The epistemology of urban morphology

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Abstract. *A very broad conceptual diagram of the epistemology of the field of urban morphology is provided as a first step to illustrating the potential connections between different schools of thought. A study of the methods of generating knowledge in this field shows that there are many conceptual and methodological practices that are shared. This shared epistemology can become a basis for comparing the kinds of theories and knowledge generated by different schools of thought. The methods used, the bases for judging their validity, and the scope of enquiries are considered. A systematic definition of the elements that morphologists use for their interpretations is proposed.*

Keywords: urban form, epistemology, patterns, evolution, schools of thought

Epistemology is a branch of philosophy that seeks to ascertain how the truth of something is established (Turri, 2014). In the case of urban morphology, the main epistemological framework has not been adequately explored. Many of the assertions in this field are *inferences* that come from expert observation. But much is based on measurements and calculations relating to observed physical phenomena that tend to be accepted as *basic* as distinct from inferred. What distinguishes justified belief (inferred knowledge) from opinion is a question that needs to be addressed. Furthermore, it is necessary to be clear about the kind of knowledge that falls within the purview of urban morphology and how that knowledge is acquired.

One of the reasons to explore epistemology is to help distinguish the commonalties of knowledge generation of different schools of thought. Research within ISUF has been heavily influenced by three schools: the Italian (process typological), the British (historico-geographical), and the mathematically-oriented space syntax. One can also argue for an emerging school of thought, dominated by North American researchers, which gives greater emphasis to present-day urban landscapes. Similarities of formal analyses between these schools have encouraged the search for common reference points and definitions. While it may not be necessary to bring these schools of thought into a definitive alignment, it is helpful to have points of comparison. It is proposed in this paper that understanding the methods, knowledge generation, and criteria of validity is a promising way of understanding the key differences and commonalities of the varied schools of thought and practice.

No attempt will be made here to summarize the theories and ideas behind the traditional schools of urban morphological thought. Oliveira *et al.* (2015) have recently covered this ground concisely in an informative case study, and the reader is also directed to the seminal texts of the three major schools of thought that have been prominent within ISUF from

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its beginning (see, for example, Caniggia and Maffei, 2001; Conzen 1960, 2004; Hillier and Hanson, 1984; Moudon, 1997; Panerai *et al*., 2004). Excellent summaries of these schools are provided by Whitehand (2001), Larkham (2006), Marzot (2002) and Bafna (2003).

There have been many attempts over the years to unite different conceptions of urban morphology, an early one within the history of ISUF being Anne Vernez Moudon's article in the first issue of *Urban Morphology*. She identifies three principles on which urban morphological analysis is based.

1. Urban form is defined by three fundamental physical elements: buildings and their related open spaces, plots or lots, and streets.
2. Urban form can be understood at different levels of resolution. Commonly, four are recognized, corresponding to the building/lot, the street/block, the city, and the region.
3. Urban form can only be understood historically, since the elements of which it is comprised undergo continuous transformation and replacement (Moudon, 1997, p. 7).

Summarizing Whitehand's perspective, Pinho and Oliveira (2009) offer a few more commonalities of the two predominant schools – Italian and English: '(1) both were concerned with cities as historical phenomena; (2) both conceptualize these phenomena in a manner and to a degree that contrasts with the dominant descriptive approaches; (3) both recognized cycles in development and focused on periodicities in the creation and adaptation of physical forms; and finally (4) both privileged the predominant forms in the landscape, the huge number of ordinary buildings, rather than the small minority of buildings of architectural distinction.'

Gauthier and Gilliland (2006) provide another framework for classifying various schools of thought about urban form. First, using the conception of Moudon (1997), they distinguish research programmes according to their intentions. They recognize *normative* – intending to use research as a guide for future plans – and *cognitive* – intending to use research to describe urban form and its historical change over time. Following this division, they arrange schools of thought on a continuum from autonomous systems to dependent ones, asserting that some schools of thought are more internally directed and others are far more intertwined in relationships with other kinds of analysis.

Karl Kropf (2001, 2009, 2011, 2013, 2014) seeks common ground between various conceptions of urban form research, eventually coming down on the built form itself as the potential 'registration mark' of different types of urban morphological research (Kropf, 2009). In so doing, he places other potential connections and relationships, including land use, activities and flows, in a different knowledge category. This reduction of the key knowledge of urban morphology to fundamental built form elements and patterns is a way of paring down the scope of the field. This is important because urban morphology has a tendency to co-opt urban facets that are not strictly formal – using the word 'formal' to denote the semi-permanent and definitively located physical elements of a place, including, for example, the tracks of the streetcar, but not the vehicles.

This sensitivity to the inclusiveness or autonomy of the knowledge base was also argued in articles in *Urban Morphology* by Michael Conzen (2013), then ISUF's President, and Kropf and Malfroy (2013). Conzen argued that morphology not only included the formal analysis but also the interpretation of that analysis, for example as revealing intention, memory, and meaning. Kropf and Malfoy argued for a more contained version of urban morphology, so that it could become a distinct field of knowledge. This difference of opinion essentially relates to the extent to which urban morphology as a distinct category of knowledge is autonomous observation and analysis of formal elements or whether it also includes linking those formal elements to other conditions, such as agents and meanings, as a part of enlightening the historical or urban record. However, Kropf and Malfroy acknowledge that 'the built environment is an enormous set of indices of the human activity that created them' (Kropf and Malfroy, 2013, p. 129). Moreover, on the subject of autonomy, many concur with Moudon, (1997, p. 9) who states that 'urban morphology approaches the city as an organism, where the physical world is inseparable from the processes of change to which it is subjected'.

The assumption of this paper is that urban morphology is a distinct field of knowledge that does not have the ambition of achieving a complete description of the complicated dynamics of the city. Rather, it is concerned with describing, defining and theorizing a single segment of urban knowledge (form and formal change) *and* suggesting how that knowledge is brought into specific relationship with other dynamics and conditions in a particular place (including transport, ecology, social and economic conditions, human behaviour, and political agents). This is not to say that physical form determines other conditions, or that physical form is a direct resultant of these forces. Rather, in Moudon's words, the challenge of urban morphology 'is to demonstrate the common ways in which cities are built and transformed and to illustrate how the principles of change work in many different contexts' (Moudon, 1997, p. 9).

The first part of this paper is a framework of epistemology encompassing how morphologists develop knowledge, the scope of their knowledge, and how the knowledge is validated. These modes of knowledge seek to discover what morphologists do and how they know what they know. In the second part of the paper, the epistemological framework is used to elaborate on topics, particularly the organization of data, where morphologists might find common ground.

This epistemology is entirely based on a conception of urban morphology as cognitive knowledge as distinct from prescription. In the Italian school and in the work of those employing space syntax, the intention of the work is often very strongly related to design or prescription. However, the analysis and observations of these researchers forms a basis of knowledge apart from their design work. In the process of developing design or other action, cognitive study is or should be the first step (Moudon, 1992).

Epistemologically, all the urban morphology schools of thought share certain methods of acquiring knowledge, analysing it, and validating it. These are (1) collection of formal data about the study area; (2) recognition of common patterns in the study area and across study areas; (3) developing and testing theories of change; and (4) linking the results of the physical analysis to conditions not directly related to urban form (hereafter non-formal conditions).

Data collection as basic knowledge

As Kropf (2009) suggests, one way in which urban morphology is distinguished from other kinds of urban analysis is the starting point of acquiring formal urban data. The researcher starts by gathering formal data, for example in contemporary and historical maps, surveys, field measurements, photographs, and documentary records. The data used in urban morphology are substantially measurable or mathematically derived from measurements or co-ordinates of built form, and thus for the most part objective. Formal data have scale, are associated with a particular date and a particular study area, and can be located geographically. There are large amounts of data for any area under study and, depending on the scale of inquiry, might include density of built form, size or segment length of features, street widths, and location of footpaths and plot boundaries. For buildings the data frequently include descriptions of materials, plans and dates of construction. For some studies, data include topography, elevation, slope, and location of waterways. The data are always intended to be studied in comparison with one another. Viewing the same place in different time periods (diachronic), and different places in the same time period (synchronic) are widely employed comparisons (Caniggia and Maffei, 2001, Coehlo and Forma Urbis Lab, 2014) (Figure 1).

One of the key epistemological questions of urban morphology is data selectivity.

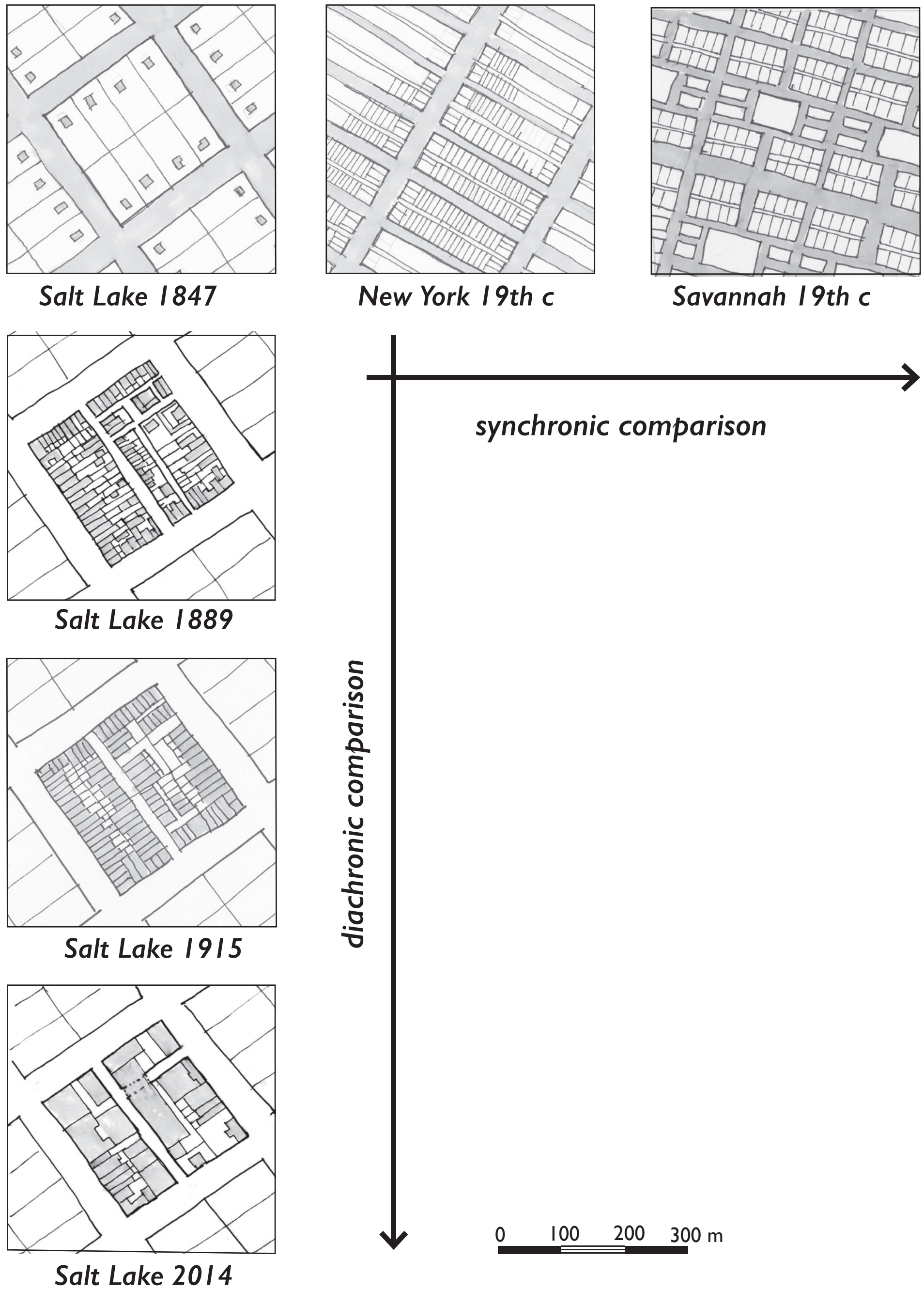

Figure 1. Comparative framework for urban morphological data collection. For comparison, data in urban morphology are collected both diachronically and synchronically, at the same scale.

Some researchers (for example those employing space syntax) rely primarily on a figure-ground map or a tracing of street segments (Bafna, 2003). While all urban morphologists collect data, not all collect the same type of data. The type of data collected is one of the differences between the schools. Urban morphologists are far more inclusive of data and have greater agreement about what constitute the important elements than most architects writing about urban form. Architects may only use a figure-ground map, and/or neglect any focus on time-series comparison (see, for example, Jacobs, 1993; Rowe and Koetter, 1978).

Data validity is a common concern, so researchers often use comparisons across time and data from different sources to help validation. However, the fact that urban form data are largely objective and measurable helps underpin the validity of the field. Though the data collected vary, there is a general consensus about the importance of specific elements: buildings, streets, plots, and, less frequently, land use. Including land use as a formal element could be interpreted as a confusion between use as describing a built form and use as describing a human or economic activity (Scheer, 2010, pp. 10–12). Here land use is excluded from the definition of formal data.

Pattern recognition

The primary form of knowledge in urban morphology is the recognition of *patterns*, at different times and across places. Strictly speaking, the data collected by morphologists are always organized into sets of similar elements (for example, all streets), and these sets in and of themselves constitute patterns; that is, we recognize them as belonging to a fundamental class of things. However, the pattern recognition in urban morphology that lends itself to more sophisticated knowledge accumulation is abstract, rather than objective, and derived from a comparative analysis of the physical data. Fixation lines, grids and matrix routes are examples of specific patterns. Patterns can sometimes be recognized through a computer algorithm, usually by radically minimizing the selected data (Stanilov, 2010). However, the complexity, diversity, volume and interrelationships of most urban form data lead to abstract patterns that may be difficult to capture in an algorithm, at least at present. Figure 2 shows some of the hundreds of patterns identified by urban morphologists.

Pattern recognition is theoretically one of the most critical aspects of developing human knowledge (Margolis, 1987). According to gestalt theory, it is clear that humans will find patterns in most activities and physical artifacts, especially in visual examples (Todorovic, 2008). Because they deal in measurable, mappable and mostly graphic data, morphologists are especially adept at finding and naming patterns that reveal themselves by sight. However, research has shown that humans will find patterns even in random arrangements, which raises the question of their validity and may point to the ultimate importance of pattern recognition derived algorithmically.

Part of the validity, even of patterns derived algorithmically, comes from recognizing similar patterns in comparable circumstances. When we call something a ‘grid’, we are asserting its pattern similarity to other forms, as well as its own particular shape that we can easily ‘see’, even if it has been significantly distorted from an ancient time, like the plan of Florence. The pattern ‘grid’ is an abstraction from many different data points around the world: a grid pattern in Cincinnati, for example, is not ‘the’ grid, but an example of that pattern type. Commonly, patterns are defined in more detail: for example, categorizing and naming many different sub-types of grids. This particularly happens with the common patterns we know as ‘building types’ (Firley and Stahl, 2009).

Patterns may be exclusive to a particular place, but identifying, comparing, and naming those that occur over time and in different places is one of the key aims of urban morphology. In the Italian school, an operation known as ‘reading the city’ entails looking for similarities among forms, both current and historical. In the British school, a ‘plot series’ consists of similar plots laid out together. Patterns identified by British researchers and widely applied are fixation lines, plan units, and fringe belts (Conzen, 2004). Patterns identified and defined in the Italian School include matrix route, elementary cell, foundation type, tissue, pertinent strip and block (Caniggia and Maffei, 2001).

Because of the interrelatedness and co-extensiveness of the data it is difficult to identify a single pattern that does not involve more

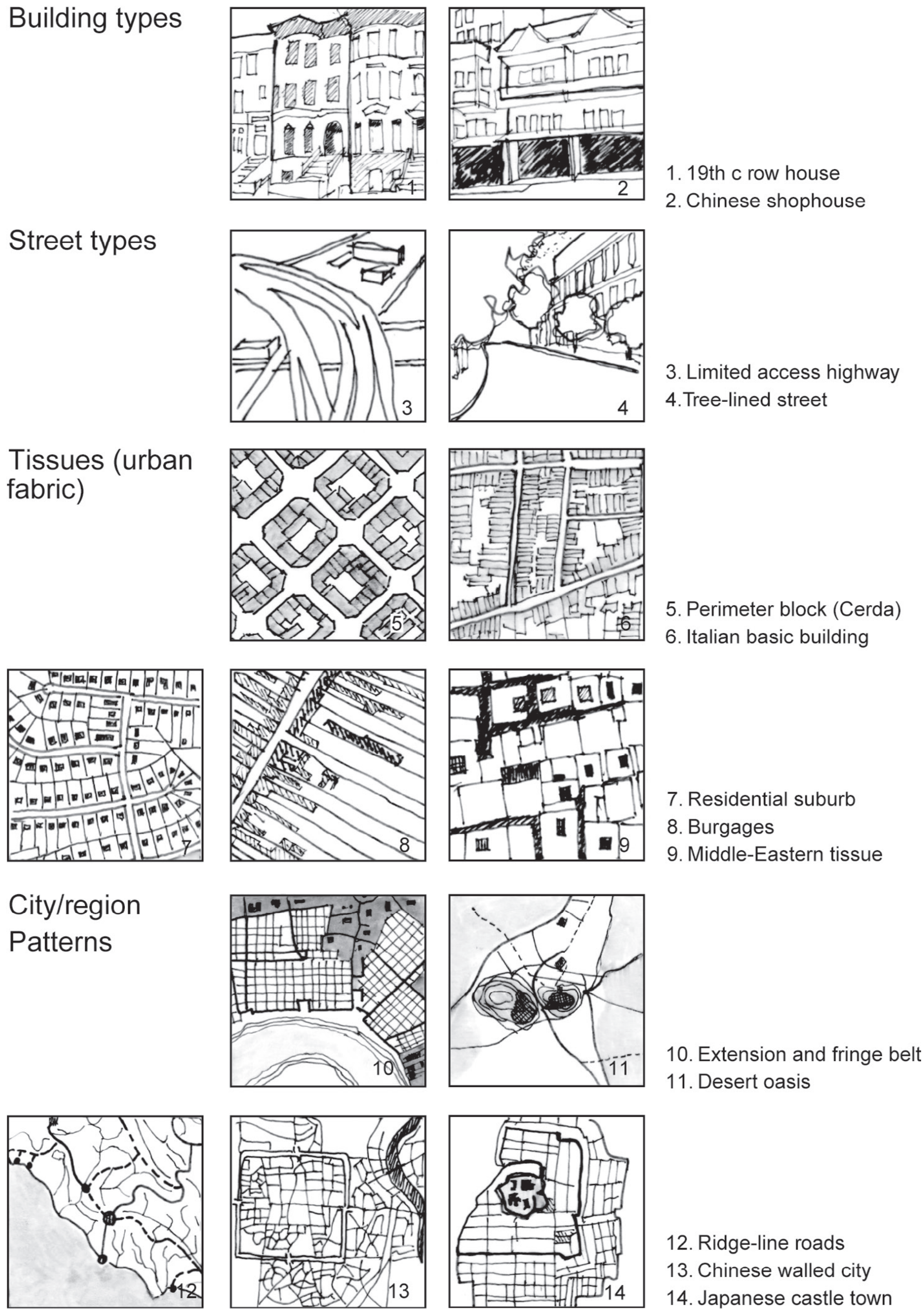

Figure 2. Diagram of patterns. Patterns are interpreted from physical form data and are abstract conceptions that apply to multiple documented examples. They are recognized at different scales and each pattern may be composed of several different elements of form (for example, plot, building, footpath).

than one category of data. A building type, for example, is almost always associated with a certain scale and dimension of plot pattern. In fact, most theories of change suggest that the two have a reciprocal relationship: the building type initially generates the plot pattern and the plot pattern thereafter constrains the evolution of the building type (Scheer, 2010).

Unlike data, which objectively exist at all scales, patterns may only be evident at somewhat specific resolutions of scale, as indicated graphically in Figure 2. A pattern of building types cannot be recognized by looking at the regional scale, for example. This concept of *resolution* relates to another type of pattern recognition: the idea of a hierarchy in urban forms, in which smaller patterns are aggregated to form larger patterns. In a simplified version of this, the recognized scales are building/plot, street/block, city, and region or territory (Kropf, 2014). Within the concept of hierarchy this is the relationship between patterns at different scales.

Pattern recognition is a respect in which morphologists can productively share their analyses. Different patterns can be identified, even using the same data from the same place (Pinho and Oliveira, 2009). While there are infinite patterns and each may only be important in a particular place or in a particular type of analysis, it is also axiomatic that similar patterns can be identified from place to place, and may even have some universal, or at least very wide, applications. An example is the concept of 'fringe belts', which have been identified in very different environments worldwide (Conzen, 2009).

Theories of change

Having recognized recurrent patterns, some morphologists have developed theories of autonomous change that are thought to have greater generality. These are theories about how patterns change, not *why* they change in any particular place. It is known that there are conditions not directly related to urban forms that drive changes in those forms. Autonomous theories of change are concerned with the dynamics of physical change itself, the assumption being that there are highly varied non-formal conditions that can induce or influence the same pattern of formal change. The theories of change in urban form include concepts such as constraint, persistence, disruption, plot cycles, emergence, evolution, typological process, spatio-temporal hierarchy, organic hierarchy, and cellular or axial relationships. These theories apply to data and pattern observations. They drive data collection and interpretation, becoming the basis for the most important kinds of knowledge in urban morphology.

Attempting to catalogue and compare the theories of change that are prevalent in urban morphology is beyond the scope of this paper. Kropf (2001) has provided insightful categorizations of change and more recently Whitehand *et al*. (2014) have compared change mechanisms across two cultures and across two schools.

Theories of autonomous change are quite diverse among the schools, but there are some basic, shared concepts. First, cities are built upon existing forms and by evolving, transforming and dispersing existing forms. These changes are reflected in concepts such as evolutionary cycles and the typological process. Secondly, there are similar dynamic interactions related to the effects of time and resolution that occur across many examples studied, implying that very different conditions can result in similar changes. Thirdly, certain physical forms tend to endure for a longer period of time than others in the same place. Fourthly, the persistence of some forms can retard changes that might happen more quickly if built forms were subject only to the forces of non-formal conditions.

Theories of change are interesting as potent means of bringing together different ideas. Many ideas that may be thought of as 'competing' do not actually conflict: it is more that theories of change have different reference points and have not been convincingly linked to one another. An example of this is the potential linkage between the typological process and plot cycles. It is only one step removed to suggest that the Conzenian plot development observed by Koter in Łódź, for example, may have been driven by the typological transformation of the initial buildings, and that both kinds of changes are connected to the local economy, technology, law, and so on (Koter, 1990).

Linkage to non-formal conditions

The field of urban morphology becomes more controversial when relating patterns to non-formal conditions. One of the validations of urban morphology is the correlation of observations about physical form, its patterns and processes, with non-formal conditions and events. The patterns and changes observed in physical form (whether viewed synchronically or diachronically) have complex causes. The changes that are observed and abstracted in the physical world are commonly related to known historical facts, land uses, population shifts, economic and cultural movements and political influences in a particular study area, as well as to general and culturally-conditioned human behaviour, habits and meaning. These correlations lead us to an understanding of *why* physical components changed in a particular place. The physical city then becomes another data point to be read and interpreted as a way of understanding history or to observe and correlate what is not observable by other means. While not all urban morphologists correlate their findings to events, periods and conditions, all will understand this relationship. Many find that seeking these connections is the very purpose of the research investigation (Conzen, 2013). However, for empirical observations of urban morphologists to be validly correlated with other factors and conditions, it is critical that researchers are familiar with those other conditions (for example, land value) as well as with urban form.

Table 1 briefly outlines four schools of thought in relation to the epistemological schema outlined above. These schools are compared according to the kinds of data they generally employ, the patterns they have identified and compared in different places, and brief notes on theories of change that each has promoted. The table also notes the connections to non-formal conditions that each school has been interested in exploring. For each school, there is much more that could be said: the table is just an example of how the schema is applied. It could be expanded so that many other ideas and theories of urban

Table 1. Epistemological schema, demonstrated in four different lines of enquiry

	Italian	British	Space syntax	North American
Data	Buildings, materials and structures, plots, streets, topography, regional networks. Synchronic and diachronic	Streets, plots, building masses, regional networks. Mostly diachronic	Streets, segment length, spaces, isovists, axial maps. Synchronic but some diachronic	Built form, boundary matrix, land. Synchronic and diachronic. Short term contemporary
Patterns	Building types, hierarchy of scale, matrix route, basic building tissues, ridge settlement	Plan units, morphological frame, fringe belts, plot series, micro patterns	Network depth, movement patterns, foreground and background networks	Static tissue, elastic tissue, campus tissue, pre-urban structure, destruction, nodes, arterials
Theories of change	Typological process, diffusion of type in space, adaptation, persistence. The city as organism	Origin, plot cycles, burgage cycle, disjunction, repletion	Evolution, emergent, predictive, generative	Origination, disruption, temporal hierarchy, evolution, persistence
Frequently explored non-formal linkages	Cultural region, human meaning, material conditions	Land use, land value, historical periodicity, agency, economy	Crime, poverty, land use, accessibility, social cohesion	Power, real estate and property, laws, modern transportation, liveability

morphology could be similarly compared with useful results. Examples of standpoints that arguably do not fit precisely within the ISUF canon include those of Bosselmann (2008), Lynch (1981), Marshall (2005) and Steadman (1979).

A common framework

One of the first steps to finding a common framework is to agree about what are *data* and what is *analysis* in our studies. In the present schema data collection is sharply defined as objective, and the analysis consists of three kinds of interpretative knowledge generation: pattern recognition, theories of change, and relations to non-formal conditions.

In searching for a simple framework that might include the many rich ideas of urban morphology and typology it became apparent that the common conflation of data and analysis was restraining the creation of comparable data from place to place. Similarly, patterns need to be recognized as abstractions that not only can be compared but also may occur in many places and times. Isolating patterns as such would be the first step to cataloguing them.

Although we cannot provide the same data from place to place, it is important to consciously recognize that measured and mapped data about a particular place at a particular time are different from the interpretation or analysis of those data as belonging to a class of patterns. For example, a city wall is a specific construction that can be measured and tracked over different eras of a city's development. When we call that same wall 'a fixation line', we are interpreting it as a widely known pattern, and relating it to other patterns in other places and in other times. However, because in the common frameworks of urban morphology the data (the measurable information on the ground) are frequently conflated with ideas about analysis, a plethora of seemingly conflicting conceptual ideas and terms results. This can be illustrated by the idea of 'building type'. Type is a rich concept in urban morphology. When we document a series of buildings and their plots (the data), we are apt to recognize them as being similar but not identical (pattern recognition). We may call that pattern a 'type'. Of course, the reason that we are documenting them at all is related to an a priori recognition of their similarity – in practice we cannot help but form ideas about patterns as we move through the world. Importantly, not one of the particular buildings we measure or photograph or document is the 'type'. All are, instead, exemplars of the type – by definition a type is an abstract concept (Caniggia and Maffei, 2001). Nevertheless, the buildings do or did exist and the documentation of the timing and nature of their change helps shape our ideas about the building type pattern these buildings may share with others as well as validate one or another theory of change.

As we accumulate data about a place, we normally sort that information into categories. Here a very slight reorganization is proposed of the categories that constitute the common urban form elements that morphologists use, usually termed buildings, streets and plots. This reformulation assists with defining these elements separately from the patterns in which they appear. Figure 2 shows the kinds of data that are commonly collected to represent urban form, isolated from other conditions of the urban environment (that is, not related to land use or other non-physical data). The following primary *elements* have been identified: built form, the boundaries of paths and plots, and land.

The following general principles about the elements are proposed:

1. They are universal and always present in a settled place. They can be compared across time and space, as long as reliable sources are available.
2. They are measurable in physical dimensions, or in relation to dates, or mathematically calculated from measurable data (for example, isovists or density of plots).
3. They exist objectively. There may be uncertainty about the correctness of any kind of data, but our assumption is that the information gathered represents forms that exist or once existed. Although there

may be some ambiguity in the definition of a particular form element, in general the ambiguity rests in the definition, not in the physical form itself.
4. They are co-existent in space.

The three elements

The three elements described here vary from the building/plot/street formula that is commonly regarded as the fundamental building block of urban morphology. First, they are intended to be far more inclusive. They include land and objects that are not part of buildings. Secondly, the categorization of these elements is based on the need to easily distinguish one kind of element from another. Three categories have been developed. *Built form* has substantial reality and is man-made. The *boundary matrix*, which is defined as the combination of plots and the linear paths of public rights of way, describes lines and spaces that are measurable and traceable over time, even if they have no physical substance. Finally, *land* is the natural landscape terrain upon which the built form rests. These elements co-exist in space and may have literal co-presence – for example, a boundary may be marked by built form (for example, a wall) or a natural feature (for example, a stream).

Built form is further broken down in Figure 3, where different kinds of built form are classified. Three general categories are recognized – *objects*, which are non-occupied constructions; *buildings*; and *infrastructure*. Built forms are independent pieces, although they are always composed of sub-parts. A building, for example, is independent of its plot in the sense that it can be demolished without affecting the plot boundaries.

The *boundary matrix* (Figure 3) is perhaps the most overlooked of the three elements, especially by those not familiar with urban morphology's traditions. The matrix is the subdivision of an area into bounded spaces. The matrix includes what we know of as plots or lots and also the space or right-of-way of the streets and the delimited space devoted to other continuous paths (for example, highways, railways, trails, canals, greenways).

The early work of Conzen (1960) and Giovannoni (Marzot, 2002, p. 62) has led morphologists to recognize the ground plan (including plots) as a critical element in the organization of built form. However, it is not widely noted in urban morphology that streets and other continuous built forms also lie within their own 'plots', that is, the space they occupy and that is next to them that is bounded and owned by a civil authority or private utility (like a rail company or a canal company). If we understand the house as a built form that usually sits within a plot, then it is useful to conceive that the paving of the street and its accessory objects (kerbs, footpaths, street trees, lighting, sewers) also sit within a designated, measurable and bounded space, that may be termed a 'path'. As with all other elements, the paths and plots of the boundary matrix are measurable and, though they may lack substantive form, are at least recorded, or generally acknowledged, as fact.

In almost all urbanized places (in fact, in most places), paths and plots continuously underlie the entire built form, providing a slow-changing game board upon which built form plays. As complicated and varied as built form is, the boundary matrix is far simpler, and that simplicity helps us see the structure and the containers in which all built form largely rests. By isolating the elements that constitute the boundary matrix, it is possible to isolate and name some very clear patterns that appear in cross-cultural comparisons (Scheer, 2001). The boundary matrix relates to another important distinction: plots, and especially paths, have much greater endurance than buildings, and most theories of change are built upon this recognition. By unlinking, at least for the purposes of data collection, built form and boundary matrix, we may also start to have a consistent set of elements and maps from place to place and era to era.

The boundary matrix of path and plots is also a useful mapping key to many other kinds of data, including land use, taxation, ownership, land value, construction data, soil conditions, and demographics. Already, many studies and

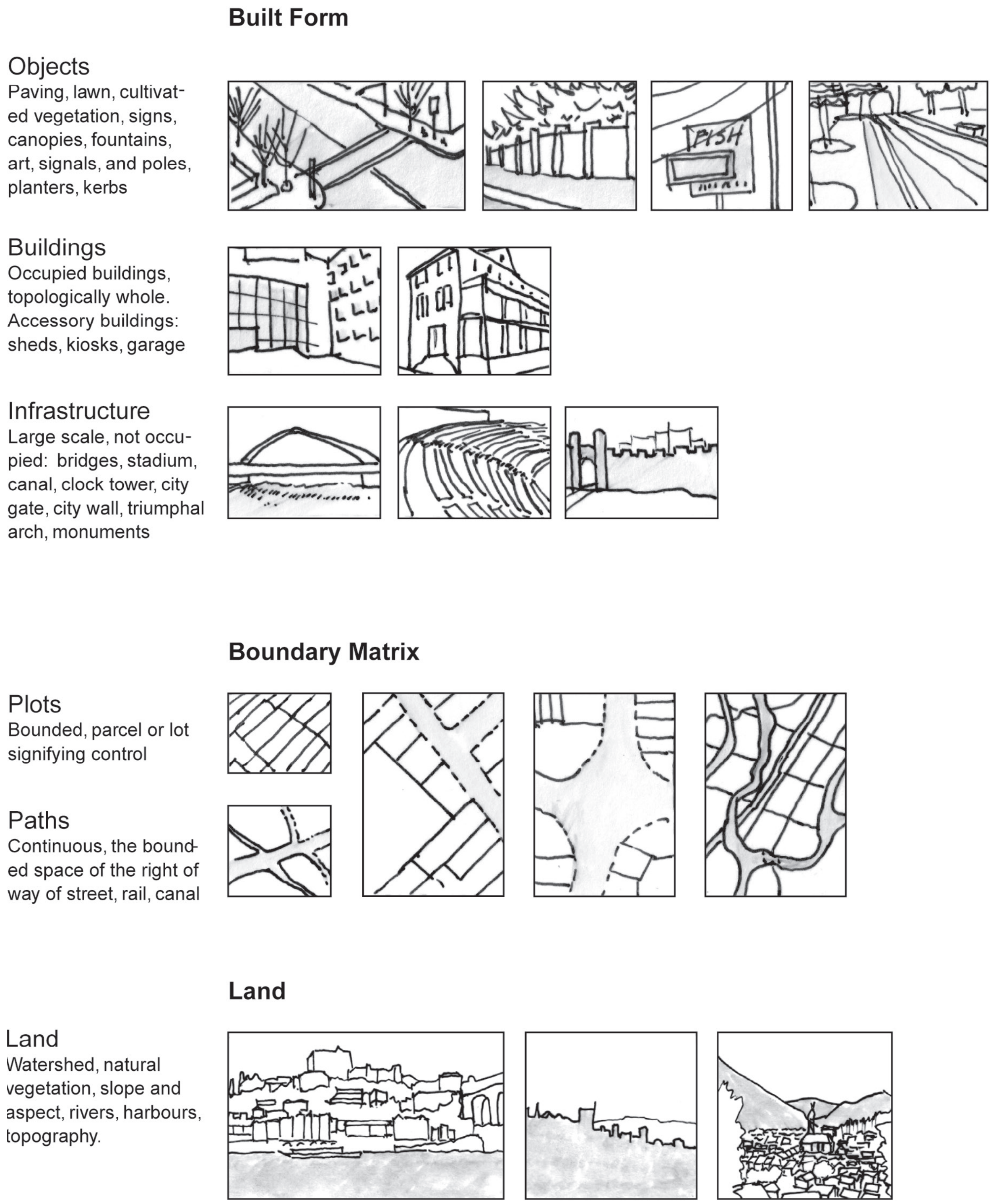

Figure 3. Elements of urban form: a categorization of data most commonly collected, with the basic categories shown as unique, non-overlapping sets, though they are co-existent in space.

plans use the containers/cells/spaces of the boundary matrix in GIS to record many kinds of data, which assists urban morphologists in their quest to connect physical form with other conditions of urban life, economy, and history (Moudon and Hubner, 2000).

Land is the final category of elements. For purposes of urban morphology, the natural vegetation, soils, water bodies and topography are the key data points, although other categories pertaining to the natural landscape may also be important from time to time to describe the form of a city. Land is sometimes neglected or only referred to at larger scales, but it is present at all scales and it frequently influences building types and the evolution of even very small sites. In contemporary morphological studies, the natural landscape has become a very important element because its interaction with built form and the boundary matrix can illuminate an ecological perspective on the form of the city, even historically.

There is a certain amount of ambiguity in the definition of these elements. A particular example is the boundary matrix, because its presence requires a recording of the land subdivision or at least a specific agreement among a group of people: this might be clear even in a very early society, even if it is based on boundaries defined by elements on the land (for example, a river) or a traditional fence. While these boundaries usually signify control, communal land ownership can be more complicated, although in practice boundaries can usually be identified. In many places, eras, and conditions, boundaries can sometimes be established apart from ownership (Akbar, 1988).

Conclusion

This paper demonstrates that morphologists can compare their contributions to the knowledge base, using a simple epistemological schema. The schema is not built on a common methodology, rather on the understanding of the kinds of knowledge that are produced. These include the data that are gathered as objectively as possible, and the three general kinds of interpretation: pattern recognition, autonomous theories of change, and linkage to non-formal conditions.

The comparison of the schools under this schema is incomplete in this paper. However, if it could be rigorously pursued, the comparison could begin to provide clarity in relation to the terms and concepts of the field, without requiring that one or another research technique be brought into conformity. This framework also allows researchers from outside ISUF's canon to draw connections to that work and productively introduce new patterns and new and revised theories of change based on the observation and study of very different kinds of urban growth patterns and forms.

The context of the region is often the distinction that separates the epistemological frames of different schools. For example, the Italians based their data and analysis on the transformation and continuing evolution of the forms of the ancient world, while the British did the same with the medieval one. Although Asian urban morphologists have not formulated a separate school of thought, that may arise. A North American school, focused on newer urban forms, arguably has already come into existence. Despite different contexts, comparative analysis across cultures enriches urban morphology. Comparisons can share not only techniques, but assumptions about how knowledge accumulation works in each school.

Finally, using a common framework and definitions for the primary elements, it would be possible to compare, say, a boundary matrix in the suburbs of the US with the same element in the city centre or in a European city. Clarifying the distinctions between data and patterns allows the comparison and cataloguing of both, perhaps enabling a scientific renaissance that can increase urban morphology's influence.

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