Bionics and Urban Health: A New Level of Smart City Modelling

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Abstract. Currently, the innovation agenda of the industry professional and academic community in the information and conceptual plans is largely filled with topics related to Building Information Modeling (BIM) technologies. In this sense, often, in a different context, we are talking about several new “digital” subject areas for the qualitative development of creation technologies, united by the new convergent paradigm “Smart City”. The general logic of convergent modeling of the “Smart City” is presented, the key target priority of which is the new socio-technological paradigm “Urban Health” at the level of relationships between the entity models “Smart City” and the results of their convergence. At the same time, the main directions of the development of subject areas of application of bionics in construction and on the scale of creative activity in the whole are indicated.

1. Introduction. Smart City
Currently, the innovative development directions of the construction industry are largely associated with technologies for advanced modeling in general and Building Information Modeling (BIM) in particular [1–18]. In this sense, often, in a different context, we are talking about several new “digital” subject areas for the qualitative development of creation technologies, united by the new convergent paradigm “smart city” [15–18]. In [15,18], for the first time, the only formally comprehensive definition of this new technological concept was presented, suggesting in the future the possibility of constructing qualitatively different fundamentals of the conceptual regulation system of creative activity in a new understanding of the field of its professional responsibility, not limited to this or that stage, but extended to their exhaustive sequence including motivation, planning, designing, creating, adapting, using, transforming and disposing of lancing elements.

“Smart city” is a coherent convergent socio-cyber-physical complex, the process of parameter management of which is optimally adaptive to its own state space. In a subject-oriented sense, a “smart city” is a convergent socio-cyber-physical complex that is optimally adaptive to a person, society, nature. In all cases, we are talking about the convergence of a tetrad of entities “human” – “society” – “nature” – “technology” (Fig. 1) at the model level of goal formulation.

In addition, in [15,17,18] the author’s view on the system engineering of digital modeling of creative activity as a whole was presented. On the original logical-semantic scheme in the cybernetics paradigm of problem-oriented modeling, the main subject-object (object-subject) relationships of the constituent elements were abstractly identified, each pair of which determined the correspondence of their own level of digital modeling corresponding to the levels of link aggregation: “plan” – “goal”,

“object” – “project”, “process” – “time”, “technology” – “economics”, “system” – “resource”, “complex” – “convergence”.

![Diagram of the convergence of four entities: HUMAN, NATURE, TECHNOLOGY, SOCIETY.]

**Figure 1.** The convergence of the four entities “smart city”

At the same time, adequate implementation of a comprehensive approach to digital modeling and the digital economy of the construction industry as a whole, adequate in scale and perspective, allows us to talk about some qualitative effects in the horizon of the life cycle of objects and processes of creative activity:

- cybernetics projects;
- the scale of the projects;
- collaboration;
- the prospect of modeling;
- analysis retrospective;
- resource management;
- quality management;
- risk management;
- organizational management;
- convergent perspective.

All of the above, as well as set forth in [1–19], makes it possible to justifiably state that the axiomatics of the system design scheme for digital modeling of creative activity, obviously, involves the formulation and solution of any problems of convergence of the four entities “smart city” (see Fig. 1) exclusively at the sixth and seventh levels of modeling subject-object and object-subject relationships (Fig. 2), which have not only not yet become the norm of strategic and objective analysis of the city’s development practice, but also form a fundamentally new Blast academia and the world of professional competence building only at the initial stage.
Additionally, the analysis of the relationship between the levels of modeling the four entities “smart city” and the results of their convergence becomes the conceptual basis of another, in fact, a key element of the quality of life and sustainable development of the city – “Urban Health”.

2. Domain. Urban Health

The modern city, as a result of the creative and professional work of architects, urban planners and builders, should be created and developed on the basis of a harmonious combination of traditional and perspective understanding of the triad “strength, usefulness, beauty” of the ancient Roman architect and mechanic Vitruvius.

On the other hand, the modern city – buildings, structures, engineering infrastructure, the environment of our life as a whole – are becoming an area of intersection and concentration of a huge number of high-tech and new areas of promising technologies and equipment (analysis and use of big data, the Internet of things, artificial intelligence, cloud technologies and blockchain, cognitive systems and identification of objects and processes, virtual and augmented reality, geolocation and positioning, telemetroning, robotics, distributed alternative and alternative energy, unmanned vehicles, bionics, additive technologies, etc.) [15,17,18].

In fact, this area is becoming a field of fundamentally new academic and applied professional competencies for the development of human capital at a convergent level, which no one today fully possesses. Moreover, this situation is characteristic not only for our country, but also for the global high-tech progress as a whole. On the other hand, it is obvious that this area exists and is extremely promising – these are new, much larger and more capital-intensive markets for traditionally more segmented high-tech products, which will be expanded to the results of the labor of builders - used territories, objects and infrastructure elements, to plan, design , to create and use which is now necessary in a new way.

Thus, it is obvious that the modern city makes up, and it, in turn, combines many different systems. In fact, the “intelligence” of the city in this sense determines how well it technologically combines all its systems at the functional and cognitive level of modeling and results for human, society and nature. Moreover, the task is many times complicated by the dynamic, and often stochastic, nature of most of these systems and their complex as a whole at the model level. In addition, we are talking not only about solving technological problems, but also, to a no lesser extent, the tasks of dynamics adequate to the pace of modern scientific and technological progress of social and social adaptation of a human in a city.

In the context of the constituent entities “smart city” (see Fig. 1) and the modern achievements of scientific and technological progress, the new field of modern fundamental and applied scientific research, in turn, should today be oriented toward the search for a convergent perspective at all levels of modeling of constituent objects and processes. At the same time, more and more often the most significant motivational element and the main criterion for evaluating various practical decisions in the development of the city is the health of its residents - the main indicator of quality of life and sustainable development. In this sense, the term “Urban Health” unites a new general concept and subject area in this sense, which defines how and how much the city contributes to a healthy lifestyle in every possible sense.
In terms of “Urban Health”, the discussion in the professional community in our country and in the world is just beginning, but it is clear that this subject area will unite a record number of areas of interdisciplinary research in the very near future. The nature and scale of such tasks, the direct impact of the success of their solution on the quality of life for each of us, the public and public character and resonance of most of the problem areas involved, the perspective and potential capital intensity of new markets for mass high-tech products – all this makes the new subject area unprecedentedly relevant.

In order to streamline our knowledge and form an objective idea of the technology development prospects of the new philosophy of a “healthy city” in the general paradigm of creative activity, we further focus on, in the framework of this article, so far only the general logic of convergent modeling of a “smart city”, the key target priority which becomes the new socio-technological paradigm of “Urban Health”.

In fig. Figure 3 presents a diagram of the relationships between the models of the four entities “smart city” and the results of their convergence.

![Diagram of relationships between models and results](image)

**Figure 3.** The relationship between the models of the four entities “smart city” and the results of their convergence

In the upper segment of the circuit (see Fig. 3), for the purpose of further analysis, the models are presented on functional (VI. BIM 6D: “system” – “resource”) and cognitive (VII. BIM 7 + D: “complex” – “convergence”) levels of subject-object and object-subject relations. In the lower segment, at the functional and cognitive level, the target results of convergence of the four entities “smart city” are classified: “human” – “society” – “nature” – “technology”.

Thus, the correct models, high-quality design, formation and use of various, generally heterogeneous, systems and elements of the systems that make up the city, allow at the functional level of planning and resource management to ensure their effective and, in relation to nature, rational use, a certain standard of living in society and human security.

The next, much more complex, task is to combine various, generally heterogeneous, systems and elements of the systems that make up the city, at the level of complex modeling and design, and then in the practice of their creation and application. The successful solution of such problems will allow at the cognitive level of convergent results to ensure not only the efficient and rational use of resources, but also the sustainable development of the city, the conservation and reproduction of nature, not only...
a certain level, but also a new quality of society, not only the physical and technological safety of human, but also his health.

At the same time, practical tasks at the functional level of system design today are solved, as a rule, using a wide range of modern automation technologies, and solving problems at the cognitive level of complex effects requires the use of technologies and equipment with elements of artificial intelligence – a new area of fundamental knowledge that can really to qualitatively change our life in the first half of the 21st century. In this sense, we are talking not only about the progress of research in the subject area under consideration, but also about the dynamics of scientific and technological progress in general, the next technological structure, convergent and nature-like technologies, the use of which is extremely promising in creative activity [15–19].

3. Outlook and Problem. Bionics
Given the above, the development of bionics in the field of construction progress and creative activity is gaining new significance today. Bionics (in a general sense) is a field of knowledge about the creation and application in artificial (technical) systems of the principles of organization and functioning, material form, composition, properties and structures of wildlife. Bionics is not a new, but very promising field of research and practice. To solve practical problems using bionics in construction, a modern engineer needs to have knowledge not only in his own subject area, but also to deeply understand the principles and features of the functioning of objects and systems – analogues in nature (biological bionics) and have the necessary qualifications in modeling objects and systems – analogues and processes of their functioning (theoretical bionics). In this case, his own professional competencies are expanded by knowledge and skills in the field of technical bionics, i.e. the ability to apply theoretical bionics to solve engineering problems in construction.

The general classification of the subject areas of application of bionics in construction and on the scale of creative activity of a person as a whole can be represented today by the following main directions: architecture; building structures; building materials; construction technologies; urban development; infrastructure; resources; security; ecology; logistics; organization and management; social analysis and adaptation.

At the same time, in the context of the convergent paradigm “smart city” considered above, a new area of research and modeling in bionics is the analysis of the possibilities of applying its principles for setting and solving problems in terms of “Urban Health”, i.e. the integrated impact of engineering and other solutions within the framework of the above areas on human health and society.

The statement of the problem in a similar formulation in the field of construction and creative activity as a whole today can be attributed to new ones, since the application of the principles of bionics is traditional (and the traditions of bionics are estimated in almost a century in modern history, and in the history of mankind as a whole at all stages of the global progress of technology and technology they are much more ancient) to a greater extent concerned architectural decisions in terms of shaping, creative appeal to the “wisdom, logic and intuition” of nature, and constructive solutions of the terms of their durability, reliability and efficiency. To a lesser extent, but similar studies are developing today in the field of building materials, demonstrating new, sometimes qualitatively new, possibilities in the entire spectrum of their physicochemical properties.

The next level of possibilities for applying the achievements of bionics in solving problems in the modern understanding of the field of professional responsibility of the industry today opens up two new global directions in the theory and practice of analysis and modeling of building systems – this is an integrated approach to information modeling and the formation of a digital “worldview” of creative activity as a whole with on the one hand, and the intensive introduction of cyber-physical systems and technologies at all stages of design, construction and operation construction objects.

The systems engineering of digital modeling of creative activity was mentioned above [15,17,18], and the development of cyber-physical systems in our subject area today is being formed at the level of a new scientific direction “cybernetics of building systems” – the science of management,
information and relations of elements, objects, construction complex [14].

At the same time, the “cyber-physical building system” is a finite set of functional components (elements, objects, construction complex, computing resources integrated into the included physical processes) and the relationships between them, allocated in accordance with a specific purpose for a certain time interval [14].

The use of cyber-physical building systems at the modern level of technology development allows you to take a fresh look at the formulation and solution of design and creation problems of the “building structures control systems” with integrated adaptive control systems for their stress-strain state.

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