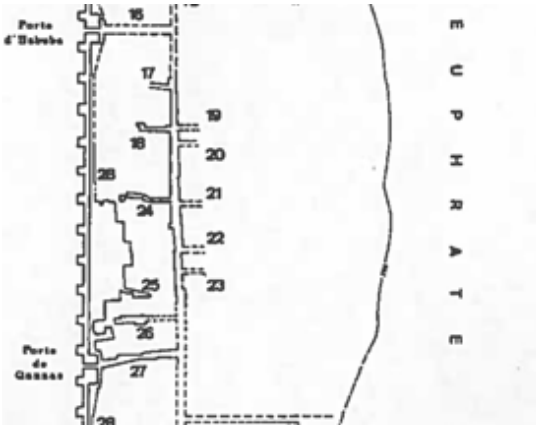
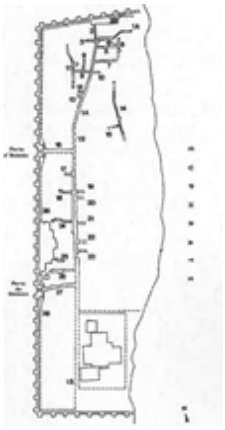
What are cities *for*? And how does this relate to their spatial form?

Bill Hillier
Space Syntax Laboratory
Bartlett School of Architecture
University College London

Pages: 199-212





The Journal of Space Syntax
ISSN: 2044-7507 | Year: 2016 | volume: 6 | issue: 2 | Online Publication Date: 16 May 2016

JOSS

What are cities *for*? And how does this relate to their spatial form?

Bill Hillier
Space Syntax Laboratory
Bartlett School of Architecture
University College London

In this paper, we ask what cities are for, and how this relates to their spatial form. This is an issue on which space syntax so far has said nothing. It is routine to say cities exist to create contact, but this seems at least overgeneralised, since cities are also often noted for their anonymity. Here we argue that cities exist to create not contact in general, but two very specific kinds of contact, and these relate to the dual form of what syntax has called the generic city – the idea that the urban grid is made up of two interlocking grids, each with its own metric and geometric properties: a foreground grid structured by and serving microeconomics, and a background grid structured by sociocultural factors and serving mainly residence, the two being linked by a pattern of pervasive centres. These different spatial structures generate fundamental differences in social networks which in the foreground grid serve the need for morphogenesis, and in the background grid, the need for stability. The coexistence of microeconomic morphogenesis and sociocultural stability is what the city is for, and it is both reflected in and created by the dual form of the generic city.

The problem of what cities are for

In my presentation to the Ninth Space Syntax Symposium in Seoul, *The Past and Future of Space Syntax*, I suggested that a key priority for future space syntax research would be the relation between spatial and social networks. I made some suggestions as to various factors this might involve. Today I want to present a general theory of this relation at the urban level – how key concepts of social network theory fit into the spatial model of the city proposed by syntax. I will suggest this leads us to a plausible answer to the question: what are cities *for*? The argument will focus on the concept of the *generic city*, and will mean looking at the *origins* of cities as well as their future. So some of my arguments will be rather broad and general, but I think necessarily so.

Space syntax explains how cities work – how space, movement, land uses, human activity and psychology combine to create the complex forms we occupy and experience. But it does not explain what they work *for*, why we have them or whether we will need them in the future. It does not explain how the nature of human societies interdepends with the fact and nature of cities. It is easy to say cities are about creating contact between people, but in many ways cities are conspicuously about non-contact in spite of proximity: not knowing your neighbours, that you're mad if you talk to strangers in the street, a nuisance if you talk in the doctor's waiting room or the crowded tube, and so on. Many leading writers about cities in the 20th century (for example, Simmel 1908, Wirth 1938, Sennett 1970) have stressed the isolation of urban dwellers, compared with the intensive interaction found in villages, and noted urban anonymity. It is not enough then to say cities are about contact without saying what kinds of contact we mean, how it happens, what its consequences are, and why it is distinctively urban.

And there is of course a profound problem in asking what cities are for. To understand them, it is not enough – perhaps sometimes not even relevant – to know the reasons why particular cities were

created. It's what they become that matters. Cities are not designed things, but emergent processes. Even Brasilia as designed is now only a fragment of a much larger urban system with emergent properties. To understand cities, then, we must understand the process of emergence and even more, the structure of emergence, and ask how and why the city, defined this way, reflects or shapes human experience and activity, and with what outcomes.

What cities have in common

One of the most unexpected outcomes of the syntactic analysis of large numbers of cities is the discovery that spatially speaking, and at a deep enough level, cities seem to be the same kind of thing. This does not mean that cities are not individuals, with idiosyncratic properties – no one could live in London and not know this – or that they are not at some level cultural types – no one could go to America or North Africa and not be struck by this. What it means is that underlying all these differences there is at a deep enough level a *generic city*, that is, a structure that makes a city a city in the first place (Hillier 2012, 2014).

It is not just syntax that has reached this kind of general conclusion about cities. In 'The Social Construction of Ancient Cities', the anthropologist Monica Smith (Smith 2005) argues that "anthropological research suggests that both ancient and modern cities are the result of a limited range of configurations that structure human action" (p.2)….. "a manifestation of underlying principles that prove fundamental to the organization of concentrated populations." (p.6). She is not talking about space in the way that we are, of course, but of human activity in space – so spatiality rather than space – but the similarity of the formulation is striking.

What syntax does is to define a key spatial dimension of the common structure and associate it broadly with different types of human action. However, in doing so, I will argue, it allows us to address in a spatially more precise way the two fundamental linked unknowns about cities: what cities are *for*? And how and why did they come into being? So: what is the generic city for? And how and why did it come into being? It is these questions I will try to address in this paper.

The generic city

What then is the generic city? (Hillier 2012, 2014). It is the idea that the street network that links the buildings that make up the city is a dual system made up of two inter-related sub-networks, each with its own metric and geometric properties:

- a foreground network made up of a small number of longer lines with route continuity; and
- a background network made up of a much larger number of shorter lines, with more localised connections.

The *foreground network*, through what I have called the 'city making process', acquires the form of a *pervasive network of linked centres at all scales*, and is driven by *microeconomic* activity, which in its nature seeks to concentrate and maximise movement and co-presence, and so optimise the potential of spaces to create this. The *background* network is driven by a sociocultural *residential process*, which typically seeks to diffuse and structure movement in the image of cultural ideas expressed through residence. With all their differences, particularly in the structure of the background network, most cities to some degree approximate this pattern. The two images in Figure 1 are Denver in the USA and historical Shiraz in Iran, two cities which although metrically and geometrically are about as different as they could be, nevertheless have these generic relational properties in common.

This paper offers two fundamental propositions about the generic city, one about the origin of the structure, and one about its functional effects and its future, both areas where current theory is somewhat chaotic:

1 that the appearance of the city was coterminous with the appearance of the dual form of the *generic city* – the implication being that the *generic city* may have made the city possible; if there was a reason for, or process of, concentration of people, then the *generic city* allowed it to happen, and very fast by structuring it.

2 that the generic city evolved as the dominant form for large and dense settlements, and so dominated evolution because it both reflects and generates two very specific kinds of contact which are necessary to the success of large and dense concentrations of people living in close proximity – and this is just as true today as it was then, and will perhaps be no less important in the future.

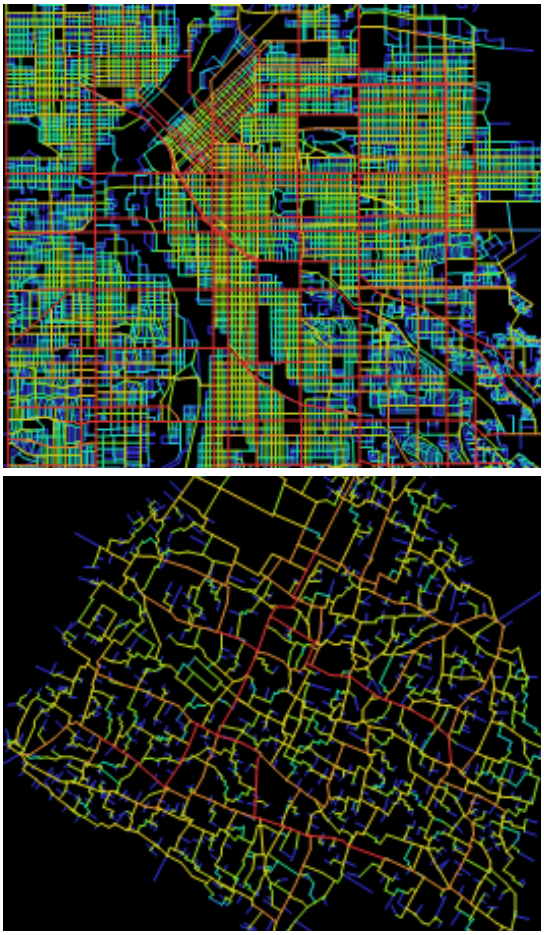


Figure 1:

Top: normalised angular choice radius n, Denver, showing the foreground and background grids.

Bottom: normalised angular choice radius n, Shiraz (historic), showing the foreground and background grids.

Proposition 1: that the generic city dates from the first cities

The problem in understanding the origin of cities lies in how suddenly they appeared and how fast they grew around half way through the fourth millenium BC, or about five and a half thousand years before the present, after what seems to have been several thousand years of essentially village-based development. As Yoffee says, against this background, "cities appeared almost as supernovas, and society changed utterly" (Yoffee 2005, p. 214). But there is little agreed theory about why the supernovas happened, or how they transformed society. Most theories, in any case, see the city as a social, rather than spatial, system, and see the task of theory purely in social terms. (Adams 1966)

For example, Wittvogel's theory that the sources of the hierarchical social forms we find in cities lay in the "water bureaucracies" that created and controlled the irrigation canals which made larger concentrations of people possible in terms of food production, was aimed at the origins of the city as a social system rather than as a physical and spatial object (Wittfogel 1957). As a consequence, the common sense view (and Yoffee's) that cities are objects that take part in the creation of social systems is lost sight of. The city becomes a placeless system of social roles and relations. In cases where there is spatial evidence, discussion of the physical and spatial form tends to be confined to the organic-geometric distinction, with the assumption that the former is, socially as well as spatially, bottom-up, the latter top-down. This encounters the problem that, of the earliest cities, those with the clearest geometric grid, in the Indus valley, are also those where the evidence of a top-down hierarchical social structure is least clear, and may be absent (Maisels 1999).

In the case of the city that was believed for most of the 20th century to be the first city – it seems mistakenly, as it turns out (Ur et al. 2007) – Uruk in southern Mesopotamia in the fourth millennium BC,

and which many have seen as generating the modern city as we know it (Maisels op cit), the problem is much greater. There has been until recently no evidence at all about the detailed urban structure, since all excavations have been of buildings like 'temples' and 'palaces' (all highly dubious terms in the light of what is known and not known) and none at all of the urban fabric.

Can we then learn anything from the historic context, and what is known about settlement forms at the time? If we examine the villages – sometimes quite large and complex – in the area which predate the city, we do not find evidence of systematic urban layout (Rothman 2002). Figure 2a shows the oldest excavated level in a village dating from just around the beginning of the Uruk period. There are irregular but more or less linear spaces to which it would be reasonable to assign the term 'street'. But there are no indications of relations between these spaces which might define some kind of network of public space, as in a street system. Likewise, at the next level (figure 2b) there are spaces described by the archaeologists as 'plazas' by virtue of their scale and adjacency to buildings having some kind of public function, but no evidence of these spaces being connected to a wider network of space, as would be expected of an urban plaza. It would be safe to conclude that in these villages and small towns, there is little evidence of the potential of a generic spatial structure which could hold a much larger system together.

Figure 2:

Figure 2a (top left): the oldest level of Tepe Gawra
Figure 2b (top right): the second oldest level
Figure 2c (bottom left): level X of Tepe Gawra
Figure 2d (bottom right): the uppermost level

Images 2a-d courtesy of the Penn Museum

If we look at these patterns in terms of a generative process Figure 2c, it is clearly not the 'beady ring' process (Hillier 1984), based on cells joining the open spaces adjacent to their entrances, which would develop a continuous network of spaces. But it does resemble the inverse process in which cells, rather than spaces, are joined and spatially linked through doorways, generating at the global level deep spaces penetrating into an irregular block form. One effect of this is that there are often routes from one part of the outside to another through the cellular structure. This suggests an extended family based process – but of course it may turn out to be nothing of the kind. But we could with more security suggest that, right down to the most recent level Figure 2d, it is not a conspicuously 'public space' process, as a beady ring process would be, and this in itself would suggest a self-generated limit to scale. A larger system based on these principles would be a labyrinth!

In this connection, however, a remarkable (1996) paper by a French archaeologist, Regis Vallet, subtitled 'La naissance de l'urbanisme', looks at what he argues is the first evidence of urbanism in the spatial sense – a theme barely touched in the Anglophone literature – in a village called Habuba Kebira. Figures 3a-d This village is of particular interest since it was created in the mid-fourth millennium, early in the Uruk period, by colonists from Uruk. There is clear evidence of urban spatial planning covering the scaling and shaping of plots, and the creation and regularisation of a network

Figure 3:

Four images of the lay-out of Habuba Kebira.

Images courtesy of Regis Vallet

of movement space. There is even a distinction between the microeconomic and residential parts of the plan. The distinction between this and the locally grown villages is consistent and striking. Since Habuba Kebira was created by colonists from Uruk, this strongly suggests at the very least some degree of spatial order in the residential and other areas of Uruk. The creators of the settlement knew how to plan.

In fact, with regard to the actual spatial structure of Uruk, there have been some remarkable recent developments. The first is that intensive studies of economic patterns, notably by Algaze (Algaze 2001, 2005), have shown that the appearance of a system of cities in southern Mesopotamia, of which Uruk was the earliest and largest, was closely associated with a highly developed regional system of trade and exchange which both preceded, and grew with, the increasing scale of settlements. This led to the emergence of a system of canals in the growing settlements, fed by the Euphrates and playing a key role in growing trade, and attracting people from the countryside to fill the jobs created by the system. This, according to Algaze (Algaze 2001), coupled to the highly advantageous local agricultural conditions, generated the increase in the scale of the settlement that we call the 'city'. As Algaze remarks: "In the end it turns out that Wittfogel (1957) was right, but for the wrong reasons. Rivers were indeed central to the development of early Mesopotamian civilization, as he argued, but not so much as a source of irrigation water but because of their role as conduits transportation for subsistence commodities, building materials, necessary resources, and sumptuary goods" (Algaze 2005, p. 26).

In the light of these economic analyses, the results of magnetometry of the Uruk site in the early years of the 21st century are remarkable. To quote the archaeologist: "Already the first evening of the 2001 campaign we realized that we have traced the main canal as well as some house structures. The following days we found, that the old city of Uruk had a complete canal system with a nearly 5m wide main canal from north to the south and several secondary canals in the area to the west. Besides this canal system some streets existed at different levels, but the canal system seems to be much more important. Not a single city gate for streets were found, but on the outer side of the city wall another canal parallel to the wall was found. Possibly all the transportation at Uruk was only on the water." (Becker and Fassbinder 2001, p. 96). Or to quote another of the investigators: "The more astonishing thing [we learned] is that they used water canals to move through the city and not big streets or something else." (Recknagel 2002).

But even more strikingly, what is being described in terms of the canal system seems clearly to be some kind of foreground grid, associated with microeconomic activity, with streets forming the putative residential background. As has often been pointed out, we seem to be talking about a 'Venice in the sands'. From this point of view, the syntactic comparison with Venice is instructive (Figure 4a,b). We follow here a syntactic comparison of Venice, with and without the canals, made by Sophia Psarra (Psarra 2014). Without the canals (upper image), Venice has a lower mean normalised choice than any city we have analysed, with only two segments on the route from the Rialto Bridge to the railway station having a value above 1.4, again the lowest maximum that has so far been found (Hillier et al. 2012). With the canals added to the system (lower image), the maximum and the mean are virtually normalised, and the foreground grid acquires something approaching a normal structure. In further support of this argument, (Figure 5) it is also the case that the only early Mesopotamian city of around this time that has been analysed as a full layout Mashkan-shapir (Stone 2004) also has a

network of canals, and so again suggestive of being at least part of a foreground network.

It must remain only a conjecture at this stage, but there does seem a strong possibility that these networks of canals formed part of the emergence of the dual grid, and so the 'generic city'. It suggests that the generic city with its foreground network in the form of canals, was the spatial structure which was associated with, and perhaps even permitted, the rapid growth of the world's first cities. If this is the case, it would be a clear example of the common process of an emergent pattern becoming a recognised structure that can be used in design and planning.

Figure 4:

Venice without the canals (left) and with (right).

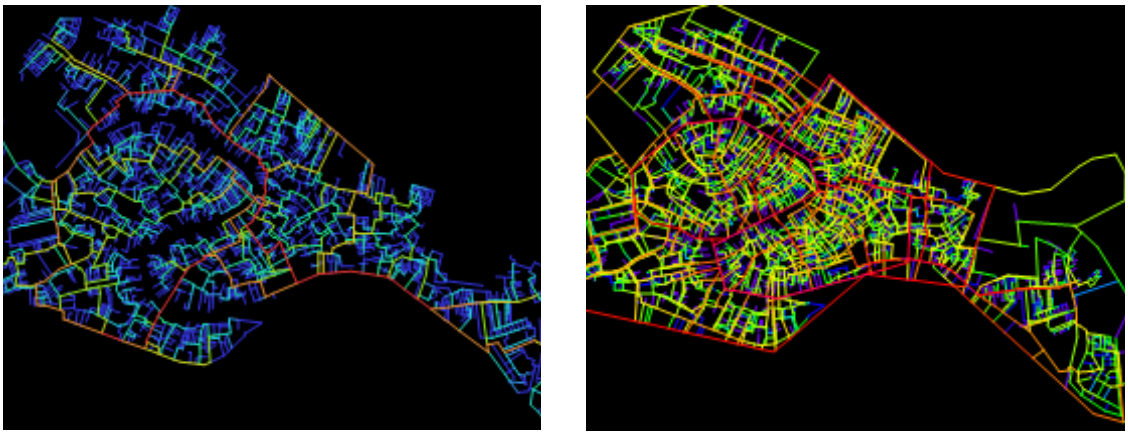


Figure 5:

Mashkan-shapir, with its canals.

Image courtesy of Eisenbrauns, Indiana.

Proposition 2: why the generic city

So how and why has the generic city dominated the evolution of cities, from their origins until now? We begin with a fact and a question. The fact is that cities generate a disproportionate fraction of the innovations through which economy, society and technology advance (Bettencourt 2010, McKinsey 2012). We might say they are characterised by *informational morphogenesis*. The question is how? Informational morphogenesis must in some sense be a function of the increase in human contact and information flow that cities bring about. What is not understood is a credible mechanism through which this takes place and how it relates to the spatial and physical fact of the city. Part of the answer, I will propose, lies in the different ways the two parts of the generic city generate social networks.

Since we are talking about knowledge, it will be useful to begin by reflecting on cities as knowledge systems, in comparison to pre-urban societies. To survive as societies, pre-urban societies, whether mobile or settled, need two kinds of knowledge. The first is practical knowledge of their material environment and where and how to get enough to eat for its members to survive biologically. This kind of knowledge, which governs the economic aspects of collective existence, is held and applied at the level of the group that lives and works together, the 'spatial group'.

The second kind of knowledge we can call social knowledge comprises the social rules and categories which link the spatial group to others. This kind of knowledge, while it assigns a label to each individual (for example, clan membership) is a-spatial (it does not have a location) and is held at the level of the regional super-group of spatial groups who exchange marriage partners and share the interdependence that comes through this. It will be expressed in rituals and ceremonies and is characteristically a long model in that it needs to overcome space in order to work. The first kind of knowledge ensures the survival of individuals, the second of society.

This structure of knowledge is inverted by the city. Practical knowledge becomes a global economic system, not only within the city, but between cities, and assigns categories to individuals by virtue of their place in the global knowledge system – the division of labour. So it is practical knowledge in the global economic system which assigns individuals to groups. These knowledge groups (as we may call them), like clans, are a-spatial, but as we will see, like clans, they play a critical spatial role in holding the system together spatially and generating its dynamics. At the same time, social knowledge in terms of purely social relations, becomes a local and short model as the old long model systems disappear as they no longer have their global role to play. This knowledge duality is of course reflected in the spatial duality of the city, with the foreground network playing its economic role and the background network the sociocultural.

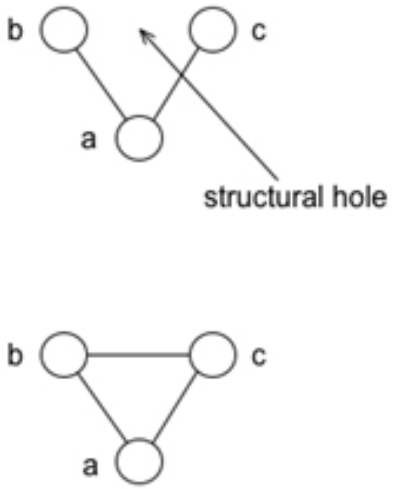
Compared to pre-urban societies, then, the city is a new kind of dual knowledge system, with the microeconomic and the sociocultural essentially reversed. Economic life is about the interaction of knowledge groups in the foreground network, and so globalised, while social life is about the interaction of spatially located groups in the background network, and so more localised.

How then does this relate to patterns of social contact and so information flow? We must begin with some reflections on social network theory and its relations with space syntax. A key network variable in social network analysis, and one associated with some of its most powerful results, is *clustering*: that if a knows b, and a knows c, then b knows c. (Figure 6). The more this relation holds in a system then the more the system will be *dense*, meaning that a high proportion of possible relations are actual relations. It is easy to see why highly clustered, and so dense, systems should be thought significant. It

seems to give a formal meaning to the intuitive idea of a community, or sub-community, as an internally communicating collectivity of some kind.

Figure 6:

A structural hole.



Perhaps because clusteredness is so strongly associated with a positive and important social concept, there is no everyday positive term for the lack of clusteredness in a system.

Burt, a key student of such systems, describes it in terms of the proportion of "structural holes" in the system, meaning the proportion of triads where a knows b and c, but b does not know c. Because of its centrality to my argument, I will call such systems 'sparse', to mean lack of clusteredness, or many structural holes in Burt's terms (Burt 1992).

The dense-sparse distinction (more precisely, clustered-unclustered) is spatially interesting because it allows us to picture social networks in a spatial way. The fundamental unit of urban spatial experience is the isovist, as analysed by Benedikt (1979), made up of a local convex area, where everyone can see everyone else, and so points are clustered, and the 'spikes' reaching out into non-local areas where people cannot see each other, so links are sparse. This has a suggestive resemblance to an individual's social network. There is a convex core where everyone knows everyone else, and 'spikes' reaching farther out into the network, where people do not directly know each other.

Without too much fantasy, we might even use the spatial analogy to generate a picture of the whole network. To the degree that sparse spikes reaching out from the dense local groups were associated with particular groups of people, it would form something like a *foreground* network, linking the dense, more localised *background* networks. This would mean that dense groups would be associated with the more conservative background parts of the network, and sparse groups with the morphogenetic foreground parts. In this way, we can at least begin to think of social networks in the same kind of way that we think of spatial networks.

The dense-sparse distinction is also important for the research results it has delivered on social networks, including their spatial dimensions. Burt, for example, showed how remuneration in an organisation was positively correlated with the number of "structural holes" in an individual's network, so with its sparseness, not with its denseness (Burt 1992). More recently, in a paper on communication patterns and economic development, Eagle et al. showed that those living in socioeconomically successful areas had networks that were less dense, with social advantage again clearly associated with sparse networks. At the same time, networks in successful areas were both socially and spatially more diverse, and those in less advantaged areas more concentrated socially and spatially (Eagle et al. 2010).

These results seem to generate a problem for the idea that cities play a role in informational morphogenesis. Looked at syntactically, sparse systems seem to be non-distributed and segregated, and dense systems distributed and integrated. If cities do in themselves somehow generate social networks, common sense suggests we would expect them to be primarily local and dense, reflecting the spatial closeness of populations. But

such networks seem to be associated with social disadvantage. So the questions become: how can the city create spatially dispersed sparse networks, and why should they do so? The answer, I will propose, lies in the different ways the two parts of the generic generate social networks. For this we need more theoretical concepts.

First, we define the individuals that make up the system not just as individuals, but as positions in a network of information, so that contact with them activates for us the network they are part of; and we allow both the contact, and the network activated, to vary on denseness and sparseness. It is clear that from the point of view of acquiring information through a certain number of contacts, to the degree that contacts are in the sparse (so 'non-distributed' and 'segregated') system, they will get information from different parts of the system, and so get unexpected information, whereas to the degree they are in the more ('distributed' and 'integrated') dense system, they will tend acquire more similar information, because of the high degree of interconnection in the dense parts of the system. As remarked by Burt, "At minimum the dense network is inefficient in the sense that it returns less diverse information for the same cost as that of the sparse network." (1992, p.17). For the same number of contacts, the sparse system will also be much bigger than the dense system. This can be seen in Figure 7.

We can clarify this theoretically by making an analogy between network structures and Shannon's mathematical theory of information. Shannon distinguishes between the redundancy (or structure) of a language, and the information that it can transmit. Information can be measured in terms of the degree of choice permitted by the redundancy, and so the degree of unexpectedness in the message. In the analogy with social networks, the structure is the existing structure of the network at any point in time and the information it contains, and the message is the information accessed by contacts, measured

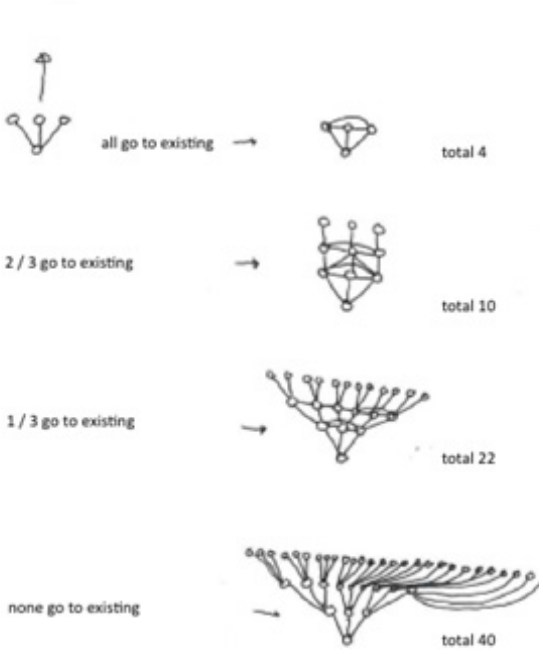


Figure 7:

Model of the dense-sparse dimension in a network up to 3 steps from ego, where each node has 3 contacts which vary on the proportion going to the existing system. The wholly sparse system, where no contacts go to the existing system is 10 times the size of the wholly dense system, where all do, so new contacts at levels 2 and 3 cannot be generated. At the same time, sparseness makes it much more likely that information generated will be new. Syntactically, the sparse 'asymmetric, nondistributed' system is much more efficient at accessing new information in a large complex than the dense 'symmetric, distributed' system.

by the unexpectedness of the information acquired. The more the contacts are with the dense parts of the network, the more the information will refer to the existing structure of information, and so to the redundancy of the system, in Shannon's terms. The more the contacts are with the sparse parts of the network, the more the information may be unexpected, and so constitute information in Shannonian terms.

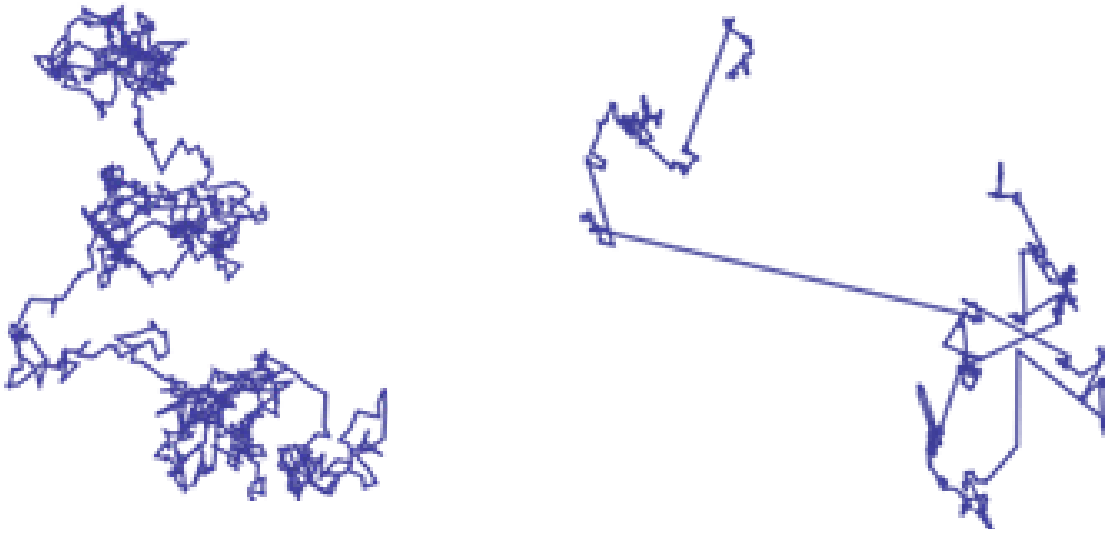
In terms of the functioning of the system and how contacts are generated, it is useful to bring another concept into the frame: the distinction between 'Brownian' and 'Levy flight' search strategies, as applied to the ways animal predators seek prey (Chechkin, no date) (Figure 8a, b). Here what is sought is not prey, but contacts, and so information. Brownian motion is random local motion, and operates efficiently for predators seeking prey where prey are plentiful in a locality. But where prey are sparsely dispersed, as potential contacts with unexpected information are likely to be, a more ef-

Figure 8:

Brownian motion (left) and Levy flight motion (right)

These images are reproduced from Wikipedia under the Creative Commons Share-Alike Licence

https://en.wikipedia.org/wiki/L%C3%A9vy_flight



ficient strategy is a pattern of movement called Levy flights, made up of a mixture of localised movements coupled to periodic much longer steps. Reasons for the greater efficiency of Levy flights in sparse target situations include both a greater range of search, and a substantially reduced chance of repeating a search in the same space (Chechkin A (no date)).

The aim of introducing this concept is not to enter the debate on how far human movement in general can be regarded as Levy flight or Brownian or neither (Gonzalez et al. 2008), but to suggest some useful conceptual analogies between these concepts and the structure and functioning of the city. The spatial configuration of the city as we have described it in terms of foreground and background networks, seems to reflect the distinction between Brownian and Levy flight motion to a remarkable degree. The foreground network, with its strong linear relations between local centres, and the highly explorable small scale local grids of those centres, reflects the two components of the Levy flight. The background network, with its more localised and uniform grid structure, seems more simply Brownian. The foreground grid is a global system, so characteristic movement in the system will often involve Levy-like jumps. These will be much rarer for characteristic movement in the more localised background grid. The urban grid does not determine these two kinds of movement, but its structure strongly reflects them.

We can bring these concepts together to conjecture a general theoretical model of the ways in which cities generate social, and so informational, networks (Figure 9). The fundamental idea is that the city creates two different types of network, one to do with the interaction of a-spatial knowledge groups in the microeconomic realm, one to do with the interaction of spatially defined residential groups in the sociocultural realm. These reflect both the dual spatial structure of the city, with its integrated foreground and localised background networks, and the dual social network with its sparse non-local foreground and dense localised background.

The critical step is to distinguish between the two functions of social networks: social stability and morphogenesis, and link them to the spatial and social networks. Social stability in a network will be enhanced by density, in the sense that the information activated by spatial contact will refer to the existing structure of the system, and so constitute redundancy, rather than unexpected

form → / function ↓	social network	information	groups	space	process	spatial network
stability	dense (community)	redundancy	spatial	local	'brownian' type	background, sociocultural residence
morphogenesis	sparse (individual)	unexpected	knowledge	non-local	'levy-flight' type	foreground, micro-economic
measures →	clustering coefficient	Shannonian information redundancy	dichotomy	angular integration	mean metric distance	angular normalized choice

Figure 9:

Social and spatial networks model with possible measures.

'information' in the Shannonian sense. This then will be found predominantly in the localised background grid where space supports density. This does not of course mean that everyone locally in the background network knows everyone else, just that a certain proportion of the networks of individuals in the area are likely to be local and dense (Goldenberg & Levy 2009). Dense groups are in this sense spatial groups, and as such can be generated and maintained by Brownian motion in the background network with its localised structure and lack of local to global spatial connections.

In contrast, spatial contact in the sparse network will tend towards morphogenesis, since the information will tend to constitute unexpected Shannonian information rather than redundancy, due to the sparseness of the network. This then will be found predominantly in the foreground network where contacts are generated non-locally by interaction among and within a-spatial knowledge groups, creating a pattern which resembles Levy flights in the foreground network, with its strong local to global connections, linked to the intense local structures formed by centres. We should note that it is not being argued that human movement takes the form of Levy flights, simply that the pattern of movement in the spatial network created by the contacts among and within a-spatial knowledge groups will take a form, and have an effect, comparable to Levy flights in that it will be made up of non-local jumps as well as local contacts in those locations, and so will act as though it were an efficient search technique for an unknown objective.

These properties form a context for a contact process in the foreground network in which the sparseness of the system, linked to the quasi-Levy flight structure of search, mean that the unexpected information generated by spatial contacts will be maximised. To this can be added the likelihood that contacts are likely to also generate random add-ons in the form of others who are also present at the contact, and these are also likely to take the form of unexpected information through sparseness rather than known information through density. So the structure of the system of contacts generated by knowledge networks will increase the probability of finding contacts with unexpected information which could potentially contribute to informational morphogenesis. The morphogenetic pattern of contact which brings this about is fundamentally driven by the spatialisation of the a-spatial and non-local knowledge groupings, not by local dense spatial groupings. This is why economic success is associated with non-local rather than local measures. It reflects how cities work economically to develop and innovate, rather than how they work to create social stability.

To summarise, then, in the background network, social contacts will tend to be dense, reproduce existing information, and affirm spatial groupings which maintain contact locally by Brownian move-

ment. In these senses they will support the sociocultural *stability* of the system. In the foreground network, social contacts will be in a sparse domain, generate new information, affirm a-spatial knowledge groupings, and maintain contact non-locally by movement which emulates the Levy flight pattern. Through the unexpected information this will generate, it will contribute to information morphogenesis. We see then that there is a relation between the spatial and social foreground networks, as there is between the spatial and social background networks. Taken as a whole, the spatial nature of the city supports the development of both social stability and morphogenesis through social networks.

It can be argued, then, that one of the fundamental effects of the city is to create non-local connections, and so to overcome distance. In this sense it can be compared to pre-urban societies where the form and nature of society is given by the devices through which society overcomes space to inter-relate a region of separate spatial groups. The difference is that whereas in pre-urban societies the space of a sparse population is overcome through the structure of social reproduction (devices like clans and age sets), in cities the space of a highly aggregated population is overcome through the structure of production. This is perhaps the basic difference between cities and other forms of human spatial organisation. In this context, it is striking, perhaps, that denseness gives a network meaning to the concept of community through the interrelatedness of a group of people, while sparseness gives a network meaning to individuality, in that an individual's network it likely to be unique, and held together only by that individual.

What causes what?

This is only a theoretical model, of course, but it is consistent with the many kinds of data we do have, and the theoretically unexpected propositions to which this has led. It suggests at least that there is a profound analogy between the generation and functioning of social networks and the dual spatial structure of the city. We might ask then, what causes what? In the case of 'city-creating' mechanisms through which cities go from being collections of buildings to the complex economic and social systems we experience in space, a causal role can be assigned to space through its effect on movement. In the case of the formation of social networks this seems not to be the case. There is structural comparability between the spatial and social networks, but no sense in which the spatial causes the social. It seems much more likely, then, that the spatial structure of the city has evolved in response to the need for these networks, rather than vice versa – that the urban spatial structure has been called into existence to facilitate a close but distinct relation between social stability through residence and morphogenesis through economic activity.

We can then in this sense say this is what the generic city seems to be *for*, so perhaps what cities are for as emergent structures. Overall, we may say that cities are shaped to create sparse non-local social networks for microeconomic morphogenesis, and dense local networks for sociocultural stability – more precisely, through the generic city, to generate both through the same dual structure. This then may be what it means to say that cities exist to create contact. And this seems then to be what cities are for. In present circumstances this must surely be what they will continue to be *for*.

References

Adams, R. (1966), *The Evolution of Urban Society: early Mesopotamia and prehispanic Mexico*, Chicago: Aldine

Algaze, G. (2001), 'Initial Social Complexity in Southwestern Asia'. In *Current Anthropology,* Vol 42(2), 199-233.

Algaze, G. (2005), 'The Sumerian Takeoff Structure and Dynamics'. In *e-Journal of Anthropological and Related Sciences*, Vol 1(1), 5-48.

Becker, H., Fassbinder, J. (2001), *Magnetic Prospecting in archaeological sites ICOMOS and Bavarian State Conservation Office*; www.academia.edu/1639647/Uruk_-_City_of_Gilgamesh_Iraq_first_test_in_2001_for_magnetic_prospecting

Bendikt, M. (1979), 'To take hold of space'. In *Environment and Planning B: Planning and Design*, Vol. 6, 47-65.

Bettencourt, L. and West, G. (2010), 'A unified theory of urban living'. In *Nature,* Vol. 467, 912-913.

Burt, R. (1992), *Structural Holes: the social structure of competition,* Cambridge: Harvard University Press.

Chechkin, A. (no date) *A short introduction to the theory of the Levy flight*; www.maths.qmul.ac.uk/~klages/bee_wshop/bbees_chechkin.pdf

Eagle, N., Macy, M., and Claxton, R. (2010) 'Network diversity and economic development'. In: *Science,* Vol. 328, 1029-1031.

Goldenberg, J. and Levy, M. (2009), *Distance is not dead* arXiv:0906.3202 [cs.CY]

Gonzalez, M., Hidalgo, A. and Barabasi, A. (2008), 'Understanding human mobility patterns'. In: *Nature*, Vol. 453, 779-782

Hillier, B. and Hanson, J. (1984), *The Social Logic of Space,* Cambridge: Cambridge University Press.

Hillier, B., Yang, T. and Turner, A. (2012a), 'Normalising choice, and how it opens up new perspectives on the global and local analysis of city space'. In: *Journal of Space Syntax*, Vol. 3(2), 155-193 .

Hillier, B. (2012), 'The City as a socio-technical system'. In: Müller, S., Arisona, P. Wonka, G. Aschwanden, J. Halatsch (eds.), *Digital Urban Planning and Modelling*, Berlin: Springer.

Hillier, B. (2014), 'The generic city'. In: *AD:: Empathic space,* Vol, 5, 100-105.

Maisels, K. (1999), *Early Civilisations of the Old World,* London: Routledge.

McKinsey Global Institute 2012 (http://www.mckinsey.com/insights/urbanization/us_cities_in_the_global economy)

Moles, A. (1968), *Information theory and aesthetic perception*, Urbana: University of Illunois Press.

Psarra, S. (2014), 'Beyond analytical knowledge: the need for a combined theory of generation and explanation'. In: *AIZ ITU*, Vol. 11(2), 47-68.

Recknagel, C. (2002) *Radio Free Europe*; www.rferl.org/content/article/1099592.html

Rothman, M. (2002), *Tepe Gawra: the Evolution of a Small Prehistoric Centre in Northern Iraq*, Philadelphia: University of Pennsylvania.

Sennett, R. (1970), *The Uses of Disorder*, New York, NY.

Shannon, C. and Weaver, W. (1949), *The Mathematical Theory of Communication*, Urbana: University of Illinois,

Simmel, G. (1908), *Soziologie*, Leipzig: Duncker & Humblot.

Smith, M. (2005), *The Social Construction of Ancient Cities,* Washington DC: Smithsonian Institution Press

Stone, C. and Zimansky, P. (2004), *The Anatomy of a Mesopotamian City*, Indiana: Eisenbrauns.

Ur, Jason, A., Karsgaard, P., and Oates, J. (2007) 'Early Urban Development in the Near East', In: *Science*, Vol. 317, 1188

Vallet R (1996), 'Habuba Kebira: ou la naissance de l'urbanisme'. *Paleorient*, Vol. 22(2), 45-76.

Wirth, L. (1938), 'Urbanism as a way of life'. In *American Journal of Sociology*, Vol. 44, 1–24.

Wittfogel K (1957) *Oriental Despotism: a comparative study of total power,* New Haven: Yale University Press.

Yoffee N (2005) *Myths of the archaic state: evolution of the earliest cities, states and civilisations,* Cambridge: Cambridge University Press.

About the author:

Bill Hillier
(b.hillier@ucl.ac.uk)
Bill Hillier is Professor of Architectural and Urban Morphology in the University of London, and a director of Space Syntax. He holds a DSc in the University of London. As the original pioneer of the methods for the analysis of spatial patterns known as 'space syntax', his work includes a general theory of how people relate to space in built environments, a substantial body of research built on that theory, and a large number of articles. He has also written extensively on other aspects of architecture theory.