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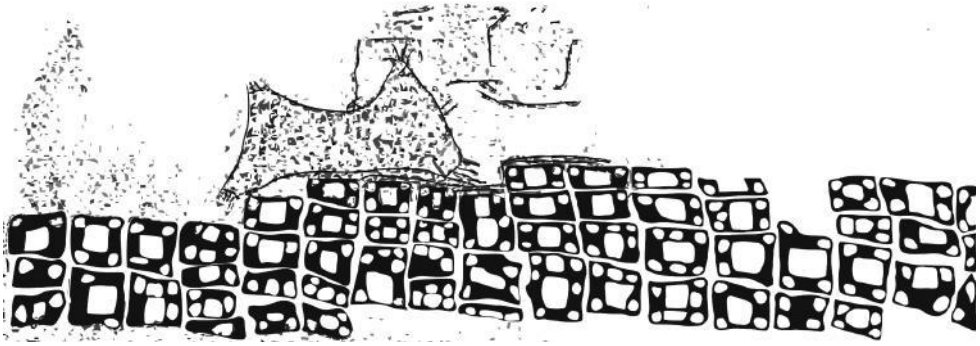
The Social Fabric of Cities

6 Notes on the genesis of form



The title of this chapter is of course a reference to Christopher Alexander's book on the creation of urban environments, *Notes on the Synthesis of Form*.[1] Alexander is interested in 'the process of inventing physical things which display new physical order, organisation, form, in response to function', the form-making process that leads, among other things, to buildings and cities.[2] Alexander considered how form responds to patterns of interaction and how such systems react to change. I would like in turn to explore the *implications* of spatial form as they involve our practices – as in the previous part of this book, with a particular focus on the moment when acts unfold into new acts by actors in association. The key difference from those previous chapters, however, is that the inherent relationship between act and space, previously seen as semantic and cognitive, will now be seen as fundamentally mediated by our bodies in space. I will explore a particular instance in the relationship between social and material processes, examining what I call the 'adherence of act and space', considered as an active force in the production of urban spatialities and complementing the meaningfully mediated 'reference of act and space' seen in Chapter 3 'Communication and space'.

I will argue that this adherence is part of the process of producing and folding space into urban space, bending extensity into structures which, through complex arrangements of built and open spaces, expand the possibilities of interaction and association – from the movement of bodies and artefacts to the transmission of information, or the endless webs of exchange that constitute urban life. In other words, this chapter attempts to identify the necessary connections between urban form and practices of interaction, and the inherent tensions in the passages between their

materialities, by addressing a classic problem for socio-spatial theory: the material processes and properties active in the shaping of cities as part of how social interactions come into being – or, to put it more simply, the spatial conditions of interactivity.

Indeed, if there is one element that is shared by different socio-spatial theories in different disciplines it is the idea that space is active in social processes, and vice-versa. For instance, the relationship between society and space is frequently seen as a dialectical relationship of materialities and processes reacting on each other in opposition, unity and contradiction, as social relations are inscribed in an arena of urbanised space that in turn constitutes social relations.[3] However, as Westin has recently stated, 'the social sciences in general and human geography in particular tend to overlook the physical dimension in the discussions of the urban. . . . How can we capture the urban as a socio-material phenomenon in a way that it takes into account both its tangible and intangible dimensions?'[4]

Of course most theories do not use the term 'effect', but if they are right in claiming that space matters, we must assume that space has a *presence* in social processes; that space becomes a material condition of anything 'social' that comes into being. My understanding of the idea of effect does not mean that as *a* affects *b*, *a* must be clearly separated from *b*; it does not imply detaching space from practice or seeing them as independent.[5] My use of the term is a way of addressing the threads that relate them, not as undifferentiated entities – given that acts and spaces are not the same phenomenon and do not consist of the same materiality – but evoke their inherent relationship, since no acts are free from spatiality and there is no space that does not effect how practice comes into being. Such effects do not determine phenomena externally, but are part of the process of their very materialisation – as ontological threads or necessary connections that constitute them as part of the world. The term 'effect' is a way of addressing these threads – a theoretical resource aimed at recognising a form of relationship emanating from the deep material properties (of space) and conditions (of practice). It is a way of grasping the active presence of space, its singular materiality and complex heterogeneity *as part of social practice*. Effects are forms of inherent relation – or more precisely, manifestations of tensions between entities of different materialities when they enter into relation.

If this were the case, space would be a condition that is 'necessary rather than contingent',[6] rather than a passive background to the social. It would also imply that different spatialities would provide different conditions for the emergence of social practices. Conditions for association would change, and associations could take different forms or directions in time, or not emerge at all.

Furthermore, if space does have effects on the social, it seems that the actual form of space must have been able to generate such effects *throughout its history*. If this is the case, even though we must always bear in mind the role of contingencies and non-causal events in any instance of the society-space relationship, it raises the question of whether space is somehow produced and urbanised – consciously or unconsciously – *in such a way as to have such presence and effects, so that its very materiality and properties are put 'on the side' of our practices*.

This question has clear teleological implications – but let us not forget that the very idea of a space that expresses, materialises and shapes social relations, as if caught in threads of causality, has teleological implications at its heart – in Aristotle's sense of 'final cause', as that for the sake of which something is, acts or is acted upon.[7]

This needs further clarification. If space really matters and the social comes into being through the actual practices of social actors, space must therefore be an active part of those practices. If that were so, the effects of spatial form would somehow be inherently part of our social practices and how they come into being. In other words, if there is a socio-spatial dialectics or an inherent relationship between the social and the spatial, it must go as far as our social practices in space, and the ways in which *practices become social* through space. An inherent relationship between society and space should be *enacted* in daily practices, and in the practices of the production of space itself. We must consider the problem of '(urbanised) space as an effect of practice' related to the 'effects of (urbanised) space on practices' as part of any inherent relationship between the social and the spatial. And if this silent material relationship is somehow enacted, it should be possible to find traces of it.[8]

So how can these traces be found? How can space be materially active in the ways our practices become social? I would initially argue that we need a richer concept of spatiality and how it is related to practices, in processes of *spatial formation*. A first point to be clarified here is the relationship between 'space' and 'spatial form'. Beyond broad notions of spatiality, such as 'striated spaces',[9] whatever else space is it is *also* defined by its durable materiality. Although space cannot be reduced to physical space, since it is ambiguous – extensity and meaning, material and immaterial, rigidity and void – space is tied to its distinct materiality.[10] Indeed, these particular material properties are very important in social reproduction. It is through the shaping of space into (tangible, durable) formations that space becomes part of the social; I will argue that it is through its very diversities of form that space may find a deeper role in social practices and processes.[11] My attempts at connecting the encompassing notion of space found in socio-spatial theory to the rich morphologies found in urban theories do not propose to avoid the physical dimension of space, but rather to recognise that, as part of the unique ontological condition of space, such a dimension must be part of space's relation to the social. I propose to go deeper into its inherent relationship with the social to understand how, as immediate spatiality, it involves social practices.

In this case, *what would the 'effects' of spatial form have to do with the 'generation' of spatial form?* Would individuals recognise such potential effects of form over their practices? Would they explore such effects in the actual production of space, even unconsciously? How might they do so? In short, how would the inherent socio-spatial relationship involve perhaps the most basic instances of the social – our practices of association – and the most basic constituents of urbanised space – such as the densities and heterogeneities of built form? I would argue that in order to understand the effects of form we need first to understand the reasons these effects exist and how they come into being. And I would suggest that we could best assess this condition by attempting to return to the processes that lead to the structuring of space in the form of cities in the first place, and relate them to the materiality of practices themselves, in the way they become *social* practices. I would suggest that the effects of form on practices of association could only exist if they were inherently related to the material properties of form, and already inherent to practices on their way to materialisation – therefore part of our relationship with form. The same material properties that create the effects of form would have to be active in the genesis of form. An initial hypothesis is that this is the only way in which such effects could

be part of the reasons why different cultures have produced space as urban space, adopting certain morphogenetic approaches among the many. I will consider the effects of form on association as 'material interaction' (that is, emphasising the material conditions for association, in addition to the informational conditions analysed in Chapter 3), attempting first to consider *form as an effect of material interaction*, in the following stages:

(1) An interesting – but not easy – way of pursuing such an investigation would be to try to understand how cities are born – and more precisely, how the *first cities* were born in different regions and urban cultures. Some kind of *genealogy* is needed to understand the emergence of the spatialities we now recognise as 'urban'. I shall include here a series of speculations on elementary city-creating processes, arising mostly out of the material conditions of interaction and association, discussing works by Jane Jacobs, Luis Bettencourt and Mike Batty.
(2) Exploring Hillier and Hanson's studies of the paths of spatial aggregation, this chapter discusses morphologies that seem to have historically defined the spatiality we now recognise as urban formations – starting with *the emergence of the urban block*. In an examination of prototypical formations and a hypothesis that urban formations are ways of intensifying mobility and interactivity, the invention of the urban block is investigated as a remarkable achievement in the material reproduction of emerging urban societies.
(3) Analysis of urban form as an effect of material association and interaction will lead to a series of hypotheses about how spatialities unfold and why they consistently become visibly complex formations in the histories of urban development in different regions – complex spatialities that seem to follow particular paths, some established over thousands of years, while others have only been arrived at more recently.
(4) Rethinking the fundamental processes of urban formation will allow a closer approach to the relationship between interaction and space. The final section explores Alexander's ideas on the synthesis of form, and addresses city-creation processes – including trial and error, randomness and necessity, knowledge and reflexivity, the changing requirements of interactivity, and the role of contingency, context and idiosyncrasy – to reject an exclusively evolutionary, Darwinian explanation for the urbanisation of form. I hope that this will allow a better understanding of the *effects of form on interaction* in the following chapter, 'The social effects of architecture'.

Spatial formations and the material condition of association

> The urban is not a soul, a spirit, a philosophical entity . . .
> [It] cannot go without a practice-material base, a morphology.
>
> Lefebvre in Westin (2014:154)

> . . . what we want is to understand how such non-physical things as purposes, deliberations, plans, decisions, theories, intentions, and values, can play a part in bringing about physical changes in the physical world.
>
> Popper (1972:229)

Theorists from completely different epistemological approaches remind us of relationships between physical and non-physical entities. Popper sees them in relationships between social ideas and the physical world, whereas Lefebvre sees them in space itself. Of course Lefebvre did not forget the concrete condition of space as a 'set of relations between things', he also relentlessly denounced the risks of the 'illusion of opaqueness', the belief that space can be understood only by surface appearance.[12] Like Lefebvre, Edward Soja does not ignore physical form in spatial causality and the socio-spatial dialectic. Exploring Aristotle's idea of *synoikismos*, the impulse for collective life in the city,[13] Soja has called for greater attention to the impulse for urbanisation, found especially in Jane Jacobs's 1969 book, *The Economy of Cities*, and to the particular spatiality of cities, or the 'spatial specificity of urbanism'.

Of course the impulse for spatial formation is not unknown to spatial economics. Since the early nineteenth century, economic geography has located the origins of cities in agglomerations generated by centripetal forces, and by externalities of processes of production and exchange.[14] Nevertheless, I would like to try to go beyond the usual reduction of 'practice' to 'economic action' in economics, to address the genesis of urban form as part of the emergence of networks of practices. I would also like to get closer to the elementary material processes and properties active in urban formation, which are often absent from economic and geographical analyses, in an attempt to identify the social and material tensions that constitute the inherent relationship of practice to space.

An interesting recognition of this social dimension – rather than spatial – can be found in the physicist Luis Bettencourt's recent work on the reasons for the existence of cities as interdependencies between morphology and social interactivity. Cities are seen as social networks of people and institutions, whose physical organisation allows the exchange of goods and information. In the spirit of economic theory, Bettencourt sees cities as a fluctuating balance of density, mobility and social connectivity. Taking into account costs related to distance, cities will emerge if there is a positive balance of outputs resulting from interactions, since cities are likely to promote greater mobility and density, increasing potential for social contact. Bettencourt recognises that cities may also not realise their full social potential if mobility costs are higher than the benefits stemming from their densities. Looking into a very extensive pool of empirical data, he finds that cities tend to *accelerate interactions* as they grow, in a progression of greater proportions. For instance, when cities double their size, communications tend to occur more than twice as much.[15] Continuous adaptation is the rule, rather than equilibrium. But, as insightful as this Jacobsian relationship between social networks and cities may be, Bettencourt admits that his theory is still far from the rich spatial variations found in cities.

The leading theorist of spatial interaction, Mike Batty, comes closer to these variations, emphasising the importance of physical proximity in the city's development processes: 'Cities develop by filling the space available to them in different ways, at different densities, and using different patterns to deliver the energy in terms of the people and materials that enable their constituent parts to function.'[16] An interesting element in Batty's recent work is a somewhat belated recognition:

> Cities, as Glaeser and Jacobs before him have argued so persuasively, are about 'connections'. . . . The various processes that take place in cities, which bring

> people together to produce and exchange goods and ideas, define a multitude of networks that enable populations to deliver materials and information to support such endeavour. (p.30)

Social networks will be critical to a new science of the city as 'sets of *actions, interactions, and transactions* . . ., patterns of flows, of networks of relations, pertaining to both physical-material as well as ethereal movements'.[17] Location still matters, but only as 'places that anchor interactions', and as 'patterns of interactions acting as the glue that holds populations together through flows of material, people, and information' and 'the nodes that define the points where processes of interaction begin and end'.[18] Since the 1980s, Batty has been considering processes of space-filling growth in urban formation as a modular construction, a progressive aggregation of cells simulated through models of *diffusion-limited aggregation* (DLA).[19] Based on principles of physical contiguity and adjacency for establishing spatial relationships inherent to growth, the complex forms that emerge from such dynamic models evoke the main tree-like structures apparently found in cities. But, as Alexander would have it, 'a city is not a tree'.[20] These representations fail to grasp a common feature of cities: the generation of interconnected *street networks* linking cells, related perhaps to the practical need for mobility. This implies consideration of the emergence of a crucial process in architectural aggregation, a most striking feature that seems to differentiate the spatialities of cities from those of non-urban settlements: how are cities formed in such a way as to generate the systems of 'rings' of built forms we call 'blocks'? If we are to understand urban formation as part of the processes of association, it would seem that we have to account for the remarkable morphogenesis of the urban block.

The invention of the urban block

> . . . because cities are still largely observed as if they are in equilibrium, progress has been slow in building ideas about how various urban morphologies evolve and change.
> Batty (2013:245)

Why has the urban block been created by different societies? Why has it become so emblematic and so uniquely defining of the form of the city? Why is there no consistent appearance of these deformed rings of built form in non-urban spatialities? Before asserting the block as an 'innovative material counterpart' for socialities in growing association, it would be useful to compare it to other spatial renditions of the material problem of agglomeration. Although only introduced in this chapter, this initial comparison will suggest that the block is a most extraordinary event in the emergence and consolidation of the city in different spatial cultures. While urban or proto-urban formations *without* blocks may be found in archaeological record, of more or less scattered arrangements without fully defined systems of access channels around built forms, the block is the most constant element in the stabilisation of spatial formations that came to be defined as 'urban'.

However, first we need to define what an urban 'block' is. A tentative definition would describe an aggregation of buildings within a convex area, defined by continuous specialised channels for movement and access, regardless of the shape of this area. This aggregation is arranged as a 'deformed ring' with a virtually infinite

number of shapes. Revisiting practical aspects of the emergence of the urban block among possible morphologies, the crucial point to explore is the reason for its consolidation in urban societies in different regions and cultures, seemingly with no contact between each other.

Second, it is important to clarify that in speaking of morphogenetic processes, I am not evoking biology as a model, but instead looking for precise terminology for addressing the process of creating form. In *The Social Logic of Space*, Hillier and Hanson approach this process as *restrictions in a random process*, seeing urban morphology as a system containing underlying social rules – the 'genotypes' – active in the generation of relationships between components of urban form that are deemed necessary rather than contingent.[21] The formation of settlements is investigated as a cumulative process unguided by intentional or conscious design. The structure of settlements emerges from local rules of aggregations whose cells – from houses to buildings – have at least one of their faces open, along with empty spaces between them, arranged in such a way as to be continuous. The rule is to join open spaces together while randomising other spatial relationships (Figure 6.1). The 'global form' of aggregates of cells 'has arisen from the independent dynamics of a process that is distributed among a collection of individuals . . . although the global structure of the object has arisen through the agency of those who constructed the object, the form the object has taken is not the product of that agency, but of *spatial* laws which are quite independent of that agency'.[22] It is not a simply random process – otherwise we would build cells without access and open spaces fully disconnected from each other.

Hillier and Hanson ask, 'what was the nature of these restrictions, that is, the "rules", and how did they relate to each other?' [23] This morphogenetic process can be controlled to a greater or lesser extent, ranging from random structures to visually ordered patterns (Figure 6.2), particularly in appearance rather than in their deeper

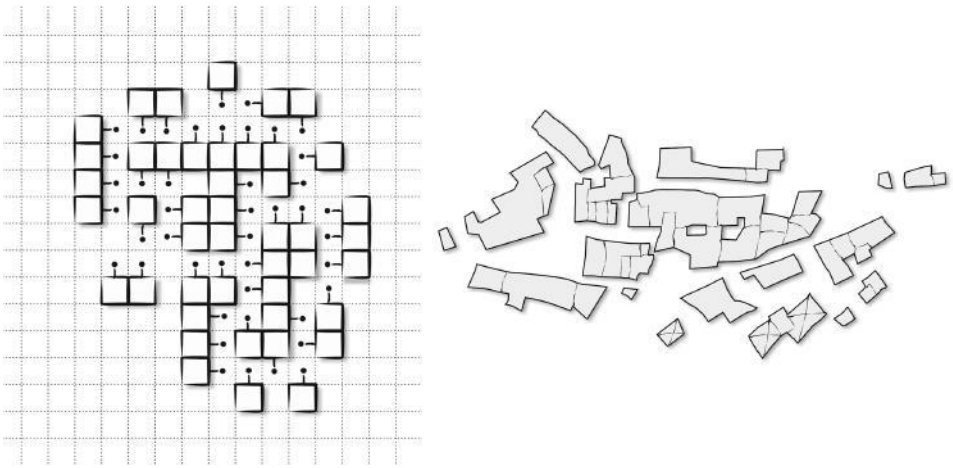


Figure 6.1 The genesis of a settlement: experiment with cell aggregation (left), and Le Petit Clements in 1968, France (right)

Source: Elaborated by Netto and Cacholas after Hillier and Hanson (1984).

topological structure. Interestingly, Hillier and Hanson recognise such a process to be shaped by (i) requirements of human practice, based on physical access to cells; (ii) different levels of order and disorder in the production of settlements in different spatial cultures; (iii) an inherent social dimension expressed in the form of encounter patterns related to and emerging from spatial patterns, ranging from less to more controlled, interpreted through Durkheim's twin concepts of organic solidarity (based on instrumental interaction between functionally different actors) and mechanical solidarity (based on symbolic interaction between socially similar actors). These patterns are associated with degrees of accessibility (from segregated to integrated spaces) latent in and generated by relational complexes that constitute the spatial configuration of settlements. These material forces would shape spatial form from its very foundation, namely the 'beady ring' of aggregated open spaces as an elementary complex in the emergence of continuous street networks – a 'fundamentally linear logic of urban space'.[24] Of course this view of morphology reverses the focus on occupation and the aggregation of cells in the urban block system. The centrality of movement and encounter patterns for different societies have led Hillier and Hanson to emphasise systems of open spaces theoretically and empirically, from buildings to settlements and cities.

These are some of the main original ideas behind the emergence of urban form as a process of cellular aggregation. Of course, they face a natural difficulty regarding empirical demonstration, and can hardly account for actual historical processes with any certainty. We simply do not have a recorded genealogy of the urbanisation of

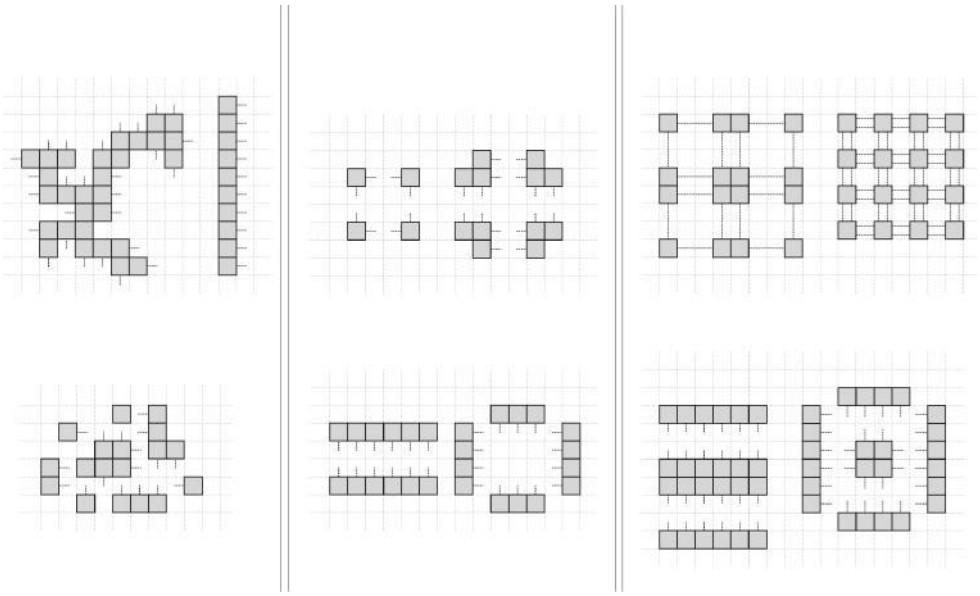


Figure 6.2 Elementary variations in cell aggregation: from fully random arrangements unable to generate permeability (top left), through permeable aggregations in 'islands' (bottom left) to linear aggregations and convex arrangements (centre and right)

Source: Elaborated by Netto and Cacholas after Hillier and Hanson (1984).

space. Exploring the fact that this is an open research question, I would like to investigate some processes in the genesis of urban form centred on the urban block as a key spatial feature, situating this process as an expression of a 'generalisation of proximity', as both a material force and an effect in the emergence of cities as systems of material interaction. Even though my emphasis is on the material properties at play, an attempt should be made to look at historical traces of urbanisation found in different regions and to explore a few prototypical cases.

(Possible) events in the morphogenesis of the urban block

> If the world were totally regular and homogeneous, there would be no forces, and no forms.
>
> Alexander (1964:15)

> The forces that shape these dwellings and give them clearly identifiable characteristics, and their lessons for the present day, have been my primary interests.
>
> Rapoport (1969:vii)

> Architecture will remain a collection of walls and spaces unless it is animated by questions about social structure, cognitive worlds, and domains of interaction.
>
> Banning and Chazan (2006:13)

Archaeological records show recognisable urban or proto-urban formations close to the deformed ring formation characteristic of the urban block, mostly in two ways: (a) buildings relatively scattered within convex spaces defined by continuous channels for access and movement; and (b) linear aggregations of cells forming actual rings also defined in close relation to the channel system. An illustration of the former would be the Maya urban tradition, which remained for 2500 years in Central America and produced cities like Chunchucmil on the Yucatan Peninsula (corresponding to Mexico today). In Chunchucmil, paths extend from the monumental core towards the residential area. These elementary street systems circumscribe irregular convex areas with architectural units arranged to share common internal areas. Even without the density found in other Mayan cities such as Mayapan, this arrangement provides a possible indication of the formation of blocks or 'proto-blocks' (Figures 6.3a and 6.3b). A similar network of paths circumscribing occupation areas is not found in the case of a classic example of early urbanism in Ur, the Sumerian city founded in around 3800 BC and reaching its peak in around 2000 BC in ancient Mesopotamia (today's Iraq). Instead, a tree-like system of paths along continuous edges of densely occupied areas is clearly visible – without forming complete rings (Figure 6.3c).

In both cases, paths are spaces for movement. Unlike other Mayan cities, Chunchucmil has open spaces that are differentiated for movement and occupation, separated by low walls.[25] Ur, in turn, has compact aggregations of buildings in quasi-blocks in prototypical form, connected by a tree-like street system. The settlement differentiates between public and private spaces by the border of buildings themselves: axial external spaces on the one hand, and private internal spaces on the other.

I am interested in these two prototypical cases as a way of looking closer at the process of aggregation of architectural cells defining or defined by paths, leading to

Figure 6.3 (a) and (b) The emergence of patterns of occupation and path networks in Chunchucmil; (c) proto-blocks in Ur

Source: Elaborated by Netto and Cacholas after Hutson (2012), Vis (2013), and Benevolo (1980) respectively.

the main spatial characteristic of the urban block. Let us now speculate on possible events in the emergence of the block as a solution found in different spatial cultures – a solution that somehow came to dominate the stimulus towards urbanisation in different regions of the world, to an extent that it became an essential feature of the city.[26] As I have mentioned, my description seeks to situate the emergence of the block in close relation to the material requirements of social practice – and vice-versa. I shall illustrate these morphogenetic events by looking at the earliest signs of urban concepts in the light of new archaeological data from proto-historic sites, especially the Pottery Neolithic site, during the Late Prehistoric and Proto-historic Near East (Jordan, Turkey, Syria, Israel) from the eighth to sixth millennia BC, which are landmarks in the transition from early villages to urban sites. As evidence of clustering processes is limited by the impossibility of full-scale excavation, we should avoid the 'oversimplification of the evidence' and the tailoring of data to fit a particular model.[27] These reflections must be seen as hypotheses. There is no intention of offering few cases as demonstrations of spatial processes, let alone asserting a universal morphogenetic process. Neither could these suggestions claim the status of a theory. They will describe processes that may be part of urban formation but which might not have occurred at the origins of urban settlements in every region and spatial culture.

(i) *Pedestrian and solar access to pedestrian cells*. Spatial arrangements are deeply related to architectural form. Two of the determining factors are *pedestrian access* (emphasised by Hillier and Hanson) and *solar access* (emphasised by Phillip Steadman) to architectural cells.[28] The need for pedestrian and solar access requires that at least one face of the cell be connected to an open space. There are a number of solutions to these determinants, some of which are archetypical cells in *circular* and *rectangular* form (Figure 6.4a). Cells can have access from at least one side.[29] Cells with front and rear entrances are typically found in European urban cultures, for instance. A second archetype distinguishes solar access from pedestrian access by incorporating an open internal space (Figure 6.4c), as the courtyard house in Near Eastern Pottery Neolithic sites, with apparent benefits of allowing domestic activities, minimising solar heat and allowing water reservoirs as humidity-control devices.[30]

(ii) *Agglomeration by proximity and adjacency*. Spatial arrangements include possibilities of association between cells, from agglomeration by *proximity*, where cells are near but separated by open spaces (Figure 6.4b), to agglomeration by *adjacency* allowing continuous aggregation (Figure 6.4d). The first case relates naturally to the circular cell, a spatial form not very conducive to associations by adjacency, characteristic of more dispersed arrangements. It appears frequently in records of non-urban spatialities, where built space tends to be dominated by open space and distances between cells. Circular hut compounds are arranged around a central space where production occurs. Conjugal partners (a man and his wives, say) may have huts grouped together, separated from relatives (such as brother and his wives). Huts may also be segregated by gender. Members of the compound are related, forming a basic labour group.[31] The second archetypal case is the *rectangular house*, involving partition and adjacency, where individual buildings are grouped into larger clusters constructed with their own outer set of walls, used as a foundation for the new building or wall sharing without an interconnecting passage as segregated work spaces (labour is not shared) (Figure 6.5).[32] They seem to relate to the creation of institutions that move beyond kinship in 'household-type societies'. Tasks require a large number of individuals, marked by competition and cooperation: each house unit contributing to the completion of communal tasks benefited from their participation.

There are evidences of two key transitions in historical morphogenetic processes: a concomitant change in house form, *from circular to rectangular structures*, and the use of *nearly right angles in architectural aggregation*.[33] These transitions were introduced by Kent Flannery's seminal argument concerning the relationship between architectural form, settlement structure and social organisation in sites located in the southern Levant and Iraq. Alterations indicated larger social changes that were not readily apparent.[34] Clustered neighbourhoods, identified with the rectangular house form, allow for greater intensification of production, more stable socio-economic units, and the creation of supra-kinship bonds, making the individual house subordinate to larger social and economic formations. In this way, clustered settlements are able to expand beyond the limitations placed on circular hut compounds in terms of community size, as well as overcome issues related to available labour. Change in house

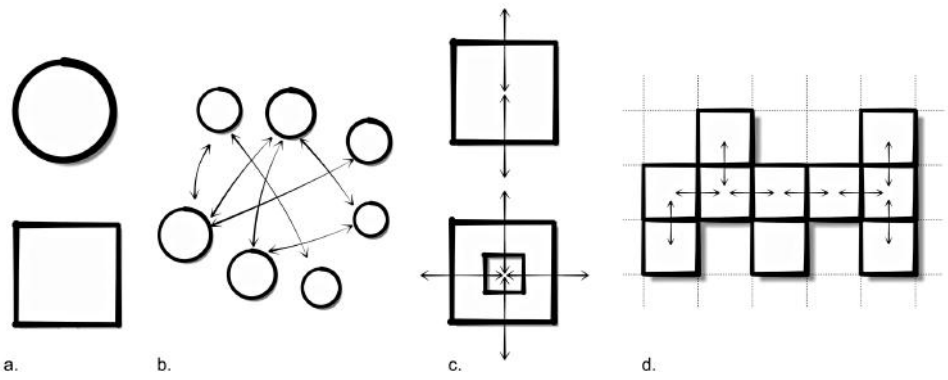


Figure 6.4 (a) Archetypical cells; (b) agglomeration by proximity; (c) rectangular cells; (d) agglomeration by adjacency

Source: Elaborated by Netto and Cacholas.

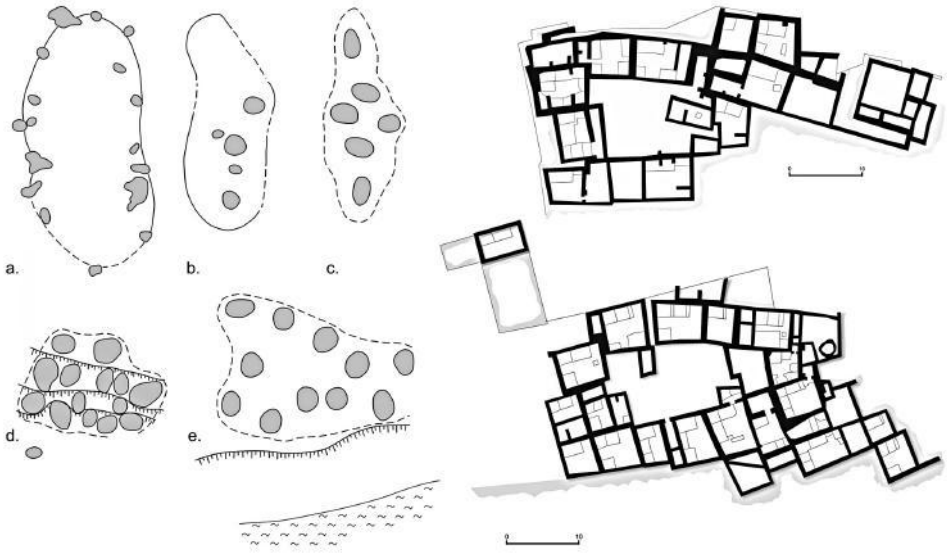


Figure 6.5 Arrangement of dwellings from European Palaeolithic (a. Kostienki I, b. Mezin); European Mesolithic (c. Bergumermeer), and Near Eastern Pre-Pottery Neolithic (d. Nahal Oren, e. Çayönü); and Çatal Höyük (Pottery Neolithic settlement in today's Turkey)

Source: Elaborated by Netto and Cacholas after Kozlowski (2006) and Mellaart (1967), respectively.

form and social organisation relates to population increase. Cutting identifies this arrangement as the primary level of social organisation and one of the most important and enduring traditions in the Central Anatolian Neolithic (Hacılar, Boncuklu Höyük, Çatal Höyük East, today's Turkey). These 'quintessential examples of agglomerative architecture'[35] were also found in cross-cultural ethnographic studies in Jordan and North Africa.[36]

(iii) *Emerging partial alignments*. Looking at aggregations by adjacency, more appropriate for reducing distances between built forms, Hillier and Hanson observed that certain random arrangements (Figures 6.6 and 6.7a) might prevent the continuity of open space and access to built forms.[37] Interestingly, arrangements such as this have been produced in the Proto-historic Near East. Buildings were often constructed directly adjacent to one another, leading to extensive formations with no doors or spaces left for linear interconnected spaces that might have served as streets. There are open areas within neighbourhood blocks, however, as 'negative spaces' generally used as 'midden' areas. The neighbourhood blocks are separated from one another by streets, large courts and alleys.[38] Mellaart identified these large 'blocks' of agglomerated architecture at Aşıklı Höyük and Çatal Höyük (Level VIB), with a marked pattern of repetitive architecture over time. Mellaart believed that this extended aggregation related to protection from enemies, seemingly inducing access to cells from the roof, a hypothesis rejected by Cutting and others. The absence of passageways may relate to occasional enlargement of buildings occurred by encroaching onto the small areas of remaining open space left. 'Locking-in' patterns

such as this, associated with changes in socio-economic activity, might have led this particular spatial culture to abandon the (then) traditional agglomeration in large blocks (Figure 6.6).[39]

Architectural cells need to retain pedestrian and solar access (item (i) above), and maintain the possibility of continuity of open spaces. Practical requirements for the continuity of open space and full facial connection are met through *partial alignments*, allowing the progressive addition of cells. Hillier and Hanson point out that architectural cells are not likely to connect at their corners (as in Figure 6.7a). This result in the emergence of *linear* aggregations of cells connected to open spaces (Figure 6.7b), especially recognisable in early Mesopotamian urbanism (fifth millennium BC) (Figure 6.7c) – but also earlier, as we shall see shortly below.

(iv) *Bending rows*. Aggregations that reduce distances between built forms also favour access and reduce time and effort expended in movement: the importance of such material features in intensifying bodily-mediated interactions and moving artefacts can hardly be denied.[40] This material condition was of course realised at the very origins of economic geography and already seems to be active in elementary aggregations between architectural cells, in the formation of pre-urban settlements,

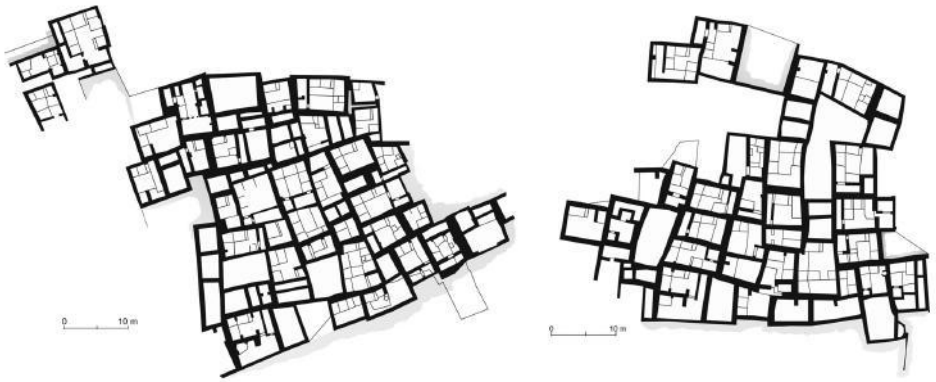


Figure 6.6 Çatal Höyük, plans of building-level VI B and VII

Source: Elaborated by Netto and Cacholas after Mellaart (1967).

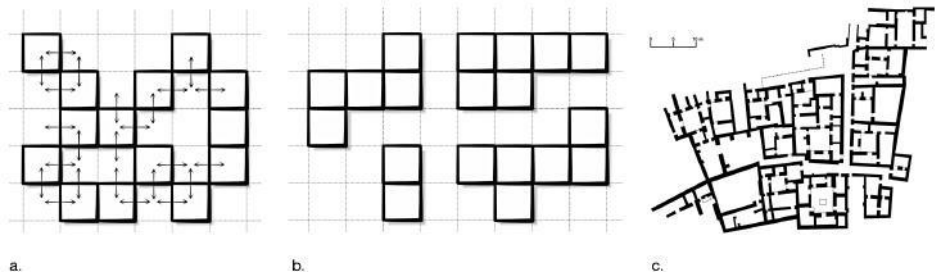


Figure 6.7 (a) The aggregation of cells is hampered by the association at the corner and fails to produce a system of open spaces – elements solved in the aggregation (b) and (c) in Ur

Source: Elaborated by Netto and Cacholas; figure (c) after Benevolo (1980).

in ways that extend well beyond instrumental practices and material reproduction. But might there be limits to linear aggregation? Linear aggregation may lead to continuous rows (Figure 6.8a). Also, as Bürkin and Peterek point out, the existence of rows on both sides of a street also brings advantages, initially by minimising distances and increasing densities of people.[41] But there is one crucial reason why linear formations cannot continue lengthwise ad infinitum, which is perhaps a reason for their transformation over time. Long linear arrangements tend to *increase* distances between built forms and are therefore unable to fully generalise proximity, tending to bring friction to interaction as they grow. A key event in morphogenesis seems at some point to involve *bifurcating* or *bending* linear aggregations (Figure 6.8b), generating new branches of rows and channels, in a morphic stage illustrated (incidentally or not) by Heptonstall's morphology in nineteenth-century England (Figure 6.8c).

(v) *Folding rows over themselves*. Bending the extensity of form raises more potential problems for the practice of interaction. These ramified rows, whose potential positive effects on interactivity (intended or otherwise) tend to be greater than simple linear aggregations, can easily lead to a *tree-like formation* which when sufficiently extended still imposes limits on the generalisation of proximity, namely between branches themselves. With the addition of new cells, more permeability is required for movement. Permeability is of course achieved by adding more bends, curving rows until access channels meet others or new channels are formed. Aggregation seems to 'fold over itself', progressively taking the form of the deformed ring, in architectural clusters of 'islands' (fairly compact or otherwise) surrounded by open spaces. This remarkable morphogenetic achievement leads to the creation of the urban block (Figure 6.9a).

According to Ben-Shlomo and Garfinkel, the transition to cell aggregation in rows along streets as a major morphogenetic event may already be found in the Pottery Neolithic site of Sha'ar Hagolan, which also presented a new type of dwelling likely used by extended families – the *courtyard* structure. These modular arrangements were built along both sides of paved passageways, and extended into an actual street network with main roads and small alleys, some oriented on a north–south axis, others on an east–west axis. The street is clearly a communal space, requiring maintenance and organised communal effort. This indicates a sophisticated settlement plan – the earliest street system found in the Jordan Valley, associated with infrastructure

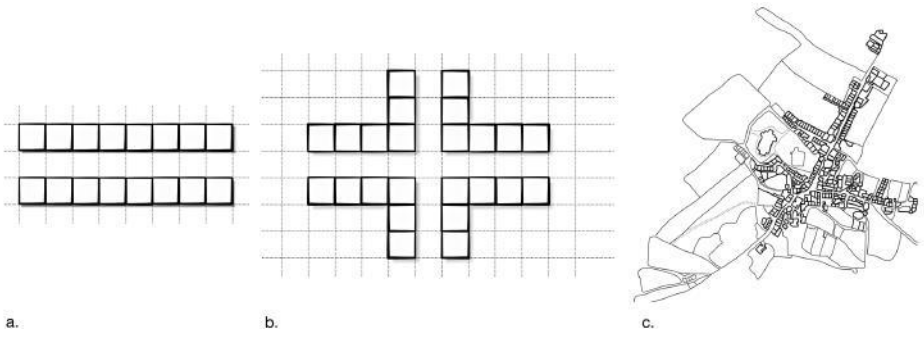


Figure 6.8 (a) Linear aggregation; (b) bending the row into crosses and tree-like formations; (c) an interesting morphic stage found in Heptonstall, England

Source: Elaborated by Netto and Cacholas; figure © after Hillier and Hanson (1984).

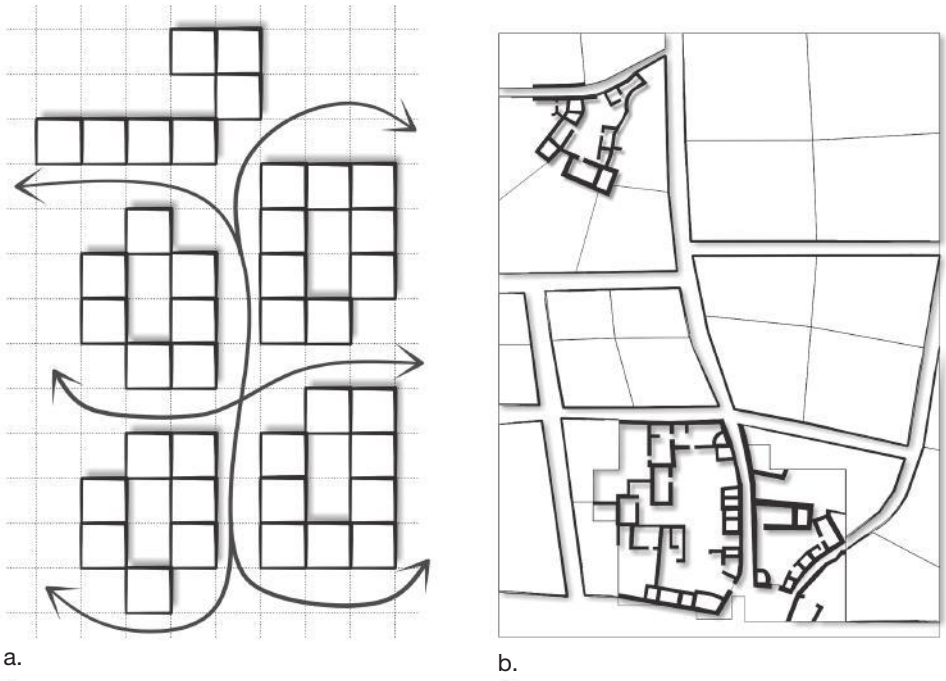


Figure 6.9 (a) The successive bending of aggregation forming rings; (b) excavated sections in Sha'ar Hagolan

Source: Elaborated by Netto and Cacholas; figure (b) after Garfinkel (2006).

(water wells), and indicating cooperation on a large scale[42] – which is seemingly an early materialisation of the concept of the block/street system (Figure 6.9b).

Developments in the Early Near Eastern Neolithic period are dominated by a range of agglomeration processes, and appear to have progressed in geographically varied and polycentric ways, influenced by regional environmental conditions, and by the increasing role of interaction between regions.[43] Local-to-global aggregation in horizontal and vertical association expressed forces of growth and expansion by adding the use of the third dimension, and adding increasing spatial pressure by allowing a higher population density within settlements. Social and spatial agglomeration continuously gave rise to cooperative structures, and cooperative structures in turn led to more agglomeration processes, and adaptations to more complex social and socio-economic structures.[44]

The spatiality of the block involves interesting properties regarding human occupation. The deformed ring of built forms, perfectly continuous or not, has another property: high capacity for absorbing density and activity, as demonstrated by Leslie Martin and Lionel March.[45] Aggregation in successive rings progressively generates *sets of blocks* and broader conditions for mobility, while 'filling the space available', to recall Batty, allowing the predominance of built spaces over open spaces, and of axial spaces over convex spaces (which we have come to call 'squares').

This is where *block* and *street systems* are born and inextricably coupled together, as morphological features shared by most cities in different cultures and regions. This dual system can of course contain some quite diverse spatialities, from the seemingly chaotic to the visually ordered, depending perhaps on the levels of conscious intent and rationalisation during the processes of production. As many studies by Hillier and colleagues have shown in contemporary cities, distortion of the resulting spatial formation does not necessarily bring practical problems in terms of mobility, as higher-order hierarchies emerge relating to different scales of movement and activity, from local to global, within the city.[46]

(vi) *Emerging blocks and the problem of size*. But the size of blocks does matter, however. As Jacobs realised in her *Death and Life of Great American Cities*, they cannot be so large as to increase distances (Figure 6.10a). Nor should they be so small as to generate high permeability but a low proportion of built form relative to the amount of open spaces invested in street systems, leading to low, unsustainable densities of built form and people – especially in places with high accessibility, centrality and potential for interactivity. Indeed, Arnis Siksna's studies of American and Australian cities identified beneficial effects of small blocks of 60–80 m and 80–110 metres in length (less than 10,000m^2) on pedestrian movement.[47] Siksna also found that smaller blocks tend to keep their original configuration, suggesting that they can well support changes in built form over time. Large blocks (greater than 200,000 m^2) tend to change considerably over time, with the addition of streets and alleys.

Studies by Hillier and Karimi show that urban centrality is associated with accessibility effects related to block sizes: much higher densities of (smaller) blocks with a higher area–perimeter ratio are likely to be found in urban central areas, and increase overall accessibility – *not just local accessibility*, as Jacobs and Siksna supposed. Studies in London by Chiaradia *et al*. confirmed Jacobs's proposition and the findings of Siksna and Hillier, showing that reduced block sizes increase permeability with the surroundings, increase linear and surface frontage and reduce journey times. Analysing a larger international sample ranging from ancient to

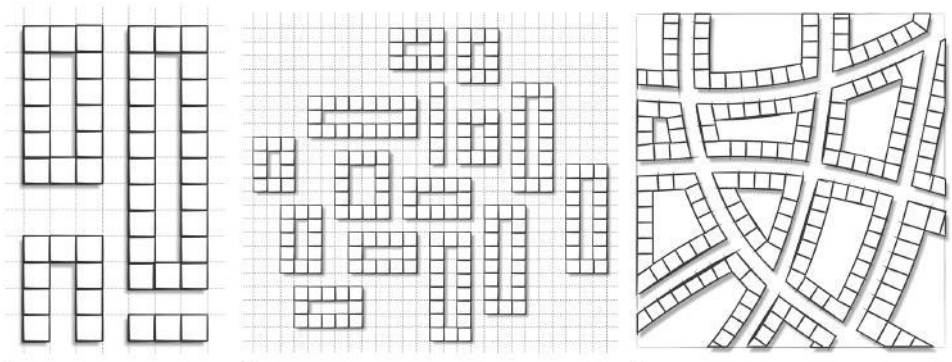


Figure 6.10 (a) Large blocks impair mobility by increasing mean journey lengths; (b) a fragmented street network has similar effects, adding difficulties in way-finding; (c) block systems with continuous street network create conditions for interactivity

Source: Elaborated by Netto and Cacholas.

contemporary case studies, Porta *et al.* have also found empirical evidence of consistent patterns in the smaller scale of main street networks in traditional urban areas.[48] Considered together, these findings suggest that when settlements grow, the blocks at their centres tend to be broken, creating a denser block/street system, with beneficial effects on mobility.

(vii) *Block systems and the continuity of open spaces*. Systems with urban blocks of varying sizes may also be arranged into a fragmented street network (Figure 6.10b), to the point of loss of intelligibility.[49] The extreme case is the labyrinth, an archetypal morphology associated with spatial (and psychological) disorientation. Local discontinuities, once generalised, also increase the average length of possible urban routes, countering the morphological effect of generalisation of proximity allowed by block/street systems and affecting mobility. The local effects of block sizes on mobility have to be coupled with larger-scale properties that give rise to the accessibility structures found in cities – instead of tree-like formations or mazes. The more continuity is broken, the more material efforts will be needed, eventually leading to decreases in the combinatorial potential of new interactions.

This description might suggest a linear process due to the chain of argument and its retrospective character, but I certainly do not consider this a fixed sequence. If these events occurred in urban or proto-urban settlements, they need not have done so in a particular order, and are probably subject to contingent conditions, which will be discussed in the next section.

Urbanising interactivity

These hypotheses of events in the spatial genesis of the urban block as a means of generating conditions for the compression of networks of material interaction offer an initial interpretation of the processes behind the synthesis of urban spatiality as an expression of interactivity. The implication here is that block systems have the potential to expand the number of directions of movement exponentially, providing exceptional gains, while limiting control and increasing the potential for interactivity.[50] Cities can thus generalise density, proximity, and connectivity between actors. The formation of block systems allows variations in urban routes, expanding possibilities of exchange, which is an interesting element in societies with a complex division of labour. Even if there is no conscious intention behind such processes, these factors are likely to be associated in a circular causation process *a la* Myrdal, leading ultimately to the emergence of differences in cities.

This allows the *relationship between morphology, mobility and interactivity* to be seen as a key instance of the society-space relationship, albeit an underestimated one. Complex systems of interaction seem to rely on/expand the randomness of interaction that is important in generating new relationships in social systems and positive externalities in emerging microeconomic systems. At the same time, social reproduction requires the recursivity of practices and interactions.[51] Such relationships also allow the proposition that interactivity is also a reason for the consistency of block sizes observed in different spatial cultures,[52] to be examined below. Finally, if generalising proximity is an issue, *agglomeration by adjacency* is a more intensive way of achieving it than agglomeration by proximity – extending the regional forces that generate agglomerations seen in economics into local, morphogenetic processes.[53] The morphology of the deformed ring and the spatial possibilities introduced by the

block system, regardless of origin or exact form, seem to have enabled unprecedented levels of occupation, mobility and interactivity.

Of course, as Durkheim reminds us, a selection of cases does not corroborate a hypothesis, even if partial support can be found in previous studies.[54] These processes call for a systematic immersion in archaeological records, to see how the block emerged in different spatial cultures, possibly without contact with each other – something that can only be anticipated here. The historic role of the block system as a means for the intensification and diversification of interactions and for material resilience in emerging urban societies needs further exploration and empirical verification before it can in fact be determined as a quintessential component of the urban.[55] Also, we need to avoid teleological reductions of this morphogenetic process as stages that lead *necessarily* to a kind of spatial order – in this case, the varied configurations of the block system 'at the service' of interaction.

Some questions may help prevent such reductions, in fact. Are cellular aggregation and the block inevitable formations in the urbanisation of space? How does aggregation lead to larger formations and variations in cities? How do they relate to social and economic forces operating at larger, regional levels? How could the aggregation of built forms in block systems be stabilised as part of the development of cities in different spatial cultures? Is this process anything like a teleological, Darwinian 'selection of the fittest forms'? In order to answer these questions, we need to identify in more detail how social activities and interactions materialise in space, and how complex urban formations are part of that process – in other words, how cities can express and support the diversity of actions produced by societies that grow in complexity.[56] We also need to understand the part played by randomness, contingency and causality in morphogenesis. There is a field in the city-creation process where these properties simultaneously and jointly come into play, and this field needs to be clarified.

Morphogenetic pathways to the city

> . . . while there is ample evidence for the propensity of human social groups to generate complex adaptive solutions to the plethora of social, political and economic problems with which they are faced, equally there are many instances in which disorder and collapse can emerge as unanticipated consequences from well-ordered and apparently stable organizations.
>
> Van der Leeuw and McGlade (1997:3)

> . . . freedom is not just chance but, rather, the result of a subtle interplay between something almost random or haphazard, and something like a restrictive or selective control – such as an aim or a standard – though certainly not a cast-iron control.
>
> Popper (1972:232)

> The only reason we have for thinking that there must be some kind of fit to be achieved between [form and social context] is that we can detect incongruities, or negative instances of it.
>
> Alexander (1964:26–7)

I would now like to explore a set of potentially active processes in the morphogenesis of the block/street system formed by associations of adjacency, and the development

of such localised emergences into larger formations. These processes may overlap or come and go, as parts and versions of the same story. The descriptions below seek to leave room for contingency and unpredictability, while retaining a possible role for materiality as a potential causal force. Finally, they relate to instances that seem crucial if the society-space relationship is to involve practices and their immediate spatialities – relating also to theories aimed at recognising traces of such a relationship.

(a) Randomness and necessity in the relationship of form and interactivity. Batty's work on aggregation asserts that form-making processes through modular construction do not simply ensure that parts of the system are efficiently combined. Notions such as modularity, self-similarity, recurrence and hierarchy would be central to the way in which urban form is structured. 'Indeed, one of the hallmarks of systems that evolve in relatively stable ways is that they grow in terms of their modules, with each of their components adjusting to those they are most closely related to as they evolve in terms of size and complexity.'[57] These transformations would be able to produce and preserve structure, affecting the system through small local adaptations that gradually converge in configurations appropriate for urban life. Christopher Alexander sheds further light on this:

> How can a complex system find its way to a good configuration? In a theoretical sense, we may say that the system walks through configuration space, taking this turn and that, and always arriving at a well-adapted configuration. The huge question, of course, is how this walk is controlled: what are the rules of the walk, that make it lead to good adaptation? Although a few, very preliminary answers have been given to this question, no good ones have yet been given. This is perhaps *the* scientific question of our present era.[58]

Both authors deal with form-structuring processes capable of responding to and generating urban life, produced from little additions and changes. Batty evokes a Darwinian principle of selection of shapes that 'slowly but surely preserves the fittest in the population and destroys the rest. This view appears increasingly attractive in explaining the growth dynamics of a variety of nonbiological organizations such as cities'. Batty suggests that 'it is now possible to simulate such evolutionary processes, thereby suggesting how "good" designs might emerge among a universe of possible designs'.[59] Batty and Alexander share understandings about urban formation that can be seen as teleological, and more specifically, evolutionist. But urban formation is not a completely random process either. First, the initially infinite possibilities of combinations of cells are reduced by the practical need for aggregation between interdependent actors. Many combination possibilities would be unsuitable for the requirements of mobility and interactivity, as we have seen above. Second, they are limited by the very extensity generated by an emergent structure, even if shaped in rings and block systems that can allow a heightened interactivity. This idea of course converges with Hillier and Hanson's morphogenesis as a random process subject to restrictions stemming from the inelastic materiality of space and from particular forms of social life.

Another noteworthy point is of an entirely logical nature: the morphogenesis of the block with such characteristics and practical implications cannot be just a fortunate coincidence. The morphogenetic events reconstructed above suggest that the block system supports interactivity in remarkable ways. Entirely random morphogenetic

processes can take any direction without in any way needing to meet such specific practical requirements, and certainly do not have to find structures consistently reproduced in the history of settlements, such as the block system and the broader variations we find in cities. Even if a 'standard block' was reproduced by sheer luck and repetition, the very arrival at such a highly specific form is highly unlikely – especially one able to respond so fluidly to mobility and interactivity. There are too many possibilities of forms for such a coincidence.

Besides, in a world defined only by randomness, everything would be incidental. Forms and cities could just have taken radically different morphogenetic paths, leading to entirely different built environments where events could not be linked intelligibly, such is the multitude of possible spatial combinations. Relations between form, structure and process would be equally unintelligible, with no consistent effects or recognisable threads of material causality relating form and social context. This is why the consistent existence of particular spatialities, as combinations of events in time and in different contexts, cannot be simply attributed to coincidence. Given the improbability of coincidence, we are forced to admit that there are material reasons for conjunctions found empirically, such as those involving the problem of distance, from agglomeration and forms of aggregation to the consistent range of block sizes. Randomness and necessity interact: of all possible structures, there are material reasons why different spatial cultures have arrived at the spatiality of the block system.

(b) Trial and error. But if there is such a thing as a material necessity stemming from practice intense enough to shape urban form so that it generates effects back to practice, how does that happen? How can a society or a spatial culture come to the 'right' morphological decisions in any sense? Of course urban form was not originally a deliberate rational creation: it emerged before any kind of institutionalised design or planning, probably without any self-conscious decision to create certain kinds of spatial aggregation or positive externality. So how can this question be resolved? Alexander suggests that, although steeped in randomness, spatial formation through cellular aggregation includes a process stemming from material necessity: trial and error.[60] Imagining a scenario where a settlement emerges through agglomeration of architectural cells, built forms are first arranged in a territory at random – some further apart, others closer together, say. During this process, decisions about their positions are taken. Initially, built forms can be produced that are both suitable and unsuitable for intensive practices of interaction. Once in use, this arrangement is tried and tested in practice.

Issues about suitability for interactivity (what Alexander calls the *fit*) might arise. Practically inappropriate (*misfit*) examples of virtually infinite aggregations include those which fail to provide enough information and intelligibility for social actors in their (conscious or unconscious, constant or inconstant) impulses for interaction; and those that induce greater effort at overcoming distances lead to difficulties to interaction. Successive changes in the settlement can be implemented over time. Those built forms appropriately engaging with practices of interaction may serve as guides for new forms, perhaps reaching a certain stability as 'templates'. The process of trial and error involves ongoing transformations in paths of urban formation. Suitability problems might be noticed and changed over time. Alexander understands the suitability of urban form as the 'absence of misfits'. In this case, built forms that can express, support and perhaps stimulate interactivity without too much friction would continue to be reproduced, changing over time according to changes in social practices

and their own material requirements. But I would argue that this cannot be all there is to this process.

(c) Randomness and path dependence. This possibility may be addressed through a concept in economic theory: path dependence – or, as the economist W. Brian Arthur introduced, processes in which one outcome comes to be selected (consciously or otherwise) over time by small-scale, chance events when there are several possible long-run outcomes – 'phase-locking' into one of many possible configurations. Identical social tendencies under the same material conditions do not necessarily take the same path. 'History may decide the outcome.'[61] Accidental events or contingent choices (i.e. unexpected or dependent on the situation) can set in motion a sequence of small events. These events may be preserved in the form of durable structures, enclosing the process in itself. That is the case of cities. Moreover, in sequence-dependent processes, influences on the process can be performed by remote, incidental, non-systematic events. Initial conditions and accidental events can have significant effects on a process until it reaches a certain state or structure. Network effects may further enhance such tendencies. Urban settlements can in fact offer striking examples of the remarkable force of path-dependent dynamics. Even if an initial event is merely incidental – the decision to locate the first built form on a territory, say – it can play an active part in the direction of future locations – as if the past had an influence on present decisions. Morphogenetic paths develop in randomness and path dependence.

How can we understand the emergence of block systems in a process where actors' decisions have roles and may influence each other, and where initial decisions might influence the direction of subsequent decisions? What is the possibility of particular decisions on form or spatial events occurring? However influential each decision or event may be, it seems impossible to know in advance what decision or event might occur in a given case. Since the work of the mathematician George Polya in 1931, a number of theorists have studied the probability of a given phenomenon emerging under a set of initial conditions – for example, a particular type of built form being produced in a territory according (i) *adjacency* or (ii) *proximity* in relation to other cells. In a context where there is no feedback from spatial events into the process – or if both types offer the same advantages for interaction – selection and position of the next type of built form is determined by chance. In a context of feedback stemming from a particular type, the probability of selection of a particular type is related to the current proportion of that type on the territory. Put another way, if the system of interactions shows positive feedback from a particular type, an increasing proportion of that type increases the probability of another built form of the same type being added to the territory. Each decision in favour of a particular pattern increases the probability that the next selection will favour the dominant pattern. In cases of negative feedback, a higher proportion of a given type would lower the probability of adding more cells of that type. As built forms continue to be added, the proportions of currently available types will influence future choices.

In a further exploration of the language of path dependence theory, decisions may influence other decisions in situations of lack of knowledge *ex ante* and imperfect information (as in the growth of a city) and the system can lock into less efficient patterns. The economy offers many examples of this in fields such as technology, like the QWERTY keyboard layout, for example. The relative positions of keys matter in typing. Although other layouts were allegedly superior in performance, QWERTY has been dominant since the 1880s.[62] Other classic examples include VHS and Beta

videocassette technologies, introduced at about the same time and price, with roughly equal market shares and equally able to realise increasing returns as their shares increased. Early fluctuations led rapidly to increases in VHS shares, leading to competitive advantages for video outlets and new costumers, and eventual market dominance.[63] Similar stories appear in the information–technology industry, where certain social networking applications accumulate enough advantages to attract and take over virtually the whole system of users.

Cities as spatial systems of interaction might be subject to similar dynamics. Actors producing space or taking location decisions do not have a full view of the system and understanding of its material workings. The risks of locking in spatial patterns that are less than adequate increase in situations where actors do not have complete information about the actions of other actors and available possibilities and contextual conditions. So decisions of form are not exclusively shaped by trial and error, chance or by a fully informed test of fitness to practice. As in the economy, actors engaged in appropriating and producing space tend to define pragmatic criteria for taking decisions. Earlier decisions in contexts without complete information, including those of other actors, may suggest possibilities of choice: future selections will favour known selections, including previously selected types of built form.

Economics indicates appealing features, such as cost, time or energy. Falling costs in selection or events associated with positive feedback increase the probability that the next selector favours a particular pattern. Recognisable externalities may interfere with future decisions. Even though pervaded by randomness, this process can lead either to a particular morphology through self-reinforcing mechanisms, or to radical changes in a morphogenetic path. Finally, as social actors, we are able to *know* the conditions of events we engage with – even *material* conditions. Spatial arrangements associated with whatever is interpreted as positive externalities may be favoured – such as control in social situations where segregation is desired, or encounters when interactivity is deemed important. But how does our knowledge of the material conditions of interaction influence our decisions? What part do they play in defining morphogenetic paths that shape a certain spatial culture?

(d) Materiality and causal force. Actors deal in their daily practices with material properties and their effects. Some of these effects are recognised in spatial economics as 'externalities of agglomeration'. Actors physically feel and understand that greater distance means more bodily effort; that dense urban centralities are more likely to be more accessible than other areas or offer a higher diversity of services and retail; that less spatial density tends to mean fewer gatherings of people, and so forth. Even if we cannot express it verbally, we are practically conscious that material conditions exist for interactions to occur in greater or lesser intensity and diversity, or requiring more or less effort. We are tacitly aware of fundamental causalities, although we rarely bring them to conscious attention.[64] Chapter 7 will further explore the causal forces always at work, arising from the inherent relation of space to practice. And if we can recognise that differences in material conditions, such as a density or accessibility, matter for social processes, then we must admit that actors might shape space *knowledgeably* – even if unaware of such implications.

(e) Knowledge and reflexivity. Different cultures may well have shaped their spatialities gradually and cumulatively, including trial and error – perhaps even in entirely random attempts. In this sense, Alexander's trial-and-error selection of forms in time, evoked by Batty, suggests a Darwinian process, in which forms that respond

well to requirements of interaction would be reproduced. The morphogenesis of the block may well have certain Darwinian contours. But differently from biological processes, knowledgeable actors render the city-creation process more complex than processes exclusively subject to random variation, trial and selection. Actors learn (consciously or not) about material properties of form and anticipate its effects on our actions. We can reflexively *infer* potential causal connections between certain spatial formations and probable social outcomes; we can infer appropriateness and the reasons for appropriateness, to find particular forms of fit. For instance, we produce spatialities suitable for situations where intensity of interaction is less required or needs to be controlled, segregating ourselves spatially in less accessible locations.

This renders the form-making process more than just random or based on sequences of trials: our capacity to infer effects and outputs, develop scenarios and translate profound, intuitive spatial knowledge into conscious thoughts through language – into explanations and theory – brings a whole new dimension to the process. In this dimension, solutions and selections are not merely arrived at – they are *created*. However underestimated in previous approaches to morphogenesis and emergence, our cognitive abilities may define patterns and change patterns, actively shaping morphogenetic paths. Morphogenesis cannot be equated to teleological evolution guided by blind trials, lucky fits and incidental selection. Concomitant with previous properties, form is also 'intended creation' – especially in societies of cooperation and growing specialisation.

(f) Interactivity and division of labour. Different spatial cultures have taken morphological paths related to the highly permeable spatiality of the block system. I now wish to return to the moment of the block's emergence as a material response to the intensification and diversification of interaction. As Jacobs persuasively argued in *The Economy of Cities*, heightened interactivity seems closely related to increasing specialisation and technical development – stimulating the division of labour. Jacobs's earlier view of the role of small blocks for microeconomic diversity perhaps only hinted at the idea that the block system provides conditions for the critical mass – the combinatory explosion of unpredictable interactions that leads to further specialisation and diversity – right at the very origins of such spatial formations in cities.

This is perhaps a radical hypothesis that puts the block system at the centre of the view of cities as driving forces of social and technical complexity – a complementary – position to those of Jacobs, Soja, Glaeser and Bettencourt concerning the place of the city in the production of interactions and the history of innovation.[65] These authors speak of the role of agglomeration in stimulating random interactions, but we need to move on to descriptions of detailed spatial conditions of these stimuli – going *beyond* density. I would argue that there is a need for further study about the role of the block system in enhancing the conditions for interactivity in societies with a greater demand for cooperation in material and symbolic reproduction. This means being aware of the rich spatiality of interaction, as well as its place in our 'drive to interaction'.

The block system is absent from non-urban settlements, and is certainly revealing about the diversity of social dynamics it supports. What does the repetition of blocks in cities with grid systems imply in practical terms?[66] First, the ring of aggregated cells allows more activities in the same area. Second, the possibility of repetition opened by its structure reveals a tendency to increased scale: a growth in numbers

of families and homes, demand for material support (food, work, exchange), and supply of products and activities – a larger microeconomy, with more actors involved. Is there any connection between repetition of blocks and an increase in the potential for exchange and diversity – a more extensive and complex culture of specialisation? This question is interesting from the point of view of approaches to material reproduction, such as economics, many of which offer an 'axiom' of economic life: a profound correspondence between population size, diversity of activities and specialisation of occupations. In fact, extensive archaeological studies by Ortman and colleagues have recently found the same correspondence in cities throughout history.[67] If this correspondence makes empirical sense, the block system could be seen as an indication of well-established cultures of mutually dependent specialists. The diversity of buildings arranged in blocks connected by paths can be understood as able to support a greater variety of opportunities for interaction. Finally, the twin-configuration of blocks and street systems makes the spatiality of the city particularly *adaptable* to change over time, both in activities and built form; architectural cells are replaced as activities change and new actions and techniques emerge. The block system is a means of adding adaptability to systems of material interaction.[68]

(g) Stabilisation and change. Accidental or not, the spatiality of the block is an extraordinary response to the intensification and diversification of interactions. This process of feedback and adjustment to social potential and demands involves constant tension and confrontation between the daily efforts of materialisation of practices and the rigid materiality of space. The relationship between social practice and urban form materialises in the continuous impact between space and its surfaces and the flows of movement of people and artefacts in material interaction: space unfolding and shaped according to *centripetal forces of association*, tensions that generate attraction between activities, and proximity between built forms, producing and re/arranging its surfaces. Spatialities change, mature and are partially replaced through *reflexive* morphogenesis. Instead of an initial plan there is constant response – sometimes through violent confrontation – to material demands raised by ever-changing practices.

Considering the resilience of the block system, work in urban economics and configurational studies has shown that such processes are cyclical, like waves of 'structure-preserving transformations', to borrow Alexander's term.[69] However, the stability of a formation does not make it impervious to change. Consistent with stochastic transformations in the path-dependent reproduction of a pattern, especially in a context of reflexive actors, was the deliberate *creation* of a formidable break in the adjacency principle in the structure-generating process that led to the deformed rings of blocks in the twentieth century. This radical invention was born out of a complete rejection of traditional spatialities and soon expanded to cities virtually anywhere in the world.[70]

(h) Contingency and idiosyncrasy. Cities share virtually the same basic physical features of buildings and open spaces. Nevertheless, variety in spatial characteristics can be found even within the same region or culture. Radical differences can operate in built forms, or in their size and shape – but their arrangement along channels of streets and other blocks remains. Contingencies and local forces establish idiosyncrasies and differences between cities, leading eventually to completely distinct spatial cultures. But the fact that we can still recognise common features between cities is intriguing enough, and can only be explained by something that allows for

the improbability of materialisation of a common solution in different contexts – all as the same recognisable phenomenon.

A final note: from 'form as an effect' to the 'effects of form'

The above descriptions offer glimpses of the ongoing, intersecting processes seemingly active in morphogenesis – both causally and non-causally. Spatial production is durable, so outcomes and outputs of actions leave durable traces, in a landscape where the results of decisions are accumulated and not easily changed, and where effects reverberate on form. As Myrdian movements of circular causation in contexts where feedback from material conditions and the behaviour of actors is important, restrictions on randomness lead to emerging formations, progressively shaped through chance and trial and error by actors knowledgeable (consciously or not) about the material properties at play – over and over again; micro-decisions accumulating into visible larger formations. Variations are generated that define spatial cultures, yet with features common enough to approximate such spatial formations, allowing them to have a same name: the city.

This brief description of a series of speculations attempts to address the cycle of generation, change and stabilisation of urban form as it involves the creation of the block system, interpreted as an outstanding event in the emergence of cities. Inspired mostly by Alexander's work on the synthesis of form and that of Hillier and Hanson on restrictions to random cellular processes, these descriptions are intended to open up possibilities for more systematic investigations of the genesis of urban form, suggesting that a particularly useful starting point could be found in the elementary, detailed spatial conditions that seem vital to the practice of material association.

My argument here has centred mostly on the unlikelihood of coincidences in the relationship between interaction and spatial formation, or between the emergence of the block system and growing divisions of labour. Consistent with contributions from spatial economics, this process may be thought of as expressing a single teleological thread: *interactivity*, as the original centripetal force driving the urbanisation of space, starting from cell aggregations at the origins of cities, in a process that expresses and sustains the connectivity of actions and actors. This condition of association can be considered as an instance of the society-space relationship. One of the first arguments in this chapter was that this relationship must be explained at the level of social practices, mediated by the body, moulding and bending space to inform and increase fluidity of interaction in 'societies as systems of material interaction'. Such an argument, established mostly on logical grounds, must of course explore archaeological records much further. My final argument is that issues of material reproduction play a significant part in the inherent relation of society to space. The city itself is the synthesis. This does not diminish it; it does not remove its elusive symbolic, interpretive and affective dimensions. They are all there, at the same time, intertwined – but a synthesis able to encompass all of them at once has so far eluded theory. Perhaps our analytical way of thinking prevents us from attaining it, but it is nevertheless stimulating to keep trying.

Having explored *form as an effect* of the powerful force of material interaction – the improbable idea that something as elusive as our drive to association might bring changes in durable spaces – the *effects of form* can be explored further by looking at the place of space in the materialisation of interaction.

Notes

1 Elaborated by Netto and Cacholas after Mellaart (1967:133).
2 Alexander (1964:1).
3 E.g. Harvey (1973:306), Soja (1989:77) and Lefebvre (1991:129).
4 Westin (2014:9–10; see also Chapter 5).
5 Cf. Westin (2014:156).
6 I recall Hillier and Hanson's' words (1984:14) in another context.
7 See Bogen's definition of teleology in Honderich (1995:868).
8 This recalls Latour's character in 'On the difficulty of being an ANT' (2004:150) claiming that, if entities act, even in hidden ways, 'they leave some trace'.
9 See Deleuze and Guatarri (1988); cf. Thrift (1996).
10 Netto (2008).
11 Of course this claim is not new: it has been an axiom of economic geography since Von Thünen, and may be found, with emphases on different social dimensions, in socio-spatial theories like space syntax and other configurational approaches.
12 Lefebvre (1991:83).
13 Namely in Chapter 6 '(Re)claiming the city'.
14 See Jacobs (1969), Soja (2003) and Fujita and Thisse (2009).
15 Bettencourt (2012).
16 Batty (2013:247).
17 Ibid. (p.9).
18 Batty (2013:8). Compare with the view of cities as systems of encounter and networks of trajectories in Part 1 of this book.
19 See Batty *et al.* (1989); Batty (2013, Chapter 8).
20 Alexander (1966).
21 Hillier and Hanson (1984:14; Chapters 1 and 2).
22 Hillier and Hanson (1984:36).
23 Hillier and Hanson (1984:11).
24 Hillier (1999:126).
25 Vis, in personal communication. See Hutson *et al.* (2004, 2006, 2012). Regarding the distinction between spaces for movement and occupation and its projection in axial and convex spaces, see Hillier (1996).
26 See works on the urban block as a central feature in urban morphology, e.g. Panerai (1999), Bürklin and Peterek (2008) and Panerai *et al.* (2009); and previously, Muratori (1959), Aymonino (1975) and Cannigia and Maffei (1979).
27 Cutting (2005:140). See also Banning and Chazan (2006) and Bikoulis (2013:38).
28 Steadman (1983; 2014a) focuses on the role of solar access in the morphogenesis of buildings.
29 That includes the *flat roof* of houses, as in Proto-historic settlements like Çatal Höyük. See Mellaart (1967) and Cutting (2006).
30 On the introduction of courtyard structures, see Garfinkel (2006); on its performance, see Dunham (1960).
31 Examples of Near Eastern *circular* huts compounds are found in Ain Mallaha in Jordan, Tell Mureybit in Middle Euphrates, Nahal Oren in Israel, mostly from 9000–7000 BC (see Bikoulis, 2013); in other contexts, the Winnebago compound in North America, the Moundang compound in Cameroon or the Zulu kraal in Southern Africa, analysed by Hillier and Hanson (1984). Examples 'between' these archetypal possibilities partially explore both forms of aggregation, such as the Bororo in Brazil, analysed by Lévi-Strauss (2008).
32 See Düring (2006, 2013) and Gebel (2006), respectively.
33 A shift from circular to rectangular was identified in Tell Mureybit (7500 BC) in the Middle Euphrates; in Jarmo in Northern Iraq (6750–6000 BC); Beida in Jordan (65000), Matarrah in Syria (5500 BC). Central Anatolian sites (Turkey) include Asikli Höyük (8200–7400 BC) in Western Cappadocia, (East) (7400–6200 BC). Excavations of building levels at Cayönü revealed a clear shift from circular to rectangular wattle-and-daub structures (Schirmer, 1990). The rectilinear 'grill plan' building phase at Cayönü began immediately

after the round hut phase (Bikoulis, 2013:40). A change from rounded huts to rectangular houses was also seen at Hallan Çemi (Rosenberg, 1999).

34 See Flannery (1972). Later, Flannery (2002) revisited his original formulation and reiterated that house form by itself was not the most important variable to observe but the social relations that it implied.

35 Bikoulis (2013) calls this arrangement *agglutinative*, and they include Asikli Höyük (8200–7400 BC) in Western Cappadocia, Çatal Höyük (East) (7400–6200 BC) and Can Hasan (5730–5660 BC). Cutting (2006) identifies 26 buildings at Asikli Höyük and 39 buildings at Çatal Höyük, defining a building as built forms covered by a single roof, independent of internal partition. 'The closely spaced structures from Çatal Höyük are similar in form to many sites in Central Anatolia' (Bikoulis, 2013:42).

36 See Düring (2006). Nevertheless, as we shall see in Chapter 8, both architectural cell types are present in urban settlements, including contemporary cities.

37 Hillier and Hanson (1984:60).

38 Düring (2006).

39 Mellaart (1967); Cutting (2006).

40 In fact, there are branches of disciplines focused on the effects of such material properties, namely economic geography and urban economics. On the effects of proximity on the intensification of communication patterns, see the groundbreaking empirical work of Thomas J. Allen (1977).

41 Bürkin and Peterek (2008).

42 Garfinkel (2006).

43 Kadowaki (2006).

44 Gebel in Banning and Chazan (2006).

45 Martin and March (1966, 1972). We shall see this subject in more detail in Chapter 8.

46 See Hillier and Netto (2002).

47 Siksna (1997). The number of cities analysed by Siksna (12 in total) is too small to support robust conclusions. Studies by Karimi (1997), Hillier (1999), Chiaradia *et al.* (2012) in town centres in the UK, and especially Porta *et al.* (2014) offer more support regarding patterns of block sizes.

48 Hillier (1996; 1999), Karimi (1997), Chiaradia *et al.* (2012) and Porta *et al.* (2014).

49 Hillier and Hanson (1984).

50 Cf. Batty (2013; chapters 1, 4 and 5).

51 Adopting here Hillier and Hanson's (1984) argument on the role of randomness for generating new relationships, and Giddens's (1984) emphasis on recursivity in social reproduction.

52 In fact, Porta *et al.* (2014) show that, with the exception of urban utopias (Garden City, Radiant City, New Urbanism, with average lengths for street segments around 900 m, 700 m and 700 m respectively), ancient, medieval, Renaissance, industrial and informal settlements have average lengths under 300 m for segments in main streets.

53 In exchange with Sam Griffiths. I explore the transition between agglomeration and aggregation, friction of distance and tension of proximity in the following Chapter 7.

54 Durkheim (1984).

55 In discussion with Benjamin Vis.

56 Ibid.

57 Batty (2013:246).

58 Alexander (2003:19).

59 Batty (2013:246).

60 Alexander (1964; cf. 2003).

61 Arthur (1994:14); Arthur and Paul David (1985) are originators of the concept of path dependence in economics; see also Page (2006).

62 See David (1985).

63 Arthur (1994).

64 Recalling Giddens's (1984) concept of 'practical consciousness' here, or Harvey's (1973:13) view of 'The problem of the proper conceptualisation of space is resolved through human practice with respect to it'.

65 See Jacobs (1961; 1969), Soja (2003), Glaeser (2010) and Bettencourt (2013).

66 This question was posed by Benjamin Vis in personal communication.

67 See the 'pre-history' of relations between urban scale and conditions for social interaction in Ortman *et al.* (2014).
68 I develop this argument in relation to Vis's observation on the effects of block systems on opportunities for interactions, highlighting its adaptability – complementing Hillier and Netto (2002) on how street networks and urban structures may absorb transformations in local social systems of activity.
69 Studies have shown the conditions of replacement of durable forms (Wheaton, 1982) in waves of substitution (Krafta *et al.*, 2011) and in a cyclical divergence–convergence of systems of different materiality (see Chapter 8).
70 I shall examine the belated consequences of this change in interactivity in Chapter 8.