Training transport specialists based on a contemporary view of self-organization of sophisticated developing systems

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Abstract. This paper discusses the problem of how to integrate natural-science, humanist and special technical knowledge in professional university-level training of transport specialists being a rapidly developing sophisticated system. This engages current science concepts of self-organization and self-development of sophisticated natural and man-made systems.

The urgency of the problem consists in the need to draw the attention of specialists of any field, first of all those who create sophisticated engineering systems that influence the human being and the environment, to the actively developing concepts of modern science about complex and often contradictory phenomena of self-organization and self-development.

The paper is aimed at the popularization among technical specialists of modern concepts of open, sophisticated, self-developing systems as exemplified by searching for innovative methods of studying and solving the problems of the transit system development in modern growing cities.

Content and methods.
The content of the paper includes teaching and scientific sources. 1. Textbooks on Current Concepts of Natural Science prepared in accordance with the State Educational Standard of Higher Professional Education for universities of different specialization. 2. Scientific monographs of Russian and foreign authors that substantiate and evolve insight into complex self-organizing systems. 3. Special sources of natural-science knowledge.

The methods are: the main method consists in a theoretical search for a model of studying and solving problems of managing the development of the transit system of modern cities, while the supplementary method discusses the meanings of new terms and definitions using didactic (derived from the Greek word didaktikos meaning apt to teach) schemes and drawings.

Scope.
Training of specialists in a current professional higher school sets up requirements to its teachers that emanate from conceptual, general scientific, methodological achievements of science based on the integration of various branches of knowledge. In each specialty, the general methodological concepts are detailed, they find their own particular theoretical and applied growth. This requires the teachers of higher school being widely erudite and profoundly competent, both are possible to achieve with great efforts.
So, at the stage of training transport specialists, say representatives of technical disciplines, the concepts of the transit system as a complex developing system evolve, for the comprehension of which different knowledge is required and not only of technology itself, but also of the natural and humanist sciences.

Searching for a model for managing the development of the urban transit system (not to be confused with traffic management) suggests a heuristic idea, which includes four key theoretical positions:

1. Give consideration to the transportation means of modern cities as a socio-technical system based on the concepts of modern natural science about open complex systems having properties of self-organization and self-development like biological, living organisms. Emphasize the instability of the state of such systems, the unpredictability of development trends in the humanitarian context.

2. The development of the transit system including the humanitarian, social and technical, natural and cultural components is to be considered in the model of the formation and development of a complex natural and cultural system – Person-Personality with its main components: Activity and Consciousness.

3. Consider managing the evolution of the urban transit system in terms of the relationship between internal spontaneous processes and external influences by the systems hierarchically related and non-hierarchically linked. Consider Society, Culture, and Civilization as systems to which the transportation means relates hierarchically. Focus on the effect of these systems that meet common and prospective humanist interests as opposed to private and temporary interests.

4. Take a model of the structural and functional organization of the animal brain and the Human Brain being the material carrier of Consciousness, Intelligence and Reason as feasible for practical implementation of the model of managing the evolution of the urban transit system. The human brain is a natural system, the most complex of all management systems known. Given that systems can be successfully recognized, if they are considered from the standpoint of models, analogies, metaphors of more complex systems, the biological structural-functional model of the human brain itself can serve for the development of a socio-technical model of conscious and intelligent management of the urban transit system to meet the humanist requirements.

Setup and functions of the human brain require special attention. There are examples from theoretical engineers who try to create man-made intelligence as well as to study and describe the brain in the most detailed way similarly to neurophysiologists [1]. A deep penetration into the notion of what the systems Person-Personality, Society, Culture, and Civilization mean. Appeal to the definitions Instinct, Consciousness, Reason is necessary for making them clear for application towards technical systems. This is because the transit system has intellectual and reasonable properties being a humanist phenomenon – a phenomenon of spiritual and material culture.

Modern science of the turn of the 20th and 21st centuries penetrated deeply into the nano-measurements of matter and into infinitely vast outer spaces. At the same time, it achieved considerable success in understanding how complex matter buildup arises and develops. There are representations of open spontaneous complex systems of physical and biological nature that offer self-organization and self-development [2, 3 and others]. Not only the world of natural nature, but also the world of culture - that created by man himself - is permeated with ideas about the unity of the emergence, organization and development of complex systems. They are formulated as modern concepts of natural science, which influenced the scientific worldview of society in the form of unity of natural and humanist cultures [4, 5, 6 and others].

Deep methodologic importance is the notion of Chaos reigning in the world, and the Order; conditionality and non-conditionality (determinism and indeterminism); predictability and unpredictability of events and much more [7, 2 and others]. The main initiators of such a scientific worldview, called the evolutionary genetic synergetic one and has become a universally recognized paradigm, are: Ilya Prigogine, a Belgian physical chemist and Nobel laureate, and Hermann Haken, an outstanding German physicist and mathematician.
Evolutionary and genetic definitions, terms that belong to biological sciences for many centuries happened to be included in the methodological range of other sciences in the early 21st century, showing the similarity of the mechanisms of origin and development for complex systems and organisms of a different, non-biological nature. Now, from the biological, evolutionary and genetic positions, consideration can be given to such systems as the Person-Personality, Society, Culture, Civilization, Techniques and Technologies, socio-economic organizations, intellectual theoretical systems, material and spiritual culture in general. Modern science deeply substantiates this approach on both the theoretical and the empirical level investigating the real processes of development of non-biological complex systems. Specifically owing to this methodological basis, urban transit systems have not been considered yet. One of the areas of focus of the in-depth justification for the application of evolutionary and genetic methodology to use social systems is the idea of the development of local and world civilization as one of the most sophisticated cultural systems. In order to emphasize the methodological significance of this approach, it was called the science of the 21st century by its authors [8]. It formulates the definition of socioeconomic genetics as a new methodological concept of studying and solving problems of social, economic and deeply associated technological issues using the biological definitions.

One of the particularly complex systems is the technology created by the hands and brain of human being, which arose atop of the development of the infinitely complex hierarchy of systems [9 and others] of the Earth's material world.

The alliance of technology and science form an intricate system of an even higher hierarchical order that acquires properties characteristic of such systems called emergent - unexpected in nature (supernatural) and extremely high in their effect on nature, human and cultural environment. The scientific and technological progress, moreover – the scientific and technological revolution is fraught with emergent unexpectedness possibly resulting in the catastrophe, the destruction of the system of the highest order on the Earth, which is directly above technology and science – material and spiritual culture in general, civilization and biological life. Even now we can see and feel the intensifying inhuman effect of certain technical achievements, which has become the most important problem of modern society. However, common sense says that Homo sapiens must find a way to give a positive humane value towards the human being and nature to the emergence of the alliance of technology and science.

The city and its transportation means are a huge engineering system. It includes and is surrounded by systems different in nature: social, economic, energetic, and environmental. According to the concepts of modern science, such a sophisticated system can be compared with a living organism for a number of its properties: once appeared, it gets the ability to self-organize and self-develop, interact and compete with other systems [2 and others], and finally – intellectual properties. The engineering system makes these properties real with its own unique modes, which must be disclosed, understood to be able to influence and manage them.

It is required to cover the dialectics of the relationship between spontaneous self-organization and self-development, i.e. self-management being an internal property of sophisticated systems, on the one hand, and external, necessary management of such systems, on the other. This requires a theoretical model of these relations that would satisfy the requirements of researching a complex object similarly to an object that is even more complex, capable to clear up the fullness of the content and processes of its development not reducing the insight into the object. In view of this, considering the modern unity of natural and humanist knowledge, the use of a natural, real and biological model – the human brain – is feasible in studying and solving the problems of complex engineering systems.

The brain of animals is the subject of researching by biologists, who in recent years have achieved considerable knowledge about its deep detailed structure at the level of molecular processes. The ideas of an integral and systemic functional structure of the Human Brain very important for the neurological theory and practice were obtained. The brain has been of interest for ages, and now with special strength and significance it is demonstrated by the engineering and technical community engaged in the development of man-made intelligence and the problems of its use in various spheres.
of human activity. The brain of the Person-Personality is constructed and functions in a particular way; it is developed as influenced by human activity in social conditions and its model is of fundamental importance for studying the problems of how to manage the development of a transit system that has a social and humanist component.

A broad historical-philosophical, general scientific and methodological and profound special-theoretical consideration of the foundations of the origin and development of technology is a condition for a specific theoretical definition and an empirical search for what is really existing and developing modern urban transportation means as an open sophisticated system.

First of all, the origin of technology, including transportation equipment, its genetics (from Greek genesis meaning origin) and its historical development – phylogenesis. As applied to technology, the terms genetics and phylogenesis are quoted, because they, as a rule, denote the phenomena of the biological world. Phylogenesis is a process of historical development of plant and animal organisms, their species, genera, etc. (Greek phylon, i.e. tribe). Phylogenesis is considered in unity and interdependence with the individual development of biological organisms – ontogenesis (from Greek ontos meaning being). If we consider technology as a method, technique, skill in obtaining, transporting and storing the most vital means, some of the first species of animals already possessed a certain technology and technical set (the terms are also quoted as traditionally not applicable to the animal world). This may be the basis for speaking metaphorically about the phylogenesis of technology – technogenesis.

The biological phylogenesis identifies the stage of the origin and development of Human as a species of animals gradually acquiring a special property – the Reason, the social and individual Consciousness. It is called anthropogenesis (Greek anthropos means human). Technogenesis and anthropogenesis have a close, organic interconnection, interdependence: Man creates a special kind of Technology – human technology, it becomes anthropogenic; Technology deeply transforms, improves the Man, creates Society equipped with technology – technical, technological society.

Three main periods are distinguished in anthropogenesis: the formation of Homo habilis took about a billion years; Homo erectus took several million years, finally, Homo sapiens took hundreds of millennia and continues now. Each period of anthropogenesis was accompanied by its instruments of life, e.g. the technology that the Man used.

For didactic purposes and visual perception of the idea of the genesis of technology, the chart is shown in Fig. 1.

![Fig. 1 Didactic schematic of phylogenesis of technology in the animal world and organic unity of anthropogenesis with technogenesis. Discussion of the schematic in the text.](image-url)
Considering the transportation equipment itself, for sure, raises a question about its genesis as, at first, a relatively simple, then sophisticated, spontaneously self-developing system, as an industry of material and spiritual culture. We observe the simplest forms of transport technology already in animals: ants and beetles collectively transporting a straw or pushing huge objects; hedgehogs carry mushrooms on their prickles etc. From the standpoint of the modern science of sophisticated systems, they are truly the systems, since their organization ensures the achievement of a certain vitally important target. These animal forms of transport technology are instinctive (Latin instinctus means inspiration) associated with certain biological needs. Their manifestation is strictly fixed in the biological construction and is therefore predetermined, both in form and purpose.

The biological mechanisms on which the instinctive technical actions of animals are based are similar to the intellectual processes that ensure the actions and activities of human being. The theoretical and experimental approaches to studying the intelligence often intellectualize not only human being, but animals, and even artificial technological intellectual systems. Methodological boundaries need to be determined for comparing the intellectual processes of humans, animals and engineering devices. This will allow revealing the breadth, depth and, most importantly, the freedom and activity of the human intelligence in comparison with the instinctive intellectual properties of animals that are limited in freedom and with even more limited technological intelligence.

The definition of Intelligence in the ordinary worldview traditionally does not differ from the definitions Mind, Reason. Such a confusion of terms and definitions can be found in dictionaries, reference books and, unfortunately, in popular science encyclopedias. However, this is not the case. Clarification of terms and definitions of Instinct, Intelligence, Consciousness, and Reason is necessary because of their vagueness in the humanities and philosophy. In engineering sciences and practice, this becomes increasingly important since the properties of human being meant under these definitions are supposed to be possible, say in hardware – in mechanical man-made devices. Speculations on this topic are the beginning of the search for appropriate means and mechanisms for managing the spontaneous self-development of the transit system, similar to what the Human Brain is the mechanisms of Intelligence and Reason in technical terms.

Intelligence is a property of the animal body, which gives the opportunity to solve the problems of its life activity as an individual in a particular, sensually perceived, object environment. Another thing, the Reason is a very special type of realization of intellectual abilities, namely human ones. It relates not only to the solution of individual life problems, but also collective, social issues. Some collective actions of animals can be perceived as reasonable, but they are not realized by animals, they remain instinctive. A truly reasonable property of an individual Person-Personality arises and develops on the paths of the active entry of the individual into the system of knowledge accumulated by mankind – into the Public Consciousness (co-knowledge means joint knowledge) [10]. Individual mind is formed inside the Public Consciousness.

Consciousness, both Public and Individual, is the foundation, the material for the display of the properties of Intelligence and Reason. Consciousness is the Chaos of the vast knowledge that finds the Order in external practical, intellectual actions and internal, in the mind actions. Turning to the transit system as a living organism, moreover, as to the Person-Personality, that is, endowed with intelligence and reason, this thought can be expressed by the chart shown in Fig. 2.

Reasoning whether an anthropogenic transit system is similar to the transportation equipment of animals is not rhetorical. In modern outlooks about the spontaneous emergence of sophisticated and self-developing systems, the key question is their origin – genetics. In terms of technology, the definition of genetics (the term is borrowed from biology) is attached not to biological meaning, but rather to the analogy of the mechanisms of origin and development in humanist systems that are as complex and characteristic as the living organisms. As such a system, it is important to consider modern urban transit services and an engineering system of an even higher hierarchical order – a system that facilitates all the productive and non-productive needs of people as a single technological basis for social development [8], which is the City.
The beginning of genetics, the spontaneous self-organization and self-development of the man-made transit system created in human society, as well as in animals, is a vital necessity, first realized by people for their own purposes and forms. Developing in the public consciousness in the form of scientific and technical unity, this beginning acquires new ones and generates more and more perfect mechanisms, complicating the organization and enriching the properties of the transit system. At a high level of its development, the entire transit system generally becomes the genetic origin, the core of developing a system of a higher hierarchical level that ensures the development of the global technological system of society. In this process, the genetic origin of the self-development of the transit system serves as the basis for an even more complexly organized genetic origin of scientific and technological progress and social development.

Fig. 2 A chart demonstrating the relationship between the phenomena of Consciousness, Intelligence and Reason, as a relationship of Chaos and Order as applied to the prototype of the transit system as a Person-Personality.

What is the beginning of the emergence and development of a sophisticated human transportation technology as a system – its genetic core – is the main object of search in the problem of the innovative model of the development management of the urban transit system. A productive idea may be to consider the genetic core of the transit system based on the ideas of socioeconomic genetics that have arisen and successfully developed in modern science, in which socioeconomic, including engineering structures are viewed in the likeness of biological, molecular and supermolecular genetic structures [8].

The transit system, at any stage of its development, as a man-made phenomenon, represents a communicative foundation that connects the realization of all production and non-production needs of society into a single unit, integrating it. It is made by people, society and creates society, is the main condition for its socio-economic and technological development. Therefore, according to biological terminology, it is the genetic core, the main condition determining the nature of social development. The central place in this core is taken by the idea of transportation technology, its properties, purpose, objectives, concentrated in the form of a set of certain engineering knowledge as formed in the public consciousness. Having such a fundamental importance for social development, the transportation technology focuses on other techniques and knowledge – the entirety of scientific and technical knowledge and practice, generally being the core of the relationship between science and technology. Transportation means as a sci-tech system, which takes the place of the genetic core of social development, is an incentive for scientific, technical, technological innovations and absorbs them into themselves.
Urban transportation means are a huge and complex engineering system, an industry of the material and spiritual culture of society. One of the first and most urgent challenges that facing researchers of such a system having decisive importance for people's vitality and ability to live, is the solution of the problem of the dialectics of the relationship between its internal properties of self-organization and self-development, on the one hand, and external target management, on the other.

The relationship between controllable and control systems, multiplying their tension, is influenced by the dialectics of internal mechanisms of self-organization and self-development existing in each of them, for example, such as, in technical terms, processes of dissipation mean loss of matter, information and energy [11, 3]. It is also, in terms of modern concepts of sophisticated physical and chemical, nuclear and molecular systems, the phenomenon of bifurcation is a split or even more splitting and unpredictability of development lines, a change of phase states and many others perceived by common sense as negative. However, these processes are dialectically related to indisputably positive phenomena that give the system rise to reorganize and route forward.

Managing the development of the transit system in its scientific and technical unity is one of the most pressing challenges of society related to the impact of transportation technology on health and livelihoods, on the cultural and ecological environment of people, and ultimately on the quality of life of our planet in general. These are the contradictions of emergence and bioethical problems of managing the development of the urban transit system.

The English word emergent means arising unexpectedly. The definition of emergence as applied to the rise of complex systems with new properties was previously regarded as an idealistic worldview concept that considers development as a jump-type process, where unexpectedly new higher qualities come into existence due to ideal forces (in the writings of S. Alexander and C. Lloyd Morgan.) [12]. Now, in the light of modern scientific views, this is a very real, materialistically explained property that belongs to sophisticated systems offering property of coherence of their structural and functional organization. This property is distinctly attributed to the alliance of modern science and technology in its influence on public life.

The emergence of a complex alliance of science and technology is characterized by the pretext of super – superefficiency, which is in tune with the properties of superconductivity, superstrength and similar those found in material coherent systems. In terms of the impact on people's lives, the sci-tech progress rises more and more steeply up the exponential curve leading to revolutionary changes in all spheres of life. It is necessary to foresee unexpected and possibly negative consequences that become ever-evident.

Positive consequences are important to envisage and to create conditions for their emergent growth. This requires knowledge of emergent and, at the same time, unpredictable in its development phenomena and processes in public culture; methods of forecasting, designing, managing them. The transportation sci-tech system taking the middle position in technological growth of society must necessarily be the focus of special humanist ethical requirements.

Bioethics is an interdisciplinary field of knowledge that covers a wide range of philosophical and ethical issues. The term bioethics was first applied to a special version of environmental ethics that considers the possibility of human survival in the conditions of anthropogenic civilization (the ethics of conservation of the human natural environment). However, later the meaning of the term changed due to the rapid growth of medicine, biological sciences and the use of high technologies in medicine. Alongside with this, the man-made problems of social development were exactly those which gave environmental and anthropological methodological significance to bioethics associated with the study and solution of problems of individual and public health, the vital activity of people in a natural and cultural, technically rich environment [13].

The environmental and anthropological methodology of modern science was reflected in the International Classification of Functioning, Disability and Health (ICF), developed under the auspices of the World Health Organization (WHO). It was published in 2001 and recommended by WHO as a technological tool for researching and solving practical problems of individual and public health. In the ICF, human health is considered as a potential for its vital activity, the context of which are, on the
one hand, the fundamental anthropological individual-typological and specific properties of human being, and the properties of the social and natural-ecological environment, on the other. The transit system is included in the ICF as one of the leading context factors of people's health and life.

The search for a model of managing the development of the urban transit system, should use the models of the setup and functions of the brain that are as possible in terms of complexity and corresponding to modern concepts of sophisticated systems. Such models, in continuation of the research by many biologists and technicians, have been developed from various perspectives by Russian scientists, physiologists Pyotr Kuzmich Anokhin, Nikolai Aleksandrovich Bernstein, German scientist, mathematician Hermann Haken, and American scientist Michael A. Arbib.

Having the properties of self-organization and self-development common to living organisms, a complex social and technical system can be managed by means of its specific social and technical means and tools. The controls are specific, similar, but certainly not identical to the biological – the brain controls, which are required to be defined from the position of a higher-level model, in order to be able to use them to manage the development of the system.

The model of the brain of highly organized animals according to Anokhin mainly reflects its functional properties in the vein of the mathematical cybernetics of N. Wiener as a science of proper control in the sense of imposing line of behavior on a complex system, technical or otherwise, based on certain principles and means of their implementation placed in the system itself. The model introduces physiological, psychological definitions consonant with the cybernetic definitions (specific biological and technical terms are highlighted in italics and a bright font for clarity): about afferent and efferent flows that provide direct and inverse links between the internal elements of the system with the external environment in which the behavioral act takes place in the form of a reflex ring. One of the properties that significantly differentiate the brain from non-biological systems is the extemporaneous organization of the processes of self-management by the behavior of a living organism, called a functional system by Pyotr K. Anokhin. This is an urgent organization of behavior that depends on situations and changing internal biological motives of behavior in animals or socio-psychological – in humans. The importance is given to the introduction of the definition of afferent synthesis being an analysis and generalization of signals – sensations entering the brain based on the specific and individual experience, which is the mechanism for obtaining the information – the core definition of cybernetics. Information accumulates as memory – the biological (psychological) definition actively used in technology. In terms of biological definitions, the memory lies at the heart of the animal manifestation of the property called intelligence.

Particular interest in the model of the brain's work on the principle of the formation of extemporaneous functional systems is shown by the mechanisms of biological and even psychosocial nature, such as the motive, that introduces ideas about the independent choice by the living organism of behavioral acts and the integral line of one's behavior, i.e. self-organization and self-management. A biological and psychological metaphorical notion of motive in technology is not found. Unfortunately, Anokhin's model presents the brain setup, as well as in cybernetics, as a black box, that is, a specific histological setup of the brain is not given a certain value. The functional system is not tied to the specific structures of the brain. The brain is not specified as a material carrier of the functional system. This is a significant drawback of the model to apply it as a tool for analyzing how a structurally functional system for managing the development of the transit system is being built. Other, more significant, shortcomings go on top of it. The model focuses on the properties of the animal's brain, i.e. on the processes that can be defined as intelligent. These processes are important, but in regard to the transit system, processes called reasonable and the functional structure of the human brain are of interest.

The model of the brain by Nikolai A. Bernstein extends and deepens the Anokhin's ideas. First of all, it is human brain to a greater degree meaning that it is the bearer of the mind, not only of the intelligence typical of all animals at some point. In the social systems to which transportation means belong, Reason is the ability to reflect the collective experience and knowledge of people acquiring a socially determined quality, called the Personality [14]. Personality is a complex, self-developing system governed in its formation and development by influences of the social environment,
characterized by special social needs that distinguish it from animals, ideas about the necessary future [15], imagination and creativity.

Fundamentally important in the Bernstein's model is an appeal to the material structures of the brain in their connection with certain functions in contrast to the notion of the brain as a black box. It formulated a complex anatomical and functional organization of the brain. It is represented as a solid sophisticated system, each individual material (neural) element of which being very complex systems are in dynamic hierarchical relationships; they are functionally coherent (a primarily technical definition), i.e. consistent, unified. Thanks to the dynamic and, at the same time, coherent relations of the anatomical and functional units, the brain, showing activity in the processes of management, self-management and self-organization, can create functional systems (according to Pyotr K. Anokhin) that manifest emergence (philosophical, but with a more rigorous scientific meaning) in unexpected, unusually high ability to solve problems of vital activity of an organism.

The model of the brain by Hermann Haken is a contemporary view of how the brain created by a mathematician is set up and functions. It discusses the brain from a purely functional external side assuming that its real construction, as in cybernetics, does not matter much, moreover, owing to the principles of behavioral science that takes their behavior as the main thing in the study of complex living systems, but not the material structure. According to these principles, the material structure can be any, and in such systems as the brain – so complex that methodologically, in other words essentially, it is not possible to determine anatomical and functional links in exercising complex behavioral acts. Mathematical studies conducted by Hermann Haken state that the behavior of the animal body under conditions that force changing the activity upward or downward undergoes drastic changes from one form of organization to another, essentially different ones. At the same time, it is not possible to determine which areas of the brain do this, since the brain functions as an integral whole. The brain creates the organizational form of behavior as a function of the external conditions of behavior and internal conditions associated with the capabilities of the executive apparatus. It is impossible to foresee what it will look like amid infinite complexity and unexpected conditions, but the brain creates the necessary forms of behavior, for example, as Hermann Haken writes, a centipede with damaged legs suddenly organizes a completely unexpected and effective form of movement necessary to solve the problem of movement at any given speed. The insight into the setup and function of the brain set out by Hermann Haken more than half a century after the work of Nikolai A. Bernstein is of interest because it explains the brain from new, synergetic methodological, positions about complex systems. However, they lack the approach of need to take the brain as a concrete material carrier of functions, including the Human Mind.

Michael A. Arbib compared the brain with the computer, not begging the difference between the living brain and a computer though being a quite complex device. In this comparison, like Hermann Haken, Michael A. Arbib refers to the monstrously complex setup of the brain and, if possible, as a representative of theoretical cybernetics, describes this anatomical and physiological complexity. As a result of his comparisons, he comes to the conclusion that it is nevertheless necessary to know not only the functional, but also the structural organization of the brain in order to improve the computer and create more complex intelligent systems. In his book, Michael A. Arbib notes this deficiency in the description of the brain and computer of other authors. He insists on the need to strengthen the systemic, and somatotopic approach to the setup of the computer. The word somatotopic has a purely biological meaning: soma is a Greek word that means body; topos is a Greek word for location. Thus, it is referred to the need to search not only functional analogies, but also structural-functional, somatotopographic ones. Michael A. Arbib regards the brain as the carrier of intellectual processes, hence the brain of animals and human as an animal. The brain is not regarded as a carrier of Consciousness and Reason.

From a brief survey of existing animal and human brain models that can be used to study the problems of managing the development of transportation means as a sophisticated self-organizing and self-developing socio-engineering system, the question arises of using knowledge about the Human Brain, the material carrier of Reason, as a model for managing the development of socio-engineering
urban transit system. Before the technical fellowship there is a need to utilize not only biological, but also humanist, psychological definitions in all their complexity and it becomes necessary to compare these definitions with the real structure of the urban transit system and the mechanisms for managing its development.

Referring to the human brain as a model for managing the development of the transit system requires abstracting away from many of its biological functions, concentrating, first of all, on the mechanisms and processes by which intelligent human motor behavior is organized and managed, which is a very complex self-organizing and self-developing system.

"The study of human behavior is an immense area of research. We mean under the behavior a variety of phenomena, from simple movements to highly complex behavior, such as communicating with other people or its actions in certain situations," writes Hermann Haken, the ideologist of the synergetic scientific worldview, "... that's why I chose coordination of movements" [7]. We also select coordination of movements as coordination, structurally functional arrangement of transportation, as a technological system that serves industrial and non-productive public communication processes, requiring the movement of human and material flows.

The complexity of the motor behavior of a person is related to a number of quite certain conditions in which the human life and activity occur. From the force of gravity, in which the person must find the orientation of movements, to infinitely diverse and complex ideas that the person must realize in motion. The transit system as composed of different transportation equipment created by people, and which has become sophisticated and self-developing, is assumed to be less complex than the system that represents the motor behavior of a person. The mechanisms and processes of how to organize and manage the development of these two systems may be similar, but, naturally, are not identical. In the case of human motor behavior, this is due to the setup and function of human brain, and in the case of the transit system – to a certain socio-technical organization.

To study and solve the problems of managing the development of the transit system, obviously, there are all the methodological grounds for using the theoretical model of setting up and controlling the motor behavior of the person from the brain, as well as purely practical reasons, because transportation means are a system of moving, relocating equipment and technologies. Such a model should be a concept of the structure and functions of the human brain, but not animal one, conceptually formulated by Nikolai A. Bernstein. In the very difficult and long history of the development of concept of the brain – this is the first fairly complete idea of the Human Brain being the material carrier not only of the Intelligence, within certain limits inherent in animals, but of Reason peculiar only to human being.

The human motor function is a multilevel biodynamic tissue. It is called like that by Nikolai A. Bernstein because of the complexity of its structure, similar to the structure of the most complex anatomical structures of the body. The motion behavior as composed of a variety of movements has a macrostructure, consisting of five levels of movement consistently built on top of each other as the complexity of tasks rises in various spheres of life. Spheres of human activity in which the construction of movements is carried out are areas of immediate objectives and remote goals of movement, incentives and requirements for the organization of movements, to their spatial, temporal, force and, finally, to semantic characteristics, when movements realize intellectual and reasonable functions. This transition of the construction of movements from the solution of purely physical, mechanical challenges to problems of an intellectual, semantic and reasonable nature determines the preference to consider the human brain model described by Nikolai A. Bernstein.

Now let us talk about the levels of the construction of movements different in meaning. They are Latin lettered by Nikolai A. Bernstein.

Level A. The construction of movements in the sphere being the field of gravity. It is required to imagine the importance of knowing this part of the brain model for modeling the processes of controlling the transit system similarly to it. For the movements of the human body, probably there are some basic requirements for the transit system from some forces like gravity. In the transit system, this can be assumed as its organization (construction) in global conditions of functioning, such as natural
and man-made energy resources, landscape and cultural-original conditions of local civilizational [8] of development, socio-economic basis in general.

Level B. Building the movements in structural and functional organization of one's own body. This leads to the idea of a similar existence of historically formed internal ties in transportation means that must be regarded and used in the management of transportation development as a self-organizing and self-developing system. This is obviously the manifestation of those effective acquisitions that have developed over the entire history of the formation and development of a technical, namely, transportation culture.

Level C. Building the motions in the coordinates of body and its parts relating with the objects of the surrounding environment. There is an idea of a special level of development management of the transit system – a level that ensures its openness towards the external technological environment of the city, entry into the system of a higher hierarchical, subordinate level. In the transit system, it is its organization in synergy, interaction with other non-transportation, production and non-production technologies of the city.

Level D. This is the construction of movements in the sphere of really existing semantic connections between surrounding objects. This raises an assumption about such a level of development management of the transit system. In a similar way, it is headed not to adaptation to the urban technological environment, as at the previous level, but to active participation in the development of the entire technological system of the city. In the transit system, this level, obviously, can be represented as the central link of its organizational and technological innovation development in the global system of production and non-production technologies of the city.

Level E. Building the movements in the sphere of semantic relationships between objects – movements that are perceived ideally, in thought, followed by real implementation in life. It is the highest level of human brain functioning that shows itself as the carrier of Reason, individual and social consciousness. The Level E is a prototype for managing the development of the transit system as a complex socio-technical, humanist system. It contains the potentials of the development of the transit system based on its integration into the international, outer space of sci-tech progress.

A todat technical specialist is well aware of how a computer as a tool for controlling a wide variety of processes is set up (see Figure 3).

Fig. 3 Computer connection schematic.

This schematic should be combined with the setup of the human brain (see Figure 4). This schematic characterizes the construction of a real socio-technical organization for managing the development of the transit system. It is constructed amid brain, computer and social-humanist metaphors and demonstrates the basic elements of management organization and their relationship.
Fig. 4 A general chart showing how the management of the urban transit system development is organized.

The state environmental and man-made policy of the urban transit system development

Evolutionary-genetic synergetic concept of the urban transit system development as a system of self-organizing and self-developing. Sci-tech engineering, professional education

Target long-term or short-term programs aimed at the developing the transit system

Socio-technical bodies that provide details of monitoring result

Socio-technical bodies that correct target programs

Socio-technical bodies are institutions for processing information and making decision on correction programs in five levels of development of the transit system

A  Civilizational conditions for the development of the transit system
B  Internal conditions of development beyond other technologies of the city
C  External conditions of owing to other technologies
D  Innovative conditions for the development of the transit system
E  The humanist focus of the development of the transit system

Monitoring bodies of target programs, rapid assessment of the results of their implementation.

Process means stages of development of the urban transit
The actual implementation of management according to this schematic will require a practical, empirical study: observations, experience and experiment. Then, theoretical analysis and generalization is necessary.

The institutions as really existing social bodies are the objectives of this empirical and scientific approach. The control activity of these social bodies can be compared with the intellectual and rational functions of the Person-Personality. Along with this, the study is aimed at the organization of management based on the principles of the setup of the human brain.

The chart shown in Fig. 4 with a didactic, search theoretical meaning has a clearly expressed applied say practical value with its theoretical justification.

**Conclusions.**

The use of modern ideas about the self-organization and self-development of complex systems of natural and man-made nature that emerged in the late 20th century and advancing in the 21st century reveals broad perspectives in understanding the problems of the contradictory development of the transit system of modern cities. To engage teachers and students of a professional technical higher school in this process, it is expedient to build it looking into a practical problem, such as searching for an innovative model for studying and solving the problems of the development of the transit system of modern cities. To simplify complex cognitive processes it is practicable to use didactic means, widely applicable in heuristic research. Thanks to the visual clarity which in a certain sense gives a visual idea of the logic of thought, they condition a particular sense perception of the content, structure of heuristic thought, and are its sensual tissue. This is the subject material for the rapid entry into and understanding of the problems of the contradictory development of the transit system of modern cities. To simplify complex cognitive processes it is practicable to use didactic means, widely applicable in heuristic research.

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