SYNERGY PARADIGM FOR DESIGNING COMPLEX TECHNICAL SYSTEMS OF SHIPPING

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This research considers the concept of a complex multicomponent technical navigation system, the characteristics of the relationships of the system components and the relationship with the external environment. The theory of systems by Niklas Luhmann is applied, which is based on the adaptation of the development of bio and social systems to a complex multicomponent technical system. The structure of systems is revealed through the description of the components, as a classification division of components into active and passive

Structuring takes place at a time when the post-industrial information society is being formed, the dominant problem of which is an increase in the proportion of artificial self-organizing regulators in a single integral system "society – Technosphere – nature". Mostly, interest is significantly focused on the current management problems that are associated with resource conservation, the new organization of socio-economic systems, environmental and nuclear safety of an open society. The concept of technological practice in the 21st century is significantly different; it consists in the development of significantly changed types of objects and processes, which are positioned as complex self-developing macrosystems. In macrosystems, cooperative phenomena can arise that are based on information interactions. The result of the expression of cooperative effects in developing systems is the emergence of a new structure without external force effects. We can see that structuring leads to the principle of a system that connects hierarchically arranged interacting subsystems.

One can observe vertical and horizontal structured ordering of subsystems. Horizontal structuring of subsystems leads to the fact that there is a decisive influence on each other due to the presence of complex feedbacks between them, which cannot allow producing a vertical hierarchy of subordination of goals. When the hierarchy is vertical, the systems are structured according to the level of complexity for decision making. The principle of determinism of each subsystem regardless for the type structuring is described by the corresponding model with variables and parameters immanent to a specific level of abstraction. We can say that the processes of universalization, which are studied by modern nonlinear dynamics and synergetic, can arise in complex macrosystems.

The structure of active technical systems

Studies of the autopoiesis of a complex technical navigation system show that modern complex technical navigation systems use elements of artificial and natural intelligence. The concept of autopoiesis is used exclusively for this type of systems. The term "autopoiesis" was introduced by sociologist Niklas Luhmann in his theory of social systems, which is based on three concepts that are linked together in his work. These are the following concepts: systems theory as a theory of society; communication theory; evolution theory. These provisions were developed in his work. The main categories that underlie the theory of Luhmann's systems are as follows: complexity, reduction, reflection, autopoiesis, functional differentiation. It should be noted that the theory of Luhmann systems differs qualitatively from most theories of systems of other authors. Classical systems theories are based on abstract models that are dependent on logic and mathematics. Luhmann's theory of systems is based on the development of bio and social systems.

The difference between wholes (systems) and parts (blocks of systems) in Luhmann's theory is transformed on the differences between systems and the environment. This principle is new in relation to the classical theory of complex systems since the concept of complex systems is often interpreted with closed systems. The theory of Luhmann systems is between the classical theory of systems and the theory of dynamical systems. At various stages it is constructive to various kinds of complex technical systems, including complex technical systems of navigation. Figure 1 drive the basic principles of the theory of social systems.

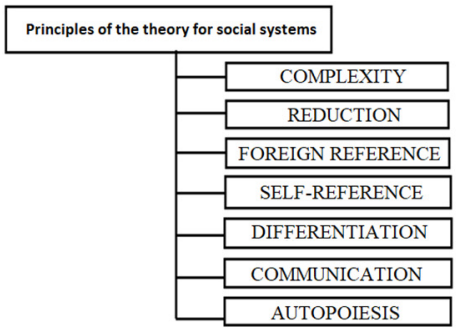

Figure 1. Basic principles of Luhmann's theory of social systems

Using Luhmann's theory of systems, it is noted that autopoiesis is a connecting link between systems theory, communication theory and the theory of evolution. Using this connection, classes of autopoietic systems were identified abroad, which it became possible to include complex technical systems of navigation.

A ***complex technical system*** is characterized by dependence on the cognitive factor. Without exception, all blocks of complex technical navigation systems are controlled using the principle of their own or external intelligence. Information interaction of the system blocks with other blocks connected with them is carried out. A separate block of the system has the possibility of development or self-development. And, through any block it is possible to influence other blocks associated with it. Information exchange between blocks contains uncertainty. Due to this, between the blocks, after some time, there is an accumulation of information asymmetry and a violation of information correspondence occurs. In the presence of blocks with intelligence, the adaptability of a complex technical navigation system and its autopoiesis are ensured. The vital activity of complex technical navigation systems takes place with an acceptable opposition of the external environment. Taking this factor into account, complex technical navigation systems form the functions of counteracting the external environment.

Table 1. Basic rational behavioural features of components

Feature	*Note*
The presence of organs technical vision and sensory perception	Allows to build sensory maps of the environment with a selected time interval
The presence of a mechanism for understanding the sensor map and recognizing the current situation	Recognition of the image of the current situation considering the existing uncertainty
Ability to form a plan of behaviour considering the available sensor map	Allows to exclude the influence of uncertainty on the behaviour of the subsystem
Availability of a mechanism for implementing a plan of behaviour	Adaptation in a changing external environment

The sensory map of the environment represents the outline of the situation in which the component can be at a given moment in time. A passive component of a multicomponent system is a technical component that does not possess any signs of intelligence. An active component is a component that has rational behavioural characteristics under conditions of uncertainty. The introduction of two new organizational and behavioural components into the depths of multicomponent systems, in particular the active and passive component, makes it possible to study its heterogeneous subsystems not from the classical position of continuous and discrete production in static or dynamic modes, but, from the point of view of intelligent self-organizing systems with a certain behaviour. This aspect is key in the formation of a new concept of system analysis of MS in conditions of uncertainty of a passive technological process

This research emphasizes the type of complex technical systems as a multicomponent system. This type of systems is the next step in navigation systems and can rather be attributed to the direction of "Big Data" than to the direction of classical systems theory. At this stage, it is necessary to modernize the theory of complex systems, since the theory of complex technical systems for navigation applies the principles of self-reference, differentiation, and communication. The concept and principle of autopoiesis is also used, the basis of which we see in more detail in the synergetic theory.