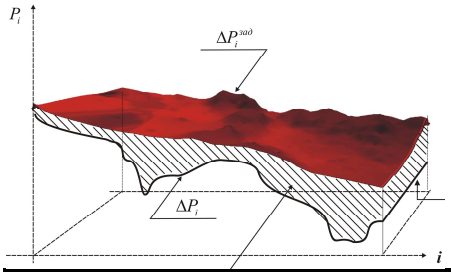

TRANSFORMATION OF URBAN SPACE: TASKS AND METHODS OF STUDY

TRANSFORMACJA PRZESTRZENI URBANISTYCZNEJ ZADANIA I METODY BADAŃ

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STRESZCZENIE

Artykuł porusza kwestie problematyki badań transformacji przestrzeni urbanistycznej z użyciem metody teorii potencjałów. Proponowana metoda otwiera nowe możliwości dla rozwiązywania następujących zagadnień: ilościowy opis poziomu organizacji systemu planowania przestrzennego; modelowania synergicznych efektów i procesów transformacji przestrzeni urbanistycznej z uwzględnieniem wzajemnej zależności jej elementów; rozwiązywanie problemów optymalizacji przekształceń przestrzeni urbanistycznej w celu zaspakajania potrzeb populacji.

Słowa kluczowe: system planowania przestrzennego, potencjał przestrzennej organizacji obszarów, transformacja przestrzeni urbanistycznej, efekt synergii; model matematyczny.

ABSTRACT

The article deals with the problem of study of transformation of urban space using the method of potential theory. The proposed method opens new opportunities for resolving the following tasks: quantitative description of the level of organization of urban planning system; modeling of synergetic effects and processes of transformation of urban planning system taking into account mutual influence of its elements; solving optimization problems of reforming urban space to satisfy demands of population.

Key words: urban planning system, potential of spatial organization of the territory, transformation of urban space, synergetic effect, mathematical model.

INTRODUCTION

History of the development of cities is the history of mankind. And every time at the new turn of development of civilization new demands of city residents emerge whose satisfaction engender transformation of urban space. And it is natural, that urban planners and architects face new problems every time searching for the effective design solutions of urban development under the conditions of limited resources (economic, human and natural) that would most fully satisfy expectations and needs of the population. At the same time envisioning of the tendencies of further development of a city as well assessment of consequences of implementation of a certain plan of development of the territory is one of the important and complicated problems of urban planning. We often observe a situation, when appearance of a new project or a new function in the city somehow provokes either development of nearby territories or, on the contrary, appears to be a factor of subsequent stagnation of the territory (Fig. 1-5). Thus, it is the study and envisioning of the peculiarities of influence of one project on the other projects (or interaction between elements of the urban planning system[1] taking place with participation of the man that are a very complicated and topical problem of urban planning theory.

Or, for example, under the conditions of limited resources (territorial and economic) there may stand a problem of either construction of a project vitally important for the city – a transport junction or an entertainment center. In such case it is important to know what synergetic effect will be produced for development of the city in the result of implementation of each of these projects.

This is why today, under the conditions of growth and sophistication of some urban structures, stagnation of other cities and the growth of population of the planet understanding the nature of mechanisms of growth of the city and regularities of modifications of its space, possession of effective tools for the study and modeling of the processes of transition of the city from one state to another in the result of implementation of some ideas or plans of development of a territory is very important.

From the standpoint of scientific validity of the results of assessment of consequences of implementation of some project solutions the most effective are methods based on quantitative indices. Owing to the rapid development of computer information technologies new opportunities for mathematical modeling of the process of growth, stagnation and transformation of cities have opened. At the same time, given the complexity of the city as an object attributed to semistructured socio-economic systems with a multitude of direct and inverse links of nonlinear character between the elements, effectiveness of application of quantitative methods to practical problems of urban planning depends on how fully and adequately mathematical models reflect the urban planning reality.

This is why the objective of the article is to reveal the nature of the mechanism of transformation of urban space and to find an approach to formalization of the process of transition of urban planning system from one state to another taking into consideration parametric interaction of its elements.

[1] In this article the notion of urban planning system is used together with the notion of the city for the purpose of considering the city as a system of elements and their interaction.

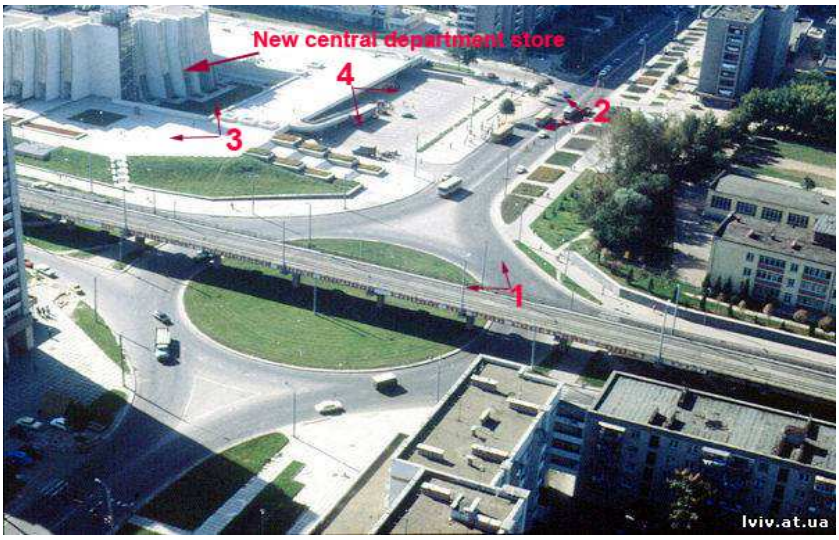

Fig. 1. New central department store in Lviv (end of the 1980's). Source: www.lviv.at.ua

Fig. 2. New central department store in Lviv and neighboring territories (2013 year). Viewpoint №1. Source: A.Hoblyk

Fig. 3. New central department store in Lviv and neighboring territories (2013 year). Viewpoint №2. Source: A.Hoblyk

Fig. 4. New central department store in Lviv and neighboring territories (2013 year). Viewpoint №3. Source: A.Hoblyk

Fig. 5. New central department store in Lviv and neighboring territories (2013 year). Viewpoint №4. Source: A.Hoblyk

THEORETICAL PREREQUISITES FOR STUDY OF THE PROBLEM

Since the city as the object of the study is an infinitely complicated and multidimensional object, representatives of various fields of science are involved in the study of

transformation of urban space and consider this problem from different angles. For example, sociologists are interested in the problems of transformation of socio-cultural space of a modern city (Baum ,1999; Sachs-Jeantet). The architects deal with the issues of the form shaping in architecture of the city (Guggenheim & Söderström, 2010; Schumacher, 2009.). Urban planners handle the problems of influence of various factors (natural, transport accessibility, economic, social, etc.) on the forms of growth of the city. Theoretical approaches to the problem of study of the mechanisms of growth of the city and modeling of peculiarities of development of the city in the 20th century have been most fully described in the work of the well-known French urbanist P. Merlin. At the same time, according to the critical notes of the author himself the models proposed in those times allowed to obtain only partial results pertaining to the problems of development and transformation of the cities, as it is very difficult to formalize behavior of every city resident in the matters of choosing the place of residence, place of work and, respectively, in the formation of urban environment (Merlin, 1973).

Of no small importance for resolving the problem set forth in this work are the works of J. Forrester in the field of system dynamics, namely, a simulation model for the description of behavior of a typical American city (Forrester, 1969).

Since a city can not develop in an isolated world, its existence depends on the links with the environment and other cities. Of great importance for further formalization of the process of transformation of urban space appeared to be the approach of M. Dyomin to the problem of growth and development of the multifunctional city (region). He elaborated a model, whose macrostructure was represented by interaction between the sectors: material production, production of information, production of services, population, territory, capital investments. Development and transformation of the city is manifested through qualitative and quantitative changes in each of the sectors and through the changes in the strength and nature of interaction between them (Dyomin, 1991).

Among the recent research works pertaining to the problems of city growth and its transformation it is worthwhile to mention the works of one of the leading centers of applied spatial analysis in Western Europe – the UCL Centre for Advanced Spatial Analysis (CASA), London. In particular, the Center's specialists have elaborated methods of fractal geometry for the study of the processes of territory development (Fatih Terzi & H.Serdar Kaya, 2008). Another work of interest is the project "Dynamics of urban sprawl" (Batty & Yichun Xie, Zhanli Sun, 1999). Within the framework of this project there have been developed: aggregation model of territorial development; a model based on cellular automatons that permits modeling of the waves of development and reconstruction of the city. This model was tested on the example of the urban situation Ann Arbor – one of the areas of Eastern Michigan (USA). The center's specialists deal also with the problems of formation of the cities-slums using the theory of self-organization. In particular, they have developed a model that explains the territorial fragmentation of Latin American cities, namely, the possibility of appearance of poor neighborhoods close to the neighborhoods of the rich (Barros, 2002).

REGULARITIES OF THE CITY DEVELOPMENT

Observation of the growth of cities and transformation of urban space allowed to identify some of the fundamental regularities of city development that further on were laid down as the foundation of the theory of spatial organization potential of territory described in the following chapters of the publication.

A city progresses from a conventional disorder to an order. Of course, such a vision of the author of evolution of cities may cause a multitude of questions from the colleagues urbanists and architects for there are numerous successful examples in the world how cities without any dramatic upheavals (cataclysms, wars, destruction, etc., that is, avoiding the stage of “disorder”) had covered their road of successful development

according to the elaborated architectural (urban development) plan. An example of such a city can be Sapporo (Japan) – the venue of Winter Olympic games of 1972, founded in the late 1860's and built literally in the "empty" place according to a clear plan, and today is one of the largest cities of Japan with the population of nearly 1.9 million people. Relatively young cities, that started from "zero" and built within a short time according to a clear plan, can also be found on the territory of the former USSR. In the period from 1917 to 1980 there came to life 1174 new cities in the former USSR and almost half of them were founded in unpopulated areas (Kutsev, 1982).

However this above described experience of founding or construction of cities does not contradict the vision of the author of the evolution of urban development. We shall specify further in this article what the author understands under the terms "conventional disorder" and "order".

The categories of "conventional disorder" and "order" are sufficiently ambiguous by themselves and depend on the standpoint of the observer (that is, of an individual or the society) and his attitude towards the state of the system or object (in our case, a city or a part of the city) at a specific time. A city may in the process of its development many a time go through the transitions from the conventional disorder to an order and back. The development of a city can be regarded as a process of transformation of urban environment according to new ideas or plans (prevailing social values), and the transformation of the city begins when its state at a given time stops to meet (correspond to) to the needs of the society (community).

A conventional disorder is such a state of the urbanized territory or a city or just a territory, which does not meet the needs of the society and does not reflect the prevailing social values at a given time, while their development may be taking place by a variety of scenarios. For example, when the question arose what to do with Warsaw destroyed in the result of World War II, there were different variants of restoration of the city, up to the point of transferring the capital to Krakow (Lodz or Poznan). Yet the final decision was made to restore the ruined Warsaw according to the preserved plans and drawings of buildings of the pre-war period (time) (Fig. 6-7). Similarly, in case of some non-built up (vacant or undeveloped) territory - we can also consider it as a "conventional disorder" for us if its present state does not correspond to our vision of what must be on such territory. Development of such a territory can also be made, as a rule, by numerous scenarios, that is, there can be proposed a variety of architectural-planning concepts of its development.

Fig.6. Ruines of Warsaw's Old Town Market Place. Source: http://www.archnadzor.ru/2007/07/07/varshava/

Fig.7. Warsaw's Old Town Market Place (after restore). Source: http://www.archnadzor.ru/2007/07/07/varshava/

Then, in the process of construction or development of a city we try to transform or build the city according to a certain idea or a city development plan. That is, we try to

subordinate this conventional disorder to some new order, which is shown, for example, in the city development plan.

The order is determined by the social values prevailing during a certain historical period. For example, having parks, educational centers, a developed system of public transport, bicycle lanes and many other things in the city is very important today. All of this can be attributed to the prevailing social values that further define requirements to the formation of functional-spatial environment of the city.

With the development of a city or an urbanized territory (territory development) the number of scenarios of their spatial organization falls. That is, developing by way of development of the territory (or space) the city turns eventually into a rather settled and stable architectural-planning structure. Attempts to increase the number of options or scenarios for development of the territory lead usually to conflict situations. For example, if at some point of space or a specific location in the city a territory has already been somehow developed (for example, there is a residential building, or a park, or a monument of architecture), it means, that some specific scenario of development in this place has already been implemented. Correspondingly, implementation or arrival of new scenarios of development of such a territory will require either liquidation of these projects, or some kind of reconstruction this territory, or some other actions.

The above described vision of the processes of development of a city can be also demonstrated on another vivid example (Fig. 8-11).

Fig. 8. The building of the newly built cinema theater «October», Lviv (1978). Source: http://www.lvivcenter.org/uk/uid/picture?pictureid=3886

Fig. 9. Abandoned cinema theater «Galicia», Lviv (2010). Cinema theater «October» was renamed in «Galicia» in early 1990's. Source: http://explorer.lviv.ua/forum/index.php?topic=2326.0

Fig. 10. Demolition (tearing down) of cinema theater «Galicia», Lviv, (August, 2013). Source: A.Hoblyk

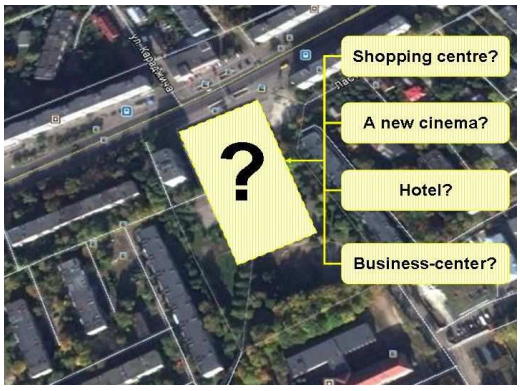

Fig. 11. What will be in this place instead of the cinema theater? Source: A.Hoblyk

Fig. 8 shows one of the largest wide-screen cinemas in Western Ukraine, built in 1978 in Lviv, the cinema theater “October”, later renamed “Galicia”. This cinema theater satisfied the needs of local residents in culture and leisure and reflected social values (the “order”) of that time. However, over time, the needs of the residents have changed, changed social values, changed the opinion of local authorities regarding expediency of existence of such a project in this place, and the cinema theater and the nearby territory fell into decay (Fig. 9). That is, from the standpoint of a present day observer (residents, authorities) the cinema theater became to some extent a “conventional disorder” for the city. Now, in 2013 the cinema theater was demolished (Fig.10) and, accordingly, the territory is now vacant and only now it is becoming possible to implement the new scenarios of its development (Fig.11) and create a new “order”, though only back in the 1980's, the possibility of appearing of a new scenario of development of this territory was not considered.

THE NOTION OF POTENTIAL OF TERRITORY SPATIAL ORGANIZATION

It is proposed in this work to investigate the processes of transformation of urban space using methods of the potential theory. These were economic geographers who had noticed that space or a territory could be described with the aid of potential. Attractiveness of the use of potential can be explained by the fact that potential is simultaneously both, quantitative and qualitative characteristics commonly describing possibilities, available capacity, reserves, resources, funds that can be used. In urban planning theory one may find the notion of structural and functional potential (Gutnov, 1984), the notion of socio-spatial potential (Dyomin, 1991), the notion of spatial potential (Habrel, 2004) and others.

To model the process of transformation of urban space it is proposed to use the notion of potential of spatial organization of the territory[2] (P_{sot}) introduced by the author in the work (Hoblyk, 2003).The notion of P_{sot} should be understood as an energy value that determines the level of space-time orderliness of some territory or an urban planning system in accordance with currently prevailing social values and landmarks. For convenience sake and universality P_{sot} should be measured in monetary units, as P_{sot} shows the work that has to be done to ensure a certain level of organization of space according to some plan. P_{sot} value can be assessed by the method of expert assessment or by other methods. Thus, the notion of potential is used to register some energy state connected with the system of urban planning system elements described by spatial and temporal characteristics. The change of spatial and temporal characteristics of the system will definitely lead to the change of the potential. Thus, P_{sot} potential is a function of state. Owing to the information component potential P_{sot} permits to describe at each point of space a certain and possible number of scenarios of changes in spatial organization of the territory.

Potential P_{sot} also shows information on the level of organization and relationship of potential carriers and structural peculiarities of formation of the potential itself. This permits to come to the conclusion on the synergetic effect – the better is space-time organization taking into account the existing social values and interdependence of potential carriers, the higher is the aggregate potential of the urban planning system or its structural components.

[2] In later works the author uses the notion of potential of space-time organization of the territory.

Several methods of quantitative assessment of the states and mathematical modeling of city development were elaborated using the notion of the potential of spatial organization of the territory in the works: method of the city integral potential assessment using methods of mathematical field theory (Habrel & Hoblyk, 2005); method of assessment of complex potential using theory of complex numbers (Hoblyk, 2006); method of assessment of the aggregate potential of the city (Hoblyk, 2006, 2007); method of induced potential (Habrel & Hoblyk, 2004).

Let us examine the method of induced potential, explaining the mechanisms of urban space transformation, in greater detail.

METHOD OF INDUCED POTENTIAL OF SPATIAL ORGANIZATION OF THE TERRITORY

This method is based on the idea or a hypothesis that potentials of the components of the urban planning system appraised by the man can be imposed one on the other provided, that the man takes a part in it, which relevantly leads to the change of aggregate value of the potential of spatial organization of the territory.

This hypothesis can be illustrated by the following example.

Example №1. Let us assume that in one area of the territory there is an apartment building. According to our potential theory this building together with the adjacent territory already has some value for the man, described by the amount of the potential P_{sot}^{1}. Then often enough in a city one can observe such a phenomenon like appearance of small sale outlets next to the neighboring residential buildings, because that is where potential customers for goods and services are concentrated. For this reason let us suppose that over time a small sale outlet appears next to the building that can be assessed by potential value P_{sot}^{2}. Then, in the result of growth of the earnings of the sale outlet owing to the neighboring building with potential consumers of the goods, the sale outlet can expand both, the range of goods and its selling floor space or, for example, it may change architectural-planning design of the premises. In the language of potentials this will mean that potential of such project will grow and the change of the potential can be assessed by the man only. Aside from that, the following transformation of urban space can be observed: absence of the project $\longrightarrow$ appearance of the project $\longrightarrow$ change of the project. Besides, indisputable will be the fact that the cost of apartments in the building may grow in the result of appearance of social infrastructure projects nearby (small shops, playgrounds for children, schools, a bank, a post office, etc.) and, relevantly, new opportunities for the residents. However, there can be situations when the cost of apartments in the building (its potential) can go down because of some neighboring object, for example such as an environmentally hazardous manufacture in the vicinity of residential quarters or a socially dangerous facility – a prison. That means that the elements of urban planning system produce influence on each other with participation of the man, and the results of such interaction are assessed in the form of reduction or increase of both, values of the components of urban planning system potentials and the value of its aggregate potential. As a rule, relationship between elements of the urban planning system is not symmetrical. We shall note, that interaction between the elements and the change of the values of potentials depend on the potential carrier that in this example is the man, because it is the man who can evaluate conveniences: owners of the sale outlet – presence of customers next door, and the building residents – opportunity of purchasing goods near their residence. Thus, monetary value of the apartment in the building and the cost of the store are interdependent provided that these objects are necessary to man.

This example confirms also the hypothesis suggested by the French urbanist P. Merlin, that the growth of cities (territorial expansion, emergence of new functions and urban facilities respectively) takes place not only because of population growth, but also because of the growth of revenues. The latter provoke new demands of the population and, correspondingly, this leads to the appearance of new projects, transformation of the existing urban space and territorial expansion of the city (Merlin, 1973).

MODEL

A mathematical model describing the process of transition of urban planning system from one level to another taking into consideration parametric interaction of its elements was developed using the method of induced potential in the work (Habrel & Hoblyk, 2004; Hoblyk, 2005). But, prior to commencement of mathematical formalization of the processes of development of the city, let us first examine peculiarities of the mechanism of transformation of urban space on another example on the qualitative level.

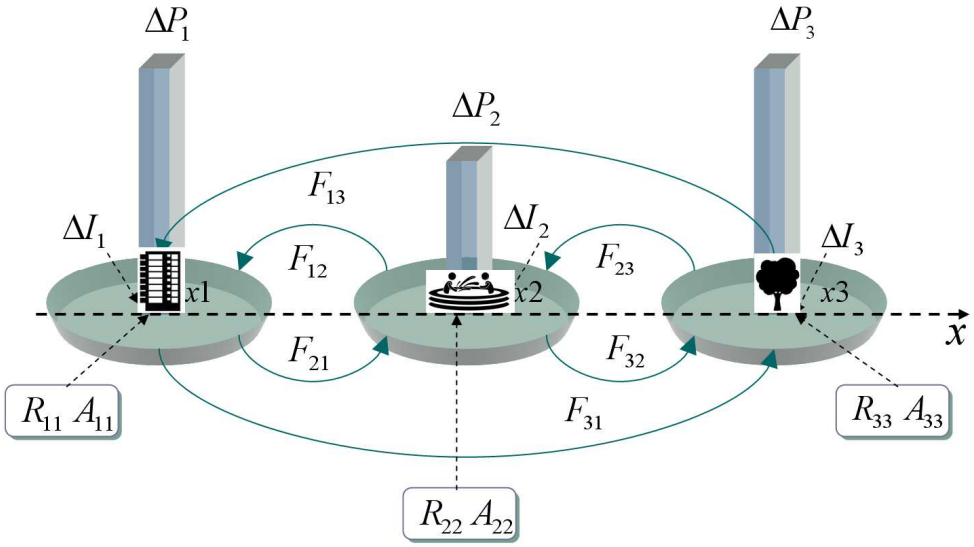

Fig. 12. Graph: the process of transition of urban planning system from one level to another taking into consideration parametric interaction of its elements. Source: A. Hoblyk

Example №2. Let us assume that there are three adjoining plots of land, linearly located relative to each other according to the conventional coordinates x1, x2, x3. Proceeding from the logic of our study, every plot has already some value, and in the language of the "potentials", this means that it is characterized by the value of its own potential of spatial organization of the territory that describes the level of orderliness of the elements within each of the plots. Suppose further that according to some urban planning project it is planned to build a hotel on the plot number 1, an indoor aquapark on the plot number 2 and make a botanical garden on the plot number 3. Thus, the level of orderliness of each of the plots will be changed or, in other words, the urban space will be transformed through construction of the new projects. In the language of the "potentials" such change of the level of orderliness of urban space can be described in the form of the growth of potential of spatial organization of the respective plots. And the growth of potential of spatial organization of the territory may in some cases be a negative value at that. To change the level of orderliness (elements) of each of the plots of land by way of erection (construction) of the said projects, it is necessary to bear certain energy costs or run in

investments in monetary units. The effectiveness of conversion of investments into growth of the potential of each plot of land is determined by the actions of the operator. In mathematics "operator" has a connotation of some mathematical transformation. For example, investments can be used in such a manner that the resulting cost of the constructed project will exceed the cost of the used materials and other resources by two times. In the theory of urban planning operator has the connotation of some "Contractor" executing the work and at that peculiarities of his structure and algorithm of action are of specific scientific interest. In our example, such a "Contractor" executing the work or the operator may be a construction company. Owing to the fact that potentials can be imposed on each other, the results of utilization of investments in the plot of land produce an effect on the scale of growth of potentials of the neighboring plots. This means that if the plots of land will be developed in accordance with the urban planning project (as a hotel, an indoor aquapark and a botanical garden), the potential of each of them will be much higher because of the synergetic effect than in case of construction on one of the plots, for example, of a mineral fertilizers plant. Such impact of one project on the other can be described by the function of mutual influence. It should be noted that the study of the laws of mutual influence of the elements of urban planning system represents a specific scientific problem. In the result of these mutual influences there can be observed both, a positive growth of the potential of neighboring plots of land (objects) and of the entire city, and a negative result. It is also known that any urban planning activity is accompanied by various risks of natural and anthropogenic origin, social and others risks. Therefore, an increase of potential of each plot will depend on probability of the risks that have influence on the effectiveness of investment utilization.

Graphically peculiarities of the process of urban space transformation can be represented by a graph (Fig.12), that shows components of a mathematical model describing the process of utilization of investments into growth of potential of the plots of land and their relationship.

The process of transition of the urban planning system from one state to another taking into consideration parametric interaction of its elements can be presented in the form of a generalized mathematical model (1), constructed by the author in the works (Habrel & Hoblyk, 2004; Hoblyk, 2005).

$$F_{pp} \times \Delta I_p + \sum_{\substack{q=1 \\ q \neq p}}^{n} F_{pq} \times \Delta I_q = \Delta P_p \ , \qquad (1)$$

where: $p, q = 1,2,...,n$; p, q – indices, indicating elements (plots of land) of the urban planning system; ΔP_p – growth of potential of the territory spatial organization; $F_{pp} = (1 - R_{pp}) \times A_{pp}$; R_{pp} – coefficient describing the amount of losses of potential ΔP_p because of the risks in p-th element (plot of land), R_{pp} takes up values from 0 to 1; A_{pp} – operator transforming investments ΔI_p into potential growth ΔP_p; ΔI_p and ΔP_p measured in monetary units, F_{pq} – coefficients taking into account interaction of investments on potential growth.

This model allows to assess results of the change of urban space in the form of a quantitative assessment of the growth of potentials of the elements of urban planning system.

THE TASKS OF STUDY OF TRANSFORMATION OF URBAN SPACE

The following tasks have been formulated and solved on demonstration examples with the use of mathematical model (1). These were the tasks of analysis and synthesis of spatial organization of the city. The essence of the task was to define the laws of distributions of the elements of urban growth potential of the system with the assigned distribution of investments and coefficients of interaction between elements of the urban planning system and vice versa – to determine distribution of investments by the elements of the urban planning system to ensure the assigned level of the city potential distribution (Hoblyk, 2005, 2006, 2008). Another task was to investigate synergetic effect resulting from implementation of both, some and all of the proposed urban planning projects on the territory of the administrative district, and assessment of the growth of aggregate potential of spatial organization of the administrative district (Hoblyk 2006, 2007, 2010). Thus, peculiarities of transformation of urban space were demonstrated with the aid of these tasks in the form of quantitative assessment of the change of potential of spatial organization of the city.

COMPUTER EXPERIMENT

Let us consider one of the tasks of investigation of the process of transformation of urban space on the example of urban planning system consisting of 19 – elements of which eighteen, with ordinal numbers $p = 1,2,...9,11,12,...19$, are residential buildings of equal value and possessing the same potential P_{sot} (Fig. 13).

The computer model was constructed on the basis of the mathematical model (1) in MATLAB environment. This model was used to study effects of the growth of potential of spatial organization of the territory for the three laws of mutual influence (Fig. 14) of the 18 – projects – residential buildings, located in the zone of influence of project No.10. It was assumed for the study that some plan envisaged transformation of the space of project No.10 (development territory) and investment of 100 million UAH for the construction of a subway station. For this reason the cost of housing in the vicinity of project No. 10 would grow or, in other words, value of the potential of each project will grow. The closer the project is located to the subway station, the greater will be the growth of potential of spatial organization of the territory of such project. With the increase of distance from the subway station to the residential building coefficient of their mutual influence declines and, consequently, value of potential induced by project No.10 on the project, for example, No. 18, located farther down from the other projects will decline too. These considerations are confirmed by calculations shown in Fig. 15-17 for the three laws of mutual influence coefficients change (Fig. 14).

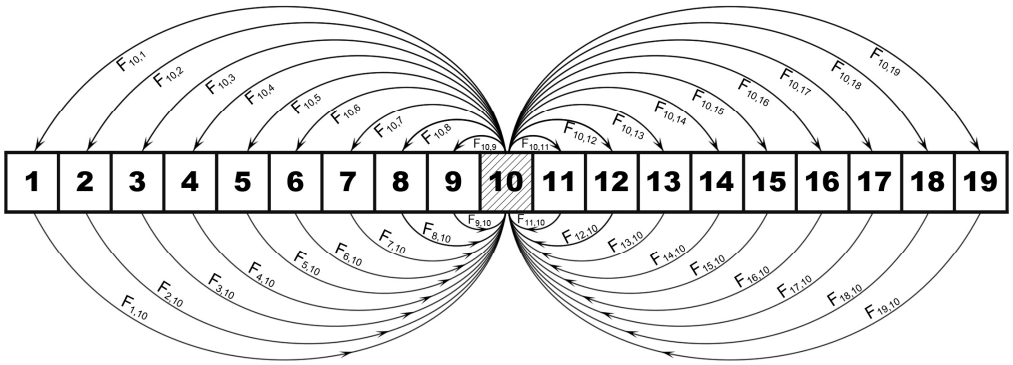

Fig. 13. The interactions between elements of the urban planning system. Source: A. Hoblyk

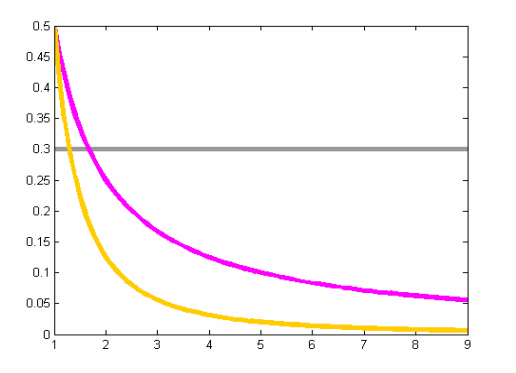

Fig. 14. The three laws of mutual influence between elements of the urban planning system. Source: A. Hoblyk

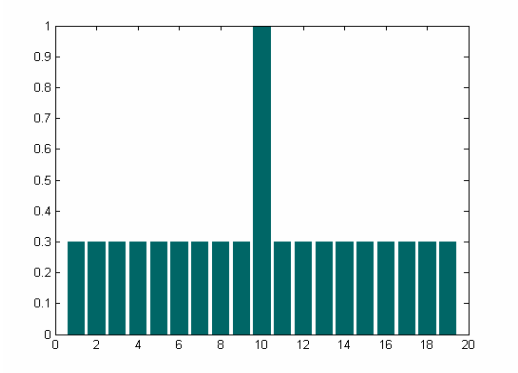

Fig. 15. Graph of the growth of potential P_{sot} for the law of mutual influence: *a(n,k)=0.3*. Source: A.Hoblyk

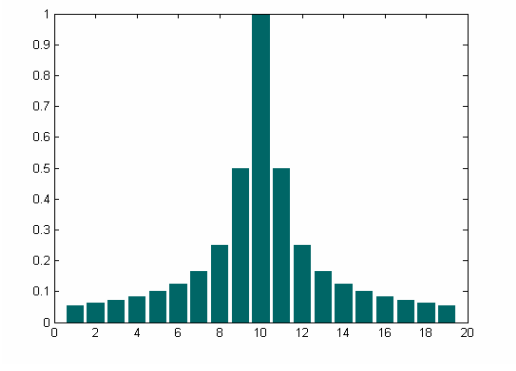

Fig. 16. Graph of the growth of potential P_{sot} for the law of mutual influence: *a(n,k)=q./(abs(n-k))*. Source: A.Hoblyk

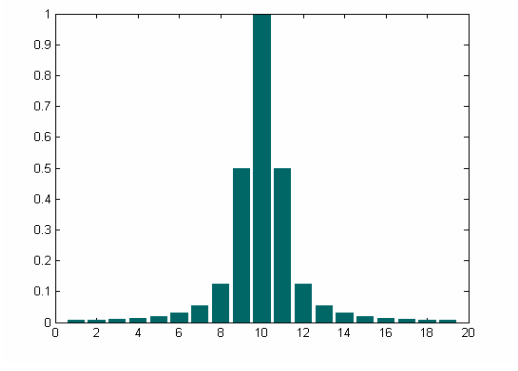

Fig. 17. Graph of the growth of potential P_{sot} for the law of mutual influence: *a(n,k)=q./(abs(n-k))^2*. Source: A.Hoblyk

CONCLUSION

A city is an infinitely complex object. Therefore, any theory intending to explain and describe the processes of development and transformation of such object, will encounter a multitude of poorly predicted factors, the complexity of mathematical formalization of

the processes of transformation of the urban planning system adequately to the urban reality and, consequently, will be able to shed light only on some sides of the object under study. At the same time, methods of the theory of potential of spatial organization of the territory open today new perspectives for modeling peculiarities and regularities of the development of urban planning system taking into account mutual influences between its elements. At present stage application of the method of induced potential for practical urban planning tasks is limited so far by the possibility of study of transformation processes for one-dimensional urban planning systems and by the absence of actual knowledge of peculiarities of interaction between elements of the urban planning system. But despite this, the method of the induced potential and the model developed on its basis allow to test hypotheses of the mechanisms of growth of the city, explore transformations of urban space, evaluate the impact of implementation of the planning solution at a given point of space on the adjacent territories; to model synergetic effects in the urban planning system occurring at its transition from one level of orderliness to another; to solve optimization problems of spatial organization of the territory; to construct the field of potential of spatial organization of the territory, the lines of equal potential, the field of the gradient of potential function for quantitative substantiation of the plans of development of the city in MatLab environment.

The next stage of the work will be elaboration of the model describing the growth and transformation of a two-dimensional urban planning system on the basis of the method of induced potential as well as further study of the peculiarities of mutual influence between the elements of urban planning system in order create a database and use this information in modeling real urban planning systems.

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