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## **DISRUPTIONS TO SUSTAINABLE CITY FUNCTIONING AS A RESULT OF DESTRUCTIVE DEVIATIONS IN ARCHITECTURE ZAKŁÓCENIA W ZRÓWNOWAŻONYM FUNKCJONOWANIU MIASTA W WYNIKU DESTRUKCYJNYCH WYPACZEŃ W ARCHITEKTURZE**

**Oksana Fomenko**

prof. dr. hab. inż. arch.

Author's Orcid number: <https://orcid.org/0000-0003-0588-4186>

Politechnika Opolska  
Wydział Budownictwa i Architektury  
Katedra Architektury i Urbanistyki

**Andrey Izbash**

Graduate student

Author's Orcid number: <https://orcid.org/0000-0002-3265-2383>

Kharkiv National University of Construction and Architecture  
Department of Innovative Technologies for Architectural Environment Design

### **ABSTRACT**

The article puts forward a hypothesis about the role and the place of “destructive deviations” in identifying indicators of crises that a city is going through, in the processes of its functioning as a complex dynamic system. It also proposes a hypothesis about classification of “destructive deviations” in architecture according to their type and development scenario. The problems of their influence on the transition of a city from a steady state to a crisis and a possible catastrophe are considered. The characteristics of a city system development are viewed in the context of interaction between the forces of stability (order) and changes (development). At the same time, the fact of inevitability of intersystem conflicts in such a complex formation as a city is regarded as obvious. In the conducted study, the concept of “Destructive deviations” is part of the method of identifying “Crisis indicators”, which, in turn, is necessary to create a model complex designed for modeling, analyzing and managing the architectural component of a city as a dynamic system.

Key words: architecture, city, dynamic system, destructive deviation, sustainability, crisis.

## 1. INTRODUCTION

One of the problems of architectural science from the time of the second industrial revolution to the works by Forrester (1967) was an unnecessarily “static” view of a city. A lot of town-planning concepts appeared during this period. Among them are the following: “Linear city” by Arturo Soria y Mata, 1882 [17], “The Metropolis” by Otto Wagner, 1892 [7], “Garden city” by Ebenezer Howard, 1898 [26], “Skyscraper city” by Auguste Perret, 1905 [1], “Industrial city” by Tony Garnier, 1911 [32], “Radiant city” by Le Corbusier [15], etc. Almost all of the mentioned works accept and reconsider civilizational changes in cities, and offer different architectural concepts to solve the problems arising therewith. Yet, nearly all of them showed the transition of a city from one static state to a new civilizational stage of another static state. The architects of that historical period viewed a city as if it was the Pantheon which stood with the Goths, Vandals, the Carolingian dynasty, Borgia, Mussolini and would continue to stand as long as Rome stood.

Ideas about a city as a complex dynamic system began to emerge in the 1960s–1970s. The basis for these ideas was formed by such scientists as Abel Wolman in his work “The Metabolism of Cities” [1], Jay Wright Forrester in “Urban Dynamics” [5], and Donella H Meadows in “The Limits to Growth” [2].

During the 1960s–1970s, a breaking point came in the consciousness of the architectural community. The metabolism ideas of Kisho Kurokawa [12] are an attempt to understand the prospects for architectural development of cities in their population growth dynamics. Similar views of a city provided the basis for the architectural doctrine “New Element of Settlement” written by Soviet architects Illya Lezhava and Alexey Gutnov [30].

In addition to the views of metabolists and followers of Paolo Soleri [25], a whole set of ideas about the “City of Sustainable Development” has been formed over the last decade. The number of publications and opinions on this issue has reached such a high level that feasibility of creating a single universal formula of “a sustainable city” raises doubts. In this study, we consider it important to understand the fact that many theoretical works dealing with the topic of modern megacities note the transition of cities to the state of post-industrial development. While comprehending the publications by David Harvey [9] and Ozawa T. [23], the conviction has been formed that modern cities have to switch from extensive to intensive types of development. In fact, this marks the beginning of a long and difficult process of subordinating most urban infrastructures to the idea of coevolutionary development with the environment [33].

The paradigm of a systematic approach to the city functioning proclaims the idea that a city functions at the intersection of many factors, including legislative, economic, political, environmental, demographic, resource, etc., which affect its structure. In the work “Structural Stability and Morphogenesis” [18], René Thom has convincingly showed the way a complex system consisting of many components accumulates errors, gradually moving from a state of stability to a sharp change in the parameters of functioning.

Our study presents the city as an open dynamic system with a large number of elements and a lot of direct and inverse connections between them. This system is subject to certain patterns, exposed to a variety of heterogeneous, sometimes random factors, and also is at risk of losing equilibrium state. It is characterized by variability in time. Goal setting of this system lies in preservation of its dynamic stability. Self-regulation of the city system towards order and stability is achievable only if it is possible to select from a variety of sustainable development options. If these conditions do not prevail at a certain point in time, the system tends towards simplification and degradation.

The influence that architecture has on the transition of the city system from sustainability to crisis and possible catastrophe is of particular interest to our research.

## 2. POPULATION, ECOSPHERE, AND TECHNOSPHERE AS THE MAIN CONSTITUENTS OF THE CITY FUNCTIONING

While agreeing with Abel Wolman [28], Jay Wright Forrester [2], Donella H Meadows [3] and “the Rio Declaration on Environment and Development” [19], we present a city as a result of interaction among its three major subsystems consisting of the following elements: people (Population), natural objects (Ecosphere), and technical artifacts (Technosphere). The interaction among these subsystems is determined by the functions they perform and the nature of their relations to an external environment. Such terms in our paradigm as Population, Ecosphere and Technosphere are used for the principled separation of the material and activity components of the city functioning. As a result, we get an opportunity to build the following hierarchical dependency:

1. “Population” is a subsystem with vitally important needs which must be satisfied. As a basic model of needs, Maslow’s “Hierarchy of needs” is suggested for consideration [16].
2. “Technosphere” is a set of technical artifacts created by the “population” to fulfill their essential needs.
3. “Ecosphere” is a set of landscape and biological objects in a city and its surrounding areas which are the resource basis for the existence of “Population” and “Technosphere”. Also, the “Ecosphere” bears the consequences of satisfying the vital needs of the “Population”.

“Ecosphere”, “Population” and “Technosphere” are united by the main goal, namely ensuring the sustainable development of the city system. Conflicts of vital interests occurring between these three subsystems occasionally overbalance a city. Economy, culture, social relations, nature management, environmental protection and hundreds of other activity aspects of a city arise from the interaction among its subsystems described above.

## 3. STABILITY AND CHANGES IN THE CITY FUNCTIONING

According to the theory of synergetics, conflicts ensure development, and endanger the existence of any complex system at the same time. When a compromise is found between the contradictions arisen, the system achieves stability. If a compromise is not found, the system is faced with a crisis that can turn into a catastrophe. This thesis allows us to put forward an idea of two parallel coexisting basic modes of the city functioning:

- Stability (hereinafter denoted by the symbol “C” - constant). It is the city’s desire to preserve itself as a system in a constant state. With an exception of certain periods, cities have been altering very slowly in the history of mankind. Hence the theorists of the mid-nineteenth and early twentieth centuries viewed a city as “static”. Mesopotamia at the times of Assyria, the Hittite Empire, and Babylon embodied “a boiling pot” in the social context, but the architecture of their cities remained almost unchanged for centuries. The city of Split, Croatia, is a typical example of a stable existence in terms of architecture. After the destruction of the city of Solon by the Avars in 639, the remaining inhabitants moved to live in the Diocletian’s Palace located nearby. The palace complex with an area of about 3 hectares, rectangular in shape, was enclosed by massive walls up to 20 meters high with fifteen towers. Outside the palace walls, the city existed for more than 700 years, and only with the beginning of the Renaissance it got beyond the old boundaries [6].
- Change (hereinafter denoted by the symbol “Δ”). It is mutations of a city system taking place under the influence of external and internal conditions of its functioning. In the course of time, changes in the principles of a city system functioning can accumulate gradually or can occur suddenly in the form of crises and disasters. The previous mode of functioning loses stability. The system chooses a new stable mode

which can either inherit certain properties of the previous one, or may be entirely different.

A plan “travaux haussmanniens” can serve as a striking example of a qualitative leap in the processes of the city functioning. This urban renewal program, carried out during the Second Empire (third quarter of the 19th century) on behalf of Napoleon III and under the guidance of Baron Haussmann (a prefect of the Seine Department), determined the modern appearance of Paris in many ways. Reconstruction on such a scale was a “shock therapy” for Paris that helped overcome the problems of rapid population growth and changes in urban life.

This example clearly illustrates “The law of the unity and conflict of opposites” [10], where there is a constant balancing of the city system between the need to preserve itself as much as possible on the one hand, and to survive in a changing world on the other hand.

Over the past 7000 years, the ratio of “C” to “Δ” in urban architecture has been constantly shifting towards “Δ”. To demonstrate this thesis, it is enough to compare “The Ten Books on Architecture” written by Vitruvius in the 1st century BC [27], “The Four Books of Architecture” published by Andrea Palladio in 1570 [21], “The Principles and Practice of Architecture” by William Le Baron Jenney [14], issued in 1869, and “Parametricist Manifesto” published by Patrik Schumacher [24] in 2008. Obviously, the work of Le Baron Jenny is much closer to Vitruvius’s rather than to Schumacher’s in terms of ideology.

The rapid growth of diversity (Δ) in the architecture of cities of the 19th–21st centuries is a logical and natural process. The causes of this phenomenon are studied in a variety of scientific works of historians, sociologists, philosophers, and architects. The purpose of this study is to analyze the consequences which both drastic changes and failure to keep up with the times have for cities, namely to analyze destructive deviations that have occurred in the processes of civilizational development of the city system.

#### **4. “DESTRUCTIVE DEVIATIONS” IN THE DEVELOPMENT OF THE ARCHITECTURAL COMPONENT OF A CITY AS A SYSTEM**

The term “destructive deviation” is semantically closest to the notion of “a system error”. These phenomena, “System errors” and “Destructive deviations”, can be regarded as an alternative reaction of the city system to changes in the parameters of its living processes. Initially in the study, preference was given to the term “Error” but it turned out that many phenomena which are destructive in nature and can bring a city to the brink of crisis or even catastrophe are not errors. Examples that do not fit into this term involve such architectural objects as: Pruitt-Igoe in the city of St. Louis, Missouri, USA; Detroit, USA; Hashima Island, Japan; Chiatura, Georgia, etc. These examples demonstrate that the cause of destructive deviations can include changes in legislation (Pruitt-Igoe), economic globalization processes (Detroit), changes in the state system (Chiatura), etc.

Destructive deviations are a natural and inevitable process of the city’s development as a system. The study examines two causes of destructive deviations:

- Destructive deviations happened for objective reasons. The study of this type of deviations has revealed the main pattern, i.e. the absolute majority of them take place due to distortions in cognitive maps of ideas that architects and investors have about the aspects of the city functioning. Examples of cognitive bias will be considered next (Table. 1). Cognitive biases are systematic errors in thinking or a pattern of deviations emerging on the basis of individual dysfunctional beliefs.
- Destructive deviations happened for subjective reasons. Among the causes of objective deviations considered, there are three main groups: social, economic and ecological.

Three scenarios for the development of destructive deviations have been identified:

- Expansion: in case a deviation is not localized on time, its influence on the system expands, affecting previously stable segments of the system (a domino effect). A good example to illustrate this statement is the Pruitt-Igoe residential complex. Emigration of the most solvent population from the region leads to a non-payment crisis, non-payments lead to buildings degradation and man-made disasters, degradation, in turn, leads to the occupation of houses by marginal people, and marginalization of population causes an increase in crime. As a result, the destructive deviation expands and leads to a catastrophe, namely demolition of thirty-three eleven-storey residential buildings 20 years after their construction.
- Accumulation: when deviations are accumulated they, as a rule, come into general resonance exacerbating city problems. When a certain critical mass is reached, it threatens the system integrity. An example is the city of Detroit. It is commonly known that in 1973 an oil crisis broke out in the USA. This led to the crisis of The United States' Big Three automobile manufacturers whose cars could no longer compete with economical European and Japanese cars. Plants were shutting down one after another, people were losing their jobs and leaving Detroit. The population of the city in its administrative borders has decreased by 2.5 times: from 1.8 million in the early 1950s to 700,000 in 2012. As a result of the population outflow, the entire city districts have been abandoned by residents. Skyscrapers, plants, and residential areas remain deserted and destroyed by time and vandalism. In Detroit you can see streets with brightly lit shop windows of expensive stores on the one side, and buildings with broken glass and trees growing from their walls on the other side.
- Amplification: a destructive deviation creates problems, solving methods for which amplify its cause. For example: degradation of Easter Island civilization due to deforestation. Easter Island is currently a treeless island with barren volcanic soil. However, according to the data of palynological studies, the island had been covered with dense forest by the time the Polynesians settled there in the 9th –10th centuries. The settlers cut down the forest both for economic needs (shipbuilding, housing construction, transportation of Moai, etc.) and to clear lands for growing crops. As a result of intensive logging that had lasted for centuries, the forest had been completely destroyed by about 1600. This led to wind erosion of the soil which destroyed the fertile layer, a sharp decrease in fishing due to the lack of timber for boats construction, a drop in food production, mass hunger, cannibalism and population decline by several times over several decades [31].

Being elements of the system, destructive deviations affect the overall dynamics of its functioning. Each type of deviation has its own typical signs of development.

Deviations of the type “C” are characterized by the following stages of development:

- The stage of stable system functioning. Deviations are contained in the system implicitly without manifesting themselves;
- The stage of crisis formation. The phase of changes in the external and internal conditions of the city system functioning.
- Attempts of the system self-preservation. Formation of the scenario for destructive deviations.
- Overcoming the crisis and city's transition to a new stage of development or termination of its functioning. The third stage determines the system's potential for survival.

Deviations of the type “Δ” are characterized by:

- Growth of the system with disproportionate development of its individual segments. The main clusters of deviations are connected with either slow-growing or too fast-growing segment of the system. A simple and illustrative example of failure in self-regulation of a system, which has occurred as a result of uneven development, is “The Pont au Change” in Paris. The bridge is famous for the fact that during some periods of its existence up to 140 houses and more than a hundred shops have

- been located on it. As a result of regular uneven superstructures, it has repeatedly collapsed.
- Already at the initial stages of development, deviations are concentrated around the dominant system-forming element. For example, Rapa Nui (Easter) Island was left without trees as a result of uncontrolled economic activity of the population. Forests were cut down for building houses and transporting the giant Moai statues. After several centuries since the island colonization, the Aboriginal civilization fell into decline.
  - Transition to a crisis is characterized by sudden bursts of dynamic processes in functioning of significant system elements. A typical example of accumulation of type “Δ” errors by the system is the USSR. The rejection of everything that connected the country with the “old world”, the subordination of the economy to the ideological canons, and the use of violence to achieve often ephemeral goals — all these things caused the accumulation of a critical mass of errors and, as a result, the end of the regime. The period of socialism had such a profound impact on the country’s architecture that “Stalinist Empire style” and “Large-panel houses” became a recognizable brand.

Table 1. Structure of destructive deviations according to their type and development scenario in the city system.

<b>Subjective reasons for destructive deviations formation</b>	
<b>“C”</b>	<b>“Δ”</b>
<b>1. Putting more effort than necessary into achieving a goal</b>	
<p>The Great Wall of China. China.</p> <p>Deviation type — “C”: the Chinese emperor Qin Shi Huang (259–210 BC) built about 1.5 thousand km of the wall to protect the newly captured territories.</p> <p>Deviation scenario — “Amplification”: according to Owen Lattimore [13], the famine and impoverishment of the population as a result of the wall construction led to the fact that earlier occupied territories became deserted, and the barbarians, against whom these walls had been built, eventually took them.</p>	<p>Kangbashi. China.</p> <p>Deviation type — “Δ”: the rapid growth of the Chinese population prompted the country’s government to build new cities. In 2003, the Ordos city authorities initiated the creation of a new urban district for 1 million people. As of 2010, the current city on a piece of land with an area of 35 square kilometers can accommodate at least 300,000 people, and its estimated investment is about 161 billion US dollars.</p> <p>Deviation scenario — “Amplification”: it was claimed that as of 2010, there were between 20,000 and 30,000 people living. Presumably, the city is empty because of the real estate “bubble” and attractive government construction loans which were used by the Ordos officials [22].</p>
<b>2. Reassessing the value of one’s own opinion / position / choice</b>	
<p>Monument to Joseph Stalin in Yerevan.</p> <p>Deviation type — “C”: one of the biggest monuments to Stalin in the USSR (its height with a pedestal was 50 m), was opened on October 29, 1950. The goal was to strengthen the personality cult [34]. By the time of construction, the personality cult had been already formed, and the construction of the monument was aimed at preserving the achieved results.</p> <p>Deviation scenario — “Expansion”: the USSR architecture and monumental art often served as part of the communist ideology. Violence and propaganda enabled the country’s government to maintain a socialist regime for quite a long time even in the conditions of an irrationally organized economy. The monument was demolished in 1962. The expansion and accumulation of destructive deviations led to the collapse of the USSR in 1991. (Fig. 1.)</p>	<p>The golden house of Nero.</p> <p>Deviation type — “Δ”: it is a landscaped palace complex built in Rome in 64 AD. In this case, a growing deviation in the emperor Nero’s inadequate understanding of own importance is obvious.</p> <p>Deviation scenario — “Amplification”: Suetonius described this complex as “ruinously prodigal” since it included groves, pastures with herds of animals, vineyards and an artificial lake in the heart of a huge overpopulated city. After Nero’s death in 68, the unfinished palace was abandoned, burned under Titus’ rule, and afterwards its territory was reopened to the public and built up with public buildings (the Colosseum, the Forum and the Baths of Trajan, the Triumphal Arch of Titus, the Basilica of Maxentius, etc.) [29].</p>
<b>3. The gap in the perception of a problem</b>	
The decline of Sparta.	Los Angeles Aqueduct.

<p>Deviation type — “C”: the refusal of almost all types of arts, science and trade to develop the military skills of the country’ citizens allowed Lacedaemon, at a certain stage of the state development, to become one of the most powerful military organizations of its time.</p> <p>Deviation scenario — “Amplification”: spartiates believed that military force was enough to solve all the arising problems. However, the very form of state government, conservation of all ways of life and practically rejection of any non-military development led the country to decline.</p>	<p>Deviation type — “Δ”: rapidly growing Los Angeles was in dire need of fresh water. For that, in 1908–1913, entrepreneur William Mulholland implemented the project of a 375-kilometer-long Los Angeles Aqueduct, which was designed to supply citizens with water from Owens Lake with an area of 300 km<sup>2</sup>.</p> <p>Deviation scenario — “Amplification”: Mulholland did not take into account the growth rate of the Los Angeles population and did not correlate it with the speed of getting the lake filled with water. By the late 1920’s, the lake had been completely drained, which led to an ecological disaster in the Valley and resulted in the “water wars” between the Los Angeles administration and the Valley residents.</p>
<b>4. Ideology</b>	
<p>Exhibition of Achievements of National Economy (Vystavka Dostizheniy Narodnogo Khozyaystva (VDNKh)).</p> <p>Deviation type — “C”: in order to preserve the image of socialism significance for the country’s population, in 1934 the leadership of the USSR came up with an idea to organize an anniversary exhibition dedicated to the 20th anniversary of the Soviet power. This exhibition reflected the positive aspects of collectivization carried out in agriculture.</p> <p>Deviation scenario — “Expansion”: similarly to “the Stalin monument”.</p>	<p>Akhetaten.</p> <p>Deviation type — “Δ”: Amenhotep IV decided to weaken the power of the Theban High Priests of Amun. Pharaoh proclaimed the sun disk of Aten as the supreme god and built a new capital — Akhetaten [11].</p> <p>Deviation scenario — “Amplification”: after Pharaoh’s death, the introduced innovations were canceled, his name was forgotten, and the constructed capital was abandoned by the inhabitants. (Fig. 2.)</p>
<b>5. Legitimization of power</b>	
<p>Deir el-Medina.</p> <p>Deviation type — “C”: the deification of pharaohs in ancient Egypt was an important factor in the legitimization of the rulers’ power. Taking into account the role that a funerary cult played in the life of society, the living god had to have an appropriate tomb.</p> <p>Deviation scenario — “Accumulation”: wars and construction activity depleted the country’s resources. It is believed that under the rule of Ramses III there was the first mass labor strike in history [4].</p>	<p>The Ryugyong Hotel in Pyongyang, North Korea.</p> <p>Deviation type — “Δ”: in order to demonstrate the superiority of the socialist way of life, the construction of a 330-meter-high hotel was started in Pyongyang in 1987.</p> <p>Deviation scenario — “Expansion”: the construction was estimated to cost 750 million dollars [8]. This example clearly demonstrates a direct connection of the way a destructive deviation in architecture deepened the grave crisis that hit the country in 1995. (Fig. 3.)</p>
<b>6. Idealized thinking</b>	
<p>Serial housing construction in the USSR .</p> <p>Deviation type — “C”: the subordination of the USSR economical sector to the Marxism–Leninism ideology formed the basis for the fact that in the late 1950s, the Soviet Union embarked on the mass construction of model housing.</p> <p>Deviation scenario — “Amplification”: over ten years, 54 million citizens received new apartments. However, the inertia of the economic system caused the construction of obsolete housing to drag on throughout the entire period of the country’s existence. Nowadays, outdated panel blocks of flats pose a significant problem for cities in countries that have outlasted the communist regime.</p>	<p>Phalanstery by Charles Fourier.</p> <p>Deviation type — “Δ”: the industrial revolutions of the 19th century changed the conditions under which the cities functioned. In response to the problems emerged, many philosophical concepts arose. One of them was the doctrine of utopian socialism by Charles Fourier.</p> <p>Deviation scenario — “Accumulation”: Fourier proposed the construction of “phalansteries”, palaces of a special type, which were the center of life of the phalanx — a self-sufficient community that included 1600–1800 people working together for mutual benefit. Most of the communes built worldwide proved unviable. (Fig. 4.)</p>
<b>Accumulation of destructive deviations by the city system for objective reasons</b>	
<b>Destructive deviations in architecture caused by social factors</b>	
<b>1. Military conflicts</b>	
<p>The conquest of Constantinople.</p> <p>Deviation type — “C”: by 1453, Constantinople had</p>	<p>The sack of Rome by the Vandals.</p> <p>Deviation type — “Δ”: the 4th–7th centuries marked</p>

<p>turned from a powerful empire into a frozen in development city with small adjacent territories.</p> <p>Deviation scenario — “Accumulation”: the power in the country has degenerated. Even a threat of a Turkish invasion did not force Emperor Constantine XI Dragases to begin the construction of artillery. At the audience given to the Hungarian military engineer Urban, the emperor stated that the city had Greek fire and that was enough. As a result, the cannon named “Basilica”, which Urban built for the Turkish Sultan Mehmed II, played a decisive role in the fall of Constantinople.</p>	<p>the beginning of the Great Migration Period in Europe. Traditional historiography states two main reasons for this event: a weakening of the Roman Empire and the climatic pessimism.</p> <p>Deviation scenario — “Expansion”: the period of “barracks emperors” accompanied by military coups and economic crises led to the weakening of the Roman Empire. As a result, in 455, the city was plundered by the forces of Gaiseric, and the term vandalism entered many languages of the world.</p>
<p><b>2. Traditions and legislation</b></p>	
<p>Segregation in the USA.</p> <p>Deviation type — “C”: racial segregation in the USA is the separation of the white population from other ethnic groups. It was carried out through creating various social barriers.</p> <p>Deviation scenario — “Amplification”: segregation in the USA. On December 1, 1955, a 42-year-old black seamstress from Alabama Rosa Parks refused to give up her seat on the bus to a white man in Montgomery. She was arrested and fined. During the same year, five women, two children, and many black men were arrested on buses in Montgomery. One man was shot by the driver on the spot. Then, on the initiative of Martin Luther King, black residents of the city declared a general boycott of the public transport. Black car owners drove their “skin brothers” without taking any payment. African Americans supported the boycott for 381 days. It was later called “Walking for freedom.” During that period, the bus companies suffered significant losses because the black people made up 70% of all bus passengers.</p>	<p>Pruitt-Igoe.</p> <p>Deviation type — “Δ”: on December 7, 1955, by decision of the Federal District Judge of St. Louis George H. Moore, it was ordered to stop segregation in public housing. The housing estate was opened in 1956. The result of the adopted resolution was the outflow of wealthier white population from the district. Pruitt-Igoe was faced with a number of local crises.</p> <p>Deviation scenario — “Expansion”: the less wealthy Afro-American population that occupied the district could not pay all utility bills. The non-payment crisis caused cycles of industrial accidents, a decrease in the district’s brand, and depopulation growth. This, in turn, brought about marginalization of the population, an increase in crime and many other problems that led to the decision on the complex demolition in 1974.</p>
<p><b>3. Social conflicts</b></p>	
<p>Girolamo Savonarola.</p> <p>Deviation type — “C”: abuse of power by the hierarchs of the Roman Catholic Church was the reason for a movement to preserve the purity of the faith and poverty of priests which emerged in Italy in the 15th century. Girolamo Savonarola became a prominent member of that movement.</p> <p>Deviation scenario — “Amplification”: “Rome is Babylon,” Savonarola preached. “Instead of instilling the basics of Christian doctrine in the people, prelates give themselves to poetry and oratorical art. You will find the works by Horace, Virgil, and Cicero in their hands.” The priest remained in history as an example of justice and incorruptibility, a fighter for the preservation of Christian values. Yet, his activities resulted in Florence losing its leading position in Europe.</p>	<p>Destruction of Old Moscow.</p> <p>Deviation type — “Δ”: the Russian Revolution of 1917 brought the Bolsheviks to power. This party needed visible confirmation of the advantages of a new order. Special attention in these processes was given to architecture.</p> <p>Deviation scenario — “Expansion”:</p> <p>A. Avtorokhanov wrote about Kaganovich in his book “The Technology of Power” [29]: “A self-taught person, who never studied, started as a shoemaker, cutter and packer”. In the pamphlet “Socialist reconstruction of Moscow and other cities in the U.S.S.R.”, Kaganovich wrote in 1931 that Moscow needed to be redeveloped and reconstructed again because “while walking along the Moscow lanes and backstreets, you get an impression that these streets were laid by a drunken builder”.</p>
<p><b>Destructive deviations in architecture caused by anthropogenic factors</b></p>	
<p><b>1. Anthropogenic aspects of urban expansion</b></p>	
<p>The Aztecs’ gold.</p> <p>Deviation type — “C”: before the discovery of America, Portugal and Spain were the most dynamically developing countries. The gold flows from the New World slowed down their technical development so much that within a century the leadership was lost.</p> <p>Deviation scenario — “Expansion”: colonization of a new continent attracted the most active and business-</p>	<p>“Urban Renewal” program</p> <p>Deviation type — “Δ”: back in the 1940s, it was decided that pedestrian streets, densely built-up areas and narrow roads were outdated, and they hindered development of the American society. Cars are the future, so cities should be redeveloped in order to cope with the increasing traffic.</p> <p>Deviation scenario — “Accumulation”: a federal pro-</p>



<p>minded part of the Spanish population. Instead, tons of precious stones and metals began to flow into the country. So, rather than develop their own productions, the Spaniards preferred to buy the goods they needed. As a result, they sponsored the development of the neighboring countries and lagged behind in their own development.</p>	<p>gram of urban renewal was launched to reconstruct “obsolete” districts. As a result, cars congested the avenues. Parking lots separated shops from pedestrian transit zones, occupying the adjacent city blocks. Cities stopped being attractive for their residents. This provoked the growth of the suburbs, which is happening to this day. Hypermarkets won in the competition. Lots of shops were ruined. The tax base and service industry declined, and the achieved result was absolutely opposite to the original intention of the program.</p>
<p><b>2. Technological development</b></p>	
<p>The “war” between guilds and manufactories in Europe</p> <p>Deviation type — “C”: in the early stages of their existence, guilds had a noticeable positive effect on the development of cities. In the Late Middle Ages, they turned into a caste strictly adhering to a lot of rites. Guilds foremen usually did not allow any technical innovations and improvements; their goal was to ensure that masters worked under equal conditions.</p> <p>Deviation scenario — “Accumulation”: during the period of industrial revolutions, the tough rules of craft production began to hinder the development of industry and gradually disappeared, giving way to more progressive manufactories.</p>	<p>Production robotization</p> <p>Deviation type — “Δ”: the problem of production robotization is related to the predicted social crises caused by the development of high technologies.</p> <p>Deviation scenario — “Expansion”: the release of thousands, and in the near future, hundreds of thousands of specialists from the production sector is creating a new pattern of the problems facing modern cities. There are already precedents for almost complete replacement of people with robots: the Chinese enterprise Changying Precision Technology Company replaced 90% of its employees with robots and increased productivity by 250%. As a result, 590 people became unemployed. In an interview with Quartz, Bill Gates pointed out the necessity of imposing a mandatory tax on robots and consequences for cities if it is not done [3].</p>
<p><b>Destructive deviations in architecture caused by ecological factors</b></p>	
<p><b>1. Problems with garbage</b></p>	
<p>Garbage crisis in Lviv</p> <p>Deviation type — “C”: the crisis arose in 2016–2017 and was caused by the city’s inability to independently reprocess household waste produced by citizens.</p> <p>Deviation scenario — “Amplification”: the crisis started after a huge fire at the Lviv solid waste landfill near Lviv, which broke out in May 2016 and killed several people. After that, operation of the landfill was prohibited by the court order.</p>	<p>“Amager Bakke” plant, Copenhagen</p> <p>Deviation type — “Δ”: the plant was opened in 2017. Today, it is one of the most equipped waste recycling plants in the world. This deviation is at the intersection of technologies and ecology. It is regarded as ecological because it demonstrates the way a potential improvement of the ecological situation can be reflected in the technical sphere.</p> <p>Deviation scenario — “Expansion”: a serious miscalculation in the loading of the recycling plant was found during its operation. A project worth \$650 million is not loaded even at half of its capacity. It has already been suggested that the European trend to reduce produced waste will have further reduced the plant load by 2025.</p>
<p><b>2. Problems with drinking water</b></p>	
<p>The Cape Town water crisis</p> <p>Deviation type — “C”: in this case, the equipment of urban fresh water collection and utilization systems cannot keep up with the opportunities that can be potentially provided by the corresponding innovations.</p> <p>Deviation scenario — “Amplification”: Cape Town is experiencing serious problems with water supplies — the consequences of a three-year drought and population growth. The city with a population of 400,000 people is going through a water crisis. The city authorities have severely limited water consumption by local residents, and violation of the norm is punishable by a considerable fine. It is allowed to use no more than 50 liters of water per person per day.</p>	<p>The Grand Ethiopian Renaissance Dam.</p> <p>Deviation type — “Δ”: drinking water scarcity in Africa poses a threat to the security of some states of the continent. Radical solutions to the problem adopted by one of the countries may have a negative impact on the neighboring states.</p> <p>Deviation scenario — “Expansion”: Ethiopia is completing the construction of the first large dam on the Blue Nile River, and then will begin to fill the gigantic reservoir outside its borders to provide the largest hydroelectric power plant in Africa with water. Egypt fears that reducing water supply will destroy part of its fertile agricultural lands that provide food for 93 million people who are already facing water shortages.</p>



Fig. 1. Monument to Joseph Stalin in Yerevan. Source: official site of Rafael Israelyan

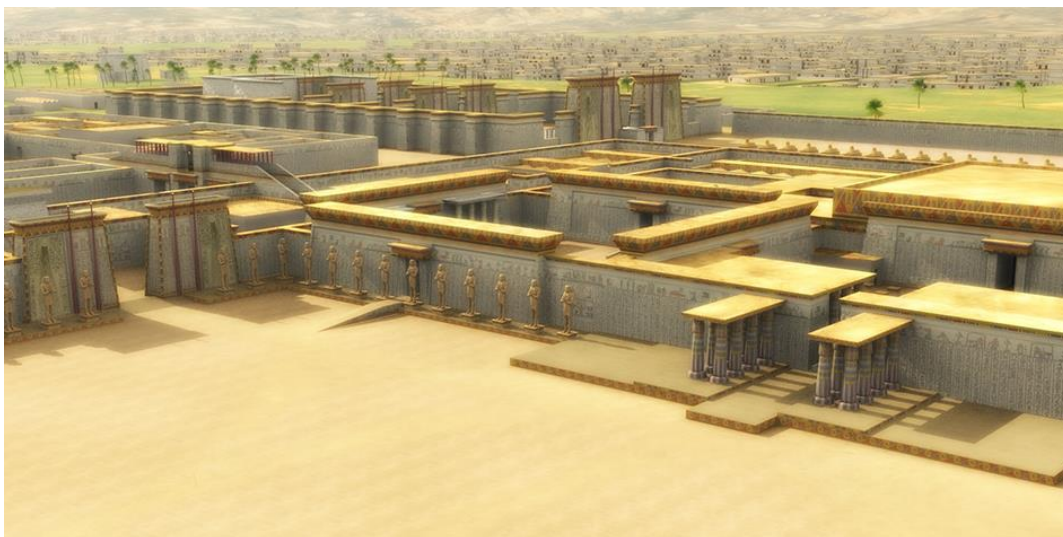


Fig. 2. Akhetaten, reconstruction. Source: Hidden Inca Tours



Fig. 3. The Ryugyong Hotel in Pyongyang, North Korea. Source: Associated Press



Fig. 4. The Phalanstère in Guise, by Jean Baptiste Godin. Source: official site of [www.familistere.com](http://www.familistere.com)

## 5. CONCLUSIONS

A city consists of many systems and subsystems, vital interests of which limit each other's development. Each element of a city as a dynamic system has its own dynamics. The combination of the dynamics of the elements creates the dynamics of the city functioning. Changing under the pressure of external and internal factors, the elements that have high dynamics of development are faced with the limitations imposed by adjacent elements. As a result, this raises contradictions in the vital interests of the city's elements and subsystems. These contradictions can be alleviated by a well-thought regulation, or can be aggravated by mistakes and miscalculations of designers and investors.

Due to compromises between conflicts of interests, the city exists and develops. If new boundaries of compromises are established, the system achieves stability, otherwise it goes into a state of crisis. Identification of critical limits in the functioning of a city system and development of methods for overcoming them is the main objective of the conducted research. The relevance of such prognosis is determined by the price of errors which can result in abandoned cities and billions spent.

The concept of "Destructive deviations" is an important component of the analysis of the city functioning as a system in terms of identifying indicators of crises and possible disasters. Crisis does not arise unexpectedly, its approaching is always accompanied by many signs. When creating an appropriate theoretical apparatus, it is possible not only to calculate the timing of a crisis but also its characteristics, duration, approximate consequences and methods for minimizing them.

In the course of the conducted research, the concept of "Destructive deviations" has got into the so-called "Hermeneutic circle". We cannot specify the types and scenarios of "Deviations" without sufficient statistical material for analysis. The nature of the missing data is directly related to the methods we are developing for assessing dynamic processes that take place in a city. We need appropriate methods for devising principles of quantitative evaluation of "Destructive deviations", and these methods cannot be developed without analyzing relevant statistical data. Things have come full circle.

The exit from the "Hermeneutic circle" traditionally lies in the methods of successive approximations. It is the use of deductive research method from the level of abstractions to the level of specific data. This article is the result of generalizations made in the process of exploring a city as a dynamic system.

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#### AUTHOR'S NOTE

**Oksana Fomenko** Professor of the Opole University of Technology, Department of Architecture and Urban Planning, Faculty of Civil Engineering and Architecture. Fields of research: development of innovative methods of analysis, modelling and planning of architectural environment.



**Andrey Izbash** graduate student Kharkiv National University of Construction and Architecture, Department of Innovative Technologies for Architectural Environment Design. Research directions: innovative methods of analysis, modeling and design of the architectural environment

#### O AUTORZE

**Oksana Fomenko** – profesor Politechniki Opolskiej, Wydziału Budownictwa i Architektury, Katedra Architektury i Urbanistyki. Kierunki badań naukowych to: innowacyjne metody analizy, modelowania i projektowania środowiska architektonicznego.

**Andrey Izbash** - absolwent Charkowskiego Narodowego Uniwersytetu Budownictwa i Architektury, Wydział Architektury, Katedra Innowacyjnych Technologii Projektowania Środowiska Architektonicznego. Kierunki badań naukowych to: innowacyjne metody analizy, modelowania i projektowania środowiska architektonicznego.

Contact | Kontakt: [o.fomenko@po.opole.pl](mailto:o.fomenko@po.opole.pl); [Izbash280593@gmail.com](mailto:Izbash280593@gmail.com)