

The Cluster Model of Development of the City

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Abstract. The article deals with issues related to the current state and development of the concept of urban development and urban analysis, whose main task is to develop an evolutionary model settlements development. However, urban science covers many related areas of knowledge, and is becoming one of the areas of fundamental research on the theory of the development of society as a whole. It is in urban planning are reflected culture, sociology, economics, politics and much more, giving to Tectological characteristics. At the same mechanics of their interactions allows us to look at the city as a system matrix structures, interacting in time and space, and have the features of the cluster and fractal models. Cited in the article description of the author's concept of cluster model of development of the city raises fundamental questions about its formation, determines the key parameters and mechanisms for its operation.

1 Introduction

We are living in the cities for thousands of years, but so far failed to realize the essence of this phenomenon. What creates the city? What principles for their development? Why do some of them disappear, while others are becoming centuries-old legends? How formed the cloth of the city and how it functions?

What processes are invisible for us in centuries in moments of an urban life? All that remains unexplained mystery. But it is precisely on how we create our city ourselves depends our future! If you do not create a quality environment - rationally organized, comfortable accommodation, combining the needs of life-support and environmental protection - we do condemn their own little world of degradation and extinction. Equally, we can't clearly answer the question of its further evolution. There are many examples in history the rapid beginning of uncontrolled growth of cities and a sudden decline without objective reasons. The roots of all these processes are much deeper and it is with them and to understand.

People create the city, gradually formed its social order, laws and regulations - its society, which in turn develops, begins to re-convert the city for themselves. The circle has been closed! City - a paradoxical phenomenon, like the mythical centaur, organically combines the seemingly incongruous things. In the words of Daniel Danin, "Rider did not lash his horse, and the horse is not tries to throw the rider, as well as the rider can't get off the horse, and the horse can't get away from the rider" - these are two terms of a single equation. It is absolutely impossible to swap them. The city as a living mechanism of the

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absolute level of difficulty, based on the six principles, the six "C" - five beneficial: compromise, consensus, consolidation, convergence, complementarity, and a depressing - confrontation. [8] Thus each six principles are being in harmony. City-Centaur does not involve struggle with the mandatory or desired victory for one of the diverse incarnations above the other - struggle with victory or defeat of one of the principles deprives the image of meaning.

The task of theory of urban planning are being formed in these conditions, the main aim of which is to define the principles, mechanisms and tools of the systemic organization of space, allowing to identify the conditions of the evolutionary development of the city.

2 The City as a problem

Speaking about the city, within the above mentioned positions of Centaurism, can be clearly divided our problem into several layers of perception. At first, the city can be regarded as a Tectological concept, as it is a single complex structural system, a kind of quasi-living organism. City, as well as the definition of an organized system Tectology based on the principle: "The whole is always greater than the sum of its parts." And it's true - the city is not a complex of buildings, roads, people, grass and trees. The city has always disproportionately - it is able to actively respond to internal or exogenous irritants, deformed, and adapting to the changed conditions, transforming them for suiting under the immediate needs. It is originally incorporated all the principles sufficient for its sustainable self-development, self-adaptation [19, 20], there is exists an invisible genetic relationship between all the elements allowing it to evolve here.

At the same time, the city as a "living organism" (and we have every right to perceive it that way) is equally constructed, and according to the laws of nature, one of the basic rules which is simplicity. Principle of Mopertyui (the principle of the least action) states: "Nature-lazy, she moves the body so as to make at least this effect", i.e., Nature does not like complexity, where is the possibility to make easy. [7]

However, sustainable development laws are constantly put before a choice: to anyone, even the most minimal change provides two ways of development: to create smith new or to improve existing. Both of these paths are equivalent justified and have their positive and negative sides, as well as its evolutionary boundaries.

This brings us to the second level of the problem: the city as a complex subordination structure consists of a system of such simple elements in a specific relationship and time-varying - city cluster. In essence, any city can be represented as a kind of mathematical matrix - a cluster consists of systems of equal or similar elements or opposite to each other elements, but it is the system. Working with each component of the system separately as a single element, we can more accurately track, process and send back on track its development. The gradual transition to more complex and large items, you can get some resultant vector and generalized indicators to work with the whole system and even combine them into larger super-system.

This provision opens up the third level concerns the city - the Fractal City. The Fractal City as a system possessing the self-similarity property, that is composed of several parts, each of which is similar to the whole figure as the whole, it brings us back to Centaurism basis of the concept of the city.

Fractal of the city, on the one hand, is a tool that allows us to work with smaller structures cluster model city, and on the other - allows you to combine clusters Tectological research model. It directly is this duality of the fractal city model: target and tool makes the possibility to further describing the principles of cluster model of development of the city.

3 The basic concept

The cluster model of development of the city.

There are many attempts to make sense of the city - this ancient Indian Vedic treatises [21] and socio-philosophical works of Thomas More [22] Tommaso Kompanello [23], Nicolo Machiavelli [24] and many others. However, in all these City (with a capital letter "C" as a philosophical term) is seen as an already existing in petrified form without its history and future development, given their model, but is not given its judgment. Exactly the same model, only much later advanced by Russian architects-constructivists: Ivan Leonidov, El Lissitzky, and others - they give the image of the City, transcending the scope of the reasonable to the highest limits. And of course, the artists of Russian "The Paper Architecture": Yuri Avvakumov, Mikhail Belov, Alexander Brodsky, Totan Kuzembaev, Ilya Utkin, Mikhail Filippov, Maxim Kharitonov and others.

However, the first person who begin to perceive the city as a complex spatial structure and try to translate it into a dynamically adaptable, this model became Makoto Sei Watanabe. In his project the INDUCTION CITY he raises questions of organization of dynamic spatial structure of the city, has built on a mathematically verified models [4, 5, 6]. In his works, the Japanese architect, shows that the city is able to become an integral part of the world. His INDUCTION CITY project is based on three complementary models:

SUNGOD CITY - city created in such way that each element receives the necessary its share of sunlight, heat and energy: "We cut tunnels in the structure so that the sunlight reaches the rear side of the device. We do the same for all the other units that do not have adequate access to sunlight. The result was the emergence of a huge "porous cube" with numerous cavities [6]. "

MOON GODDESS CITY - this component is the opposite of SUNGOD CITY. The main condition here is that the units should not be exposed to sunlight (it should not be heated). While exposure to sunlight is minimized for all items which are able for generating a cluster.

There is created a third model – it is based on these two directly the induction design, which is capable for generating a variety of forms, satisfying to both the previous requirements.

However, there is reviewed the only facet of extremely narrow understanding of the city as a multifaceted phenomenon - the relationship of the sun and the City.

Proposed to the reviewing basic concept of the cluster model of development of the city are designed to create a kind of universal evolutionary matrix allows for evolution and retrospective analysis, to identify the key points of development, and create the factorial-communication model and so on.

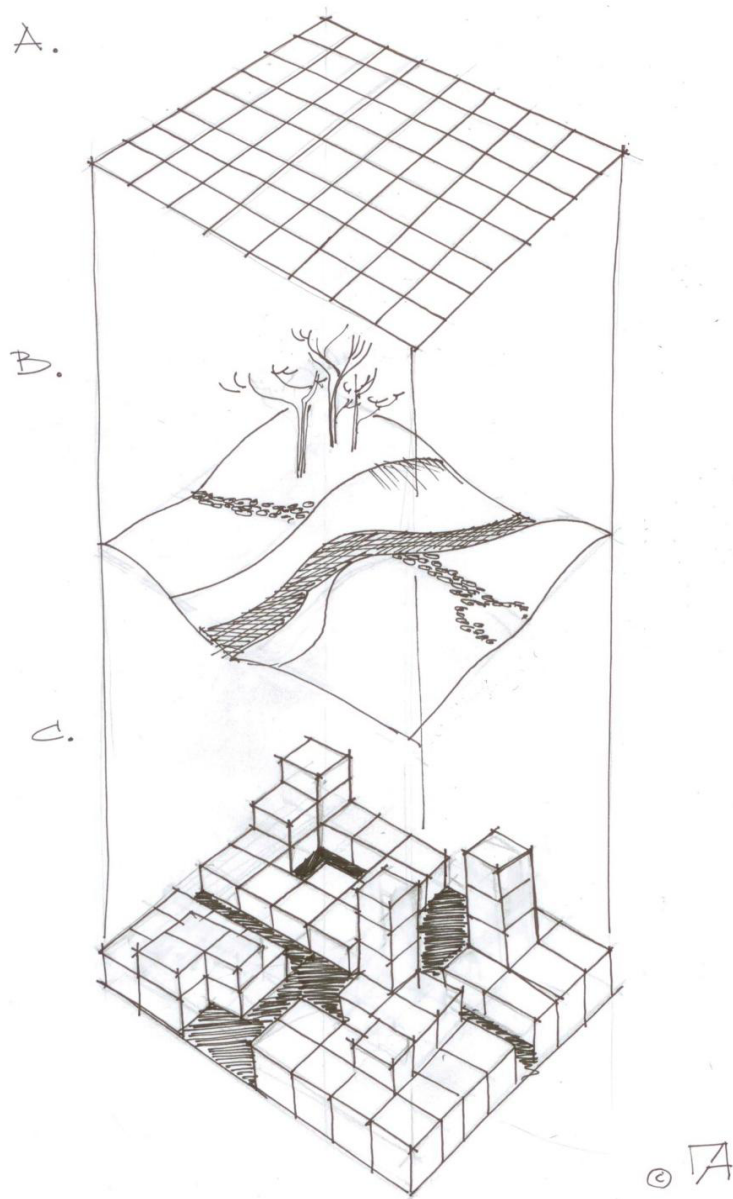


Fig. 1. The stages of initial formation of urban clusters: a - "zero-cluster" and dividing by the sub-clusters; b - "conditional area", giving the initial characteristics of cluster development; c - an example cluster reaction to given exogenous irritants.

Any of the space inhabited and developing in time: the house, quarter, neighborhood, city, state, country or the entire world can be represented by a group of interrelated independent clusters and at the same time as a single cluster-live system. For the basic cluster (zero-cluster) adopted a common unit belongings space with the initial "zero" characteristics (see Fig. 1a): the absence of points of growth and degradation, lack of communication and factors of influences, the absence of binding to the terrain (even conditional), the lack of time factors, etc.

Placing a zero-cluster in terms of a real or synthesized space, set the initial conditions of development (see Fig. 1b.) Is determined by: the natural conditions, the network cluster communication, availability of attraction points and vectors of influence, presence or absence of adjacent clusters, etc. In this case, all of the factors. affecting the null cluster can have a progressive, so the regressive direction; play the role of active, passive or secondary factor; have different time duration of influence, changing in an infinite limit of instantaneous to a constant; be single or be a link in a chain of interrelated factors.

Develop models considered two types of zero-cluster reactions:

Reaction 1. General "mass" of the cluster remains the same, and it is only its redistribution. This type of reaction is able to meet the needs of system analysis solely on the initial stage of the formation of the cluster model, as it shows only the first reaction unit or a null cluster introduced stimulus. However, this type of reaction can be used in the future as the effect of "instant camera" to get the data for certain types of reactions, bonds, irritants, dynamic progress points.

Reaction 2. This occurs deformation of elements of cluster system to the evolution of some elements, degradation and other third stopped (see. Fig. 1c). This type of reaction is a dynamic, developing in time and space of the process, which is characterized by constant reallocation of points active / passive / quiet within the cluster. Since the reaction of one object is an irritant to the other, the activity of the one element encourages the development of neighboring elements implicated him. At the same time an enhanced activation of the one plot of cluster may have a negative impact on its other portion or the adjacent portion of an adjacent cluster. It is worth noting that the result of such an impact can be even stronger as the revitalization of the dominant cluster, and the inverse process.

Another feature of the proposed cluster model of development of the city is being the fact that it and its constituent elements (zero-clusters) also possess characteristics of fractal systems, which implies the possibility of a division of a single cluster into sub-clusters minus-order, and join them in larger ones plus-order with identifying vectors of generalizing. The fractal cluster model allows us to differentiate the data and organize complex responses and influence fields for general evolutionary pattern. Concurrently, there is the possibility of identifying individual responses and irritants acting on the smallest sub-cluster members, which in turn opens the perspective analysis, differentiation and dot interference structure of the cluster.

In the course of its development, each element of the cluster (sub-cluster) can actively or passively interact with other elements of the cluster. This interaction can take place both directly to neighboring elements, and indirectly with all elements of the cluster by building a chain of direct interactions in response to perceived cluster and its elements of internal and / or exogenous irritants. It is worth noting that the interaction data can equally be seen as a cluster on the domestic level and at the level of inter-cluster cooperation.

It is possible to identify a number of typological characteristics which are responsible for the extent of the interaction. Firstly, each element (sub-cluster) can be actively or passively interoperate properly with the adjacent elements, as well as indirectly by all the elements of the cluster. The cluster in response to perceived an internal and/or exogenous irritants. The active position takes a cluster or a cluster member, received as a result of internal or exogenous irritants potential. That stimulus, for example, may be the construction or reconstruction of roads, the introduction into the fabric of the city a new attraction point (enterprise, office or shopping mall, residential education, etc.). However, it should be noted that this impact is almost always a complex consisting of a system of complementary factors, besides not always have the same direction of development.

Consider the following example. Building of the new company gives a positive vector in the development of the region and the surrounding regions, but in the conditions of absence of implement an advanced infrastructure model, the existing network (roads and

utilities) can't cope with the efforts of a new point of attraction that will have a negative impact on development. At the same time the changed environmental conditions also reduces the development of the index in mind in the conditions of negative impact on the person. On the other hand do not creating a new center of gravity does not give an overall impulse in development of the territory, which also has a negative impact on the overall system. The result of all of the above is that there is need to create a system which capable for adequately balanced analysis of vectors of development for finding their optimal proportions and rational distribution of the all elements of urban infrastructure and its constituent objects and people.

Secondly, the type of influence can be characterized on several levels:

Level I. The direct contact - the influence exerted on the sub-cluster members directly adjacent to the study. There are contact, passing on the verge of sub-elements (more active) and through the corner points (equivalent of previous or less active).

Level II. Indirect contact - contact and interaction occur through a chain of close quarters. The greater the degree of influence, then longer the chain of k-contacts (k-contact - an indefinite number of gear cluster of interdependent elements which are in the chain of indirect touch)

Level III. Broadcast influence - the influence exerted in conditions of the absence of a chain close quarters, but it occurs when there is clearly directed vectors of interaction, mutual influence between the two separate units within a cluster and between clusters. Such communications may be the cause of a new transit corridor, entailing changes in the circuit adjacent cluster units of the structure. Chains borders of indirect contact sub-cluster system elements define the field of complementarity effect of each cluster unit, with it smaller the fields can be absorbed by the larger (more active) fields and in the enlarged analysis it does not take into account or give extra points to the dominant element. Conditions for the occurrence of III-level connections in contact or intersection of two or more fields appear with this the point of intersection or area association receives an additional stimulatory effect of development as a translator of communication.

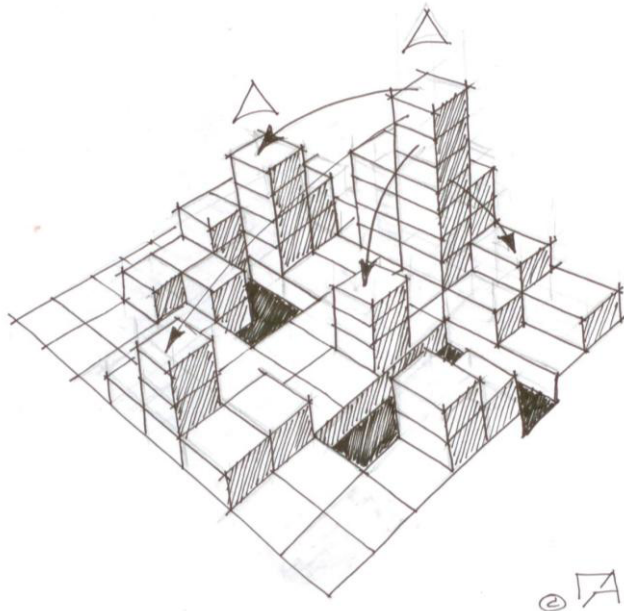


Fig. 2. An example of the further development of the urban cluster with a demonstration of the effect of different levels, the example of the dominant cluster unit.

There merged the forming a new cluster of clusters summarizing nplus-order with a sufficiently large number of connections between clusters III level and the appearance of the intersection zones of complementarity fields

Thus, there is getting a generalized model dynamically developing cluster model city. The model itself, which was originally described as a quasi-living system, which has a complex organizational structure, due to the constantly changing conditions and internal factors will continue to be in the process of evolution and making it more difficult and increasing its constituent sub-cluster elements.

At the same time it can be assumed that the process of growth of the spatial mass of sub-clusters can be in an infinite time, until it reaches the absolute dominance or balance the spatial structure of the cluster mass, with well-established old irritants and the absence of new exogenous irritants. However, none of the "tower", as well as any complex system, can't be infinitely large. At some moment of the time it begins to disintegrate under its own weight or over-weight in mind the internal conflict.

In this case, further evolutionary process can also go in two ways:

Way I. The process of the collapse of the dominant super-developed element generates one or more new zero-clusters, which are located in the proximity close to the main element.

Way II. The process of the collapse of the dominant super-developed element partially nullifies the results of previous evolutionary development of the cluster and by redistributing the sub-cluster members, in different levels and stages of development, as well as a system of relations and vectors of influence, re-launches the process of evolution in the numbers of changed conditions.

This time is the identifying the factors of influence and their boundary values, as in the influence of the factor of the plane, and the level of interaction between the factor; It is the identification system of intermediate values, enabling factors to differentiate between themselves and within themselves; It is the definition of models of complex influence factors on the development of sub-elements of the cluster.

It is worth noting the vast amounts of factors that have a potential impact on the evolutionary development of the cluster, which is an exemplary enlarged typology in differentiating their complex groups may include:

a) Natural: climatic, geological, territorial, etc. - this group of factors is responsible for the bulk of the initial characteristics and direction of the vector of zero-cluster (along with the human and economic, etc.).

b) Environmental/Ecological - group of factors measured up for the quality of the original characteristics of the "conditional areas" as well as for determining the quality of decisions in the form of a mechanism for determining the comfortable external conditions of Human existence.

c) Evolutional - this group of factors are responsible for the ability of the system development, and, as previously stated, the evolutionary means as positive (progressive) and as negative (of degradation) vector of development.

Chaotical: spontaneous, including the possibility of sudden violent changes - this group of factors is introduced, firstly, to the possibility of reverse evolutionary analysis of development of the city, when the placement of objects (territories) based is not on the comprehensive analysis, and the "pointing out" of solving old model of the planned economy; the possibilities of disasters and phenomena may also be included in this group of factors which wear a chaotic, but sufficiently predictable (in terms of an impact) character.

d) Anthropogenic, including ethnographic and anthroposophic - the most unpredictable group of factors proposed to operating this model, on the one hand, acting in terms of psycho-history, we can reverse the chaotic start of the Personality in the organizing

structure of the City, on the other hand - the man is the overriding element of the system, because of it is the measure and the aim of all solutions.

e) Generalized City-Planing - this group includes the structural elements of the urban environment: facilities, infrastructure, territory and their functional features, as well as the degree of interference.

f) Economical - the group of factors in addition to political, natural and evolutionary characterize the ways and means of achieving the global goal: to create a harmonious, efficient and comfortable environment which are able to sustainable self-development.

g) Political – the group of factors are responsible, as previously marked, on the one hand for the introduction of a number of elements of the chaotic nature and destabilizing the system and for the will to detailed development and implementation of the proposed Tectological cluster model.

h) Medical, including biomedical and psycho-physical - this group of factors, along with other groups responsible for implementing the complex task of creating high-quality habitat for man, forming the qualitative characteristics of a comfortable life, because of it allows you to create a methodology and mechanism for monitoring vital signs as at the level of the person, and the level of the surrounding environment by combining with the environmental factors.

i) and many others.

As can be seen from the description of complex sets of factors, the reduction of the problem of sustainable urban development to any one (or even several) elements, as is happening at the moment, it does not seem not only possible, but, in the authors opinion, even unacceptable, because it leads to the dead end path of unilateralism. City the same way as a person, as mentioned earlier - is a multifaceted phenomenon, capable to the full development and self-realization only at the complex equilibrium development of all of its constituent elements.

The identity of the desired characteristics is possible as a result of a number of historical and analytical studies on the development of the most old with a long and ancient history, and the young, but rapidly growing cities - their master plans, building projects, etc. Determination of factors of all necessary for study will require a rethinking of the same degree of inclusiveness related to architecture and urban development of other branches of scientific knowledge. It is also planning a series of social studies and the establishment of clear mathematically verified models of factors impact.

On the basis of elaborated system of factors of development and the general model of cluster development of the city it seems possible to create a universal intellectual cybernetic system (virtual model) which is able to scroll mode or freeze time to assess the impact of decisions (both in town and on country or region) for searching optimal ways of development of human society.

In the result of analyze of the main provisions of the concept of cluster model of the city development, in addition to identifying a set of factors of influence, internal and exogenous irritants, orientation and characteristics reactions of the vectors and action of complementarity fields of influence, as well as identify of their qualitative and quantitative characteristics are need to consider the whole multitude of possible combinations to the terms of their relationship, complementarity and synergy, as well as the degree of influence of individual factors and their complexes in the development and expansion processes of the entire cluster system.

This is considered a range of issues relating to the generalization and development model of urban null cluster, and the entire cluster system:

- What indications of a positive development factor occurring leads to growth, transformation and evolution of the sub-cluster, the cluster and all the cluster system?

- What indications of a positive development factor is the division of the cluster to additional (internal) cluster subsystem happening?
- What conditions will terminate the active phase of the evolution of individual clusters and begins the process of unification and enlargement of the cluster units?
- How to determine the critical mass of cluster development in which there is its decomposition into independently developing clusters or is born (department) new cluster zero units?

4 Conclusion

The concept of creating a cluster model of development of the city proposed to the consider in some way can be compared with the science of psycho-history, applying mathematical methods for the study of the processes taking place in society. Thus it allows the determining or predicting the possible vector of development of a society with a high degree of accuracy. However, the excluding from the common system of such an unpredictable factor as a "man" we can with enough confidence to monitor and guide the urban development of the city in the right direction.

The proposed method of analysts by dividing urban space on the cluster system, having the properties of fractal systems, provides tools, both long-term planning of development of territories and conducting retrospective studies. In addition, this tool allows a high degree of accuracy to determine the position and characteristics of the main sites of the city or region to determine the system and model of economic development in terms of placement of the individual components in the observed area (country, region, city, county, etc.).

On the other hand the proposed analytical model of development, in the conditions of it's comprehensive study, testing and application could set a precedent formation of a new model of a planned economy, based on which the allocation of resources and production will be performed with the maximum rationality and efficiency for the overall development of the country, creating a comfortable and supportive environment for its citizens. This model because of it's maximum rationality contributes to the possibility of preventive evolutionary studies. Placing an object (building, plant, infrastructure element, and even the new city), we must understand that the object appeared not for a year or two, sometimes it comes to the centuries and even millennia, in which new challenges and crises can arise based on objective, measurable analysis, accounting, modeling and forecasting of cause-effect relationships. Therefore, the city, and perhaps, the whole country, constructed on the proposed model of cluster development, subject to the application of it as a well-established system of analysis / control / actions can be active a self-adaptive system which capable to the unlimited prosperity and sustainable development.

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