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IMPLEMENTATION OF TWO-LEVEL PROJECT MANAGEMENT FOR SAFETY SYSTEMS DEVELOPMENT

Abstract. Safety systems are nonlinear complex open systems. The development of such systems in terms of a system approach is in their translation from the current state to the target. Managing this process can be considered as project management, carried out on two levels - macro and micro levels. At the macro level to create a shared vision and motion paths used synergetic principles of management. At the micro level provides a transition necessary for the efficient movement along a certain trajectory. In this micro projects are considered as self-organizing systems, which can be managed by changing their composition and external conditions. The paper attempts to harmonize the provisions of the macro and micro approaches to project management of safety systems development.
Keywords: safety systems, system approach, project management, project approach.

STOSOWANIE DWUPOZIOMOWEGO ZARZĄDZANIA PROJEKTOWEGO ROZWOJEM SYSTEMÓW BEZPIECZEŃSTWA

Streszczenie. Systemy bezpieczeństwa stosują się do klasy złożonych otwartych nieliniowych systemów. Rozwój takich systemów z punktu widzenia podejścia systemowego polega na ich przejściu z potocznego stanu do docelowego. Zarządzanie tym procesem może być uważane za zarządzanie projektowe, prowadzone na dwóch poziomach – makro- i mikropoziomie. W pierwszym wypadku stosują się synergistyczne zasady zarządzania dla kształtowania ogólnej wizji i trajektorii ruchu systemu do wyniku. W drugim wypadku zabezpiecza się spełnienie mikroprzejść, niezbędnych dla efektywnego ruchu wzdłuż pewnej trajektorii. Przy czym mikroprojekty są traktowane jako systemy samoorganizujące, które mogą być zarządzane przez zmianę ich składu i zewnętrznych warunków. W artykule przedstawiono jest próbę harmonizacji przepisów

makro- i mikro- podejścia do zarządzania projektowego rozwojem systemów bezpieczeństwa.
Słowa kluczowe: systemy bezpieczeństwa, podejście systemowe, zarządzanie projektami, podejście projektowe.

Introduction. Safety Systems (SS) function in a turbulent external environment [1]. Real-time changes occur in the objects and subjects of safety, as well as the methods and tools that provide this safety. Therefore, SS are dynamic systems; also they are adaptive because they must quickly and accurately respond to changes in the external environment.

On the other hand, the operation of SS based on regulatory and legal support of international and national level, which defines the basic parameters and rules. This component is a system factor that is inherently static and conservative. Changing safety standards is reactive and significantly lags the time of receipt of requests from the external environment.

This research is aimed at resolving the contradiction between dynamic and static nature of SS. Proposed to use a two-level project approach.

Research description. **Macro level project management.** At the macro level principles of synergetic are applied to create a shared vision and motion path to the result. If we assume that the purpose of SS is to achieve an attractor, then management of their transformation is performed by directed self-organization, by synthesis of "additional attractors" which asymptotically draw system motion path to the main goal. Obviously, consideration of the environment requirements is possible only at the initial design stage. It can be argued that the construction of the motion path to the result determines only the general outlines of the existence of the system at a certain time interval, denotes the general trend of development, based on the static nature of SS [2].

Macroscopic description of complex systems, which include safety systems, based on the axioms of continuity of all forms of movement. In this SS, as an open system, constantly interacts with the environment. To detect this interaction, design and management of SS, we should draw boundaries and to distinguish such system from the environment [6]. Legitimacy of such action is based on a system-wide property of object's state changing. As a mathematical support of modeling the open system interconnection with the environment can serve a balance equation.

As a value of system state function can be understood system measured macro parameter, which is fully and uniquely determined by the internal micro states and don't depend on the path of transition from one state to another. Open systems are characterized by irreversible processes occurring within them, and therefore, they are characterized by time orientation (time present explicitly in the equation of state). As a system state function can be considered the entropy [2, 5].

Its increase leads to safety reducing and destruction of the system. For open systems, the change in entropy can be negative due to the exchange processes with the external environment. Such exchange for SS expressed in the reservation and repairs that generally increases their reliability and manageability.

Micro level project management. To respond to instantaneous changes in the environment are encouraged to use the micro level. Implementation of micro transitions necessary for efficient movement along a predetermined path. They are treated as self-organizing micro projects within the system, which can be managed by changing their composition and external conditions.

In general, the transformation of SS means changing the states of existing elements, changing elements and changing the connections between the elements. Assuming that the elements of the system - it is a subset of the universal set, then management of the structure lies in changing the state of the elements in the parameter "is part of the product system". Relationships between elements can also be considered as a characteristic of the state of the elements included in the connection. Therefore, changes in the product system state (and therefore its functionality) is achieved solely by changing the state of both inside and outside (at the time of initiation of micro project) elements. This is possible due to temporary association of product system with an active resource system, which form a project system.

Based on the concept of self-organization rules for the formation and operation of the project system are not set. Only possible to influence exactly which resource system will be integrated with product system for their transformation and define the desired end state to which the project system should strive (defined at the macro level on the basis of the SS state function).

Implementation of two-level simulation model. The practical implementation of this approach requires appropriate mathematical support. Since detection of analytical relationships between the safety system states at the micro and macro level is very difficult, and in some cases impossible, it is advisable to use the simulation method [4, 7].

Under the proposed approach, a simulation model should be two-level. At the macro level a system dynamics model should be formed. It reflects the relationships between the elements of the SS and their states, and external environment impact. This will form a scenarios of the target state transition for the required time, and make optimization trajectories for the specified parameters. At the micro-level model will be a combination of system dynamics and agent-based approach. System dynamics model is generated for the project system and product system. To simulate the behavior of the resource system by virtue of its activity, it is advisable to apply agent-based approach. Micro-level simulation model will enable decisions about choosing a resource system for micro project (task resource assignment), as well as identifying the necessary external influences to achieve an intermediate target state in a given time frame.

Formed two-level simulation model in the general case will enable the following tasks:

- direct analysis of the problem, the solution of which is required to determine the system's response to specified impact;
- analysis of inverse problems, which is required to determine disturbance by known system reaction that forced considered system comes to this state and this reaction;
- synthesis problem, requiring a finding of such parameters under which the processes in the system will have the desired character for any reasons;
- inductive problems whose solution is to test the hypothesis, refinement equations that describing the processes occurring in the system, reveal the properties of these elements, debugging programs (algorithms) for calculations on a computer.

Direct analysis problem can be formulated as follows: structure of the model described by the system of equations, all parameters are assumed known; required to determine the response of the system defined by the action of external forces and given initial conditions. Direct problems answer the question, what if under the given conditions, we choose a particular solution from the set of admissible. In particular, what will be equal to the efficiency criterion for the chosen solution. In simulations, the direct problem can be solved through a series of simple experimentation ("what if" analysis).

Solving inverse problems of the analysis consists in determining the input data by a predetermined value the output (parameters of the model, as in the direct problem, fixed). Inverse problem solution provides an answer to the question, what "causes" led to the famous "investigation". Inverse problems are more difficult to solve because they are non-linear and generally have several solutions. To find the values of the input data, in which the function, selected as a target, take the maximum or minimum value (in the face of uncertainty, and the presence of constraints), it is advisable to use the optimization experiment.

To investigate the behavior of the safety system in the face of uncertainty can be applied Monte Carlo method. The essence of this method consists in that, the test result depends on the value of a random variable distributed according to a given law. Therefore, the result of each test well is random. After a series of tests, get a set of data points of the observed characteristics (selection). Obtained statistical data are processed and presented in the form of numerical ratings of interest variables (characteristics of the system).

Another tool for analyzing the behavior of the safety system is the sensitivity analysis. It is a procedure for assessing the impact of initial hypotheses and values of key factors on the resulting model indicators. Usually experiment with varying parameters and analysis of the model reaction helps to evaluate sensitivity of the model forecast to changing of the hypotheses underlying the model. A sensitivity analysis is recommended that you change the values of the factors separately, which allows us to rank their impact on the resulting indicators. Sensitivity analysis determines the strategy planning of experiments on the simulation model.

Plan of the above experiments, depends on the structure of safety system and its dynamic characteristics. To reduce the complexity of this process, it seems appropriate to develop typical plans for different types of safety systems. This, in turn, require construction of a special classification system.

Conclusions. The paper attempts to harmonize the provisions of the macro and micro approaches to project management of safety systems development. Implementation of simulation as a mathematical support of two-level project management has been proposed. Problems that can be solved using the simulation model have been formulated in general terms. Types of experiments aimed at solving these problems have been indicated. Identified areas for further research, which is to develop classification of safety systems and to construct typical plans of experiments than based on this classification.

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