Urban Body Mutations through the Use of the Network Configuration

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Abstract. Taking as a starting point the hypotheses that the urban body is a self-adapted ecology made of material and non-material components (Bateson, 1972), relationships between elements are examined in an attempt to destabilize the static division of matter and idea and to inquire into those relationships that determine the structural coupling (Maturana, 2002) between body and environment, as well as the constitution of the body itself. Contemporary technology is used in order to trace these alterations and the urban body is examined as a network configuration. The importance of the methodology adopted by the current research lies in the fact that social and economic factors merge with spatial characteristics, allowing for a visualization and re-interpretation of the urban body mutations based on self-adapted reconfigurations and for a prediction of the structural alterations made possible through the reconfiguration of the synaptic forces between elements.  

Keywords. Mutation; urban body; visualization techniques; network; data manipulation.

INTRODUCTION

The adoption of a methodology which involves the examination of the urban body as a network construction consisting of elements of material and non-material qualities, allows for the detection and description of the urban body mutations. The methodology described here, involves the construction of the network configuration and the production of a time-based sequence of the self-adaptational and self-organizational reconfigurations occurring during the mutational procedure (Figure 1).

The network configuration relies on nodes, connections and identity in order to reconstruct the urban body. The clusters (Blondel et al., 2008) and proximities between elements emerge from the topology produced by the strength of the connections or from the identity of the elements and not from the Cartesian topology. Betweeness centrality and closeness centrality studies (Brandes, 2001), made possible through the network configuration, reveals the self-adaptation of the urban body, provoked by the changes of the enclosing environment and by the alterations of the connections of the body elements. What is more, being able to represent material and non-material elements as nodes (Hillier and Vaughan, 2007), counter-bodies of mixed proprieties emerge, including physical presence and socio-economic attributes. In contrast to the hierarchical constructions, network constructions allow for multiple connections between elements (Alexander, 1965), therefore being closer to the complexity of the associative forces found in the structure of the urban body.
Through the application of algorithms which re-evaluate the connection forces between nodes, as well as the mathematical rules which define the cluster formations, the result-output is generated through the processing of the parameters that determine the urban structure. Data manipulation determines the construction of the algorithm itself, that is to say the relationships between component parts that describe the mutational procedure, while the alteration of the initial structure of the urban configuration produces a time-based sequence of urban mutations.

The sub-hierarchies and multiple connections between elements, found inherent in the main body of the network construction, is a decoding of the synthetic tools with mathematical terms and involves the interpretation of the mutational phenomenon with a logic of decomposition. On the other hand, the mathematical rules describing the way the components link with each other involves the reinterpretation of the urban change based on the forces that cause change and not on the result itself.

APPLICATION TO THE URBAN BODIES
When applied on the urban body, in this case Athens (Greece), the network configuration reconstructs the urban body in clusters with mixed attributes, including elements describing spatial and socio-economic proprieties, resulting in a visualization and eventual reinterpretation of the of the importance of certain nodes or clusters in what concerns the constitution of the urban body. It becomes evident that in case nodes with a high degree of betweenness centrality gradually acquire weak connections with their neighbors, urban body clusters appear to be more and more differentiated and eventually cut-off from the urban unity that once stood up as a coherent whole (Figure 2).
In the case of Athens, where dissociative spatial or social elements cause the segregation of certain areas, resulting in socio-economic frailty of certain parts of the urban body, the adoption of methodologies towards urban cohesion focusing at the spatial, social and economic attributes of the urban body seems more appropriate as opposed to the methodologies focusing merely at the spatial characteristics of the urban clusters. My research area as a participant at the on-going research currently held at the N.T.U.A, assigned by the Attica Region (Figure 3) deals with the detection of those nodes that would result in the self-adaptation of the urban body in a way that would re-evaluate its processes towards a structure of a coherent whole.

Selected urban elements, such as urban greenery, land use, land values, crime and population mixture reports, which initially form a multi-layered hierarchical structure which keeps its Cartesian coordinates are decomposed and reconnected according to the spatial accessibility and accumulated flow according to studies analyzing connectivity.
between elements in segregated areas of Athens, as well as extended areas.

Through this process, the elements lose their Cartesian coordinates while their topological placement on the 2D visualization maps depends initially on the forces that connect them. When the algorithms measuring betweenness centrality and closeness centrality are applied, the elements self-adapt and re-organize themselves according to their importance as being strongly connected with other nodes, as being close or distant to all other nodes in the network, or as being the node through which other nodes interconnect. This results on their replacement on the map in neighborhoods which are no longer merely spatial. They are self-defined and self-adapted according to forces and mathematical rules applied on them and feature certain nodes as having a specific importance in the resulting neighborhood, regardless of their identity as economy, social or spatial nodes.

Focusing on the incorporation of concrete and changing qualities of the urban body, the case study presented here represents building shells as individual nodes, while the uses and building typologies are presented in two ways; as individual nodes and as proprieties of the concrete elements of the urban body.

**Study of contained proprieties and their containers as separate elements**

The concrete elements of the urban body are connected with their proprieties defining land use and building typology. These are null nodes, meaning that they lack modularity class and are representing a single cluster. Modularity class is only applied on the concrete elements of the network, showing respectively typology and land use. Concrete elements are differentiated based on these proprieties, forming different clusters, while at the same time, through the application of the mathematical algorithms measuring Eigenvector centrality, the importance of certain nodes which represented concrete elements’ proprieties is highlighted.

**Application of modularity class on concrete elements using interconnections based on spatial proximity**

In this case, proprieties are embedded in the nodes’ attributes and are applied on them as modularity class defining concrete elements. Differentiation on edges’ weights represents nodes’ spatial proximity, as well as urban body ruptures found at inhabited concrete elements.

**RESULTS AND DISCUSSION**

**Proprieties nodes’ influence based on connectivity**

Eigenvector centrality (Figure 4), measuring the influence of nodes in a network, reveal connection strength of nodes representing building typology, in this case of multi-store residential buildings, counting 1.0 in the rank measurement (Table 1) while occupying 81,6103% on modularity class ranking based on typology (Table 2). The node representing neoclassical buildings counts 0,099 in the rank measurement while occupying 10,92% on modularity class ranking based on typology. Empty building shells occupy 23/56%, while residence occupies 40,23% of the nodes representing concrete elements (Table 3).

**Time-based evolution of the network configuration of concrete elements interconnected based on spatial proximity**

Through simultaneous studies of nodes’ significance based on betweeness centrality, Eigenvector centrality and closeness centrality, one can assume that nodes intensively highlighted on graphs measuring connectivity fail to stand as significant nodes when weight of edges connecting insignificant nodes raises. What is more, in graph representing \( t1 \) (Figure 5 left) a small number of nodes is extremely highlighted, while the majority of nodes doesn’t contribute much on the coherence of the network. At the network configuration where edges connecting inhabited units are empowered through weight in-
crease (Figure 5 right), an almost coherent whole is created and instead of segregated bodies—other networks and disconnected nodes, one single network is created. Still, the great differences in the ranking measuring betweenness centrality lies in the fact that the new nodes are still not strongly connected with their neighbors.
When weights of edges connecting new nodes further increase, the urban body consists of elements that seem to retain an equilibrium in their betweenness centrality strength, resulting in an urban body whose elements are in a state of balanced distribution of forces (Figure 6).

**CONCLUSIONS**

To conclude, the importance of the methodology adopted by the current research lies in the fact that social and economic factors merge with spatial characteristics, allowing for a visualization and re-interpretation of the urban body mutations based on self-adapted reconfigurations and for a prediction of the structural alterations made possible through the reconfiguration of the synaptic forces between elements.

The urban analysis methodology described here, focuses on the mathematical relations between elements. These are applied in a time-based sequence which visualizes the urban mutations. The emphasis on the procedure instead of the static model seems to describe a shift in thought concerning the urban phenomena, from the identification and static simulation of the urban body, to the research hypothesis claiming that the urban body is in a state of constant state and that its spatial and socio-economic elements can be examined as nodes in a self-adapted network structure which interacts with the elements coming from the area defined as environment.
REFERENCES