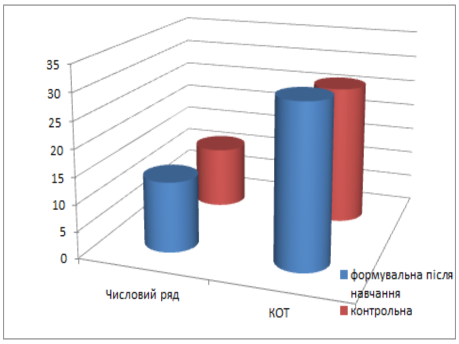
2. "Numerical series", a study of analytical thinking [16].

3. Short indicative test (SIT) [16].

Comparing the general indicators of thinking processes and mental abilities in the formative and control group (figure 9) before and after training to activate cognitive abilities, a positive increase in success in performing stimulus tasks for cadets and students from the formative group can be noticed. Considering also the fact that at the ascertaining stage of the research a slightly lower results among the respondents of the formation group were received, but after training, the general results in the formation group not only reached the level of control, but also slightly exceeded them.



a)



b)

Fig. 9. Comparison of indicators of research of thought processes (numerical series), and mental abilities (SIT) at the ascertaining (a) and formative (b) stages of experiment

The received results of psychodiagnostic study showed that, after six months of training to enhance cognitive abilities with the help of developed information technology, cadets and students from the formation group not only aligned in indicators with the parallel control group, but also surpassed them in a number of professionally significant indicators: purposefulness, communication, confidence, responsibility, stress resistance, increasing the level of general indicators of thought processes.

7 Conclusion

Based on the peculiarities of individual perception of time intervals, the logic-system procedure and the process of solving the tasks of managing the final step of action in terminal time are considered. The use of such an approach allowed to substantiate the logical aspects of forming a description of the process of solving problems by the operator in different conditions of his/her professional activity.

By taking into account the immanent temporal layer of the individual during the preparation of operational personnel for the activity that involves making operational decisions in crisis conditions of functioning of technogenic systems, we will ensure an adequate assessment of the system status and taking timely measures to eliminate threats and accidents in high-energy hierarchical systems.

References

1. Zgyrovskyy M. Z., Pankratova N. D. (2007). Basics of the system analysis. – K: BHV Publishing, 546 p.
2. O'Connor J. (2010). The art of system thinking: Needed knowledge about systems and art way of problems solving / Trans. From English, 4th edition – M.: Alpina Publishing, 254 p.
3. Dutiak I. Z. (2006). Methods of hypothesis formation: Monograph. Kyiv. 173 p.
4. Ishmuratov A. T. (2011). Logical theories of temporal contexts. Kyiv: Naukova dumka, 150 p.
5. Katrenko A. V. (2011). System analysis. Lviv : «New world», 396 p.
6. Chernorytskyy I. G. (2015). Methods of descisions making. St.-P.: BHV-Peterburh, 416 p.
7. Demri S., Goranko V., & Lange M. (2016), Temporal Logics in Computer Science, Cambridge: Cambridge University Press. 752 p.
8. Korolchuk M. S., Kraynyuk V. M. (2014). Social and psychological support activity in normal and extreme conditions. – K. : Nika Center, 580 p.
9. Smirnov V. A., Dovgopolova E. V. (2017). The psychology of an action in extremal situations. Kharkov : Humanitarian center, 292 p.
10. Ekman P. (2010). Psyhology of emotions. I know what you feel. Piter 2010, 336 p.
11. Goranko V., Vester S. (2014), Optimal Decision Procedures for Satisfiability in Fragments of Alternating-Time Temporal Logics. Pages 234–253 of: Advances in Modal Logic, vol. 10. College Publications.
12. Tkachuk R. L., & Sikora L. S. (2010). Logical-cognitive models of formation of management decisions by integrated systems in extreme conditions. Lviv: Liha-Pres, 404 p.
13. Durniak B. V., Sikora L. S., Lysa N. K., Tkachuk R. L., & Yavorskyi B. I. (2017). Information and laser technologies for data flow selection and their cognitive interpretation in automated control systems. Lviv: Ukrainian Academy of Printing, 644 p..
14. Tkachuk R. L., Sikora L. S., Lysa N. K., & Fedyna B. I. (2018). Logical and cognitive models of temporal activity in making operational decisions in crisis conditions of manmade systems functioning. Part 2. *Naukovyi visnyk NLTU Ukrainy.* № 10 (28). P. 108–119.
15. Burlachuk L. F. (2017). Dictionary of psychodiagnostics. St. Petersburg: Piter, 688 p.
16. Druzhinin V. N. (2010). Experimental psychology. St. Petersburg: Piter Publishing House, 320 p.