HIDDEN URBAN REVOLUTION IN KAUNAS DOWNTOWN

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Abstract
City is a social, economical and cultural organism. As an open system it should undergo changes in order to be able to adapt itself to changing environments. Urban history demonstrates two different ways of city’s development: urban evolution and revolution. From traditional architects’ point of view, urban revolution is the most often related to radical changes of urban form. If a complexity of urban interactions is taken into account then the possibility of hidden or inner urban revolution without radical change of urban form should be considered as possible way or city’s transformations and mutations. Radical changes of the social and political structure and formal respect of the culturally valuable urban form in Lithuania present a good material for initial investigation. Kaunas downtown area and changes of both its code and form are analyzed in the article. Three time sections are compared: 1935 (interwar period), 1988 (period of Soviet occupation) and 2011 (independence period). ‘Space syntax’ theory was used as methodological background for the investigation. Research results reveal the following changes: urban form of the investigated area was formally respected, but, because of the state land property, borders of the possessions inside the blocks were destroyed. This change led to radical changes in the urban code of the area: the depth of the system and single blocks was increased radically (from 1 to 5 steps); private places were transformed into potentially public spaces; continual system of convex spaces was fragmented; increased depth and number of axial and convex spaces; increased convex connectivity and control; decreased global integration factors; etc. Radical changes of urban code without the adequate change of urban form could be described as hidden urban revolution. It caused code mutations that made a strong negative impact on social and cultural vitality of the area, e.g. urban system lost its spatial and social unity, some areas were transformed into urban type office parks, lumpenization of the downtown started, urban structure lost its function as catalyst of street culture and night life, etc.
INTRODUCTION

City must undertake changes in order to survive in changing social, economical, cultural contexts. Besides the need for permanent changes any city must preserve its continuity in time as an integrative background for survival of city as a complex of cultural artifacts. Architects and urban planners quite often are aware about the both needs and formulate principles of new urban designs accordingly. The problem appears when consciously or unconsciously the high level or urban complexity is not considered. City as an open complex system can demonstrate close interaction of urban form and social field, nonlinear dependencies between various external impacts and feedbacks of the system or even butterfly effect. The last one aspect of complexity means that even “insignificant” urban changes or aspects can cause radical changes in the urban system. It should be noted that the lack of respect for complexity in old city parts, where urban and architectural form is formally respected and protected, could cause the change of the urban genotype which took its origin in sociality, gender and ethnicity (Hanson, 1999) many years ago. Such a radical change of urban code with formally respected architectural-urban form of the area we would like to call hidden urban revolution. The reverse situation or open urban revolution could be described as radical change of both urban phenotype and genotype. Illustrative example of the last one was presented by well known Le Corbusier’s Plan Voisin for Paris. Example of hidden urban revolution catalyzed in Soviet era could be presented by Kaunas downtown area.

THE RESEARCH OBJECT

Kaunas downtown is the research object. Kaunas is the second largest city in Lithuania. Kaunas downtown occupies about 500 ha territory in the center of the city. Kaunas downtown includes the Old Town which was established at the beginning of the 15th century and the New Town planned in the manner of the Classicism in the first half of the 19th century. During the interwar period the New Town finally became the city center, and Laisvės avenue became the most important functional space. Third floors were built above two-floor buildings, five or six floor buildings were built in significant urban places. During the Soviet occupation the major changes took place in land management in Lithuania. The cancellation of private land property and introduction of state land property became one of the most significant changes which affected urban development. The destruction of formal and informal borders between land possessions inside old quarters was the main alteration in Kaunas downtown during the Soviet times. Since 1990 the opposite process of re-privatization takes place. The important note: despite the different political regimes and architectural-urban doctrines Kaunas downtown area (especially the Old Town) was considered as valuable urban and architectural heritage and its spatial structure was preserved.

The research of Kaunas downtown area is being performed via the analysis and comparison of the three historical periods:

- 1918-1940 – the period of independent Lithuania during the interwar period with a private land property. We use maps, photographs, topographical maps etc. of 1935 for the research of convexity and axially,

- 1940-1990 – Lithuania is the part of the Soviet Union with a state land property. We use maps, photographs, topographical maps, information about addresses, observation at site etc. of 1988 for the research of convexity and axially,
• 1990-till now – the period of independent Lithuania with private land property. We use maps, photographs, topographical maps, information about addresses, observation at site etc. of 2011 for the research of convexity and axially of the object.

The investigation of Kaunas downtown during the periods of 1918-1940 and 1940-1990 was started by us in 2009. From the previous investigation of the interwar and Soviet periods (Zaleckis & Matijošaitienė, 2010; Zaleckis & Matijošaitienė, 2011) it is clear that during the Soviet times more axial spaces appeared, the connectivity and control of axes increased, the axial deformation of the system became very significant during the Soviet period, etc. Now we focus on the comparison of the three historical periods. Though due to the large area of the research object at this stage of the research we concentrate just on a part of Kaunas downtown (Fig. 1): the typical district between Gedimino, Mickeviciaus, Putvinskio streets and Laisves avenue. Laisves avenue (Freedom avenue) is the main pedestrian street in Kaunas city. It is the main core of the city and people gathering place with lots of shops, boutiques, restaurants and other service objects on both sides of the avenue. The characteristic feature of the avenue is the alley of trees (mostly lindens) which can be treated as mid axis of the avenue. The length of Laisves avenue is 1621 m and the width is 24-27 m. Nepriklausomybės square (Independence square) is involved into the research district. The church of Archangel Michael is in the middle of the square. This square and the church divide Laisves avenue into two segments: the longer segment is used more intensively, the shorter – less intensively.
In this stage of the research we pay more attention to the convexity of the research object. The convexity shows the maximum local two-dimensional development of the structure. In social terms, convexity correlates with the local organization of the space and with dwellers of the system.

THE METHODOLOGY

The aim of the research is to determine whether the alteration of the social spatial code of the area caused evolution or revolution of the area. We analyse Kaunas downtown as a local and global system. For the research of the alteration of the social spatial code we use Space Syntax model (Hillier & Hanson, 2003). Space Syntax is about identifying, representing, and measuring the spatial relationships in our built environment (Peponis, 2005). Space Syntax model lets us analyze urban structure on two different levels: the level of urban network (streets, squares and other public spaces) and the level of architecture (where and how the buildings located in urban structure, their shape). The urban network and the architecture form the city, and they are closely related to the social code of the city (Hillier, 2007). Alteration of the urban network or the architecture, or both, can cause changes in social activity and social relations. The urban network and the architecture are the key factors which enable us to research alteration of urban form, social relations and to forecast changes in social code according to the changes of urban form. As B. Hillier says “the problem of urban form is that of understanding the global pattern: a pattern that can only be seen from a multiplicity of points” (Hillier etc., 1987). Understanding of the global pattern will help us to realize how the town and its dwellers live, work and move. The local pattern will help us to realize the alteration of spatial-social code inside separate districts. Space Syntax model represents urban form as a network of lines of potential movement or a grid of spaces. Literature review revealed that the method is most commonly applied for the analysis of relations between urban streets and squares, and between various rooms in a building: P. Zamani (2009) performed the comparable analysis of changes in the plan structure of High Museum of Art in Atlanta, USA, during 1983, 1997 and 2003, B. Hillier and L. Vauhgan (2007) drew integration maps for Tate museum in Great Britain and revealed that the great part of the most integrating spaces overlay the most visited spaces of the museum, R. Conroy Dalton (2007) analyzed the system of paths of local communication through axial maps in Peachtree town, USA, A. Turner with a group of researchers (Turner etc., 2005) researched spatial and social structures of Gassin town in France, A. Turner (2007) suggested to apply space syntax method for the analysis of traffic. We apply this method for the analysis of changes in social spatial code in Kaunas Downtown through various historical periods.

According to the Space Syntax theory Kaunas downtown was divided into spaces in which social activity and links take place (Hillier & Vaughan, 2007). The spaces are bordered by building walls, fences, greenery - they limit traffic, pedestrian flows and/or visibility of the space (Klarqvist, 1993). At this stage of the research we pay more attention to the analysis of depth, integration and connectivity maps which are represented via axial lines and convex spaces. The social spatial structure of Kaunas downtown is considered in two ways: as convex (for the analysis of a local pattern) and axial (for the analysis of a global pattern) structure. The convex structure is two-dimensional and it “describes the degree to which any space extends in two dimensions” (Hillier etc., 1987). Convexity is related more with co-presence of those who are already in the system. It describes where we are in the system. The convex maps consist of fewest spaces which cover the system. The convex maps demonstrate the social spatial code of city dwellers. The convex structure is being analyzed at the local scale in the certain typical district of Kaunas Downtown (through the three historical periods). The axial structure is one-dimensional and it “describes the degree to which any space extends linearly” (Hillier etc., 1987). It gives us the information about where we might go in the system. Axiality is
more related with movement inside the town. Though we don’t tend to measure movement potential in Kaunas downtown. We just use axial maps to compare and analyse the effect of different historical periods and regimes on urban structure of the downtown. The axial structure was analyzed at the global scale in the whole Kaunas Downtown area (only the periods of 1918-1940 and 1940-1990. The period of 1990-till now will be analyzed later). The axial maps consist of the “longest and fewest straight lines that go through all convex spaces and make all axial links” (Hillier etc., 1987, Topcu & Kubat, 2007). The axial maps describe the system from the point of view of strangers and of the world outside the system. That is why it is important to analyse Kaunas Downtown from both axiality and convexity aspects: axiality – for a global analysis of the whole Downtown and convexity – for a local analysis of the district as a typical part of the Downtown.

Depth is a concept introduced by Bill Hillier. Depth measures the social cultural integrity of the inner spaces of the downtown. Depth defines the number of steps from any node to any other node (Raford & Ragland, 2004). Depth is related to the integration. According to B. Hillier (1993) the integration of axial lines correlates well with the number of pedestrians found to be walking along the axial line. Integration let us know the potentially more comfortable spaces for pedestrian movement. Integration measures how easily accessible a node is from other nodes in the system (Raford & Ragland, 2004). Spaces with higher intergration values offers greater accessibility for pedestrians, therefore these spaces are more often used than ones with low integration values. The number of turns to intergrated spaces is smaller therefore they are usually more often used by pedestrians as straighter paths. This characteristic can be used for the evaluation and prediction of pedestrian movement. Depth and integration are the main and global characteristics in space syntax used for the research of convex spaces and axial lines.

Connectivity is a local characteristic which lets us know about the direct connection of spaces. Connectivity is defined as the number of nodes that connect directly to a given node (Raford & Ragland, 2004). The analysis of connectivity will be based on the research of convex spaces of the district.

Using the convex maps helped us to draw and analyse interface and decomposition maps of the research district. Interface and decomposition maps let us know about the integrity or the autonomy of spaces. They are the main characteristics of the city when we have in mind that the city is a cell which is shared by society and has places of the functioning concentrated residence.

We used Depthmap software for the investigation of the depth, integration and connectivity of convex spaces and AutoCAD 2009 software for the investigation of the interface and decomposition of the object. The depth, integration and connectivity maps are drawn for the whole system of downtown for the periods of 1937 and 1988 (the system of 2011 will be analyzed in our further research due to the lack of the newest maps of the territory). The same maps, interface and decomposition maps are drawn for the research district for the periods of 1937, 1988 and 2011.

THE DEPTH AND INTEGRATION OF THE SYSTEM

We chose ‘n’ radius to measure the depth and the global integration of the system through axial maps. In this case measures to all lines reachable from each starting line were calculated. The whole system of Kaunas downtown of 1937 and 1988 was analysed through ‘n’ radius. Figure 2 represents the step depth from Laisves avenue. In the map of 1988 we see increased number of axes and increased number of axes which are distant from Laisves avenue (up to 9 steps).
Figure 2
The axial maps of step depth of Kaunas downtown from Laisves avenue (r=n)
For the estimation of symmetry of the system we drew the convex maps representing the depth of the district of 1937, 1988 and 2011. As an example we represent here just the maps of step depth from Laisves avenue – the major pedestrian street in the New Town (Fig. 3).

Deep spaces are reachable through other spaces. The depth is related to the asymmetry. The analysis of the maps of step depth shows that the highest value of step depth during the interwar period was 4, during the Soviet times it was 9 and in nowadays it is 13. The increased number of steps demonstrate that the system became much deeper, asymmetric and most probably less integrating since the Soviet period. The analysis of step depth via axial maps and the derived MD (Mean Depth) values for a part of the main inner and outer spaces prove it.

MD from Laisves avenue, the main and the largest pedestrian street in New Town, are:
\[ \text{MD}_{1937}=2.62, \text{MD}_{1988}=4.69 \text{ and } \text{MD}_{2011}=5.59. \]

MD from the lower space of Mickeviciaus street are:
\[ \text{MD}_{1937}=2.44, \text{MD}_{1988}=4.43 \text{ and } \text{MD}_{2011}=5.10. \]

MD from the lower space of Gedimino street are:
\[ \text{MD}_{1937}=2.06, \text{MD}_{1988}=4.50 \text{ and } \text{MD}_{2011}=5.76. \]

MD from Dobuzinsko street are:
\[ \text{MD}_{1937}=2.81, \text{MD}_{1988}=4.28 \text{ and } \text{MD}_{2011}=8.36. \]

Integration is a measure of the accessibility of a space. It measures and expresses the topological accessibility of a space from the whole system. The integrating spaces are easy accessible from other spaces, segregating spaces are hardly accessible. In more integrated areas more strangers can be found and in more segregated areas more city dwellers dominate. The integration maps of the whole downtown (Fig. 4)
demostrate appearance of more very integrating spaces (red color) and much more disintegrating spaces (light and dark blue colors) in the inside area of the blocks during the Soviet period.

**Figure 4**
The axial integration maps of Kaunas downtown ($r=n$)
According to the convex maps the average integration value for the district of 1937 is $i_{ave}=0.97$, for the district of 1988 it is $i_{ave}=0.94$ and for the district of 2011 it is $i_{ave}=0.75$. The district became deeper and less integrating since the Soviet times, and it is even less integrating in nowadays. This means that the system became more adapted for the city dwellers than for strangers. From Fig. 5 we see that Donelaciaio street was and is the most integrating space. The integration value of the lower part of Gedimino street decreased since the Soviet times and is decreasing now. The integration value of the upper part of Mickeviciaus street increased during the independence period. The integration of Laisves avenue decreased in the independence times because some entrances to the avenue were closed from the inner spaces. The example of the decreased integration value of Dobuzinsko street in the independence times demonstrates the phenomena which is taking place in some inner spaces in nowadays. The decrease of integration happens because a part of private properties in inner spaces were fenced. Buildings in that properties have no more direct links with a street. Hereby some streets and inner spaces became isolated from the buildings and asymmetric from the social point of view (in terms of dwellers). In most cases now they are just transit corridors from one space to another.

In summary it can be said that the spaces in the interwar period were adapted more for the district dwellers. During the Soviet times spaces were filled more with visitors. During the independence period outer spaces became even more adapted for the visitors, though inner spaces became more filled with the dwellers. The estimation of the integration of the whole Kaunas downtown will be done in our further research.

**CONNECTIVITY**

Connectivity is a local measure which captures the amount of space directly visible from a certain convex space (Brösamle, Hölscher and Vrachliotis, 2007). The spaces with higher connectivity offer greater accessibility to a larger number of other spaces, resulting in proportionally greater usage. Streets that offer greater access to large number of other streets act as conduits for more origin/destination pairs than streets.
with less connectivity. These streets consequently experience more usage than less connected and accessible streets (Raford & Ragland, 2003). From the connectivity maps (Fig. 6) we see that Laisves avenue is not the most connecting in the Soviet times. A lot of disconnecting axes (dark blue color) appeared in 1988 in inner structure of the blocks.

**Figure 6**
The axial connectivity maps of Kaunas downtown (r=n)
From the convex connectivity maps (Fig. 7) we see that Donelaicio street remains usable by visitors through the three historical periods.

For the better acknowledge of the alteration of the system’s structure according to its connectivity we estimated the average and the maximum connectivity values of the district from convex space maps: interwar period – $c_{ave}=2.375$ and $c_{max}=6$, Soviet times – $c_{ave}=2.835$ and $c_{max}=8$, independence times – $c_{ave}=2.391$ and $c_{max}=8$. On the other hand, the results are valid just for inner convex spaces. They don’t show the situation of the outer convex spaces such as Mickeviciaus, Gedimino streets and Laisves avenue because just a part of Kaunas downtown was used for this research and the links between these spaces and other spaces which are not included in this research have been cut (Fig. 7). The research of convex maps of the whole downtown during three historical periods is the aim of the further work. Though we can see that the connectivity of most of the spaces increased since the Soviet period. The connectivity of inner spaces decreased during the period of independence in some of cases because some inner spaces were isolated by walls and fences and they are inaccessible for the visitors.

![Convex connectivity maps of the research district](image)

**Figure 7**
Convex connectivity maps of the research district

**INTERFACE AND DECOMPOSITION**

Some principles of drawing the interface map were used in the research: a) y-space is complemented with all the buildings (circles are convex spaces and dots are buildings), b) a convex space is linked with a building when there was the adjacency or direct permeability link between them. In the research we accept that buildings and their parts, fences, walls and dense greenery form the convex spaces. Some sites mostly with residential houses were fenced in the beginning of the independence period because of the high-handed management of the private property and the absence of urban planning legislation. In the research of 2011 we accept fenced sites (or parts of sites) as separate convex spaces. Decorative landscaping and dense greenery in the inner yards of the district also separate spaces physically and visually and form separate convex spaces. The interface maps of the district are shown in Fig. 8. It is clear from the situation of 1937 that if somebody stands in almost all the spaces he/she will be adjacent to somebody’s door, id est almost
every convex space was controlled from the surrounding buildings. The number of steps from almost each building to the main streets Donelaicio, Mickevicius, Putvinskio and Laisves avenue is 1 step. This means that there are 7 convex spaces (50% of all the convex spaces) with a high value of control (4 and more controlling buildings) and 5 spaces (35.7%) with a moderate and minimum (3-1 controlling buildings) value of control. The interface maps of 1988 and 2011 demonstrate an absolutely different situation: a big part of spaces in both historical periods have no entrances to any building, moreover the most of the buildings are away from the main streets through not less than 3-5 steps, some buildings during the independence period are not connected to any space because they are unsettled and unused. During the Soviet times there were just 6.67% of spaces with a high control values (4 and more controlling buildings), and 5.63% of spaces with a high control values during the independent times. The result is that the continuous control of space from buildings entrances is lost (this is the global property of the system). The amount of extensively used areas extremely reduced since the Soviet period. This can lead to the increased crime especially in inner spaces which are not controlled by the buildings or controlled just by one building.

The decomposition map shows the extent to which the convex spaces are continuously constituted by front doors (Hillier & Hanson, 2003). Here convex spaces are linked only when both are directly adjacent and permeable to at least one building. The map demonstrates the spatial possibilities of the formation of society. As we see from the Fig. 9 the district of 1937 has quite integral system of inner spaces with one isolated convex space. There are a lot of isolated inner spaces and spaces with dead-ends in the maps of 1988 and 2011. It is evident that the system was continuously constituted in 1937, while in 1988 it was much more unconstituted because there were lots of spaces which were distant to the building entrances – these spaces are autonomous.
THE MORPHOLOGICAL COMPARISON OF THE THREE HISTORICAL PERIODS

The interface maps help us to calculate the convex articulation during different social regimes. The estimation results of the convex articulation (Table 1) show that the system was the most synchronous and socially non-distributed during the period of interwar. During the Soviet times the system became much more socially distributed and less synchronous (with a broken-up structure of settlement). The process of social distribution and unsynchronization takes even more place in nowadays. So, during the Soviet period and in the period of independence the social diffusion is observed in Kaunas downtown. The fact of the growing distribution is proved by the estimation of the convex ringiness. The estimation results of the convex ringiness (Table 1) demonstrate once more that the system was the least distributed during the interwar period and the most distributed during the Soviet times. We use the concept of the grid convexity to compare the grid of 1937, 1988 and 2011 with an orthogonal grid. The closer the value to 1 the less deformations of the grid. The calculation results of the grid convexity (Table 1) reveal that the system had quite deformed grid through the three historical periods. Though the system had the least deformed grid during the interwar period and the most deformed in nowadays.
### CONCLUSIONS

The research of Kaunas downtown revealed major alteration of the characteristics of the axial lines:

The depth of the system increased radically. The New Town became more integrating during the Soviet period according to the number of axes with very high integration values. Also a lot of disconnecting axes appeared in Soviet and independence periods in inner structure of the blocks.

The research of the typical district of Kaunas downtown revealed major alteration of the characteristics of the convex spaces:

The amount of convex spaces, axes and buildings increased radically during the Soviet period, and it increased a bit during the independence period. Though a part of spaces became isolated and not accessible for the visitors during the independence period.

The researched district became deeper and less integrating since the Soviet times, and it is even less integrating in nowadays. The step depth and average integration values for the district demonstrate it: the highest value of step depth during the interwar period was 4, during the Soviet times it was 9 and in nowadays it is 13 and $I_{1033}=0.97$, $I_{1986}=0.94$ and $I_{2011}=0.75$. Though the integration of some of the outer spaces increased in the Soviet period and during the period of independence. This explains the greater degree of socialization in these spaces. The integration of some inner spaces decreased and they became partly isolated from other inner spaces during the independence period. The connectivity and accessibility of most of the spaces increased since the Soviet period, but the connectivity and accessibility of major inner spaces decreased during the period of independence.

<table>
<thead>
<tr>
<th>Morphological properties</th>
<th>Interwar 1918-1940</th>
<th>Soviet 1940-1990</th>
<th>Independence 1990-till now</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of convex spaces $C$</td>
<td>14</td>
<td>105</td>
<td>142</td>
</tr>
<tr>
<td>Number of axial lines $L$</td>
<td>12</td>
<td>188</td>
<td>176</td>
</tr>
<tr>
<td>Number of buildings $B$</td>
<td>80</td>
<td>115</td>
<td>125</td>
</tr>
<tr>
<td>Number of islands $I$</td>
<td>14</td>
<td>15</td>
<td>19</td>
</tr>
<tr>
<td>Convex articulation $=C/B$, here $C$ is the number of convex spaces, $B$ is the number of buildings.</td>
<td>0.175</td>
<td>0.910</td>
<td>1.136</td>
</tr>
<tr>
<td>Convex ringiness $=I/(2C-S)$, here $C$ is the number of convex spaces, $I$ is the number of islands (island is a block of continuously connected buildings, completely surrounded by y-space).</td>
<td>0.609</td>
<td>0.073</td>
<td>0.106</td>
</tr>
<tr>
<td>$C^{max}=(l)^{1/2} + I^2/C$, here $C$ is the number of convex spaces, $I$ is the number of islands.</td>
<td>1.606</td>
<td>0.226</td>
<td>0.202</td>
</tr>
</tbody>
</table>

Table 1

The morphological comparisons of the research district through the three historical periods
The research of the interface maps reveals the receding synchronization and the rising social distribution of the system: Convex articulation$_{1937}$=0.175, Convex articulation$_{1988}$=0.91 and Convex articulation$_{2011}$=1.136. The process of the social diffusion (distribution) started in the Soviet times and lasts until today. Decomposition maps show that the system was continuously constituted in 1937, while in 1988 and 2010 it is much more unconstituted. The system of the district of Kaunas downtown was the least deformed during the interwar period (Gconvex$_{1937}$ =1.606) and the most deformed is in nowadays (Gconvex$_{2011}$=0.202). The percentage of controlled spaces in the system decreased since the Soviet period. The changes of the interface and decomposition are radical having in mind that the structure of streets almost was not changed during the Soviet times.

Generally it could be concluded that Kaunas downtown area demonstrates a symptoms of a hidden urban revolution. It could be considered as an important case for urban planners because of demonstrated features of urban complexity.

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