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The sixth technological revolution in construction industry: Noospheric paths

M.V. Shubenkov
Development of Education of Urban Planning and Urbanism, Department of Urban Development, Moscow Institute of Architecture, State Academy, Moscow, Russian Federation

S.D. Mityagin
JSC, NIIP Gradostroitelstva» Research and Design Institute of Urban Development, St. Petersburg, Russian Federation

Z.A. Gaevskaya
State Polytechnical University, St. Petersburg, Russian Federation

ABSTRACT: Human civilization is on the threshold of the sixth technological stage. In the heart of it there will be an energetic structure shift conditioned by transition to the society and economy not capitalizing on carbon technologies. Construction industry develops in close relation with general trends of economy development. Energy efficiency of using natural resources in the sphere of industry, transportation and constructional production remarkably influences energy balance, climate, and environmental change. In biospheric context, transformation of nature function of human society is regulated by professional apparatus of city planning activity in a system of management as it has been developed historically. Thus, nowadays, city planning may be considered as one of the major integrated means of management of social evolution of biosphere. City planning as a means of social evolution and transformation of biosphere through construction may become a basis for innovative development of the whole construction industry.

1 INTRODUCTION

The prevailing life styles that modern humankind is leading based on insufficient knowledge of laws running the Earth have resulted in global social, economic and ecological catastrophes.

At the end of the 20th Century, the issue of seeking alternative models of development of means of production, management, and consumption securing processes of societal life was put on the agenda. In 1992, the UN Conference on Environment and Development (held in Rio de Janeiro) declared a thesis about necessity to provide a balanced solution to socioeconomic problems and problems of preserving environmental public goods and natural-resources potential in order to meet the needs of present and future generations. In the conference final document, this statement came to be known as «sustainable development» (AGENDA 21).

Today, green building means, to a considerable extent, «sustainable development» (self-maintenance, balance, self-sufficiency). Construction sector is one of the largest sources of environmental pollutions due to the increase in the amount of natural resources used, degradation of vulnerable ecological zones, etc. Necessity to adopt the mandatory requirement to enable the construction sector to meet human settlement development goals, while avoiding harmful side-effects on human health and on the biosphere is obvious. However, despite being clear, this condition of future development of society is not fulfilled. This requirement was first declared in «Agenda XXI» UN report in 1992. Ch. 7 noted the necessity « to adopt standards and other regulatory measures which promote the increased use of energy-efficient designs and technologies and sustainable utilization of natural resources in an economically and environmentally appropriate way» (AGENDA 21, ch.7, article 7.69).

The combination of energy efficiency, ecology, and economy is possible only if solutions in all industrial sectors will be based on scientific knowledge. Cosmic scientific vision of the Earth which became practical in the second part of the 20th Century. brought a system of concepts about the unity of organic and inorganic worlds, their interdependence and social control of their evolution to modern commonplace sense. The information

about spatial, material, and energetic limits of social development and the role of human in global changes of biosphere has become widespread. The growth of green movements in the world can be considered as the demonstration of social attitude towards seeking forms, methods, and techniques of controlling the quality of the environment in order to create and maintain the conditions for progressive co- evolution of two interacting parts of the biosphere: nature and society (Mityagin 2011).

It is possible to achieve goals of this kind using a professional apparatus of city planning which aims to find a solution to the problems of formation of spaces of life activities with pre-planned properties. City planning should not be understood pragmatically as support building complex but should have a biospheric component. Noospheric territory planning will allow infrastructure capital construction objects to be effectively incorporated into ecologically balanced framework of engineering and transport infrastructure, real estate development, and natural complexes.

Technological revolution in resource saving and alternative energy requires the construction sector to develop an entirely new methodology of design and management aiming at constructive responses to the 21st Century challenges.

Y. P. Mukhin, T.S. Kuzmina, and V.A. Baranov distinguish two main directions of sustainable development (Mukhin 2002):

- The first direction is based on solving ecological problems (improving the environmental quality) by technical means, e.g., applying modern innovative treatment technologies, wasteless technologies, etc.
- The second direction focuses on conservation of majority of natural or near-natural ecosystems in order to prevent environmental disaster. Nowadays, when the 1% consumption threshold has been exceeded (by man), Le Châtelier's principle, according to which, whenever a system in equilibrium is disturbed, the system will adjust itself in such a way that the effect of the change will be nullified, is not true for ecosystems.

The history of humankind development at the end of the 21st Century showed that the first direction is not efficient enough to solve all environmental problems. The concept of sustainable development of the second direction continues to develop the theory of noosphere genesis first formulated in V.I. Vernadsky's works. Philosophical and scientific foundation of noosphere genesis was laid in works by Russian cosmist scientists of the 20th Century: V.I. Vernadsky (Vernadsky 2004), N.N. Moiseev (Moiseev 1987, 1985), and N.F. Glasovsky (Glazovsky 2005). The theory of noosphere genesis related to the development of Vernadsky's doctrine is in progress at the moment (Doctor of Architecture Mityagin S. D., adviser of Russian Academy of Architecture and Construction Sciences (RAACS) (Mityagin 2011, 1989,1986, 2016), Doctor of Philosophy Ursul A.D. (Ursul 2005), Doctor of philosophy and Economics Subetto A.I. (Subetto 2009), Doctors of Geography Shalnev V. A. (Shalnev 2006) and Sdasyuk G.V. (Sdasyuk 2005), academician of RAMS Kaznacheev V.P. (Kaznacheev 1989), PhD in Architecture Gaevskaya, Z.A. (Gaevskaya 2012, 2014), and foreign scientists Norgaard, R. B (Norgaard 1994) and Hödl, Elisabeth (Hödl 2012).

Thus, scientific foundations of noospheric development of the construction industry are at the early stage of their formation and need further research and extension.

According to these, proposals on defining noospheric directions of construction and city planning sectors development based on the foreseen challenges of the VI technological revolution are very relevant at present.

2 METHODS

The UNEP report prepared for Rio+20 «Towards a Green Economy: Pathways to Sustainable Development and Poverty Eradication» continues to develop the concept of sustainable development adopted at the 1992 UN conference in Rio de Janeiro in modern conditions. The report argues that «A green economy substitutes clean energy and low carbon technologies for fossil fuels, addressing climate change, … creating decent jobs and reducing import dependencies. New technologies promoting energy and resource efficiency provide growth opportunity in new directions, compensating for «brown economy» job losses (UNEP, 2011).

Transition of the world civilization to the sustainable development based on «green economy» requires modernizing all spheres of production, consumption, and environmental management. Space-based observations of dynamics of global processes show continuity of systematic unity of all natural landscape components as well as human economic and industrial activity and the environment. Life is not a purely chance phenomenon on this one little planet, the Earth. According to Vernandsky (Vernadsky 2004), the face of the Earth reveals the surface of our planet, its biosphere, and outer area dividing it from the cosmic force. Academician Ursul A.D. suggested the following definition of sustainable development: « It may be defined as a forthcoming form of co-evolution of society and nature providing their mutually safe coexistence and noosphere formation» (Ursul 2005).

In cognition and control of biosphere, scientific knowledge functions as the main tool. Academician Glasovsky N.F. stressed that... «noosphere is a scientifically conscious space-time domain of the world» (Kotlyakov 2006).

Sdasyuk G.V. thinks that the fundamental difference of the concept of sustainable development from conventional views and management practices is in its holistic (integral) approach to development as a holistic process (Sdasyuk 2005).

Noospheric thinking should be built on Vernadsky's prediction: nature is not amorphous and shapeless as people thought for centuries but has very fine organization which as such should be reflected and taken into account in all conclusions and judgments related to nature (Vernadsky 2004). This is the most important condition of sustainability of nature.

This idea is formulated in Article 39 of the Resolution adopted by the UN General Assembly July, 27, 2012 as follows: «We recognize that planet Earth and its ecosystems are our home and that the «Mother Earth» is a common expression in a number of countries and regions, and we note that some countries recognize the rights of nature in the context of the promotion of sustainable development. We are convinced that in order to achieve a just balance among the economic, social and environmental needs of present and future generations, it is necessary to promote harmony with nature» (UN General Assembly 2012).

Humankind is bound to degrade if it fails to organize rationally its life environment, protect environment, and form a convenient infrastructure. For many centuries, activities on planning, development, and management of settlements were realized without taking into account scientific knowledge and were connected to the formation of their own theoretical knowledge based on practice, development of their own language of setting, and solving problems. There is a mediation link between scientific knowledge and practical activity in city planning: planning, development, and technical implementation tools. The methodology of planning, development, and management is known to be principally different from research methodology. Fundamental and applied R&D requires expanding the range of problems addressed, changing a way of professional thinking, and elaborating a principally new approach to the phenomena under study since a quantitative accumulation of knowledge and conventional approaches of problem solving are not sufficient today (Shubenkov 2015)

The problem of efficiency is especially urgent in planning and development activity. Human practice is systemic. Systematicity of human action consists of following a certain plan or algorithm. It is necessary to compare consequences of all possible steps by modeling them rather than taking them in reality. The sixth scientific and technical revolution raises a question about the systematicity of the world, which, in turn, results in necessity to understand development as a creative process aiming at perspective, connected with decision making, developing new technical systems and technologies, new optimal in perspective models of systems (Peregudov 1987).

Algorithmization of action is an important means of its development. The algorithm is a mode of future action, its model. Modeling is the major way of building theories and goal-oriented representation of the original. Therefore, it is vital that the organization of the whole system was subordinated to the specific goal because it is an image of the desired future. The sixth technological revolution determines the following goal for construction industry. It must become a competitive industry forming safe environment for human life and action which meets high standards of quality and effective management in order to provide sustainable development of the environment based on biospheric laws.

Thus, algorithmization of a city planning activity is necessary since development depends on the ability to use resources, and not just their availability. In our view, it should consist of consequent elaboration of the above-mentioned goal at different levels of hierarchy.

1. Development of a city planning theory as Architecture of the Earth. Modern city planning must use fundamental notions of science, regularities of biosphere functioning, and development (Mityagin 2011). Spatial arrangement of the territory is characterized by natural resources location (woods, water bodies, minerals), organization of residents' settlement, the arrangement of working places, transport and engineering public facilities, and cultural and natural heritage sites. This definition allows us to consider it as a complex system, consisting of anthropogenic infrastructure and the environment. Building, industrial, and communication infrastructures cause a considerable impact on the climatic system of the Earth. According to prof. Gorshkov S.P., making the Earth abiotic environment, turning the Green Earth into Gray one due to anthropogenic impact for a short historic period changes the structure of the hydrologic system resulting in a decrease in evapotranspiration, which in turn leads to an increase in heating ground air. On the Gray Earth (which is featured by deforestation, desertification, substitution of overwetting, and aquatic habitats for fields, plantations,

and man-made grazing land; fast expansion of anthropogenic infrastructure, especially through urbanization), natural disasters are becoming more intensive (Kotlyakov 2006). Thus, for the mankind to survive, it is necessary to adapt the anthropogenic environment to local ecosystems, not vice versa.

2. Development of multidimensional systems of project management integrated with systems of modeling objects and their life cycle management based on their integration into the natural environment. Copenhagen Declaration (of International Union of Architects), adopted at 2011 General assemble of IUA, considers Sustainable by Design concept which, in particular, recognizes that «all architecture and planning projects are part of a complex interactive system, linked to their wider natural surroundings...» (Copenhagen Declaration, 2009). Architectural design lags behind engineering design, which has already experienced remarkable changes. System engineering of construction, machine-building, instrument-making, etc., are new fields of corresponding professional activity. Architectural design will have to adopt new design methodologies in the nearest future. New principles and techniques will be worked out. They will be built on the results of modern applied development and research on scientific basis of design, building, and functioning of integrated interactive complexes of analysis and synthesis of architectural and spatial systems and related design and technological documentation. Improvement of design processes based on the wide use of computer aids, information technologies, and computer networks will become the earnest of solving such problems. Principally, new methods and means of «designer-computer» interaction based on new interfaces will appear (Shubenkov 2006).
3. Considering a single building and complexes of building objects as a complex unified power aerohydrodynamic system. Such understanding lays scientific foundations of designing really «green» objects. Concept of «green architecture» is to include concepts such as power efficient, cost-effective, ecological, and ergonomic architecture.
4. Development or renovation of buildings should imply solve a threefold problem taking into account the following aspects: 1) creation of healthy indoor climate, comfort, and ecology; 2) fossil fuel and primary energy saving, using alternative energy sources; and 3) construction cost-effectiveness, reducing the consumption of material and technical resources (Belyaev 1991). Simultaneously, taking energy intensity, durability, level of thermal protection, and construction site location into account is possible only if we consider an energy-efficient building as a complex system which is an element of a more complex power-efficient architectural and landscape system (Gaevskaya 2014). Such an innovative approach will require updating standard technical documents regulating construction industry as the concept of sustainable development implies a new natural evolutionary stage of society development.

New methods of waste water treatment, human waste recycling, development of technologies of cheap autonomous shelter construction, energy generation from renewable sources, and clean industrial manufacturing are among the most promising directions in construction industry.

Mutual influence of natural and anthropogenic structures and processes, lack of solid knowledge about the variety of manifestations, and degree of disrupting impact of economic activity make development of management system of social evolution of the biosphere and its consequent formation on the global, continental, national, regional, and local scale considerably more difficult.

3 RESULTS AND DISCUSSION

The goal of modern city planning activity is to harmonize relationship and mutual influence of society and its life environment. In our opinion, this is the most reasonable way of investigating city planning sites.

Life environment artifacts are imprinted in the territory's sketch plan. We would suggest the following principles of biospheric optimization of construction industry:

1. More comprehensive and insightful study and consideration of horizontal relations among morphological components of the landscape. Thus, mutual arrangement industrial premises, residential quarters, green zones, and water bodies should be in agreement with a wind rose, geomagnetic structure of the territory, effects of groundwater flow and overland runoff, and the history of its development.
2. Creation of the «Green Earth» in order to provide continuity of evolution of natural processes. To prevent secondary gravigenic processes and loss of soil particles, it is important to provide required forest square not only along waterways and ravins but also and especially on watershed divides and slopes regardless of the value of these lands for other types of land use (Muhin, 2002).
3. Finding agreement between economic benefit and ecological balance. Capital construction

objects should not create anthropogenic load destroying nature but ought to support ecological balance resulting in maximal ecological-social--economic synergistic effect.

4. Buildings and their complexes are included into an interactive system linked to their environment based on different types of energy-efficient organization of their properties (e.g. architectural, technological, landscape, and typological) (Gaevskaya, 2014).
5. Search for modern energy-efficient building materials and technologies of building erection and renovation should be in agreement with the concept of energy efficiency of landscape and typological object organization. Careful and considered design of buildings' shape and geometry, choice of spatial strategy together with relevant materials, equipment, and functional space arrangement can reduce resource consumption, green gases emission, and total negative impact on the environment by 50–80%» (Remizov, 2016).

4 CONCLUSIONS

New directions of noospheric development of construction industry taking into account forthcoming transition to the sixth technological revolution epoch can be suggested today. They include the following directions:

- Development of «Architecture of Earth» theory. Its methodological basis consists of integration of capital construction objects into biosphere within its industrial capacity, with horizontal relations among morphological components of natural and anthropogenic landscapes being taken into account as fully as possible.
- Development of new generation program interfaces to determine properties and quality of a socio-functional and natural system in order to run multidimensional systems of design, modeling, and managing life cycle of construction objects.
- Development of the scientific basis of «green building» and «green architecture» based on the theory of noosphere genesis.

All above-mentioned directions raise questions about working out a principally new methodology of design thinking and management in construction industry aiming at a constructive response to the 21st Century challenges.

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