Problems of Architecture and Professional Development of an Architect beyond “Limits to Growth”

O O Fomenko, S M Danylov and A M Izbash

Department of Innovative Technologies of Design of Architectural Environment, Kharkiv National University of Civil Engineering and Architecture, Kharkiv, Ukraine

izbash280593@gmail.com

Abstract. The study examines the regional specifics of the formation of architectural specializations under the influence of social and resource crises experienced by Ukraine. Based on the work of D. Meadows and J. Forrester (system dynamics) a method was developed for the formation of “Knots of problems” based on “positive and negative feedback loops”. Some “Knots of problems” and their influence on the formation of needs for architects and urbanists of the new generation were described on the example of Kharkiv. The identified needs are shaped by the acute socio-economic crisis experienced by the city. The authors argue that a focus on servicing territorial communities and developing strategies to enhance the role of society in creating an energy-efficient and environmentally positive architecture should be considered a priority in the work of architects of new formation. The research based on the identified socio-economic “Knot of Problems” describes its hermeneutic circle (a circle of interconnected systemic contradictions that prohibits the solution of identified problem). The analysis of the revealed “Circle” indicates that an achievement of a sustainable state by the cities of Ukraine is practically impossible without a significant increase in socialization in urban communities. The study focuses on the importance of universities and, in particular, architectural faculties, in the revival of territorial communities.

1. Introduction

Fifty years ago, an assistant at the Massachusetts Institute of Technology (MIT) Dennis Meadows was given an assignment by the Club of Rome to conduct an unusual study of the time [1]. The essence of an assignment was to compare some of the key trends in world development under the influence of the environmental, demographic, economic and resource spheres. March 13, 1972, in Washington, at the Smithsonian Institution, saw the first presentation of the collective work “Limits to Growth, a Report to the Club of Rome” [2, p. 208].

The authors of the book analyzed 12 calculated scenarios of a possible future of the world community in the period between 1970 and 2100. Some of the calculated scenarios ended with a sharp depopulation of the planet and the decline of material living standards. But alternative calculations of sustainable options for the future were presented, in which the population size and the satisfaction of its physical and spiritual needs were harmoniously combined. The relevance of the work of Meadows and his research team is confirmed by the fact that more than 30 million copies of the book in 30 languages have been purchased worldwide [3, pp. 59-63]. The book is still relevant and causes debate. After 1972,
following works were published: Donella Meadows “The Limits to Growth: 30 Years Later” in 2004 [4] and Jörgen Randers “2052: A Global Forecast for the Next Forty Years” in 2012 [5]. These works are a continuation of the work of Dennis Meadows and largely confirm and refine his calculations.

The national specifics and the events of spring 2020 are forcing us to consider a new perspective for the problems of the development of Ukrainian architecture and the profession of architect for the next fifty years. The paradox of current situation is that the estimated lifetime of the absolute majority of buildings being designed today goes beyond the forecasts of sustainable urban functioning in the way of life that has formed nowadays.

This article proposes a number of theses based on the ideology of the work of Meadows, specifically - the analysis of the conjugations of “positive and negative feedback loops” (Meadows [6]) linking architecture, ecology, socio-economic and geopolitical factors forming the life activity of Ukrainian cities.

2. The results of the study

According to the theory of modeling dynamic processes, any exponentially growing factor in the city system is involved in the positive feedback loop in one way or another [7]. The positive feedback loop is often called a “vicious circle.” An example is the familiar “household price growth - housing demand growth” relationship: at certain time periods (for example, in 2002–2008, 2010–2014), prices per square meter of housing steadily increased in Kharkiv. This stimulated the interest of private investors in real estate, which triggered demand for housing and subsequently led to higher prices. As a result, the real estate market was overheating, creating a “soap bubble”, which periodically “burst[ed]”. In 1-2 years, the “vicious circle” begins a new turn.

In the process of researching the problems of housing estate in Kharkiv, Ukraine, several groups of “Positive and negative feedback loops” that could potentially have a strong impact on the formation of the architectural component of the city were identified. This work proposes to identify such groups as “Knots of Problems”. Together, these “Knots of Problems” create a unique map of forecasted events, specific only to Kharkiv and related to the adaptation of the architectural component of the city to the expected acute crises, including: potable water supply shortages, energy, technogenic, lack of engineering and technical staffing, food and environmental.

The uniqueness of the situation lies in the fact that the described problems are not critical at the theoretical level. However, in reality they get into the hermeneutic circle in following way:

1. Each of the “Loops” and “Knots” described further in the study severely restricts the city’s access to social, technogenic and natural types of resources.
2. The shortage of social, technogenic and natural resources leads to the aggravation of corresponding crises.
3. To solve the emergent crises, the system needs social, technogenic and natural resources, access to which is restricted, as shown in paragraph 1. The circle is closed, creating a threat of the city’s system going into a possible pre-catastrophic state, wherein the city cannot support the available number of its inhabitants.

According to authors, four among the many existing and predictable crises should be classified as basic. Their forthcoming nature makes it is necessary to adapt the architectural component of the city and partially change the current practice of preparing the next generation of specialists. These crises are listed below:

- Potable water supply shortages

Water management in the Kharkiv region nowadays is characterized by extensive water usage, formed during the Soviet era. The main problems are the non-separation of drinking and industrial water, leakage from the water supply network (according to the statistical reporting of 2-TP “Vodkhiz”, measuring up to 33-40% of the supply [8, pp. 344-348]), poor metering and control of consumption associated with lowered water prices and the lack of interest of the public service in identifying water losses in network [9]. Kharkiv is one of the main consumers of clean potable water in the region. The stability of water supply is one of the basic factors for the stability of functioning of the entire city. Today, water management technologies are being actively developed around the world. This process was reflected in
the architecture by the points for voluntary certification of buildings accrued for water saving. It becomes an almost mandatory procedure for modern architects to develop competencies related to the implementation of rainwater collection and utilization systems in the design and construction practice, including the separation of sewage water into gray and black, the separation of tap water into drinking and technical, implementation of water treatment systems and saving systems [10]. Given the shortage of economic, natural and human resources, the problem of population’s access to clean drinking water has a potential to become an acute crisis.

- Energy crisis

The city’s existence and development is linked to the consumption of three basic resources: substance, energy and information. The consumption of these resources increases exponentially, which is accompanied by problems associated both with the shortage of resources and their mutual influence with the natural environment [11, pp. 2-14]. Since the First Industrial Revolution, the role of energy in meeting the vital needs of the city has been constantly growing. Architecture is one of the significant consumers of energy. Ukrainian cities are almost completely dependent on fossil fuels – such as gas, coal, oil and nuclear fuel. Compared to Europe, the share of alternative energy sources in the country’s general market is unacceptably small and amounts to only about 1.2% of the total volume [12]. At the same time, a number of laws have been adopted in the country (“About energy efficiency of buildings”, “About alternative energy sources” etc.) which are program documents for the energy and innovative development of Ukrainian architecture.

- Economic crisis

Economy is the main factor influencing the prospects for the modernization of the architectural component of the city. This thesis does not need interpretation. The unique problem of Kharkiv is well demonstrated by the data from the experiment described in the fifth section of the dissertation research of S.M. Danylov. The purpose of the experiment is to test the working capacity of the model complex for analyzing the city as a dynamic system developed in the dissertation research, in particular, the cognitive-research matrix. The object of study is obsolete buildings of the housing estate “Novi Dom”. The objective of the study is to identify the “knots of problems” (sets of positive and negative feedback loops) associated with the adoption of the Law of Ukraine 2118-VIII “About energy efficiency of buildings” and the modernization of architectural objects in accordance to this law. Four possible scenarios of changing the socio-economic indicators of the housing estate were considered in the experiment depending on the selected estimate of modernization. The result of the study was the identification of problems associated with the insufficiently high financial situation of the population. The consequences of adopting an estimate of an option providing for the optimal modernization of buildings ($ 320 per m2) will be disastrous for their residents.

- Staffing crisis

Nowadays, the staffing crisis is not considered acute, or posing a threat to the stable functioning of the city. However, while considering this problem, it is necessary to take into account several loops of positive and negative feedback, specifically: qualification, demographic and emigration. The qualification “loops” arose as a result of the collapse of industry in the 1990s, when the reproduction cycle of engineering and labor in the construction industry was disrupted. By 2015-2020 there was an overlap of two “demographic pits” - the consequences of the Second World War and the 90s. In their totality, they caused a shortage of workers in middle and young age categories. Combined with the aging of population and a general decline in the birth rates, the demographic problem poses a serious threat to the stability of the city’s life [13, p. 65]. In 2003, 2,887,900 people lived in the region of Kharkiv, 1,470,921 in the city itself. In 2020, the population of Kharkiv region and the city of Kharkiv totaled 2,658,461 people and 1,441,932 people correspondingly. Thus, the depopulation of the region amounted to 0.5% per year, and 0.15% of the city [14]. This fact is confirmed by the data of the Main Department of Statistics in the Kharkiv region. Over the same period, housing provision in Kharkiv increased from 18.2 to 24.1 m2 per resident [15]. Labor emigration over the past five years has critically exacerbated the effects of qualification and demographic deficits. The shortage of qualified staff greatly inhibits the
modernization of the construction industry, while the crises experienced by the country provoked a powerful outflow of talented youth from the country [16, p. 263].

The above crises are listed by the decreasing order of their threat to the stable functioning of Kharkiv. According to authors, the procedure for resolving these crises mirrors their order of severity. First step is the creation of a cluster of highly qualified staff, which would allow for stabilization of the economy. Subsequently, the economic stability and the availability of highly qualified staff will unlock the possibility of an effective reorganization of the energy sector, which will make it possible to stabilize the circulation of clean potable water between the city and surrounding territories.

This thesis is the result of many years of research into architectural innovation related to sustainable development. An architect who designs under the constraints imposed by the nZEB requirements (the nearly zero-energy buildings) is able to create complex objects that are significantly superior to buildings with traditional technical content. City of sustainable development, smart building / quarter / district / city, self-sufficient city, eco-city, cyber-city, CarboNZero, green standards – all of these terms are representing today's top technologies. Together, they create a special set of competencies that an architect must possess to design the entire life-cycle of an object from its design to disposal.

There are many precedents when an engineer who developed the technical components of a “zero” building became the head of the staff serving this building. The savings that an engineer brings in ensuring the maximum efficiency of the technologies involved significantly exceed the amount of his salary. This is exemplified in the Ciem building, Zaragoza. The building was commissioned by Zaragoza City Council as part of the Digital Mile project [17] (total area: 2 309 m²; Cost / m²: 2 283 €). The aim of the project is to demonstrate various solutions in the field of achieving the highest possible energy efficiency while maintaining user comfort. The main difference between CIEM compared to other similar buildings is the combination of bioclimatics (energy passivity) with energetically active systems (photovoltaic, wind, biofuel and geothermal systems). The combination of all this as well as the use of an intelligent control system, led to very satisfactory results. The building is also designed as a research laboratory, where a large amount of data is collected from sensors of all types. In addition to allowing the real-time determination of energy characteristics of a building, this provides an additional opportunity to optimize or improve building performance.

The combination of results of studies A) trends in the development of innovative technologies for sustainable development in architecture, and B) the architectural and urbanistic problems of the housing estate "Novi Doma", allowed to calculate the aggregated indicators of the city’s needs for highly qualified specialists in the architectural and construction industry – namely, urbanists and engineers. The ideas about the circle of responsibilities and the set of competencies of the architect-urbanist, corresponding to the new needs of the city were formed [18].

The above calculations serve as the basis for forming the cycle planned by the authors of experiments. The expected results of the cycle are the formation of reasonable ideas about the nature of changes in the process of preparation of a new generation of architects able to work under conditions of many crises’ exacerbation. The main difficulty in analyzing the prospects for the development of the architectural and urban areas in the practice and pedagogy of Kharkiv is the “Socio-economic knot of the problems of modernizing the architectural environment of the city”.

A “knot” is formed by several tightly interconnected loops of positive and negative feedback. The following loops have the greatest impact on the problem: physical and moral obsolescence of buildings, degradation of the technical condition of utility networks; decrease in socialization of city residents; decrease in business activity; growth of corruption.

In the dissertation research of S.M. Danylov “Methodological foundations of modeling the city as a dynamic system” author proposes the concept of finding the optimal ratio of social, natural and technological resources necessary for the implementation of strategic and tactical tasks to modernize the architectural component of the city. The calculations of aforementioned work clearly signify that the social resource in the socio-economic conditions of Ukraine is the most important. At the same time, the parameters of socio-economic relations within the country indicate the fact that it is extremely difficult to use this resource.
A case in point is the negative experience of social relations obtained by architects and local authorities of Kharkiv in the process of reconstruction of a morally obsolete five-story residential building in Kharkiv ("Novi Doma" housing estate at Marshala Zhukova Ave., 21). The modernization of the building was completed by JSC Zhilstroy-1 in 2001 at the expense of investors and the municipality. This experience was considered as an experiment necessary to develop a socio-economic strategy for the renovation of obsolete city housing. The idea was to develop a project that was economically attractive to potential investors. The project’s supposed payback was to be provided by the attic floor superstructure on five-story buildings with subsequent sale of new apartments.

The project by architect Nikonenko E.V. provided for the implementation of a complex of works on the overhaul of the building and the superstructure of the attic floor without resettling residents, increasing the energy efficiency of the building to class C. As a result of the work carried out, the costs of utilities for residents decreased by 56% on average. In the process of architectural supervision the complaints to law enforcement bodies were written against the architect, he was threatened with physical harm, some of the residents categorically refused to sign an agreement for repairs, etc. The result of the experiment was a complete loss of ethical and economic interest in this topic among architects, investors and the local government. Similar problems in the implementation of the "Regional programs of experimental reconstruction" were confronted by the organizers of experiments in different regions of Ukraine: 7 buildings in Luhansk region, 1 building in Odesa, 2 buildings in Poltava (for off-budget funds from investors), 1 in Kharkiv, 3 in Chernigiv, 6 in Kyiv and 2 in Sevastopol [19].

The hermeneutic circle of the problem in the formation of specialists professionally prepared to adapt the architectural component of Kharkiv to predicted crises is as follows: continued technical degradation of the architectural environment and engineering networks → it is difficult to solve the problem due to investments from the city budget, as Kharkiv is economically underdeveloped and significantly lags behind similar cities in the European Union → only social resources are abundant → there is an extremely high percentage of retirement age among highly qualified staff → the collapse of the country’s economy leads to an extremely high motivation of young specialists to emigrate to Europe → a decrease in business activity due to fleeing of the nation’s most active segment of the population leads to increased degradation of the architectural part of the city. The circle is closed.

According to authors, the breaking of the described hermeneutic circle lies in the development of scientific and practical activities of universities. Ukrainian universities have immense social reserves, their realisation is possible and, furthermore, vitally necessary. The above-mentioned cycle of planned experiments is dedicated to this problem, designed to identify optimal areas linking the educational, design, entrepreneurial activities of young professionals with the processes of revival of urban communities. Experience of Nikonenko E.V. convincingly showed how heavy the legacy of the USSR and the period of 90’s is in the desocialization of city communities and the people mentality.

3. Conclusion
Dennis Meadows considers the ability of a region (or planet) to maintain the existing population density a result of the mutual influence of the biocapacity factors of the region, the availability of resources, the development of innovative technologies and the development of human potential. In the face of a decline in all four of these indicators, the survival of the city directly depends on the conscious and focused work of all its residents to correct the situation.

With a population of one and a half million, architectural and construction innovations become a weighty argument in solving the problems of adapting the city to escalating resource and environmental crises. Kharkiv and its region have a fairly high potential, allowing a positive assessment of the prospects of the city. In order to realize the existing potential, architects and urbanists of a new formation are needed, having competencies to transform the architectural environment of the city into a single, self-sufficient system.

Currently, the authors are working to determine the necessary architectural, construction and engineering competencies to form an architectural and urban specialization that meets the requirements of
the city and its community. Scientific and practical directions are being developed in relation to the need for architects to work as leaders of multidisciplinary groups.

The main problem is the need to develop the principles of interaction between the architect and the territorial community in conditions of a depressive attitude of the population to any initiatives. This problem is evaluated and considered as a promising topic for a comprehensive study of urbanists of the following specialties: architects, sociologists, psychologists, managers, lawyers and city administrators.

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