**Abstract:** The well-defined urban form has become vague and current urban formations seem to repel the old models that can not withstand recent changes. An attempt to cope with changed circumstances is the Netzstadt method of Oswald and Baccini.

The aim is to discuss three key elements of the Netzstadt model: node, link and border. Instead of using static regions, the Netzstadt method takes an advantage of the more fine graded division of land into six types of morphological aggregates called territories (settlement, infrastructure, agriculture, forest, water, fallow land). The territories will be separated from each other according to their influence in the nodal field via morphological and physiological indicators. This basic definition makes it possible to understand the urban formation process as continuous interaction between territories and test hypotheses concerning not only social but also the ecological and economical aspects as well.

The Netzstadt model contains an in-built feature of several observation scales. These fixed scales lead into several implicit and explicit thresholds that make the differentiation of modelling elements possible. The working hypothesis of this paper is that this convoluted issue of predefined scales may be surpassed via detailed analysis of the very same indicators that form the core of the method itself. It is argued that the border element is of a special kind. In fact it is the result of crisp definition of scales and should be more precisely defined as a trans-scalar boundary. The emergence of upper level
formations, scales, borders, and the fractality of entities are investigated from the settlement boundaries of various scales in the GIS platform. By confirming the hypothesis it is possible to come up with a computer-based parameterized creation process of dynamic nodal fields and create the basis for a dynamic morphological simulation model.

**Keywords:** threshold, dynamic scale, accessibility, urban planning

1 INTRODUCTION

Scale is probably one of the first concepts that students of architecture are faced with at the beginning of their studies. Yet it remains implicitly defined and the use various scales are adopted mostly via the practical learning period. Working with maps becomes almost unconsciously executed, and it is easy to forget how maps in fact eliminate a whole bunch of details in a straightforward manner. Adopting John Holland’s idea (1998), maps are considered among the earliest model-artefacts in human history. This brings into the front stage the essential characteristic of modelling: to talk about model is to talk about reduction. But when discussing on models the reduction itself is neither good nor bad, it just is the inescapable nature of it. Otherwise it would be just reflecting the idea of Jorge Luis Borges; the most accurate map is the target itself. The downside of this extreme accuracy is that it would loose most of the characteristics that in maps are found useful in a first place.

When speaking of planning and urban design, which are after all authors’ professional targets, we can hardly avoid questions concerning maps and modelling in general. This brings us into several interrelated concepts that are unavoidable when dealing with issues of planning and which are adopted simultaneously with the predefined scales and practices.

Maps are among the first models to be used in planning practice. Maps could be defined more precisely as scale models. In maps the reduction is done in a particular manner that binds the issue of scale into first related concept relevant to our paper. That is the concept of threshold. When focusing on maps, the threshold can be further defined as a perceptual threshold that in ordinary maps lies around 1 mm. This simply means that the size of a map determines the minimal size of features that can be presented in map. More broadly speaking the maps can be considered as simple spatial statistics that define the reference framework for a particular purpose.

For any kind of statistic data acquisition the scale functioning as a reference framework is of utmost importance. Geographical Information System (GIS) applications have made selection and definition of reference parameters (partially) more dynamic. However, the definition of reference scales on the base of collected data could be achieved only to a very limited extent, by the
introduction of auxiliary means such as distribution definition, distance or accumulation threshold.\footnote{1\ e.g. see definition of "settlement territory" in French (Frankhauser 2004) or Finnish (Huhdanmaki et al. 1998) land survey. Both define agglomeration as a group of buildings that don’t exceed a maximum distance of 200 metres between neighbouring units.}

Obviously some of the features that need to be present in a map lie beyond the threshold and need to be exaggerated for a particular purpose. A statue or a piece of artwork may be such an emphasized feature or even the entire road structure in for example in road maps. The effect of this basic reduction for urban analysis is nearly avoided in preliminary work of Netzstadt method by working with aerial photographs. Yet there remains an implicit threshold that defines the interpretation of photographs. What features are included and what are the excluded parts for territorial definitions? In that sense the threshold is not pretended to be avoided, but instead used as a creative part in defining the interpretation of existing urban structure. The structure that in many ways is very different from the structure that has been established in ordinary cartographical symbols.

It is argued by Oswald and Baccini (2003) that the knowledge of the borders and context, i.e. the reference territory, is necessary to analyze the nodal fields of an urban system and thus make potential centralities or edge situations identifiable in complex structures like urban agglomerations. On the base of complementary morphological and physiological analysis, the Netzstadt model consequentially qualifies nodes and links, borders and scales as key elements of the urban network. They are represented by the architecture of the territory.

On the basis of the distinct set of indicators of the Netzstadt method, territories are analyzed and translated into an abstract model, which makes it possible to identify and evaluate the elements of the net. In terms of targeted strategies a structural analysis of the system context and key data is followed by an abstraction of the characteristics of the complex system into an adapted model setup, which does not ignore important information about structural layout of urban form.

A reversed approach starting from the identification of the elements of the net, which could be able to define the perimeter of the associated territory and by that the nodal field in an unambiguous manner is not yet available. This approach is based and justified on insight that nodal fields of higher scale levels could not be represented (simplified) by the sum of the nodal fields on lower scale levels due to the disregard of emerging characteristics as a typical feature of complex systems.

The aim of this paper is to illustrate how these implicit characteristics of scale, threshold and hierarchy affect to entire planning practice and discuss the alternative modelling approaches to overcome this shortage.

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2 SCALES OF PLANNING

In the European countries various models of organizational principles of planning institutions are in use. The aim of this paper cannot be to discuss the specific characteristics of each planning system into detail, although some general statements on principle agreements and differences in these systems are unavoidable. The observations of resulting procedures and products in the form of urban projects could shed light on the meaning of hierarchies and scales in the various approaches to planning as a discipline.

As a matter of principle the organizational structure of the planning apparatus follows the general administrative structure of the state. Hence, it is not surprising that planning authorities in federative states are structured differently when compared to the way they are organized in established centralized systems. The ratio of top-down- to bottom-up-activities differs noticeably, even though that does not mean that subsidiary organized systems also make use of classic centralistic planning instruments and vice versa.

The fragmentation into various levels of planning competences demands a distinct border established between several administrative authorities or planning institutions on the one hand and a set of comparable procedures of survey and controlling of planning activities on the other. Only via this division into multiple parts, the planning system is capable of acting within their assigned competences and in bilateral agreements with other planning institutions on the same hierarchy (Sieverts et al 2005). In countries which lack of this harmonization of instruments or competence (e.g. Switzerland on the regional (cantonal) scale) collective planning processes supported by multiple planning entities are marginal phenomena.

Challenged by this need of simplification most of the administrative units (states, departments, cantons, communities, etc.) established competence and financing of planning tree-shaped organization principles. By this
standardized means easy applicable procedures and compensation mechanisms could be enforced which controls an egalitarian distribution of urban equipment and infrastructure.

At the same time the dwindling significance of public planning authorities with the increasing influence of particular stakeholders to planning processes unwanted consequences are encountered. Especially in the developing metropolitan regions in Europe the planning system seems to loose its capacity to act, since it does not reflect the needs of actual planning tasks in its structures and by this it is forced into a certain paralysis.

3 CENTRAL PLACE THEORY

The traditional division of planning tasks into separate scales (national, regional, municipal, local) is reflecting this kind of crisp, predefined hierarchy. The scales on the other hand are more or less arbitrary. From the dawn of the central place theory it is known that there is a great interdependence between scales of urban clusters – large means few. The simple models based on economics of scale are capable of explaining these hierarchies. Hierarchy and scale are concepts that are in fact convoluted in such a way, that implementations tend to circularly reflect original prejudices. When stepping out from this predefined activity-based hierarchy, that have become a normative planning principle, the reasoning has to be found elsewhere.

One of the most influential theories concerning the urban structure and the underlying notion of most of the existing institutional systems in planning in Middle and Central Europe is the central place theory introduced by Walter Christaller (1933) and later refined by August Lösch (1954). The need to harmonize the planning structures in the multitude of different administrative structures inherited from the German Länder, which formed the German Reich since 1871, was the motivation of Christaller. It led to the development of a model which overrode the traditional administrative division of southern Germany and was instead based on the existing physical structure of the urban network. Thus the system of central places formed a useful base component in the reorganized administrative structures in Germany, which controlled the distribution of limited resources for the post-war reconstruction process and the later expansion of the infrastructural networks.

The most striking feature of Christaller’s theory is the penetrating initiative of strict hierarchy of a physical structure. The theory has a background in scale economies and can be seen as a simple extension of market-area analysis. (O’Sullivan 2000) A simple central place model can be derived from different sized market areas of various industrial goods and the law of demand. The model results three well recognized characteristics that we know from urban economics and location theory. First notion derived from the simple economic rules is that the overall structure creates high diversity and scale economics centralities. Second notion is that large centres are rare in number. Third is that agglomeration is divided into different scaled shopping paths.

Even with few relaxing assumptions for the theory of simple central place model we get results that preserve the hierarchical formations that largely
resemble the real world urban agglomerations. The most convincing empirical evidence of this penetrating hierarchy created by economic forces is the rank-size rule of cities (also called Zipf's law). Yet there are some quite heavy assumptions in defining the border that is considered to be urban, more important in issues for planning practise are faced when talking about the very nature of this hierarchy.

4 EXPLAINING THE HIERARCHY

If the approaches in central place theory taken into the concept of hierarchy vary from descriptive to normative, a slightly more prescriptive approach has been taken by Batty and Longley, when they try to get a hold on multiple scale levels of urban form. The writers argue that hierarchies “are basic organizing devices for describing and measuring the importance of urban functions across many spatial scales” (1994, 47). They reflect the idea of urban agglomeration as nested systems described in the now modern classic text of Brian Berry (1964). In contrary to strict, non-overlapping hierarchy, that characterises the central place theory in regional level and which was also the target of Alexander’s manuscript “A City is Not a Tree”, Batty and Longley (1994) use the notion of scale explicitly to reveal the presumed hierarchy of urban structure. These propositions seem to be found behind several of the most recent studies of urban morphology.

There is already unarguably strong evidence that urban form retain significant constancy in terms of space filling by size and scale. (Batty & Xie 1996, Frankhauser 2004, Humpert et al 2002) This geometric feature of self-similarity or self-affinity through the scales is popularly known as fractality. The morphological property of fractality seems at first sight self-evidently refer to multi-scalar processes that can be found behind central place theory and urban economics. Yet by taking a more closer look some inconsistencies are to be found. Despite the evident fractality of some urban formation, it remains uncertain why not all the cities are fractal even though they can be described on bases of similar formation conventions. The fractality itself is sufficient but not a necessary condition of hierarchy in the traditional sense and thus the concept of hierarchy moves to centre stage.

In that sense the fractality seems to be an external morphological description and incapable of explaining the hierarchy of some internal process. Benguigui et al (2000) have in fact stated that the previous studies on fractality actually only point in direction that the fractal growth has entered the game only in some late stage of urban development. In that sense the evidence collected on fractal urban form indeed requires a notion of ‘richer order within a hierarchy’ as pointed out by Batty and Longley (1994). Moreover that is true because even completely random, stochastic processes have a capability to create fractality as well. (Kaye 1989)

With all these notions of hierarchy mentioned above one cannot really differentiate whether existing urban hierarchies in urban form are the cause or effect. The scale and hierarchy seems to be ‘the reverse side of the coin’. For planning purposes that is crucial. All that can be concluded from these various concepts of hierarchy is that there is some sort of continuous path from
‘smallness’ to ‘bigness’ with intermediate steps. What it doesn’t say is where these sizes come from. Marshall has made an additional remark that it is necessary to understand the hierarchy. It is not only a continuity of scales, he creates a hierarchy, but how those scales are related in a particular way. (Marshall 2005) The hierarchy creates complete continuity only through the upper end of a scale and removing this part causes discontinuity that breaks the hierarchy as a whole.

In this paper the hierarchy is understood as a specific relation that is created via a particular centre, concentration, hub, node or whatever, this serves as a reference entity for parts that do not exceed that level. However the authors’ feel that there is great disperse of opinions in the field of planning what really are the parts that actually form the hierarchy of urban structure. The rupture that has emerged in hierarchy of traditional urban centres has in fact made the hierarchy non-existent.

5 THE CONCEPT OF SCALES IN THE NETZSTADT MODEL

The identification of scale in the Netzstadt model is carried out on the base of defined physiological and morphological indicators. While the morphological indicators induce the hierarchy by morphologic analysis via the implicit notion of scale, the physiological indicators are based on the explicit notion of threshold that defines the hierarchy of the nodal structure.

Within the group of the four basic elements (nodes, connections, borders, scales) of the net in the Netzstadt method, the term “scale” is of particular importance. The morphological and physiological indication of nodal fields needs a clear definition of the scale level as reference parameter. By keeping the general principles of the indicators for each scale level specific sets of integrated subjects of analysis exist.

Although the general definition of the term “territory” is based on the unambiguous classification of territorial types (simplified) of the Swiss Topographic Survey, the Netzstadt method proclaims (on the background of complex systems) the dissimilarity of the territorial types on the various scale levels. Territorial types of a certain order can contain various territorial types of inferior scale levels.

For the analysis of the infrastructural networks, this conclusion is of crucial importance. Their structures, which evolved over generations, could not be described in a sufficient way by only naming the group, category or typology, to which the elements belong to. The administrative classifications were developed to link certain technical characteristics, like capacity of each single part of the network, but not to qualify the network as a whole.

The organizational principle of the configuration of accessibility network does not represent the actual reality of the formal structure. On one hand the natural growth of the cities contradict this tree-shaped hierarchical model, since the urban development is driven by non-co-ordinated individual decisions even in lower levels of hierarchy. On the other hand higher requirements of redundancy (in the case of partial failure) of a network lead to manifold branching and shortcuts in the net. Recent studies already
elaborated on the difference of model abstraction and planning reality (Michaeli 2004). However the overlapping of scales does not lead to an indistinguishable homogenous structure, but to one which is hard to grasp with the common perception of “scale”.

Therefore the Netzstadt method reverses the idea of the scale level and follows the morphological indication of the accessibility by analyzing the topological depth of node structure. This concept allows developing the idea of dynamic scale, deriving from the specific configuration of the urban fabric.

The categories (catε) of accessibility suggested by Oswald and Baccini (2003) do not refer to administrative or territorial scales, to which other tolls of the methodology refer to as reference parameter. Rather an operation is proposed, which starts from any point of the network, and from this perspective is able to evaluate the extent of the specific frame of reference. This links the structural characteristics of the net to a new definition of scale within the methodology. The documented Netzstadt study by Oswald and Baccini does not go further into detail of this relation.

6 HIERARCHY OF MOVEMENT

The morphological classification of infrastructural network implemented in Netzstadt model only provides limited insights about the accessibility to the network. This is because accessibility is not only regulated by the hierarchy of the last connecting branch, but is highly dependant of configuration of the whole of the network. The predominant majority of the entities connected to the urban networks are of local scale nature, while at the same time also regional activities fluxes can emanate from these elements.

To make a sufficient description of the position and context in the network, all possible connections (starting from any point within the network) should be evaluated to a topological depth, which could be identified on each scale by a characteristic path length. Though the single information for each path does not seem to be very productive, the superposition of the collected data could provide useful information on concentration and clustering of scale-related types of linkage and connection. Thus by indication of accessibility the nodal fields of specific scale levels could be identified.

To understand the relation to movement patterns a short note on the different nature of general typologies of infrastructural networks should be added. In terms of configuration, networks which provide a constant and continuous supply of goods, in which the user decides for usage frequency, duration or intensity (in which the physiology is mainly based on the individual demand), e.g. water supply, telecommunication networks, individual traffic, etc., differ dramatically from others which provide a service on the basis of a set frequency or only within specified time-spans, like public transport systems, educative programs (schools) or distribution systems such as mail service, etc. In a hierarchically differentiated net both types map to fundamentally dissimilar organizational principles, scales and patterns.

By empirically testing these namely configurational properties that an urban flow network can make available, we intend to show that the hierarchy of
street and road classifications and design principles have lead to new kinds of collective dynamics determined by the structure itself. The road structure defines a new centrality phenomenon that can be expressed with indicators of topological depth.

7 GRAPH DISTANCE
Watts & Strogatz (1998) have shown quite recently that even the very basic networks carry a seed of collective dynamics in their structure. The writers showed using two extremely simplified indicators that certain aspects of dynamic behaviour are defined by configurational aspects of network itself. Indicators chosen by Watts & Strogatz (1998), the Characteristic Path Length ($L_p$) and Clustering Coefficient ($C_p$), were chosen to represent two diverse properties of network structures, those of globality ($L_p$) and locality ($C_p$). Within specific configurations these properties are found to contain characteristics of two extremes of regular and random graphs and form and intermediate class of ‘small-world’ networks. It is easy to see that these in-between states are the dominant types in real world networks as well.

Characteristic path length was defined as “number of edges in the shortest path between two vertices, averaged over all pairs of vertices” and more clearly as “median of the means of the shortest path lengths” (Watts 1999). Thus it can be defined in mathematical terms as follows. Given two vertices $v_i, v_j \in V$, the characteristic path length for system V is:

$$L_p = \frac{1}{n^2} \sum_{i=1}^{n} \sum_{j=1}^{n} d_{\text{min}}(i, j)$$

where $d_{\text{min}}(i, j)$ is the shortest distance between vertices $i$ and $j$. We realize that the localized property of $L_p$ for each node of a graph, the average path length, is a measure that defines important characteristics about the topological depth of each node. In our empirical material we use this measure the emergent centrality from street/road network and relate it with the concept of accessibility.

8 ACCESSIBILITY
It is easy to show that this very simplified measure is roughly equivalent to a special case of Ingram’s concept of integral accessibility. (Ingram 1971, Joutsiniemi 2005) Yet there are some important adjustments necessary to be done when implementing the model based on aggregate data into the disaggregate network context.

Watts & Strogatz and Barabasi with his associates have shown that the most dramatic behaviour is found on networks that contain highly connected hubs. In urban realm for example the power transferring grid and the structure of air traffic are classical examples of such structures. On the other hand due to physical limitations the formation of hubs is not always possible. That is the
case for example in the most profound network of urban agglomeration, the street network.

Joutsiniemi (2002) has shown that in analyses of urban form not only crisp definitions of globality and locality are possible ways to differentiate intermediate level real world networks. By gradually localizing the property \( L_p \) it is possible to find additional valuable information about the collective features of networks that don’t fall into the category of ‘small worlds’. This can be achieved by limiting the path length calculation into a set of fixed subnetwork sizes and thus using the global indicator of Watts and Strogatz (1998) for only to the limited local extent.\(^2\) Similar technique used for aggregated network data may also find from accessibility analyses of 1970’s.

An important addition to concepts of accessibility was proposed by Wachs and Kumagai (1973) in their cumulative-opportunity based accessibility measure. The writers created an accessibility measure to be used as a social indicator which can be generalized as follows:

\[
A_{ijr} = \sum_{j=1}^{J} \sum_{k=1}^{K} \Theta(p_{ijk} E_{ijk})
\]

in which \( P_{ijk} \) and \( E_{ijk} \) define the proportion of work force and employment opportunities in income category \( j \) and occupation category \( k \). These parameters are used to create fine grained measure for different social classes and employment opportunities for each particular class. For this discussion it is important to understand these as weighted distance parameters. By setting up these clearly arbitrary parameters to unity, we are able to test the topological structure of network. In that case the equation reduces to nearly equivalent with above mentioned characteristic path length function (Eq. 1). The biggest contribution for the concept of accessibility though was the introduction of a Heaviside unit step function that can be written as:

\[
\Theta(z) = \begin{cases} 
0 & \text{if } z > r \\
1 & \text{if } z \leq r
\end{cases}
\]

It creates discontinuity for accessibility measure in a manner that is relative to the travel time radius \( r \). The implicit but very profound idea behind this is that after a certain distance (or travel time) some opportunities are not reasonably accessible at all and thus do not affect on that particular accessibility index at all. If compared to Ingram’s general solution the main difference is at the level of understanding the phenomenon. Even though it is probably possible use another type of impedance function with a very sharp drop at a certain distance and get nearly same results, Wachs and Kumagai seem to suggest something different.

\(^2\) Obviously the reverse could be done for the clustering coefficient \( C_p \) indicator and calculate it larger than the immediate first level neighbourhood.
The profound idea of the writers is that accessibility is defined by assumptions of trip origin and the movement radius only. By re-reading this idea we come to the conclusion that due to different modes of transport, scales of movement are also discontinuous and most likely to change in the course of technical development. The working hypothesis is thus that these also have some effect on the notion of centrality and the node formation likewise.

9 SOME EMPIRICAL TESTS

Focussing on only one type of network, for example the one which represents individual traffic, one can observe, that by modifying the typical path length (and by that the scale level), the nodal fields, which indicate areas of concentration and densification start to relocate in the network. This can be stated as topological characteristics of these kinds of networks. In the majority of cases the biggest movements can be found at medium range characteristic path lengths, which mark the transition from local or communal to regional scale. It seems that the configuration of the nodes of various scales alter in an identical physical form of the network.

Further it is of interest, that the concentrations on inferior scale levels could not be found self-evidently in the larger scales, nor can they be identified as parts of bigger nodes. In the multiplicity of various coexisting networks with custom characteristics this leads to a multiple of overlapping scales that are very difficult to handle in hierarchical planning apparatus, as it is organized in many European countries.

To avoid inaccuracies in the analysis an almost continuous and fine graduation of the values of characteristic path lengths was tested. By comparing various case studies the general observations on topological behaviour of the observations could be proved. The comparison of these case studies also showed, that a universally applicable absolute value for the characteristic path length could not be set, since it is highly dependent of the metric extent of the network and its meshes. Therefore, the small meshed network of the metropolitan regions could not be compared to rural networks or other typologies of networks. Further research on the topology and metric of these networks should be done to define suitable thresholds.

The analyses shown in Figures 2 and 3 follow the general pattern of previous analyses done in Helsinki metropolitan region by Joutsiniemi (2002). Different modes of transport seem to benefit from different kinds of topological centrality radii and the accessibility landscape differentiates accordingly. This is especially clear in the Tampere case where the dendric structures of local residential areas are highlighted in small radius of analysis. The areas suitable for more traditional activities are shown at intermediate level and large scale retailing and logistic activities as the centres of the most global radius.
Figure 2 Topography of accessibility in Tampere: The most accessible 'lowlands' shown blue. Numbers at lower left corner refer to $r$ parameter in Eq.3.
Figure 3 Topography of accessibility in Zürich: The most accessible 'lowlands' shown blue. Numbers at lower left corner refer to $r$ parameter in Eq.3.
The pattern is again similar in the Zürich case although the accuracy of analyses in local scale level with short characteristic path length seems to be problematic in some cases. This is caused by several shortcuts in the network, which could easily be identified as bypasses, tunnels, elevated roads or express lanes, etc., constructed to serve the net on higher scale hierarchies and open up new nodal field connections. These elements lead to very clear representation of topological patterns of the net on bigger scales. On smaller scales, they lead to nonsense results, since they cannot be compared to “regular” street or accessibility pattern, and seem to be of no relevance for this scale. Using the dynamic scale for analysis networks does not result in a total dissolution of the idea of hierarchies and scales. Still some typical behaviour of the network on various topological depth levels could be observed, which are interconnected to a certain idea of scale levels. Therefore additional information on the network hierarchy was included in a more detailed analysis on the Zurich region, which is shown in Figure 3. As could be suspect no single indicator is capable of explaining the complexity of urban formation. The results in Zürich analysis suggests that although accessibility seems to play an important role in urban development, only when combined with several other indicators can a more precise view of urban landscape be achieved.

10 DISCUSSION

The hierarchy and scales in Netzstadt model are interrelated via morphological and physiological indicators. Even though it seems not to be the original meaning of indicators by Oswald and Baccini (2003), the indicator structure seems complex enough to re-evaluate the elementary concepts of Netzstadt model. For this it is important to realise how the hierarchies are created through these indicators. The used physiological indicators are based on the explicit notion of threshold that defines the ‘bigness’ of nodal structure - the hierarchy that is. On the other hand in morphological side the hierarchy is introduced via explicit notion of scales that also define quantifiable differences for various locations.

By implementing the arbitrary scale concept used for example in analysis of fractality it is possible to explore distribution of urban indicators across the scales. The traditionally fractality measures are used for Boolean property of occupied/unoccupied land-use with arbitrary cellular metrics. (Frankhauser 2004) On the other hand by changing the metrics from crow-fly distances to cumulative accessibility or pure topological distances alternative regularities of structure are found. What counts is the scale of reference that is relevant for indicator in terms of configuration and phenomenon correspondence. In Netzstadt model of Oswald and Baccini this scale of reference was set for an upper level node. The analysis in this paper suggests that there is a need to ease the scalar requirements of a node definition.

Via this redefinition scale becomes a reference framework for a phenomenal threshold to be used by the side of indicators. Morphological analysis is performed by utilizing the dynamic reference frameworks of various phenomena and becomes building blocks of a nodal structure. Through the
access graph as it is shown in this paper or it can be built from other measures of technical neighbourhood of morphological units.

The indicators are only dealing with different morphological units very much similar way they are implemented in the original model scheme. Buildings are the units of granularity index, plots those of shredding index, and road segments of accessibility accordingly.\(^3\) The depth or the size or reference framework only differs from one indicator to another and is based on relevance defined by the dynamic scale.

From the four basic elements of Netzstadt the concept of a node seems to be the most fundamental. It can be seen as a first level aggregate that is created according to specific framework that the planners are only for the sake of convenience called the scale. We claim that by combining explicit concepts of connections and scale it is possible to simplify the model structure significantly. Moving them into implicit properties of indicators (as it is done when introducing the indicator of topological depth) it is possible to build node fields in an analytical way and come up with unbiased model where modeller’s prejudices are not reflected in the modelling result.

11 CONCLUSIONS

As an addition to and beyond the classical rating of location qualities, the proposed technique place emphasis on the dynamic evaluation of net structures. By the assessment of the existing urban structure the topological qualities of determined locations in the various specific scale levels are evaluated. Recent studies by Joutsiniemi (2002) have shown that urban interventions driven by corporate stakeholders often make use of analogue procedures, to confirm the locations of e.g. stores or logistics hubs in the network, formed by the accessibility to the clients or potential customers.

The planning authorities could benefit from the proposed methodology, since it should provide an indication of optimization potential inherent to the existing structure. This is of relevant importance, since we have to face the situation, where we have to deal with a diminishing budget to be invested in the qualification or maintenance of the infrastructural network by the public authorities. Even worse, observable processes of stagnation and shrinkage of urban population in some agglomerations already make it necessary to discuss the conservation or even the deconstruction of obsolete infrastructure which can no longer be maintained.

Admittedly the proposed approach, as the actual built urban structure does (especially in polycentric metropolitan agglomerations), diverge from the typical layout pattern of planning authorities’ competences. First, the identified perimeters rather frequently cross the borders of existing legislative units and second, there is a differentiated hierarchy of competence handling each class

\(^3\) In fact a single morphological unit may be nearly anything from the more traditional morphological entities discussed here to routes (i.e. ‘arteries of motor-based movement’) suggested by Stephen Marshall (2005) or to axial line (i.e. ‘episodes of pedestrian movement’) and convex urban space (i.e. ‘rooms of control’) used in Space Syntax.
of elements of the network. In the past, local and regional authorities (featured with a high grade of autonomy, but limited to their competence), have tried to marginalize planning phenomena, which could not be influenced by them. On that account a plenitude of unnecessary, inefficient and redundant infrastructural equipment accrued. A second spatial effect was the concentration of essential, but undesirable infrastructural construction along the edge of the administrative units, which lead to a belt of undefined, shabby space, lacking urban as well as landscape qualities. These spaces hinder the overcoming of the borders and thus the better interconnection in between two or more units. On the other hand these areas, yet carelessly handled provide new opportunities for the planning, which should be made available for a future development.

Grasping these options some local authorities have started to gather in regional pressure groups regulated by bi- or multilateral contracts, without having yet developed means to discover the potential of the urban structure beyond administrative classification. By referring to the specific existing structure the submitted tools could either help to find solutions, which are reconcilable or even better, detect opportunities to strengthen the network functionality by giving up certain elements and connections. With the tools introduced in this paper the authors want to contribute to this development process to open up a new field for future planning practice.

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