Towards an urban body ecology of elements and conections

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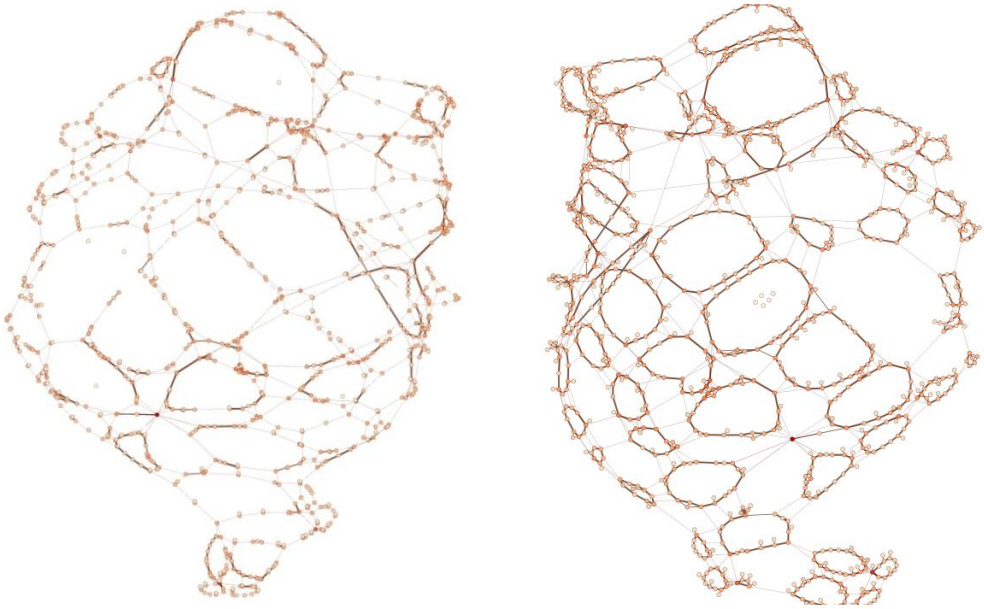
Introduction

Taking as a starting point the hypotheses that both urban settlements and designed, natural ecosystems can be described as self-adapted ecologies made of material and non-material components, the urban body is examined as a network construction consisting of elements of material and non-material qualities, allowing 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 (Figures1,2).

Permaculture principles, such as the principle of Stress and Harmony, or the principle of Stability (Molisson, 1988) could be applied both at urban bodies and cultivated ecosystems. As far as the principle of Harmony is concerned, an element is placed where it can easily develop beneficiary connections with its neighbours, both for the component itself and for the whole network. An overload of functions, or a forced function could result in a low degree of connectivity and a subsequent cut-off from the urban body. As issues of incompatibility between components arise, beneficiary functional connections between elements seem to rededine complexity, as a promising way to ensure Stability or, in other words, what this paper describes as a coherent and self-regulating body.

Here, **Stability** is replaced by the term **Coherence**, as it seems to descibe more efficiently a body unity and leaves open the opportunity to focus more on the different network constructions of the urban body through time. Although Stability is described as "the process of constant feedback and response" (Molisson, 1988), it seems to describe more an algorithmic, linear process of action and reaction. Even the cyclic structure is based on a linear internal structure of input, process and output of information. Moreover, refering to the permaculture principle of **Harmony**, where the component is placed where it can easily provide many functions and in a "position where its natural or everyday behaviours permit benefits to other parts of the system" (Molisson, 1988). This could mean a number of different network constructions through time, where the main intention would be the Coherence of the whole with the minimum intervention. Among the main intentions of the methodology descibed here, is the production of a time-based sequence of the interaction between elements befare and after the introduction of the new components, or even better, before and after the configuration of the qualities and attributes inscrribed in the existing components' proprieties (Figure 3).

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.



Figures 1,2: time-based sequence of the network reconfiguration showing the urban body mutations due to the alteration of certain nodes and their connections.

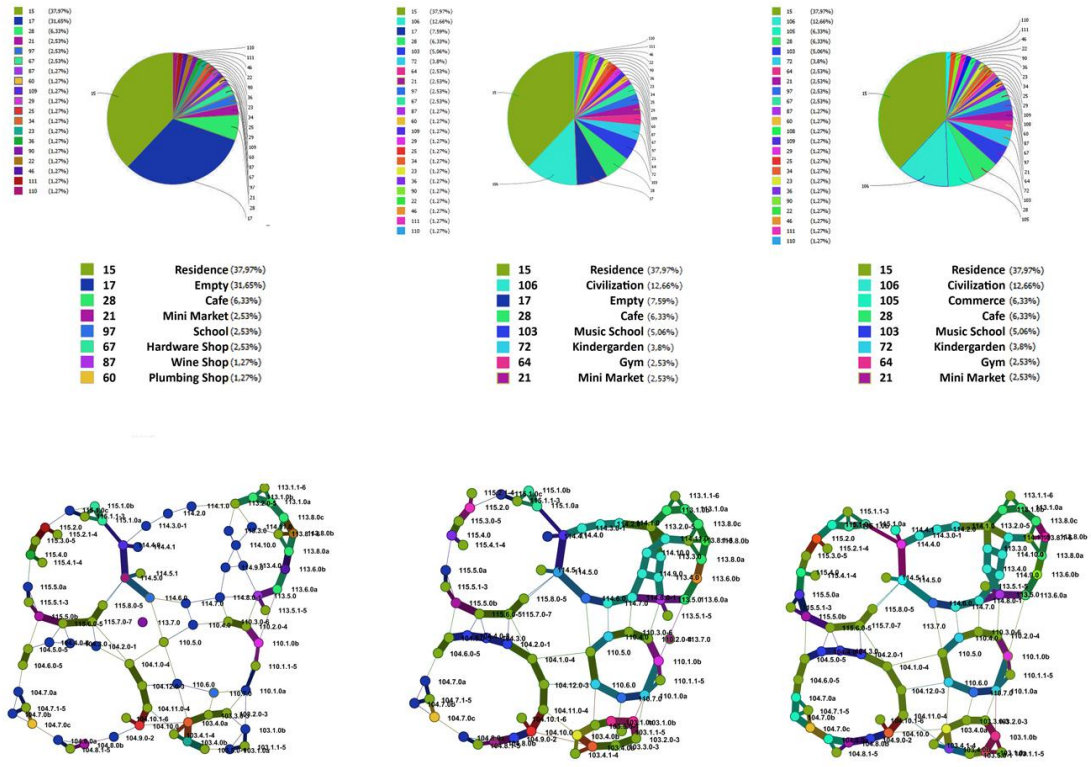


Figure 3: time-based sequence of the network reconfiguration showing the urban body mutaitons due to the configuration of the attributed inscribed in the components' proprieties.

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, 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 witch 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, 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 betweeness 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 4).

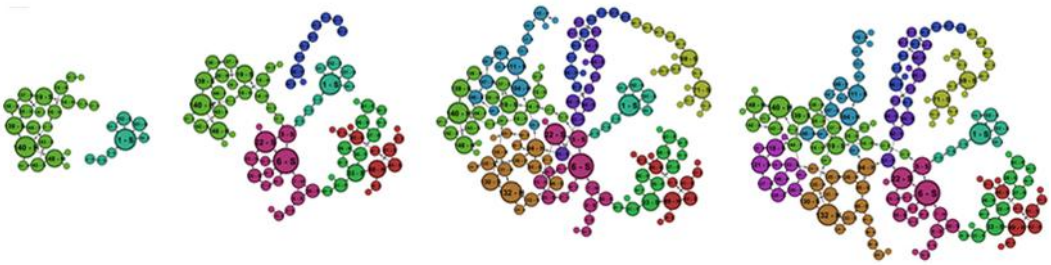


Figure 4: time-based sequence of the network reconfiguration.

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, as well as extended areas.

Through this process, the elements lose their Cartesian coordinates while their topological placement on the 2-d visualization maps depends initially on the forces that connect them. When the algorithms measuring betweeness 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.

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.
When weights of edges connecting new nodes further increase, the urban body consists of elements that seem to retain an equilibrium in their betweeness centrality strength, resulting in an urban body whose elements are in a state of balanced distribution of forces.

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

1. Bateson, G, *Steps to an Ecology of Mind*, (1972), University of Chicago Press, Chicago.

2. Maturana, H., ‘Autopoiesis, Structural Coupling and Cognition’, *Cybernetics & Human Knowing (journal),* Vol.9, No.3-4, 2002, pp. 5-34.
3. Blondel,VD, Guillaume, JL, Lambiotte, R, Lefebvre, E, ‘Fast unfolding of communities in large networks’, *Theory and Experiment 2008 (10),* P1000
4. Brandes,U, A Faster Algorithm for Betweenness Centrality, 2001, *Journal of Mathematical Sociology,* 25(2):163-177.
5. Hillier, B and Vaughan, L, 2007, ‘The city as one thing’, *Progress in Planning* , 67 (3) 205 - 230.
6. Alexander Ch., ‘A City is not a Tree’, 1965, *Architectural Form,* vol. 122, nr. 1, pp. 58–61.
7. Mollison, B, *Permaculture, A Desiner's Manual,* (1988), Tagari Publications, Tyalgum, Australia.