Linear cities: controversies, challenges and prospects

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Abstract. The article is devoted to the study of linear planning structures; identify characteristics and problems of “linear city”. The authors presented developed systematization and classification concepts of linear planning structures. The features of the development of linear cities are disclosed on the basis of the analysis of the practice and theoretical concepts of the linear city, as well as the example of the formation of the city of Stalingrad-Volgograd. This city has a linear urban structure, unique in world practice. Volgograd stretched along the Volga River for almost 100 kilometers, reaching 10-5 kilometers in width in cross section. The authors reveal the pros and cons of the linear planning development of the city. In conclusion, the trends of complication of the planning development of Volgograd are determined.

1. Introduction

Search for ways of development of modern urban formations, evolution of planning structures of modern cities, urban morphology of the plan remain relevant for modern urban development over a long period of time [1-9]. The advent of various transport modes and the development of transport systems throughout the subsequent period by the end of the 19th century has led to a dramatic transformation of cities. Linear planning structures were proposed by urban theory as means to untie “the Gordian knot” between the preservation of the historic city and values of its heritage architecture and town planning, and the need for growth of urban territories and public centers. Linear city throughout the twentieth century was regarded as the most promising type of development by domestic architects and town planners and foreign architects as well.

Recently, there was a surge of interest of architectural and urban theory and practice of urban development to the forms of structures in the context of the twenty-first century, with its rapid speed of new vehicles and globalization process. New studies have appeared in Russia, North America, Europe and Asia, associated with linear cities and corridor urbo-structures]. Thus, the theme of the linear development of cities and, in general, the so-called “Linear city” is still sharply important currently, as it was a century ago.

2. Factors of linear city development

Analysis of the emergence and development of linear structures of various urban formations showed that the story of their origin is generally associated with the presence of planning restrictions. The main factors were natural restrictions as well as artificial factors. Riverbeds or if more broadly - ponds (lake, sea) or topographic features served as natural limiters (e.g., mountains). The presence of a large river often helped extricate the planning structure of the populated places along the waterway. This feature is described in the works of A.S. Shenkov and G.Y. Mokeev, devoted to the analysis of the
formation of the planning structure of ancient Russian cities [10]. Linear system is characterized by the extension of trading quarter on the banks of the river or lake, the predominance of one-two linear streets. The linear layout of the city was considered by a well-known Russian architecture historian L.V. Tverskoy as one of the initial stages of city development.

A classic example of the linear city is Volgograd — one of the largest cities-centres in the South of Russia, which is mentioned in all the world's publications on linear development planning structures. Initial prerequisites for the linear development of the city, which was named Tsaritsyn (then since 1925 Stalingrad, since 1961 Volgograd) were natural factors — a big river and a surrounding steppe, which were not supposed to contribute to the deep-laid development of the city [11]. Soviet period became fundamental in urban planning fate of Stalingrad-Volgograd, embodying the linear form of development (Figure 1).

![Figure 1. The layout of Great Stalingrad by A. and L. Vesnin, 1930.](image)

Among the examples of major cities, the origin of which is associated with natural factors that appeared as strong planning constraints predetermined the elongated shape of the plan. Among them: Khabarovsky, Sochi (Russia), Krivoy Rog (Ukraine), Sarajevo (Bosnia and Herzegovina).

The road decided the fate of the planning structure of the city due to the fact that high-speed transportation was the main mean of transport. This revolutionary coup took place in the late 19th century, together with the advent of rail transport and car. Rapid growth occurred at the same time, in terms of population and territory growth of big cities; planning structure was not designed to suit the changed living conditions.

3. Concept of a linear city

The concept of linear cities originated in the late 19th century and was launched in 1880-ies by Spanish engineer and philosopher Soria y Mata. The heart of his project was the idea of building a light rail line, which was supposed to link Madrid with several settlements in the surrounding area. According to Soria y Mata, form of public transport must determine the form of the city development. “Cardo” communication 40-10 m wide and its main axis became the basis of the plan on for rail transport.

In the late 1920’s and early 1930’s car triumph was so uncontroversial and global, that nobody would dare to come up with any other concept. For a new kind of transportation new spatial forms were needed. The revolutionary changes of the urban structure were proposed by Le Corbusier, who formulated his ideas briefly using the famous formula about “donkey road” and “man road”.
Linear forms of urban development have been developed in the works of Soviet architects of 1920's- and early 1930-ies. This brief period was generating a large amount of time concepts of linear structures, which have had an enormous impact on the development of urban planning practices and theories of urbanism of the future century. Exploring the dynamic development of the city, Soviet architect Nikolai Ladovsky proposed a model of parabola-city, growing along the longitudinal axis. N.A. Ladovsky believed that the city centre should not be a static point, but a dynamic point - the axis. The search for new forms of resettlement, optimizing human vital activity, led to the emergence of concepts which were connected with the ideas of linear development. The first detailed proposal of this kind was a model of functional-streamline development of Soviet architect N.A. Milyutin. The solution to this problem for Milyutin was the development of its own version of the linear city, directly bound to the thing that was certainly important-to the plant and its production flows. Thus, the idea of functional-streamline systems was born, which became the basis of new town planning. The famous German architect, urban planner of Bauhaus school, Ludwig Hilberseimer, in search of new spatial forms of life activity also came to the conclusion about necessity of linear belt of urban development. Starting from 1929 onwards, working in Bauhaus, Hilberseimer conducts research on new forms of urban development [12]. The architect concluded that new forms of resettlement could only be found by developing the idea of a “linear city” of Soria y Mata and “strip city” of Milyutin. In the 20th century, industry and automobile transport became the main factors for the development of resettlement. In this regard, Hilberseimer proposed combining the two principles — the strip (Milyutin) and the linear (Soria y Mata).

In the 20th century the advent of high-speed transport, restructuring factors of urban planning structure led to fast territorial urban growth, strengthening of their external linkages, the dynamics of urban development. The obvious was the need to move from closed structures to open, flexible and freely developing. The optimal form of the flexible and open structure of the layout was represented by a linear structure. Linear planning structures have become a notable phenomenon in the global planning practice of the period of the 1950-1970s [13, 14]. This trend is reflected in project proposals for the development of the world's major centers of London, Paris, Stockholm, Tokyo, Copenhagen and other. In the UK so-called "city-inserts", were created, which allowed to turn difficult organized urban agglomerations into the "new-type of regional cities". Such “cities-inserts” were designed between Manchester and Liverpool and between Portsmouth and Southhampton. Linear structure was recognized as the most appropriate due to the preferential development of public mass transport.

In the middle of the 1970-ies Soviet town planners Y.P. Bocharov and D.C. Kudryavtsev set dependencies between a structure type and geometry of the plan [15]. The result of these studies was the proposal for urban development in terms of flexible linear planning structures. Such a structure ensures the development of all important zones and the preservation of stable links between them in the process of city growth.

In the second half of the twentieth century, rapid development of transport infrastructures required new designs of finding forms of planning urban entities. Since the 1950-s, problems associated with the excessive development of road transport became evident. Transportation problems of cities were in the first row of social and scientific-technical problems. Driving speed of a car at peak hours began to approach pedestrian speed. The search for an optimal planning structure capable of meeting the scale of development of motor transport has become an extremely urgent urban planning task.

The city-building concept of C. Doxiadis, an American architect-town planner of Greek origin became widely known [16]. By Doxiadis, a modern city should change the system based on pedestrian velocity and radial-axial scheme to the system with multispeed and axial development scheme. At present historical single speed pedestrian cities have to be transformed into two-, three-, and four speed systems. The idea of a development corridor was used by a group of Russian architects, consisted of I.G. Lezhava, M.D. Khazanov, M.V. Shubenkov and R.M. Mulagildin for the prediction of urbanized development of Russia. They offered a linear system of resettlement along the giant transport corridor connecting the Atlantic Ocean with the Pacific Ocean [17,18]. Defining the difference between the old and the new form of resettlement, the authors make comparison with living
beings. Having the same vital organs a “hedgehog” and a “snake” (compact city and linear city) have completely different spatial arrangements. The authors predict the victory of a «snake» over a “hedgehog”.

Linear artery of Sibstreem (or “new Moscow”) will be the main but not the only, according to authors. It can be crossed by seven cross highways linking water areas of the Arctic Ocean to the southern border of Russia. Sibstreem corridor in many places will become bifurcated and complicated (for example, Baikal-Amur mainline area), but its main part, according to the author, can become the backbone of future Russia by the end of the next century. The proposed linear structure must solve not only issues of transport; its use will preserve historical cities, as it is entering new areas for territorial development.

Corridor development of urbanized territories today is seen as a way out of the dead-end development of contemporary cities. Studies on the formation of linear structures, crossing the whole country, are being conducted in Canada, the United States, China [19]. In the context of globalization, corridor systems can be thought of as "space of flows" through which modern globalization processes operate. In the nodes of crossing corridors "world control cities" or "global cities" are situated.

The linear form of the planning development was seen as an opportunity to solve various problems such as:

- optimum spatial form of territorial economy development (G. Hotelling);
- management and control form of skyrocketing growth of urban entities when searching for open and flexible urban systems (Y.P. Bocharov, A.E. Gutnov, I.G. Lezhava, C. Doxiadis, Le Corbusier and others);
- new spatial form of optimization of social processes of vital activity (N.A. Milyutin, F. Wright, L. Hilberseimer, etc.).

4. Pros and cons of linear urban development

Concept analysis of linear urban development identified three main groups. One of them consists of “linear cities”, the second one consists of “strip cities” and the third includes “corridors of urbanized development”.

“Linear city” – is urban development, formed and developing along an axis. Axis is usually transport artery and other communications of transport and engineering infrastructure. Linear city is free to grow in both sides, constantly reproducing its structure. The positive side of a linear city is the possibility of close connection with nature, natural landscape and countryside. In addition, the advantages can include greater flexibility of such structures.

“Strip city” consists of a series of functionally specialized parallel stripes. With the growth of the city, in turn, functional strips are lengthened and, leaving the linear development as the main way of development, without any possibility of growth in width.

Linear pattern of corridor development of urbanized formations represents a mesh structure composed of corridors bands (strips). Each band covers a very wide area, adjacent to the bed of transport communications, among which a public transport route plays a predominant role.

Positive linear property of city planning is that it can be developed without a radical reconstruction of the established areas. Other positive qualities of a linear development are flexibility and openness for growth. The advantage of linear development is that all structures are close to the main line and easily accessible in terms of time or effort, taking into account the transport efficiency.

However, the analysis of territorial development of such cities as Volgograd shows that over extension of linear form of layout leads to “suffocation” of longitudinal transport arteries in the presence of active intersection in one level [20-22].

Another major drawback of the city is its lines, actual dismemberment of its areas largely separated from each other. In addition, the quality of life is deteriorating due to the fact that it is virtually inaccessible to the marginal areas of the city center. In the scale of a great city there is a lack of central functions. In other words, the analysis of the practical functioning of the city with the linear structure (Volgograd) revealed the following disadvantages of linear development:
• low connectivity of the urban body due to the lack of high-speed modes and highways. The so-called high-speed tram cannot replace rail types of high-speed transport with those really needed by the city;
• low accessibility of urban center for remote areas that have not yet acquired the necessary potential for a city of one million people (there is no range of required facilities in quantitative and qualitative terms;
• due to weak intracity communications, a kind of “pupation” of the southern regions takes place, formation of a “city in the city”;
• difficulties of reconstruction of the strip structures prevailing along the Volga River. The inertia of the existence of a powerful band of industrial enterprises in the northern zone and in the southern outskirts of the city, with the width of 0.5–2 km, does not allow the reconstruction and transformation of these territories.

5. Conclusion

Thus, the analysis showed that, historically, settlements with linear planning structure arose due to natural and topographic circumstances. At the same time, the concept of the linear city is a modern idea, which was born due to the transportation revolution and the search for effective opportunities for urban development.

The main proposals and projects for new forms of resettlement constitute palette of diverse, mutually complementary and intertwining ideas. Noteworthy is the fact, that most of these concepts play an important role in the way the movement of residents between the individual functional areas of residential complexes. This applies to projects of Soria y Mata, Milyutin, Corbusier, Hilberseimer, Wright, Doxiadis and other authors, each of them approaches the issue of linear planning development from their positions. These theoretical concepts, despite the fact that many of them are unrealistic and rather sketchy, reflected new opportunities for resettlement development. All of them were the result of attempts to understand, consider and use some new phenomenon associated with transportation and its impact on the urban environment formation. The point of view reflected differently on the fact that historic compact centric city belongs to the past and should be replaced by a new linear structures, which would be more in line with contemporary needs.

The linear form of development is appropriate in cases when it is used as a connecting element of more complex structures. The mere fact of configuration complexity of planning structures of reality, in comparison with classical theoretical model of linear unidirectional schema, cannot be interpreted solely by the topography of the area or other features of specific situation. It points out that the process and territorial development of cities should not be interpreted unequivocally, they are associated with continuous change and complexity of their internal structure.

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