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Named streets and the cognition of path units

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ABSTRACT

How can we tell where a street ends and another one begins? In most cities, streets have names, and quite often, a street that bears the same name is perceived as some kind of spatial unit, persistent over time regardless of the perpetually changing scenery of passers-by, traffic, shops, residents and even buildings. Naming is crucial in this respect. It means that a space is not only identified once by an individual, but that this perception is shared by many and can be communicated. However, naming spaces turns out to be much less straightforward than naming people or objects, as it requires a discernible partitioning of a spatial continuum. We introduce the concept of "path units" to subsume various related notions of identifiable, continuous and linear sequences of urban space that have been proposed in cognitive studies, in Space Syntax and in urban morphology. We then have a closer look at a case in point in order to better understand how street names are related to continuity and changes in angle, and how they reflect the historical formation of the route network. This leads to a discussion of convergences as well as differences between cognitive, morphological and semantic approaches to the partitioning and identification of urban street spaces.

KEYWORDS

Named streets, intelligibility, continuity, spatial cognition, wayfinding

1 INTRODUCTION

This paper explores how path units in a street network can be conceived from a cognitive, spatial and morphogenetical perspective. We relate these perspectives to the problem of naming streets, revolving around the question of how a meaningful partitioning of the essentially continuous system of urban street networks has been achieved in order to allow for the attribution of names.

Naming things is an essential element of human cognition. Attributing a name to something postulates that it makes sense to speak about a particular object, a group of objects, a process or a set of relationships, and to distinguish them from their context. A name proposes a partitioning of the multiplicity of phenomena: certain phenomena are said to belong together and allowed to share a name (Cassirer 1985, 130). Beyond their function as tools of direct reference, names also allow to express thoughts focused on and representing the named entity (Corazza 2021, 4). Importantly, names go beyond individual perception and cognition. They encode a framing of reality that may be shared and passed on through language, that is persistent in time and remains open to debate. In this sense, something moves to a different level of existence once it has been given a name.

Naming has a stabilizing effect: it turns a formerly amorphous condition with unclear boundaries into a more or less clearly distinguishable entity. For instance, humans have been plagued by many illnesses long before they were able to identify and name them. But once the possibility of diagnosing a particular illness is achieved, this drastically changes our outlook. If a condition of not feeling well has a name, it can be shared with others, and certain courses of action are more recommended than others. On the other hand, this stabilizing effect is also one of the pitfalls of naming something: by reinforcing the perception of the named entity, a feedback loop is created that might end up obscuring other, equally legitimate framings of reality.

Street names are a cornerstone of the administrative structuration of space in most parts of the world – Japan providing some notable and interesting exceptions. Clearly assigned street names are essential for address systems based on nested sets of country names, municipality names, zip codes, street names and street numbers. They provide a basic tool for orientation and wayfinding at local and intermediate levels of scale, they are necessary for the functioning of urban logistics, law enforcement or emergency services, and they form indispensable administrative tools for modern governments who require not only unambiguous personal identities, but also unambiguous locations in space, that is at least temporary valid, physical addresses.

Therefore, the street naming system needs some kind of built-in logic, and it should relate somehow to the perceived reality of urban spaces on the ground: it has to “make sense”. If one wants to figure out how this is achieved, it needs to be recognized first of all that the identification of a particular street is not a trivial problem: Every street segment is linked to myriads of other segments, and together they form intricate networks encompassing entire cities, countries and even continents. So how can we tell where one street ends and another one begins, in order to name them appropriately?

We first approach this question through a review of approaches from different viewpoints. The concept of “path units” is introduced to denote a linear, continuous and meaningful sequence of urban spaces. We discuss path units from a cognitive perspective, focusing on the importance of spatial continuity; from a spatial-analytical perspective, discussing different approaches to the mapping of continuous routes; and from a historical perspective looking at the formation processes of street networks as they have been studied in urban morphology.

We then turn to the question, if and how street names relate to conceptions of path units as they have emerged from a cognitive, spatial-analytical or historical perspective. At first sight, two hypotheses may be envisaged. One is functional: consciously or not, street names are assigned in accordance with principles of spatial cognition to make sure that the best possible fit between intuitively perceived spatial entities and named streets is achieved. The other is historical: a street gets named when it is built, just like a child gets named when it is born. In this sense, the catalogue of street names would form a kind of archive of the successive transformations and extensions of an urban fabric, reflecting the regularities, but also the contingencies of this historical process.

We attempt to show that both hypotheses are valid, albeit neither one is complete, and that they might be related in a remarkable way. Investigating the named routes – including streets, footpaths, walkways and bridges – within the city of Zurich, we found that many, but not all of them were named when they were built. Some routes started out as nameless paths and acquired a proper name only much later, for example after they got transferred into public property. Others were renamed, for example by extending the name of a more important street once missing links had been filled in. Comparing the named routes to an axial map, we also found that many, but again not all of them correspond to strongly continuous path units: they are either completely straight or include only gradual and minor deviations in angle. There are interesting exceptions – L-, U- or Z-shaped routes including rather sharp curves, zigzagging routes and even the occasional bifurcating route. In the concluding section, we discuss these exceptions in more detail, and we formulate conjectural conclusions about the relationships between the formation process of the route network, the process of naming and renaming and the cognitive quality of identifiable street spaces.

2 PATH UNITS: A REVIEW

We define a path unit as a linear, continuous and meaningful sequence of urban spaces. We propose this concept as an umbrella for several approaches and notions that have emerged in various areas of research to allow for the identification of such units from cognitive, spatial – analytical and morphological perspectives. Linearity implies that we are primarily concerned with spaces allowing for movement through the urban system, with wayfinding and the identification of addresses. Continuity implies that a path unit proposes a partitioning of the continuum of urban space that is not arbitrary, but based on an identifiable principle of coherence. Meaningfulness implies that path units are easily identified by their users and that they correspond in some way to the social use and meaning of urban spaces.

2.1 Paths and cognition

In his foundational study of the mental representations of American cities as captured in maps and interviews with residents, Kevin Lynch identified the "path" as one of five fundamental concepts by which such representations tend to be structured (Lynch, 1960). While Lynch presents all five elements – nodes, paths and districts, edges and landmarks – as visual concepts, it can be argued that Lynch's nodes, paths and districts have a strong spatial component, thus going beyond the purely visual (Conroy Dalton and Bafna 2003, 3). There are similarities between Lynch's chosen elements to describe the mental image of the city and how space syntax's axial maps relate to how we understand cities cognitively. Space syntax's "inherently cognitive basis" (Conroy Dalton and Bafna 2003, 21) has assumed an increasingly important role over the last two decades. There is growing evidence to support Penn's early hypothesis that some link must exist between space syntax's abstract representation and how people actually perceive the city (Penn, 2003). Empirical research on how individuals navigate cities show a correlation between actual behavioural patterns and space syntax's predictive model, for the case of navigation in VR (Conroy Dalton 2001 and 2003), and in a lab-based study based on real-world photographs (Emo, 2014). Some studies have explored this connection outside of a lab setting, in indoor (Lazaridou, 2017) and outdoor settings (Pinelo 2010, Emo et al., 2016, Mavros et al., 2019). There is also evidence for a neurological connection between the mental processes during urban navigation and street grid connectivity which is the basis for space syntax's model (Javadi et al., 2017).

The way in which path units are understood cognitively may be influenced by how we process information on distance. Understanding distance in the urban environment "affects the decision to stay or go...the decision of where to go...[and] the decision of which route to take" (Cadwallader 1976). Different types of distance exist:

- Functional distance – distance needed to reach a certain destination
- Physical or metric distance – related to the number of meters
- Perceptual distance - related to an individuals' knowledge of the distance between places that are directly visible from each other
- Cognitive distance – related to an individuals' knowledge of the distance between places that are too far apart to be perceived from a single vantage point
- Environmental distance - distances within physical spaces that are larger than the human body and surround it, but not so large that they cannot be apprehended through direct travel experience eg. parks

Understanding these types of distance is important when modelling route choice and shortest path preferences. For this paper, the notion of cognitive distance is the most relevant. A recent review by Manley et al. (2021) lists nine factors that can contribute to considerable differences between physical and cognitive distance. Two of these factors have been highlighted early on in space syntax research: the number and angle of turns, and the overall intelligibility of the network. We will therefore have a closer look at concepts of continuous path units that have been introduced from this point of view.

2.2 Mapping continuity

The concept of convex spaces and its extension into the axial line representation of urban space proposed in Space Syntax (Hillier and Hanson 1984) has been the first successful attempt at partitioning the continuum of urban open space into formally defined and analyzable spatial units. The set of least and longest axial lines that can be drawn within a given spatial system provides a mapping of several overlapping convex spaces into contiguous, linear entities. The mapping of relationships between these entities as networks has opened up the way for studying global as well as local properties of urban spatial systems.

As Hillier (1999) recognized, the distribution of angles between axial lines follows a particular pattern: A high proportion of angles between axial lines are concentrated within little more than a third of the possible range. More or less right angles between 75 and 105 degrees and very obtuse angles within 15 degrees from a straight line prevail. Noting further that highly obtuse angles are predominantly associated with long lines and near right angles with shorter lines, Hillier points out how, compared to a random distribution of angles and line lengths, such a system obviously provides major benefits for wayfinding.

Due to some limitations of the axial map representation, for example when applied to continuously curved streets, and following attempts to facilitate the integration of Space Syntax within GIS, a series of alternative representations of linear spatial entities have been proposed. Relating the problem of map generalization to the question of mapping continuous street sections in Space Syntax, Robert C. Thomson (2004) proposed to "bend" the axial lines based on the principle of continuity that had been introduced in the framework of Gestalt psychology by Max Wertheimer (1923). This principle has long been successfully applied in map generalization as an essential prerequsiste for the production of intuitively readable, two-dimensional maps of complex spatial systems. Thomson hypothezised that such a principle might not only render maps more readable, but also underly human cognition of three-dimensional space on the ground. In his words: "routes on a map that look relatively important generally are relatively important" (Thomson 2004, 50.6).

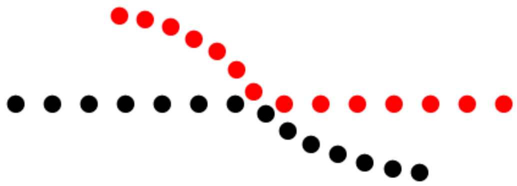

Figure 1: The Gestalt principle of continuity

To arrive at continuous path units including changes of direction, Thomson proposed a process of concatenation starting out with a road centreline map and guided by a small set of rules. Based on these rules, street segments "negotiate" with each other at each intersection in order to decide which segments should be linked together. This results in a partitioning of the street network into continuous path units that Thomson called "strokes". Several other methods and algorithms for the generation of path units through aggregation of axial lines or road centreline segments have since been introduced and labelled, respectively, "continuity lines" (Figueiredo and Armorim 2005), "natural streets" (Jiang 2008) or, in French, "voies" (Lagesse 2015).

Interestingly, the application of named streets for network analysis has been considered as well (Jiang and Claramunt 2004). However, as Porta et al. (2004) remarked, "street names are not always meaningful in any sense, they are not always reliable as the same street may be termed in different ways by different social groups, or in different contexts, at different scales, in different ages." Clearly, a robust method for the analysis of urban spatial networks should rely on morphological information only.

To conclude this summary, we need to add a few words on the use of the concept of "self-organization". What Jiang and Liu (2008, 14) address when they speak about "self-organized natural roads" is not the actual, historical process of the formation of these roads, but rather the process of their identification: "Roads are generated from segments by a self-organized process, but they demonstrate intelligence that underlying constituent segments lack." To this, we should add that the road network as we find it today has indeed evolved over long periods of time, but not according to an algorithm of segments negotiating with each other at intersections. On the one hand, its complexity and richness is the result of successive and not necessarily coordinated top-down planning interventions, on the other hand it attests to countless local bottom-up-processes of self-organization. Let us therefore turn to urban morphology in order to summarize a couple of hypotheses on the historical processes of route formation.

2.3 On the formation of path units

In the words of Chinese poet Lu Xun (1960) "the earth had no roads to begin with, but when many men pass one way, a road is made". This is how the first human tracks seem to have emerged, forming the basis for the consolidation of primal networks of footpaths and possibly integrating preexisting animal tracks (Kropf 2018). Over the millenia, the subsequent processes of adaptation, extension, consolidation and optimization led to the formation of one of the greatest artifacts created by humanity: the worldwide network of tracks, roads and streets.

Alongside with plot patterns and building fabrics, the evolution of road networks has been studied extensively in urban morphology. To date, the most comprehensive account of the formative principles leading to the emergence of complex urban street networks is due to Caniggia and Maffei (1979) and draws on numerous diachronic analyses of the long-term evolution of Italian cities. While Caniggia and Maffei do not explicitly refer to graph theory, they nevertheless identify centrality as a fundamental driver of urban development and functional differentiation. They also make it clear that centrality is a relative notion, depending on the scale of an investigation.

Based on the factors leading to their formation, Caniggia and Maffei (1979, 132) postulate four basic categories of roads:

- Arterial roads or so-called “matrix roads”
- Access roads branching from arterial roads
- Connecting roads providing supplementary links between access roads
- Restructuration roads providing new, direct connections through established tissue

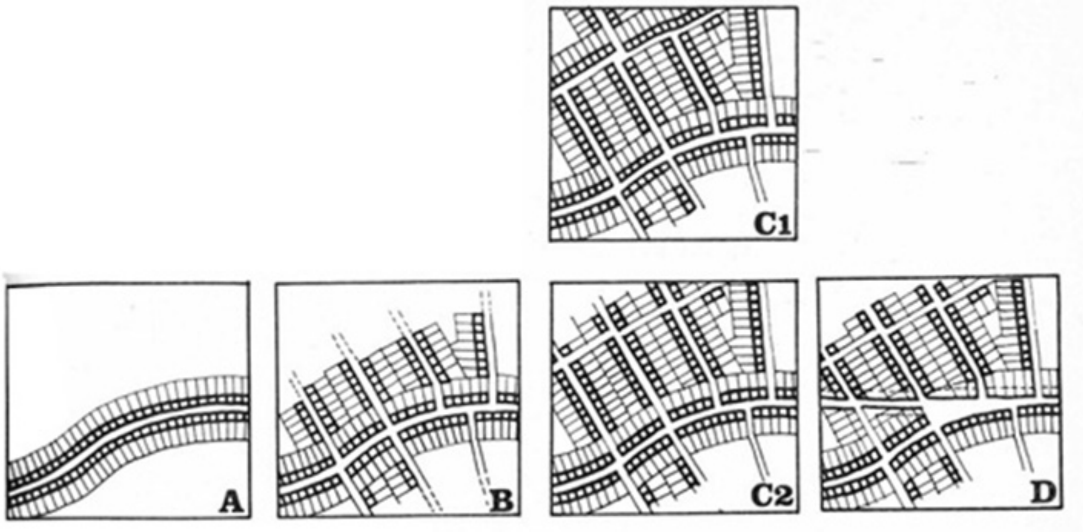

Figure 2: Successive processes of road network and built-up tissue formation according to Caniggia and Maffe (1979, 132): Arterial roads (A), access roads (B), connecting roads (C) and restructuration roads (D)

The arterial “matrix roads” provide primary connections between nodes. They are often characterised by a curvilinear course resulting from the need to approach a straight line as closely as possible while bypassing obstacles or serving secondary nodes on the way. In the vicinity of nodes, buildings line up exploiting the benefits of easy accessibility. As this benefit diminishes with increasing distance from the node, at a certain threshold it becomes more efficient to further densify the area immediately surrounding it. This entails the formation of a secondary network of perpendicular “access roads” and parallel “connecting roads”. Once an urban fabric has formed in this way, existing nodes may grow more attractive, or new ones might emerge that need to be integrated into the network. Existing arterial roads attract more and more movement and start to suffer from congestion. Eventually, this may lead to the opening up of so-called “restructuration roads”. According to the process leading to the restructuration, this category can be further differentiated into subcategories:

- Widening and straightening of existing roads
- Break-through roads opened up by cutting through established urban fabric

- Roads replacing former obstacles and boundaries such as city walls, abandoned railway lines or highway sections that have been put underground

Caniggia and Maffei go on to demonstrate how a careful analysis of street plan and plot patterns can reveal much about the historical evolution of the network. While the ancient arterial roads are characterised by approximative straight lines, gentle curves and obtuse angles, restructuration roads introduced in later phases either tend to approach geometrically straight lines or to follow the outlines of the obstacles they have replaced. Meanwhile, the local sub-networks of perpendicular access roads and connecting roads create networks of shorter lines with more or less right angles corresponding to the modularity of plots and building types.

This generative account of street morphology recalls Hilliers observations regarding axial maps. The long lines with obtuse angles seem to correspond to arterial roads and restructuration roads, while the local near-orthogonal grid patterns of shorter lines correspond to acces roads and connecting roads (Primas 2021). This observation points to a possible convergence of perceptual, spatial-analytical and morphogenetical accounts of road network configurations. Does naming streets when they are built lead to a naming system that corresponds to a partitioning of the continuum of urban space into linear, continuous and meaningful path units? In order to test this hypothesis, we had a closer look at a specific case in point.

3 THE NAMED STREETS OF ZURICH: A CASE STUDY

The city boundaries of Zurich comprise 2505 named routes: streets, footpaths, alleys, walkways, bridges and tunnels. Recently, the city has furnished an open database linking names to road centre lines, to annotations explaining each name and to the respective proceedings of the deliberations of the municipal council, in some cases also referring to the recommendations of a naming commission that is in office since 1906 (Stadt Zürich, 2021).

3.1 Questions and Methods

Already a cursory examination of the database showed numerous named routes following remarkably straight and continuous trajectories. Therefore, we further studied the dataset and compared it to an axial map and to a historical account of route formation in order to investigate the following questions:

- How large is the portion of named routes that are identical with axial lines?
- How large is the portion of named routes covering a continuous sequence of axial lines?
- How might discontinuities and sharp turns within named routes be explained?
- How frequent are route name changes within single axial lines, and how might they be explained?
- Are there correspondences between named route continuity and the processes of route formation ?

- Are there correspondences between named route continuity and topographical or infrastructural features?
- Can we find evidence for the application of a principle of named route continuity in the deliberations of the council or naming commission?

Highways, tunnels, forest roads and footpaths outside the built-up fabric were removed from the dataset.

The remaining 1971 streets, footpaths and bridges were classified according to their continuity. The highest degree of continuity corresponds to a named route that is identical with a single axial line – a route allowing for an uninterrupted line of sight from one end to the other. A second category comprises named routes with deviations from a straight line of less than 45 degrees, an intuitive threshold value halfway between a straight line and a right-angle intersection that has been used before to characterise continuity (Jiang et al. 2008). A further advantage of setting the threshold at 45 degrees is that there is only a small number of limiting cases, since angles around 45 degrees between axial lines rarely occur in the sample. To capture highly continuous sequences of axial lines, a subcategory was defined with a threshold angle based on Hillier (1999) who found a large portion of intersections between axial lines to deviate less than 15 degrees from a straight line.

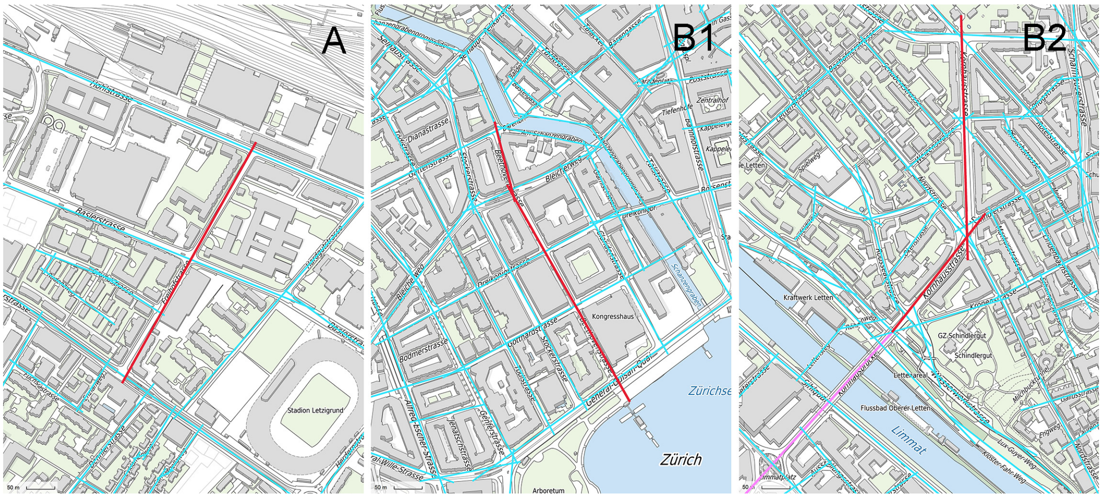

Figure 3: Examples for continuous named routes. Freihofstrasse (A, left) is identical with a single axial line. Beethovenstrasse (B1, middle) covers a sequence of axial lines deviating by less than 15 degrees from a straight line. Kornhausstrasse (B2, right) includes deviations between 15 and 45 degrees from a straight line. The axial line for the southern segment of Kornhausstrasse continues without interruption into Kornhausbrücke and Langstrasse (highlighted in pink). Background map source: www.maps.stadt-zuerich.ch

The remaining set of named routes featuring more important angular discontinuities was further subdivided according to topological characteristics that could be relevant for the perception of continuity. The first subcategory comprises named routes including sharp turns, but always turning in the same sense such as in L-shaped or U-shaped routes. The second subcategory includes named routes with alternating sharp turns such as Z-shaped and zigzagging routes. The third subcategory assembles bifurcating named routes and other instances of topological discontinuity such as X-shaped, tree-shaped or completely disconnected configurations.

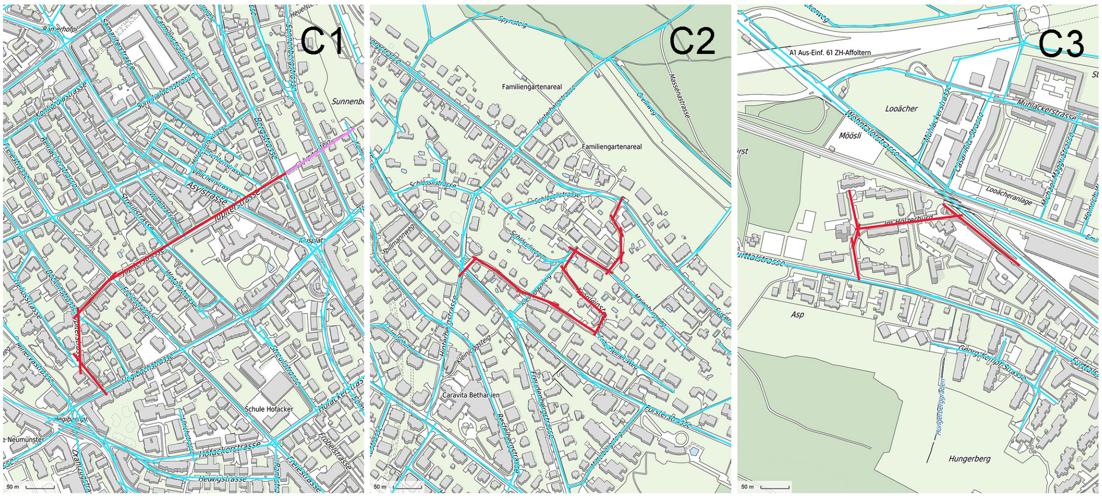

Figure 4: Examples for discontinuous named routes. Jupiterstrasse (C1, left) covers a sequence of axial lines deviating by more than 45 degrees from a straight line while turning in the same sense. Krönleinstrasse (C2, middle) includes deviations of more than 45 degrees with alternating turns. Holzerhurd (C3, right) forms a bifurcating, Y-shaped configuration. The axial line for the western segment of Jupiterstrasse continues without interruption into Jupitersteig (highlighted in pink). Background map source: www.maps.stadt-zuerich.ch

Continuity categories:

A: Named routes that are identical with single axial lines

B1: Named routes covering a continuous sequence of axial lines deviating by less than 15 degrees from a straight line

B2: Named routes covering a continuous sequence of axial lines deviating between 15 and 45 degrees from a straight line

C: Named routes covering sequences of axial lines including deviations from a straight line of more than 45 degrees

C1 discontinuous named routes turning in the same sense (L-shaped or U-shaped)

C2 discontinuous named routes with alternating turns (Z-shaped or zigzagging)

C3 Y-shaped, X-shaped, tree-shaped and disconnected configurations

The length of the named routes varies greatly. While the shortest measure around 30 metres, the longest stretch over several kilometres. To investigate in what way route length is related to continuity, we partitioned the dataset into length categories. The minimum number of required categories was established based on k-means clustering, assigning every instance of the dataset to the cluster with the nearest centroid. We found that partitioning into the following four length categories leads to a ratio of variance explained of 0.9:

S < 420 m (70.5% of all named routes)

M 420 m – 1150m (22.4 % of all named routes)

L 1150 m – 2800 m (6.3 % of all named routes)

XL > 2800 m (0.8% of all named routes)

The axial lines both outside and inside the built-up area were created on the basis of walkable and / or drivable surfaces and not on the basis of building footprints. In streets where a visually unobstructed axial line between buildings would remain possible, but where the walkable space turns due to the boundaries of private plots, an additional axial line was generated. Conversely, for streets ending in a square the axial lines were continued onto the square, even in cases where the square is not entirely paved.

The routes in category C were examined one by one in order to find possible explanations for the discontinuity of these named routes. Furthermore, all categories comprise instances of route names changing within the same axial line. These cases were examined individually as well in order to look for explanations.

3.2 Results and Discussion

The results of the comparison between the named routes database and the axial map are summarized in the following table:

Table 1 Named route continuity categories

	Named Route continuity categories						Split Axial lines
	A	B		C			
		B1	B2	C1	C2	C3	
Entire set	72.8%			27.2%			6.4%
	39.5%	25.4%	7.8%	16.3%	8.5%	2.5%	
S	77.4%			22.6%			8.2%
	52.2%	20.9%	4.3%	16.3%	8.5%	2.5%	
M	60.6%			39.4%			8.1%
	11.0%	35.0%	14.6%	22.3%	11.8%	5.3%	
L	64.3%			35.7%			5.7%
	4.3%	40.0%	20.0%	15.7%	18.6%	1.4%	
XL	66.3%			33.7%			0%
	0%	31.2%	35.1%	16.0%	17.7%	0%	

A clear majority of all named routes are either completely straight or include angular deviations of less than 45 degrees. This share is even bigger in the large group of short routes (< 420 m), where also the biggest portion of named routes entirely coinciding with axial lines can be found. Not surprisingly, this portion decreases with route length - while more than half of the short routes fall in this category, only a few routes longer than 1150 m and none longer than 2800 m coincide with a single axial line.

Around 16% of all routes include turns of more than 45 degrees between axial lines, but maintain continuity in the sense that they turn in the same sense – L-shaped and U-shaped routes. At closer examination, many of these routes are actually quite straight along most of their trajectory and turn sharpy only at one end in order to achieve a more or less orthogonal junction to a more important route running at an angle.

Most of the remaining named routes featuring more important discontinuities fall into one of the following types:

- Routes following topographic features such as a contour line, the edge of a forest, a creek or a meandering river
- Routes climbing steep slopes in serpentines
- Routes crisscrossing around obstacles, for example caused by large infrastructures
- Internal circulation systems of campus-like estates and planned neighbourhoods

This last category also covers almost all instances of branching or completely discontinuous named streets (category C3).

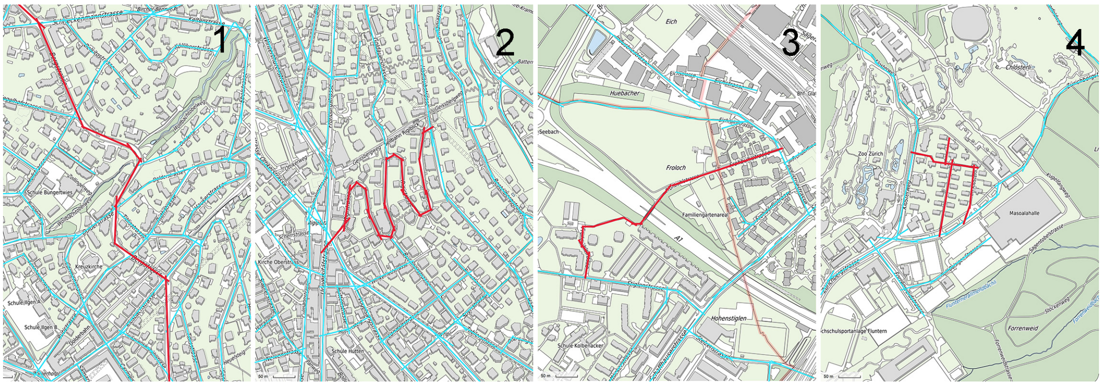

Figure 5: Examples of named routes deviating from continuous trajectories for different reasons. Bergstrasse (1) avoids slopes by following a contour line. Rigistrasse (2) climbs a steep slope in serpentines. Frohbühlstrasse (3) follows a contrived trajectory forced by the location of a highway underpass. Im Klösterli (4) covers all branches of the internal circulation system of a residential neighbourhood constructed in 1937. Background map source: www.maps.stadt-zuerich.ch

Finally, there is a small but significant amount of route name changes within single axial lines. Many of these cases can be explained through the successive incorporation of adjacent municipalities by the city in 1893 and 1934. In general, the pre-existing route names in these newly integrated boroughs were kept, and sometimes this led to a change of name within a straight route segment. Another observation is that named squares tend to break route names: while a single axial line might continue across a square into the following street, the street names often change (see for example Kornhausstrasse / Kornhausbrücke / Langstrasse in Figure 3). Finally, route names sometimes change when a route continues in a straight line, but completely changes in character, for example from a two-lane road to a footpath (see for example Jupiterstrasse / Jupitersteig in Figure 4).

Looking at the route names themselves and at the reasoning adopted by the municipal naming commission, we found that a couple of principles seem to have been applied quite consistently in order to support wayfinding, avoid errors and maximize intuitive intelligibility of the system. First of all, efforts were made to make sure that in no case two routes had the same or a very similar name. This was a recurring issue especially during the administrative integration of the new boroughs after 1893 and 1934. Furthermore, efforts were made to spatially group routes with similar names. Colinear routes of different types were often assigned similar names. On a larger scale, ancient field names, estate names and other topographical designations were frequently picked up in route names, leading to groups of spatially and etymologically related names. A more recent version of this process is the phenomenon of themed neighborhoods: The important urban extensions of the late nineteenth and twentieth century involved the simultaneous construction of entire groups of streets that were sometimes named around a specific theme, such as flower names, mountain names or women's names. Usually, these groups of streets belong to the categories of shorter access roads and connecting roads. In these cases, only the grouping of names plays a role for orientation and the names themselves appear unrelated to the spatial properties of the named routes, but this is not always the case. Regarding the longer lines of arterial and restructuration roads, a principle of naming a street after where it is heading is quite consistently applied, so for instance the "Badenerstrasse" is leading to Baden. A significant portion of route names for lengths beyond 1050m falls in this category. Sometimes, also the name of a topographical feature, such as a river, or of an obstacle such as a railway line is transferred to the route following its course.

Comparing the named routes to a historical account of the evolution of the route network helped to formulate a couple of observations concerning the relations between route formation and route naming. Figure 6 and 7 below show the development and the resulting properties of the street network in a flat area to the west of the city center that underwent substantial densification during the course of the twentieth century.

Figure 6: Temporal evolution of the route network in the Hardau area west of the city centre in 1885 (top left)., 1915 (top right), 1945 (bottom left) and 2020 (bottom right). Map source: www.maps.stadt-zuerich.ch.

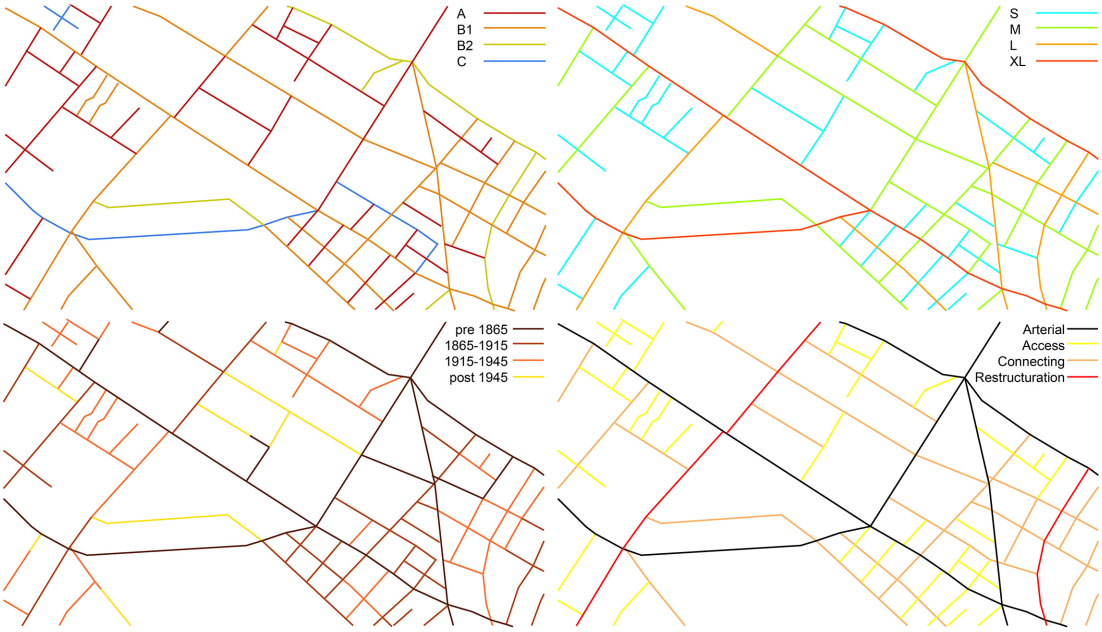

Figure 6: Analysis of the route network in the Hardau area according to named route continuity categories (top left), length of named routes (top right), date of establishment (bottom right) and route formation types (bottom right). The longest, named routes correspond to the primal network of arterial roads. With one exception (Albisriederstrasse), these routes are characterized by considerable continuity. The shortest, named routes, often covered by a single axial line, correspond to access roads. The names of connecting and restructuration roads change frequently within relatively continuous trajectories.

Many of the important arterial roads are very old and have kept their names over the centuries, notwithstanding continuous and sometimes significant adaptations of their trajectories. Usually, these long, named routes do not start in the city centre but further outside, at the former entrances to the fortified city or in formerly independent villages that had later been swallowed by the city. In the course of the nineteenth and twentieth century, many of these old arterial roads have been doubled up by new and straighter ones. Sometimes, this doubling is reflected in a transfer of the name to the new road, the original road acquiring the qualification “old”, as in “Alte Regensdorferstrasse”, or inversely, the old road keeping its name and the new one acquiring the suffix “Neue”.

On the other side of the length spectrum, there is a large group of short streets (below 420m) corresponding to single axial lines. In terms of route formation types, these short, straight streets represent almost exclusively access roads and connecting roads. Many of them have been created and named in the course of local, small-scale development operations. Interestingly, this is also the case for some of the most discontinuous and contrived named routes. While this group is much smaller, it reflects an interesting hiatus in urban planning ideology. Up to and including the second world war, even minor streets seem to have quite consistently been named according to a principle of spatial continuity: Street names generally change at the corner. In the post-war period and continuing until the 1980’s, we suddenly find a principle of campus-like development extended to housing neighborhoods. Not only are the building volumes uncoupled from the street patterns, also street names are freely attributed to the circulation loops serving entire compounds, regardless of their spatial continuity. In these cases, the naming system tends to disconnect itself from the spatial form, exclusively reflecting the historical fact that the whole compound of streets and buildings has been constructed at the same time.

Finally, a subcategory of restructuration roads deserves special mention: the break-through streets opened up through established urban fabric. Many of these streets have “authors” – urban planners, engineers or municipal officials that conceived them and campaigned for their realization. This seems to explain why for instance the “Uraniastrasse”, conceived by city architect Gustav Gull at the beginning of the twentieth century and providing a new east-west axis through the historical center, is named consistently along its sinuous trajectory, notwithstanding important deviations in angle.

4 CONCLUSIONS

The assignment of names to streets and other types of routes is a historical process running in parallel and interacting in various ways with the evolution of the urban spatial network itself. In the early stages of urban growth, routes acquired their names through ongoing use. The assignment of a name in common parlance reflected the stabilization of a linear spatial sequence that was continuously traversed by many people. Later on, street names were formally registered, and newly laid out streets were assigned names from the outset. Starting with the development of a modern city administration during the 19th century, the municipality intervened regularly in the naming of streets in order to ensure a clear and unambiguous address system. These interventions were not limited to the correction of ambiguities. In many cases, they included explicit measures to assure intuitive readability and coherence of named routes. Today’s naming system can therefore be understood as an interplay of a bottom-up process of routes acquiring their names in common parlance or being named when they were established, and a top-down correcting activity of the municipal council and of the naming commission.

We found a significant correspondence between the naming system and the continuity of path units. Many named routes follow linear sequences of urban spaces comprising only minor deviations in angle, and many street names change at near-to right-angle intersections or sharp turns. Considering length, categories S. L and XL comprise a more important share of named routes corresponding to continuous path units than the medium-length category M. This observation points at a possible correspondence between the formative processes of the street network and the degree of continuity of named routes. Most of the named routes in category S (below 420m) correspond to local networks of access roads. Many of them have been named when they were established, often resulting in a self-evident correspondence between street names and single axial lines or short, continuous sequences of axial lines with minor angular deviations. On the other end of the length spectrum, categories L and XL (longer than 1150m) comprise many of the major arterial roads that have structured the outward growth of the city for extended periods of time. Typically, these long lines are characterized by prolonged sequences of axial lines joining at obtuse angles, and sharp turns occur only in exceptional cases. Meanwhile, the middle-sized category M comprise many connecting roads that first emerged as disjoint segments in successive phases of growth and that have been linked and, in some cases, aligned only later on. It seems likely that the contingencies of urban growth have initially produced a certain amount of mismatch between route names and spatial or topographical continuity in this category, not all of which was corrected later on.

Angular continuity is not the only factor contributing to the intelligibility of the naming system. Particularly in category L (1150 m – 2800 m), we frequently find the influence of continuous topographical or infrastructural features overruling angular continuity. This leads to the conjecture that the fact that a route follows a contour line, a river, a lakeshore, the edge of a forest or a linear infrastructure might cognitively be as relevant as its spatial continuity. Another way in which topography influences the formation of routes and consequently their naming is by forcing serpentines and zigzagging trajectories to negotiate steep slopes. There are two strategies for naming such routes: either the names change at each hairpin, or the entire route acquires a single name. Both options can be found in the sample. The latter seems to be the rule outside the built-up area, while the former occurs more frequently in densely built streets.

Campus-like compounds and planned neighbourhood developments make for a small, but important exception from the prevailing principle of correspondence between route names and intelligible path units. The association of street names with building compounds rather than with continuous units of open space leads to complex configurations of named routes that are utterly different from the vast majority of other routes whose names have been attributed based on some form of spatial or topographical continuity. A more detailed study of the implications of these extraordinary situations for wayfinding could help to establish principles for an intuitively readable practice of street naming based on cognitive evidence.

Further research should include investigations of the cognitive bases of street naming systems in other cities and cultural areas, including for example numbered streets or the differentiation between streets and avenues in Northern American cities. The comparison of named streets with cognitively or morphologically defined path units should not be limited to the axial line representation, but include other approaches to the mapping of continuous path units, such as for example “natural streets” or “voies”. Finally, toponymical research combined with studies in Space Syntax and urban morphology seems especially promising regarding the important role of long lines. A relatively small number of very long and continuous path units acquires a high number of intersections with other streets, and to a certain extent this “foreground network” (Hillier and Stonor 2010) with longer lines, nearly straight connections and route continuity seems to reflect itself in street names.

The investigation of route naming systems opens up a fascinating area of research at the boundaries of spatial cognition, urban morphology, and toponymy. We may be too familiar with the long-standing conventions of our street naming system to realize how extraordinary it is that some routes change their name after less than a hundred meters while others bear the same name of several kilometres, and how this multi-scale naming system helps us to navigate the complexity and spatial depth of our urban environments. While the street names themselves may appear arbitrary, the hidden rules according to which they have been attributed to urban spaces certainly are not.

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