Ambiguity in the definition of built form

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Abstract. *A detailed critical analysis of the definitions of built form as used in urban morphology is reported. The overarching aim of the analysis was to establish a common reference point for examination of the different aspects of urban form in a given case and comparative study of cases from different times and places. Seminal works are examined in detail, in particular those of M. R. G. Conzen, Gianfranco Caniggia and Gian Luigi Maffei. The starting point is the common conception of a hierarchical relationship between buildings, plots and streets and the overlapping of aspects and elements. Different types of ambiguity inherent in the generic structure of built form are identified. Incorporation of these into a rigorous conception of the hierarchy that allows for the richness of overlapping sets reconciles earlier conceptions and accommodates a wide range of specific forms*

Keywords: streets, plots, buildings, hierarchy, typology, abstraction

However simple and concrete the experience of a particular place might be, the built environment as a whole is both diverse and complex. Jane Jacobs (1961) suggested that cities are examples of 'organized complexity' – neither simple nor chaotic. This is to say we should be able to discern some kind of *order* within the complexity and diversity.

The hunt for order is a search for regularities – repeating patterns – in a diverse body of evidence. Like picking out the metre and rhyming scheme of a poem, finding order in the built environment involves abstraction. In referring to rhyming schemes more incisively, we tend to give them names and abstract schemas: ABA BCB CDC, heroic couplets or *ottava rima*.

It is not suggested of course that the abstract scheme in itself is the substance of the poem or communicates its emotional power. It is an analytical tool that helps us to construct a work or understand how the structure and semantic content, amongst other things, work together to produce emotional power.

Similarly, one of the roles of urban morphology is to identify the repeating patterns in the structure, formation and transformation of the built environment to help comprehend how the elements work together, notably to meet human needs and accommodate human culture. The abstraction of these patterns involves several kinds of simplification. To retain analytical rigour, it is important to identify distinct aspects and seek patterns within a single aspect (just as the rhyming scheme is only one aspect of a poem) in order to understand better how the aspects interact. Following the definition of urban form provided by Kevin Lynch (1981), it is possible to identify four broad aspects based on an analysis of properties, classes and relations (Kropf, 2009):

- Spatial relations of physical features
  - natural physical form
  - built physical form
- Interrelations between humans and physical features
  - social and economic context
  - use/function/activity
  - control
  - intention
  - construction
  - perception
- Flows
  - natural
  - human
- Change
  - formation / transformation / cyclical change

Looking at any one aspect, the act of abstraction then involves moving from an aggregate of particulars to the 'universal' of a repeating pattern (as Pierce (1959) would have it, by working through hypothesis, deduction and induction). This involves investigating a number of different examples and comparing them.

To make valid and rigorous comparisons, it is necessary not only to clearly distinguish the different aspects but also to have a common point of reference for comparison (Kropf, 2009). This is the case both when examining the different aspects of a particular case and when comparing different cases. The aspect that provides the most effective reference key for correlating information about the other aspects and comparing different cases in a consistent way is physical built form. Physical built form, as opposed to use, control or intention, for example, is the most comprehensive, evident and persistent aspect and therefore facilitates a rigorous approach to understanding how the aspects interact and affect each other and to identifying common patterns by comparison of different cases.

For physical built form to fulfil that co-ordinating role it is essential to have a consistent definition. In a strict sense this is the principal subject of morphology as applied in other fields such as linguistics and biology. What are the fundamental constituents that make up individual entities and how do the constituents go together?

Within urban morphology there is general consensus on the core, fundamental elements of physical built form: streets, plots and buildings. Similarly, a common feature in the definition of built form is the hierarchical structure of elements based on the relationship of part-to-whole (a pattern also commonly identified in other fields, from physics and chemistry to biology, mathematics, linguistics and computer science). The compositional hierarchy of 'levels of scale' is generally implied in the term 'urban grain', referring to the combined pattern of streets, plots and buildings (see, for example, DETR/CABE, 2000).

Various authors have made reference to the principle of compositional hierarchy, though often in a fairly loose or figurative fashion (Alberti, 1988; van Eyck, 1968; Smithson, 1968). Similarly, in their different ways, Habraken (1972, 1998), Alexander (1979, 2003) and Salingaros (2000) have pursued the concept in more formal detail. The concept of the compositional hierarchy focusing on the specific aspect of built form has been most fully developed within the typological and historico-geographical approaches to urban morphology, in particular as used by Conzen (1960), Caniggia and Maffei (1979, 1984), Castex and Panerai (Castex *et al*., 1980, Panerai *et al*., 2012), Moudon (1988) and Allain (2004).

These various sources are not, however, entirely consistent, either within themselves or one with the other when it comes to establishing a clear definition of built form that might be used as a common point of reference for comparison. The limited purpose of this paper is to report on research into the structure of the compositional hierarchy used in urban morphology as a basis for defining built form and identifying a common, central foundation for analysis, comparison and synthesis. The work of M. R. G. Conzen (1960), and Caniggia and Maffei (1979, 1984) was selected as the focus of analysis because these researchers have developed the relevant concepts in the greatest detail.

Consistency, ambiguity and language

The task of identifying a consistent definition of built form as a reference key is a move toward formalization and it is appropriate to put that move in context and qualify what the results might mean and claim to achieve. What is suggested here is not a strict formalization in logical or mathematical terms. Rather it is an effort to clarify definitions formulated separately by different authors. Indeed, the effort was considered worth pursuing because of the broad similarities in the different definitions. However, there are a number of inconsistencies within the definitions used by Conzen, Caniggia and Maffei and the initial task was therefore to specify those inconsistencies in informal but logical terms and then to compare the definitions with each other to check the extent to which they might correspond and fit together in a consistent way. Iterations of deductive analysis and inductive checking against a wide range of examples gave rise to suggested modifications and further iterations of analysis and checking.

The criteria for evaluation of the potential definitions include: *consistency*, *specificity*, *generality*, *comprehension* and *coherence* (see Kropf (2009) for an elaboration of the criteria). The principal means of meeting these criteria is to follow one of the fundamental principles of morphology, which is to define the elements in terms of their positions relative to the others in a structure.

The move toward a more rigorous definition has its inherent dangers and limitations. For example, Bertrand Russell found that 'naïve' set theory produced a paradox. Similarly Whitehead and Russell's formalization of mathematics, *Principia Mathematica*, was studiously picked apart by Kurt Gödel, who found a fundamental flaw within it. But while Gödel punctured one of the grander aims of the *Principia* – completeness – elements of the work remain valid and fruitful within certain limits. Russell's theory of types has been developed further by Martin-Löf (1998) and recent collaborative work at the Institute for Advanced Study in Princeton (Univalent Foundations Program, 2013).

Within the realm of the built environment, the work of Christopher Alexander taken as a whole might be seen as a progressive investigation of the limits of formalization. By contrast, the work of Hillier and Hanson (1984), Hillier (1996), Steadman (1984), Batty (2005) and Wilson (2012) shows that formalization can be extremely fruitful, but still within certain limits. What seems abundantly clear is that the different formalizations work but they never tell the whole story. The next obvious step is to acknowledge the principle of *limits* from the start. One way or another, the task is to locate the limits.

In this respect, one of the most important starting conditions is the central point made by Alexander (1965). He argues that the built environment is more accurately characterized by overlapping sets rather than strictly nested sets. With overlapping sets a given element can be a member of two or more sets simultaneously. This characterization therefore fundamentally admits ambiguity. A given element can have two or more meanings. Any move toward formalization must therefore accept ambiguity as a fundamental feature. The task is not to eliminate ambiguity but to identify the limits of the ambiguities. Which sets overlap and where exactly do they overlap? Given the distinction of different *aspects* of urban form, there is potential for ambiguity both *between* and *within* aspects. There are different types of ambiguity. An ambiguity between use and form, for example, has been identified by several authors as a potential source of confusion in the definition of building types (Lynch, 1981, Rossi, 1982; Scheer, 2010). Another example is the plot, which can be identified as a physical form, unit of land use and a unit of control (Kropf, 1997, 2009). Identifying aspects is not a means of denying overlaps but articulating them.

A further issue that arises from the aim of seeking consistent definitions of built form is the choice of the specific terms and examples used to frame the definitions. As pointed out by Marshall (2008), the physical characteristics of the core elements of streets, plots and

buildings are different and an important part of seeking to understand how cities develop and evolve is to determine the specific ways in which those differences affect the way the elements can be put together. By the same token, the wide range of specific types of street, plot and building presents a challenge of language if any definition is to encompass the full diversity.

A critical variable in this respect is the degree of abstraction of the definition. The wider the range of forms to be included the more abstract the definition must become. That is, the common, defining features will be deeper, underlying patterns of relationship rather than obvious, outward substance. An almost inevitable consequence of focusing on underlying relationships is that there will not be a single, widely understood common term to refer to the pattern. It becomes necessary to either invent terms or use existing terms in unconventional ways.

It became clear in undertaking the research reported here, and in applying the results in practice, that the benefit of using simple, common terms that allow people to visualize relationships far outweigh the disadvantage of stretching those terms. The terms 'room' and 'plot' are prime examples. As will be seen, it becomes necessary and very fruitful to allow for a very wide interpretation of these terms. To get the benefits it is necessary to temporarily suspend literal interpretations. But it is that stretching of terms that allows the concepts to account for a diversity of forms. What has not been possible within the constraints of this article is to provide a wide range of illustrative examples. Rather, the aim has been to explain the basic phenomena in simple terms, which then allows for dealing with more complex forms and diverse examples by building up a composite view.

The principal elements of built form

The identification of the building, plot and street as the principal elements of built form can be traced in the UK literature most directly to Conzen's seminal work, *Alnwick, Northumberland: a study in town-plan analysis* (1960). As noted by Conzen in his introduction, up until that time the main focus in the investigation of urban form had been on street patterns. Conzen sought to redress that imbalance in the study of Alnwick by directing more attention to the plot. And while he was only identifying what he called *plan elements* and explicitly limiting his study to the two dimensions of *town-plan* analysis, it is notable that Marshall (2008) identifies the same trio of elements in his investigation of the evolution of urban form. The agreement is notable because the two authors come to the three elements from different directions, providing complementary support for the choice. Similarly the general adoption of the term *urban grain*, defined as the combination of building pattern, plot pattern and street pattern, reinforces the choice of the three basic elements of built form.

The hierarchy of elements

There is also general consensus that the elements are related to each other in a hierarchy (Figure 1). The specific nature of the hierarchy is, however, not often set out in detail. Conzen is one of the most explicit in stating that the hierarchy is essentially one of 'containment'. The building pattern is contained within the plot pattern, which is in turn contained within the street pattern. Looking closely at these two relationships shows, however, that they are not the same. Buildings are bounded within a single plot

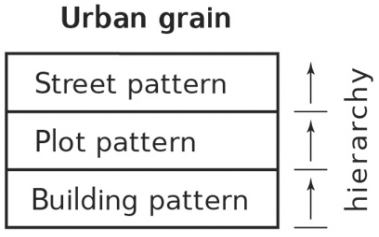

Figure 1. Hierarchy of the basic elements of built form.

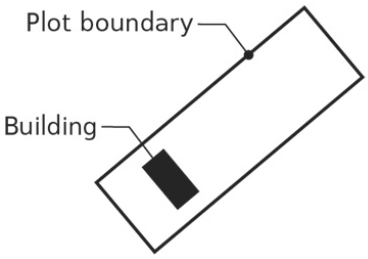

Figure 2. The building contained within the plot.

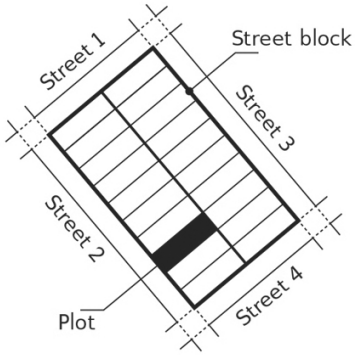

Figure 3. Plots contained within the boundary created by a number of streets.

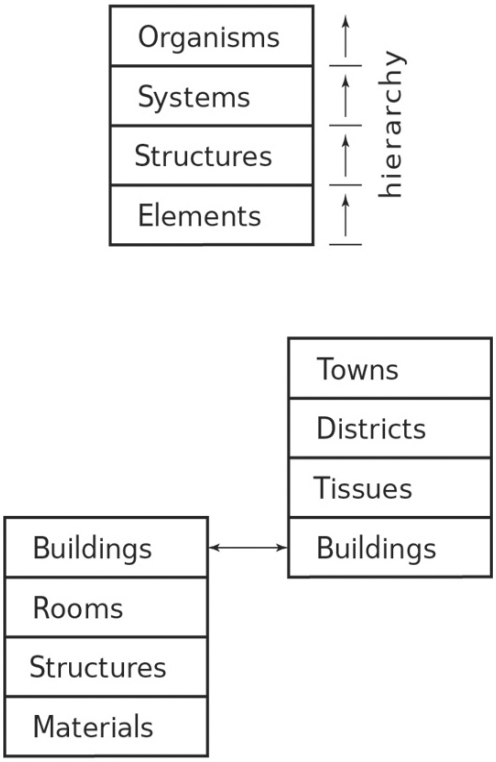

Figure 4. Caniggia and Maffei's schematic (top) and double, four-level hierarchy of elements.

(Figure 2) but plots are not bounded within a single 'street' if the street is conceived as just the route or highway. As set out by Conzen, the relationship is unclear. On the one hand, plots, as part of a *street block*, are contained within the street *pattern*; that is, the aggregate formed by a number of different streets (Figure 3). The line bounding a street block as defined by Conzen is made up of the street lines of several different streets. On the other hand, because Conzen identifies both the plot series and street block as subdivisions of the *plot pattern*, in strict terms the plot is 'contained' within either or both of these subdivisions. Rather than defining a hierarchical relationship between the plot and street, this only states the evident point that an aggregate of plots contains the plot.

An alternative view of the hierarchy is set out by Caniggia and Maffei (1974), which can help shed light on this apparent conflict. Caniggia and Maffei's work is rooted in the concepts developed by Saverio Muratori at about the same time Conzen was working on the principles of town-plan analysis (see Cataldi, 1984). Muratori, Caniggia and Maffei start from the principle of *aggregation* as the basis for the hierarchy of elements stated as an abstract schema. The schema is a compositional hierarchy made up of *elements, structures, systems* and *organisms*. Structures are aggregates of elements, systems are aggregates of structures and organisms are aggregates of systems (Figure 4, top). The basic relationship between the levels is therefore part-to-whole. Set in terms specific to the built environment, materials such as bricks, tiles and timbers are the elements that go together to form structures such as floors, walls and roofs; structures go together to form rooms, stairs, corridors and the like, which in turn go together to form whole buildings. The schema is then used to extend the hierarchy upward by taking the building as the element and identi-

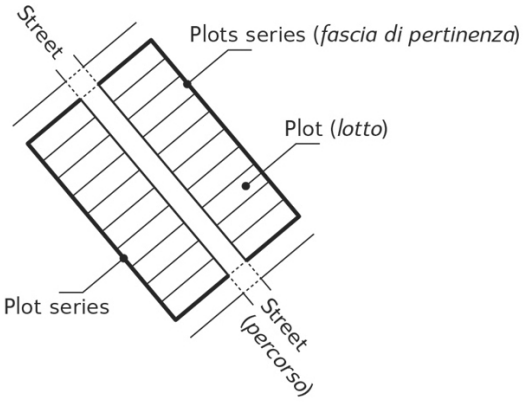

Figure 5. Caniggia and Maffei's conception of the street.

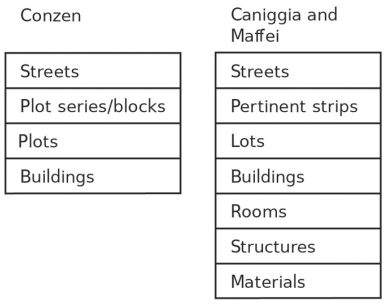

Figure 6. Comparison of elements identified by Conzen, and Caniggia and Maffei.

fying the further levels of urban tissue, urban quarter and settlement (Figure 4).

Missing elements in the hierarchy

hile this provides a consistent basis for defining the hierarchy in principle, there remains a degree of confusion over the elements. The confusion is reinforced by noting that Caniggia and Maffei identify further entities in their discussion of urban tissue. They identify the plot (*lotto*) as the 'module' of urban tissue. The plot is itself made up of the building and its *area di pertinenza* or associated private open space. They also go on to distinguish the route (*percorso*) and plot series (*fascia di pertinenza*) as the constituent parts of urban tissue (Figure 5). This suggests that there are several levels missing between the building and tissue. Taking the principle of aggregation *in all three dimensions* and the relation of part-to-whole as the basis for the hierarchy and putting Conzen's and Caniggia and Maffei's versions side by side starts to point to a potential solution (Figure 6).

One part of that solution is a conception of the 'street' that can resolve the problem in Conzen's version of how the plot is 'contained' within the street and where the plot series and block fit into the hierarchy. To realize the potential of a combined hierarchy, however, requires reassessing the principle of 'aggregation' as the basic relationship between the levels. In particular, the plot would not seem to be an aggregate of buildings. Rather, this example begs the question of what 'aggregation' means in detail. Looking more closely at particular examples of built form suggests that aggregation is too vague and not sufficiently accurate or complete to provide a robust definition of the hierarchy of elements.

Different types of part

In fact, Caniggia and Maffei do provide a more specific definition of the relationship as they go through the details of each level. Starting from what they call simple 'co-presence', they focus on *structure*, which is to say, the specific, three-dimensional spatial relations between generically similar parts. A useful illustration is to examine the relation between the levels of 'rooms' and 'buildings' in Caniggia and Maffei's hierarchy.

One of the first things to note is that 'rooms' are, strictly, *voids* defined as a combination of structures: a floor, walls and a ceiling or roof. To call this an 'aggregate' is clearly too vague primarily because the word tends to assume all the entities in the aggregate are the same kind of thing and not arranged in any particular order. This is distinctly not the case. Similarly, in the move from rooms to building, the entities combined are not all the same. Different types of void are combined to make, for example, a viable dwelling. The types might include rooms in the conventional sense but also, for example, corridors, stairs, attics,

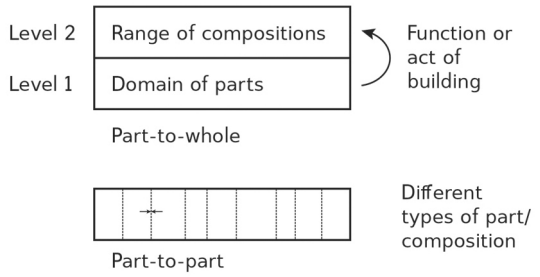

Figure 7. The relationships between and within levels in the hierarchy of built form.

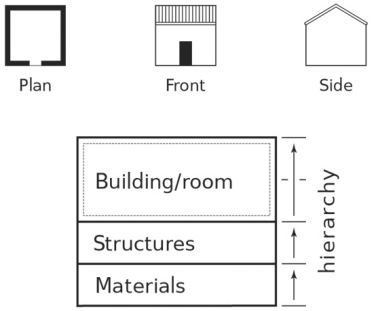

Figure 8. A one-room building and its corresponding multi-level diagram.

cellars, closets and chimneys. The term 'room' needs to be interpreted very widely as 'any void composed of structures'.

A building is then a specific arrangement or composition of different types of room. The pertinent characteristics that define a particular building are: the type of rooms, the number of each type and their specific spatial arrangement in three dimensions. A building *type*, can then be defined as the class of all buildings with the same type, number and arrangement of rooms.

The compositional function and generic types

What should be clear from this is that the levels in the hierarchy represent general classes or *generic types* of element that can be composed in different ways to make types at the next level up the hierarchy. The move from one level to the next thus involves an act or function of composition. The entities at the lower level represent the *domain* of potential parts and those at the upper level the *range* of potential compositions. Referring to the multi-level diagrams of the hierarchy, Figure 7 illustrates diagrammatically that a horizontal row represents a level or generic class of element. A vertical move across a boundary between levels represents the potential relation of part-to-whole as created by an act of composition. The horizontal axis within a level can then be taken to represent the potential relations of part-to-part between the elements within the level (obviously more accurately shown in a representational orthographic plan diagram). A given level is, then, the range of potential compositions from the level below and, at the same time, the domain of potential parts for compositions making up the next level above.

Single element compositions and coextensive forms

Seen in terms of classes or sets, it is straightforward to conceive of a 'composition of one part' or single member set such as a one-room building (Figure 8). This phenomenon represents the first kind of ambiguity it is necessary to acknowledge in order to construct a coherent hierarchy of built form. The ambiguity lies in the fact that a single entity can be seen as both a room and a building. The form occupies both classes at once. Using a term from set theory, the room and building are *coextensive*. Illustrated by the multi-level diagram to represent this sub-class of form, the two levels would be merged (Figure 8). Another way to state this is that the room functions at the level of the building by *coextension*.

Looking across the range of forms it becomes evident that this phenomenon is not limited to the levels of rooms and buildings. The principle of *coextension* applies at all the levels. A compacted earth floor is not a composition of materials but a single material functioning at the level of structure by *coextension*. A single building can occupy the place of an entire plot by *coextension* and a

single street can constitute a settlement. Again, the logical basis for *coextension* is the single member set.

The plot

Using the concept of coextensive forms helps to resolve the uncertainty over the full range of levels in the compositional hierarchy, in particular the status of the plot. It also helps to take into account more fully the range of specific forms of plot found in the built environment. The starting point is the fundamental principle that the levels of the compositional hierarchy are defined in two directions, from below by the domain of its potential parts *and* from above by the position of the element as a part in a composition. To identify a form we ask both, what are its parts and of what is it a part? A building is both a composition of rooms and an element that is part of a plot.

Since compositions can contain a range of different types of part, what are the other types of part that make up a plot? Conzen breaks the plot down into a plot head (building on the frontage) and plot tail (the garden/open area to the rear, with or without additional buildings). Similarly, Caniggia and Maffei make the distinction between the building and *area di pertinenza* – the pertinent area, a courtyard or garden. Such plots can also typically contain a range of other types of building such as sheds, garages and summer houses.

With these definitions it is tempting to dismiss the open areas as merely 'space around the buildings'. But that is to ignore both the physical structures that make up and define the areas and their essential role in the functioning of the building. The external areas within a plot are not leftover, unstructured spaces but form a distinct element with a definite role and boundary (even if in some cases that boundary is not physical but social). It is enough to have a defined area of ground. Going beyond the traditional 'attached' type, many plots include a range of different kinds of external area such as front gardens, side gardens, courtyards, parking, hardstanding, open storage, manoeuvring space and structural landscape.

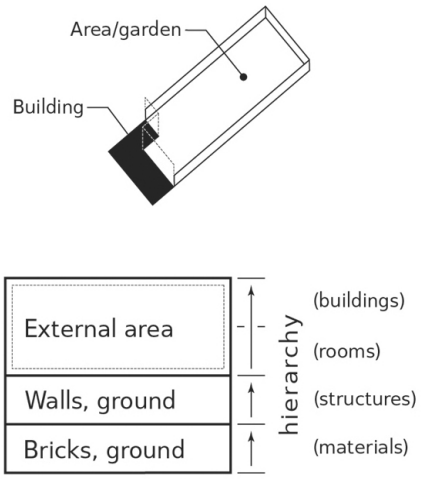

Figure 9. The plot tail or pertinent area functioning at the level of the building by *coextension*.

These elements are generally composed of structures such as walls or fences, paved surfaces and bare or cultivated ground. As such, the external areas occupy the level between 'structures' and 'buildings' and fall into the level labelled 'rooms' (which is not entirely a misnomer – they are voids).

As 'rooms', the external spaces might be seen as part of a composition making up a building. This would mean, however, that the internal and external spaces would together make a single entity. Rather than reveal levels of order, this would obscure them. Alternatively the plot could be seen as a composition of buildings and external spaces with the spaces functioning at that level by *coextension* (Figure 9). Seeing both buildings and external areas as potential parts to be put together to form a plot is preferable because it more clearly gives the external area a substantive status and is more flexible in accommodating a range of examples, including Caniggia and Maffei's *lotto* as well as larger plots characteristic of fringe belts. In this conception the building and external area function together at the same level, like figure and ground – but the ground is still itself defined as a composition of structures.

Perhaps more importantly, like rooms,

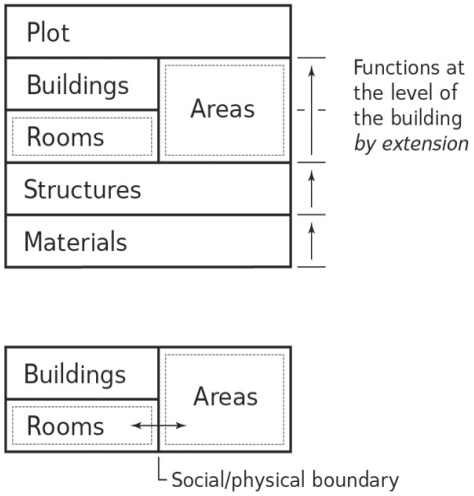

Figure 10. Multi-level diagrams showing the position of the 'area' within the hierarchy (top) and the boundary between two types of void or space (below).

external areas are spaces that constitute the principal realm within which human activity occurs. Both types of void are composed of structures (or materials by *coextension*) but one type forms internal private spaces and the other forms private or semi-private external spaces. As represented in the diagram in Figure 10, there is contiguity between the two different types of space or void. The line between them can thus be seen to represent the boundary/opening between these types of space. As will be seen when examining streets, this convention helps to illustrate and clarify the overall relationship between solid and void within built form and begins to mark out the interface between different forms of urban morphological analysis (most particularly between the configurational and typological and historico-geographical 'schools').

The plot series

Both Conzen and Caniggia and Maffei identify a composition or aggregate of plots as a distinct entity. Yet for reasons that are not entirely clear they do not give it a distinct level in their hierarchies. One criterion for justifying the identification of a distinct level – borrowed from McShea 2001 – is the 'free-standing test'. Entities that warrant a distinct level in the structural hierarchy are combinations of elements that can be found on their own in the built environment. A row of plots each occupied by one or more buildings is a common enough sight in many parts of the world. The logical and physical point is that no other elements are needed to support the existence of the row. The exception is the route, but as pointed out by Caniggia and Maffei (1979), all human constructions must be attached in some way to a route. This subject will be explored in the discussion of the street.

For Conzen, the status of the plot series is also unclear because of the way in which he defines streets. As a plan element, the street is limited to the public highway defined by 'street lines' (the boundary between plots and the public highway). By this definition, the plot series can only be a part of the plot *pattern*. By contrast, for Caniggia and Maffei the street, or simple tissue, is composed of a route with a plot series along each side (Figure 5). This conception, (the 'double-loaded street') is commonly identified as the basic unit of development, tied together as an entity by the route providing common access to the plots ranged along each edge. Access and movement form a kind of glue to hold the elements together. The same conception of the street is put forward by Marshall (2008) and advocated in best practice (DETR/CABE. 2000; Llewelyn-Davies, 2000).

The street, simple urban tissue and plan unit

Looking at the structure of the double-loaded street alongside the other basic elements of the building and the plot reveals both similarities and differences. The similarity is that each includes a type of void or space. A building is an arrangement of rooms, which are voids composed of structures; a plot is a composition of buildings and external areas, and a street is composed of two plot series and public

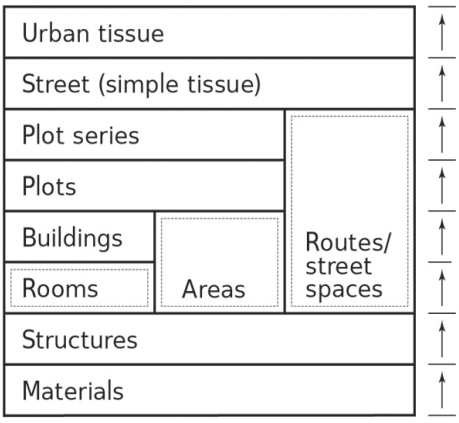

Figure 11. Multi-level diagram showing the position of the route or street space and its relationship to plot series to form the street.

space such as a route, highway, square or piazza. As in the case of the plot, the street space is not a leftover but a deliberate composition of structures, for example the sub-base, base course and surface course, haunching and curbing of a carriageway. The carriageway and the space it defines function by *coexten-sion* at a higher level, in this case up to the level of the plot series to form an element in the domain of parts for the street. These levels are shown in a multi-level diagram in Figure 11.

Seen from this perspective the street or simple tissue is a combination of all the elements in the hierarchy identified so far. In terms of the plan elements identified by Conzen, the street tissue is a unique combination of buildings, plots and streets (or a single street). This is very similar to Conzen's definition of a *plan unit*. In essence, Caniggia and Maffei's simple tissue is equivalent to a version of Conzen's plan unit (though strictly the plan unit only includes two-dimensional plan features).

As set out by Caniggia and Maffei in the discussion of urban tissue, simple tissues combine to form more complex types of tissue, which again are essentially equivalent to plan units as identified by Conzen . For clarity, Caniggia and Maffei's *simple tissue* (a single street) will be referred to as a 'street' and more complex combinations of streets as *urban tissue*.

Generic structure and the roots of the three types of void

Returning to the hierarchy of elements, there are three distinct types of void embedded in built form, each with a distinct role within the multi-level generic structure (Figure 11). Taken together, the three types form a contiguous network of spaces with distinct boundaries between the different types. The boundaries correspond to the physical and social boundaries found in specific examples between internal, 'private' space, external, private/semi-private space, and public space (see also Habraken (1998) on 'territorial depth').

This diagrammatic expression of the relationships between solid and void in built form is important in at least two respects. The multi-level diagram can be seen as a 'vertical section' of generic structure, illustrating the generic types of form making up built form. A 'horizontal section' through a particular level corresponds to a plan view at a given *level of resolution*. By explicitly identifying the different types of void and their relative position within the whole structure, the diagram very usefully illustrates in simplified form the respective realms of the configurational and typological approaches to urban morphology. As a crude summary, the configurational approach (for example, Hillier, 1996) deals principally with the horizontal section through the level of 'rooms' and the role of the different types of space as they function by *coextension* at the levels of the plot and street. In this approach the characteristics of the network of voids and the ways in which the generic functions of access and movement through the voids contribute to the structure of built form are investigated. The typological approach deals more with the vertical section of levels and the relations between them, acknowledging that the voids at the lower levels are incorporated in the 'solids' further up the hierarchy. The two approaches are

complementary and can work together to provide a broader based view of built form than either on its own.

Figure 11 also points to an important principle in thinking about the evolution of urban form. It suggests that the three types of void emerged together from a common level as rudimentary precursors and have developed into the three forms identified as the primary elements of urban morphology: buildings, plots and streets. The simpler precursors and the diversified forms are rooted in the same basic human needs: shelter from the elements, a protected core habitat for outdoor activity and long distance travel for resources (Kropf (2013) and Weinstock (2010) provide further discussion of these points).

Composite forms and intermediate levels

The question remains, however, whether the multi-level structure fully resolves the issues raised when scrutinizing and comparing the core elements of built form as defined by Conzen, Caniggia and Maffei. Perhaps more importantly, can the generic structure adequately accommodate the diversity of specific forms found in the built environment?

One common specific form that immediately raises questions is the multi-dwelling building. Examples extend as far back as the Ancient Roman *insula* up to any number of different contemporary apartment houses. The issue is this. Within a single building, located within a single plot, there are several additional levels of compositional structure. Rooms are composed into individual apartments, apartments, along with corridors, are composed into floors and the building as a whole has several floors linked by vertical circulation. If the definition were to treat the whole building as composed solely of rooms, the significant, repeating structural order of the apartments and floors would not be fully taken into account.

But one way or another we already recognize that order because we have terms to refer to the repeating patterns. What we lack is a systematic way to place those patterns in the overall generic structure of built form. The acknowledged internal structure of the apartment house remains a kind of free-floating entity. Where that issue becomes significant is when we seek to compare different types in order to understand their formation, transformation and function *in the context of their role within a larger structure*.

There are two fundamental principles of the compositional hierarchy that are pertinent to this issue. First, the compositional hierarchy is infinitely extensible in logical terms. There is potentially an unlimited number of levels, though there are practical limits to how many there might be. The second principle is the point that the levels are defined both from below, by the domain of constituent parts *and* from above, by the position of the element as a part in a composition.

The power of the second principle comes out when we begin to compare different forms within their respective contexts. Comparing a single detached house on a plot with a single apartment house on a plot, the similarities are obvious. Both are composed of rooms and are part of a plot. From this point of view, the individual apartments and floors of the apartment house, as distinct repeating patterns, are in effect 'invisible', compressed within the level of the building. Within the logic of the compositional hierarchy, our options are either to add primary levels for apartments and floors or treat those levels as *intermediate*. The reason for not adding levels for apartments and floors is that they fail the free-standing test. A free-standing apartment or floor is simply a building.

The idea of coextensive forms has already been introduced to deal with one kind of ambiguity within the structural hierarchy of levels: an element occupying several levels at once. The apartment is an example of the converse type of ambiguity: a composition of elements from a given level that function *at the same level*. Another example is plywood, which is composed of wood, a material, but the resulting composition – a sheet of plywood – is used as a material with others to form a structure. So, with apartments and plywood, it could be said that they are compositions that occupy an *intermediate level* and function as a

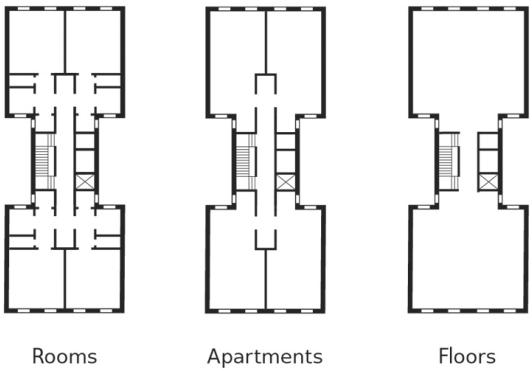

Figure 12. A multi-storey apartment house with two intermediate levels: apartments composed of rooms and floors composed of apartments, each intermediate level functioning at the level of the room by *compression*.

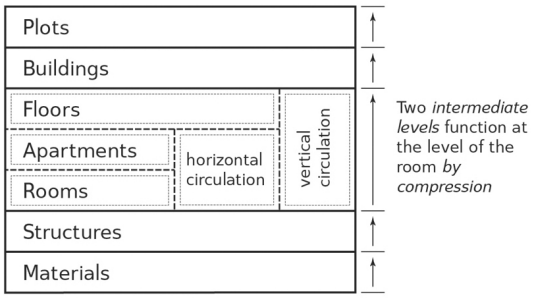

Figure 13. Multi-level diagram of the multi-storey apartment house.

part within the principal level by *compression.* This can be imagined by visualizing the apartment house with each apartment as a 'solid' (Figure 12). To reveal the internal arrangement of the individual apartments is to reveal the sub-structure within the level and show that the apartment house as a whole is a composite element.

As represented in a multi-level diagram (Figure 13) it is also possible to show the semi-private shared circulation space in the same way that the external area of a plot and the public space of the street are treated. Internal corridors function at the level of the apartment to form floors, and vertical circulation (stairs and lifts) function at the level of the storeys to form the building as a whole. Again, the diagrammatic representation of the levels can work in a complimentary way with configurational analysis, as well as with Habraken's concept of territorial depth, to give a more nuanced picture of the relation between movement space and occupation space and the physical and social context of movement at different levels of scale.

The street block

A key issue that remains unresolved with respect to the elements identified by Conzen, Caniggia and Maffei is the status of the street block. The addition of a level for the plot series accommodated entities identified by these authors and the adoption of Caniggia and Maffei's conception of the street provides a basis for a structure that accommodates Conzen's version of the street when incorporated as part of a plan unit. The place for the street block remains unclear. Caniggia and Maffei explicitly consider the block or *insula* to be equivocal as an element of built form. Their conception of the street means there is no unambiguous place for the block within the compositional hierarchy. That conception is based on a generative process and the block is seen as a by-product of that process. There are, however, different modes by which a block might be formed from precursors.

In Caniggia and Maffei's account, the block emerges from the progressive construction of 'built routes'; that is, connecting simple tissues to make a grid of streets. Another mode involves the progressive construction of a block within the context of an existing pattern of simple 'unbuilt' routes. A third mode is the creation of a grid of built streets from the start.

Serial blocks

The simplest form of block and one that does not involve ambiguity is the result of the third mode. It involves creating a tissue from a series of single-loaded streets (Figure 14, based on the Eastern Workman's Village at Amarna in Egypt). In this case, there is an

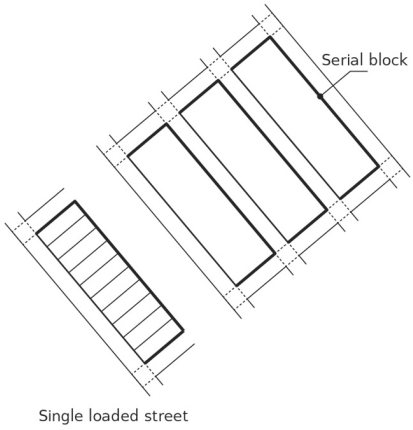

Figure 14. A serial block created by combining several single-loaded streets in a series.

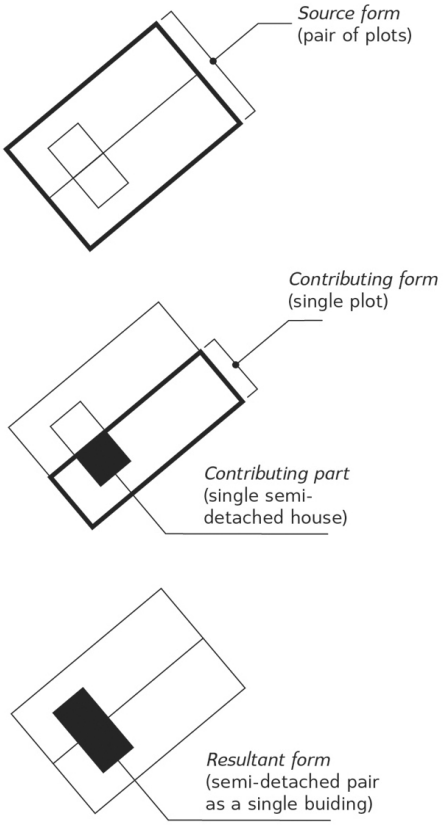

Figure 15. Analysis of the semi-detached building as a resultant form.

unambiguous relation between the route and the plot series because the route only gives access to one series of plots. The back side of the series does not allow access. The series is isolated as a block because it is surrounded on all sides by street spaces. The street of the next in the sequence abuts the back of the series, and side streets abut the edges (but allow no access).

Co-inflection and resultant forms

The ambiguity involved in Caniggia and Maffei's account of the block also occurs in a simpler case, the semi-detached house, which serves as a good illustration. In common parlance the semi-detached house is a type of *building*. It is a composition of rooms that is constructed as a single building but straddles the boundary of two plots. As an element it is ambiguously related to two plots (Figure 15) and is strictly part of a plot series. Alternatively, it could be said that each plot contributes one half of the pair that results in the appearance of a single building.

Thinking in terms of a generative process aids the interpretation. There are two ways in which the semi-detached form might have originated from the transformation of a simpler precursor. One mode is the subdivision of a single detached house into two dwelling units. The second mode is the fusion of two adjacent buildings on separate plots with a shared wall between them. In both cases the starting point or source is the area bounded by the pair of plots or its equivalent in the single precursor plot prior to subdivision.

The ambiguity of the single building and pair of plots extends across three levels: buildings, plots and plot series (Figure 16). Working within those limits it is possible to account fully for the ambiguity in a consistent and coherent way. The source form (whether by division or amalgamation) is the pair of plots – this occupies the level of plot series as a sub-series (Figure 15) The *contributing forms* are the two individual plots, each of which provides a *contributing part* to the *resultant form*, which is the single building. Put another way, the contributing forms give rise to a resultant form by *co-inflection*. Each contributing form and the contributing parts are inflected toward one another to produce a

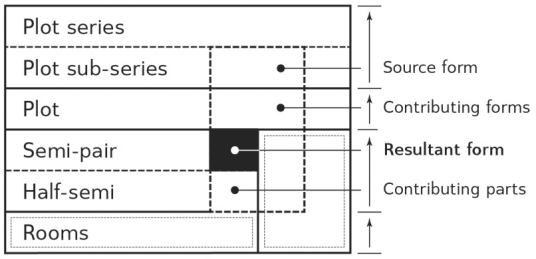

Figure 16. Multi-level diagram of the semi-detached house.

form that, as a whole, is ambiguously related to the contributing forms.

Using this conception, the source form of Caniggia and Maffei's block is an urban tissue made up of at least three mutually connected streets (simple tissues), which are the contributing forms. The contributing parts are the abutting plot series, each from one side of the connected streets (Figure 17). The resultant block is co-inflected because the contributing plot series are inflected into each other to create an identifiable form that, as a whole, is ambiguously related to the surrounding streets. The block as a whole can also be seen as inflected internally, illustrated for example by Cerdà's grid in Barcelona, where the contributing series within the block reflect the character of the contributing streets. The result is a block that has a different internal structure and character on each side.

Figure 17. Urban tissue as the source form of a resultant block made up by the co-inflection of plots series from the contributing streets.

Shared elements and interlocking forms

The other generative process for the emergence of blocks starts with a local territory traversed by a number of established but 'unbuilt' paths or routes. The pattern of multiple routes comes before any building. The formation of the block then proceeds by progressive filling in of the areas bounded by routes without necessarily orienting the plots and buildings to the streets. Even in this process, however, the logic of access is likely to lead to the generation of plots either side of a bounding route to form a double-loaded street. A progression of this kind is traced by Anne Vernez Moudon in her study of Alamo Square in San Francisco (Moudon, 1988). In the case of Cerdà's grid the blocks are uniform in outline shape but inflected in internal structure to articulate a pattern of double-loaded streets. Moudon's study also shows that transformations within an established block can lead away from the double-loaded street toward greater ambiguity between the plot and street with the amalgamation of plots. Castex, Depaule and Panerai (1980) trace this as a trend in urban design and planning from the mid-nineteenth to the mid-twentieth century in western Europe for the progressive omission of the traditional plot. The resulting ambiguity of building, plot and street is not, however, limited to cases relating to Modernist redevelopment. In cases of cities with planned grids with small blocks and large buildings, such as Trani, in Italy (where some blocks are roughly 30 metres square), the block might be subdivided into only four plots, each of which is a 'corner plot'. Another case is Brindleyplace in Birmingham where the blocks are constituted by single buildings functioning at the level of the block by *coextension*. Even though there is enclosure of the street and relatively active fronts, there is still ambiguity: where is the 'front' and where is the service entrance? Which street does the building

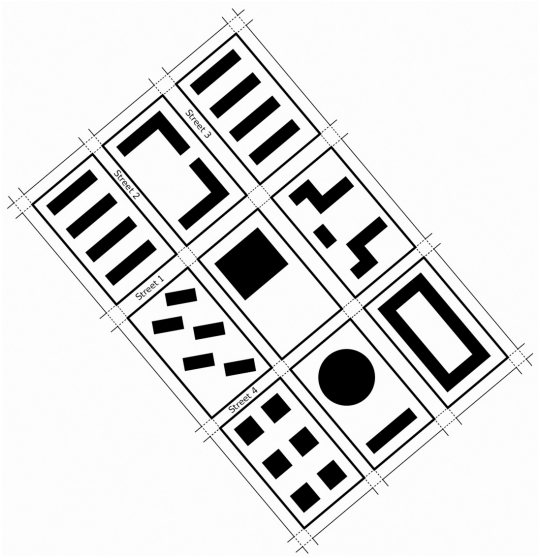

Figure 18. Plots within blocks that have access from more than one side are shared between the bounding streets and create an interlocking grid.

use for its address?

In cases where there is access to individual plots on more than one side of the block and the plots cannot be unambiguously associated with a single street, the resulting pattern of streets and blocks becomes an *interlocking form* (Figure 18). The interlocking occurs because the plot series on one side of a route is shared with the adjacent route on the other side of the series. Because there is no way to unambiguously separate out individual streets as simple tissues, the streets and blocks are taken together as an interlocking urban tissue. In terms of the multi-level diagram, the level of the street and tissue become fused. Examination of examples suggests there can be a range of variation between fully interlocking grid tissues with blocks of a single plot and fully *articulated grid* tissues, in which each street is lined on both sides with plot series and the blocks are resultant forms. Some tissues might then be partially interlocking/articu-lated, depending on the extent to which the routes are lined with plot series.

In all three cases, using the two-way definition, the block can be defined as a plot series, either simple or composite, that is part of a tissue. It functions at the level of the tissue either as a serial block by simple composition, as a resultant block by co-inflection, or a shared block by interlocking. The respective structural types of tissue are serial, articulated and interlocking.

To define a block merely as an area isolated by several streets is a simplistic conception that separates rather than integrates it as an element of built form. Similarly, to treat it as merely part of a figure-ground pattern is to deny its internal structure and the connections that bind it into the fabric of urban tissue. By contrast, the conception of a block as a serial, shared or resultant form emphasizes its connections and role in the fabric.

Conclusion

A compositional hierarchy of physical built form that reconciles Conzen, Caniggia and Maffei's versions and explicitly takes into account the various forms of ambiguity can be seen as constituted by eight primary levels, best illustrated in a multi-level diagram (Figure 11).

The fundamental aim of clarifying the definition of built form and seeking to identify a version of the compositional hierarchy that accommodates and reconciles earlier conceptions has been to provide a consistent framework for comparison of the different aspects of urban form and examples of different forms from different times and places. One of the principal means of clarification is the two-way definition based on the compositional hierarchy, identifying both the position of the form as a part and its component parts. This follows the basic morphological principle of defining elements in terms of their position relative to other elements within a larger structure. The further aim has been to go beyond a naïve compositional hierarchy of buildings, plots and streets. The examination of a range of different but extremely common specific types of built form reveals that a rigorous conception of the hierarchy – that allows for the richness of overlapping sets – contains various types of ambiguity. The ambiguities are not anomalies that need to be expunged but regularities of

built form that need to be accounted for in a systematic way if we are to understand fully the structure and dynamics of the built environment. The multi-level hierarchical structure of built form is an emergent feature of progressive aggregation and composition and it is clear from the logical and structural analysis that the phenomena of *coextension* (single element forms), compression (composite forms), co-inflection (resultant forms) and shared and interlocking forms emerge with it.

But just as the map is not the territory, the multi-level diagram is not the substance of built form. The labelled hierarchy of generic structure and the multi-level phenomena are merely critical tools that allow us to investigate the diversity of built form, construct more rigorous and nuanced explanations, and get better results when we participate in its formation and transformation. And however rigorous we might be in identifying different patterns, there will always be equally rigorous alternative orders and patterns that focus on different features or attributes.

Nevertheless, the multi-level diagram helps to articulate the relationships between the kinds of physical form found at different scales in the built environment. The diagram also makes it possible to identify the limits of the apparent ambiguities of form and describe the phenomena in terms of specific relationships. The clarification of those relationships opens the way for potential advances. First and foremost, the generic structure of urban form provides the registration key to allow more rigorous comparative studies of different specific types of physical built form in context and in association with the other aspects of urban form. Such studies in turn pave the way for identifying developmental regularities and general processes that should form the basis for more extensive and rigorous theoretical and practical understanding. In addition, because the generic structure clearly identifies the three types of void and their position within the generic structure, there would appear to be significant potential for bringing together the complementary perspectives of the configurational, typological and historico-geographical approaches to urban morphology. Generic structure also points the way to a potentially very fruitful fusion of the concept of the type in urban morphology and the formal concept of type in mathematics.

Going back to poetry, if ambiguity is an inherent feature of built form, it is well to remember that ambiguity is an integral part of literature. Metaphor is a kind of ambiguity and ambiguity of levels can contribute to the power of literature. But knowing specifically how the ambiguity works does not lessen that power.

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