



## Briefing Paper 3

# Space Syntax Approach to Urban Morphology

The space syntax approach focuses on the properties of the spaces between the urban blocks rather than the morphology of the blocks themselves.

Certainly general principles about space in cities follow from the space syntax's theory of city formation. Grid-movement relation – the law of natural movement - is fundamental to cities. Most relations between the form of the city and the way it functions pass through this relation in some way. The properties of the spatial network relate to movement and other social, economic and environmental performance of places in cities.

Space syntax was pioneered in the 1970s by Prof Bill Hillier, Prof Julienne Hanson and colleagues at The Bartlett, University College London. Today, space syntax is used and developed in hundreds of universities and educational institutions as well as professional practices worldwide. Built on quantitative analysis and geospatial computer technology, space syntax provides a set of theories and methods for the analysis of spatial configurations of all kinds and at all scales. The space syntax approach was

conceived to help architects simulate the likely effects of their designs on the people who occupied and moved around them, be they buildings or urban settlements. It has since grown around the world in a variety of research areas and practical applications including archaeology, criminology, information technology, urban and human geography, anthropology and cognitive science.

Space syntax developed from academic origins, but the steady growth of interest from planners, developers and architects created a demand for consultancy on “live” projects. To do so, UCL established Space Syntax Limited as a university “spin out” company.

In practice, Space Syntax Limited provides a set of planning and design principles as well as a toolkit for the generation and evaluation of ideas. “Live” projects raise fundamental research questions that are fed back from practice to university. The result is a process of knowledge exchange and co-creation that stimulates innovation, facilitates practice and, ultimately, benefits our buildings and cities. Space syntax is a science-based, human-focused approach that investigates relationships between spatial layout and a range of social, economic

### Key ideas

- Space is not a background to human activity but is intrinsic to it.
- Space is first and foremost configurational. In other words, what happens in any individual space – a room, corridor, street or public space – is fundamentally influenced by the relationships between that space and the network of spaces to which it is connected.

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and environmental phenomena. These phenomena include patterns of movement, awareness and interaction; density, land use and land value; urban growth and societal differentiation; safety and crime distribution. It is a set of techniques for analysing spatial layouts and human activity patterns in buildings and urban areas. It is also a set of theories linking space and society. Space syntax theory addresses where people are, how they move, how they adapt, how they develop and how they talk about it.

Relationship between form and function

Cities appear to us as patterns of activity related to patterns of space. This is how the task of design is presented to the designer: how a specific pattern of activity is to be related to a specific pattern of space. But theoretically it is not like that, and this is not how cities become as they are. Space is created not directly by the inter-related demands of specific activity patterns, but indirectly by the different demands that kinds of activity place on the movement and co-presence that is created by space.

### Multiscale spatial networks

Space syntax model's ability to bring to light structures at many scales, from the most local to the most global, is vital, because research has amply shown that most urban phenomena are multi-scale. For example, the degree and nature of the movement passing along a street will be shaped by how the street is embedded in both the global as well as the local network. The same applies to local centres. These occur and grow in parts of cities that are embedded in a local metric system (brought about by small blocks) and a more global least angle system - in other words, with how they are linked to both components of the dual grid. Similarly, public squares are affected in their functioning not only by how the space is defined by the surrounding buildings, but also by how it is spatially embedded in the larger scale system of space.

### Foreground and background spatial networks

Space in cities works in more than one way. The foreground network is structured to maximise movement, and it is so

because it is driven by micro-economic factors which benefit from high levels of movement, while the background network restricts and structures movement, and does so because it is driven by social and cultural factors which find expression in the way residential space is structured. The dual network in cities reflects functional as well as spatial processes. This is an instance of the more general potential of space to operate in two ways. Space can be used generatively to create new patterns of movement and so co-presence and potential relations in the social system, or it can be used conservatively to express and so reproduce existing social patterns and structures. The former is associated with spatial integration, the latter with spatial segregation. The difference between the foreground and background networks is the difference between more morphogenetic and more conservative space. The former focuses movement to create development and change, the latter diffuses it to keep things as they are. This generic structure seems to underlie all cities in some sense, and it can be concluded that beneath the individuality and cultural typing of cities, there is a universal generic city which makes the city what it essentially is. All societies must in some sense be morphogenetic in order to cope with changing technological and social circumstances, and all societies must also act in ways that reproduce their structures – hence the dual use of space.

### An Integrated approach

Space syntax acts as a frame for all kinds of urban data by simply adding data to the model segment by segment: movement flows, land uses, densities, demographic information, land and rental values and so on. It is a tool for asking spatial questions of the city, of the form: is there a spatial dimension to this or that urban problem – to social malaise, to migration patterns, crime distributions, to the emergence of centres, to the success or failure of areas – all these are areas have been investigated using space syntax.

### 3.1. Key concepts in the Space Syntax Approach to Urban Morphology

Space syntax is founded on two fundamental propositions-  
a. space is not a background to human activity, but is

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intrinsic to it.

b. space is first and foremost configurational. In other words, what happens in any individual space – a room, corridor, street or public space – is fundamentally influenced by the relationships between that space and the network of spaces to which it is connected.

### Four components of space syntax

Space syntax comprises four fundamental components, which are used in all space syntax applications:

#### a. Representations of space

Spatial elements are represented through their geometric forms and how people experience them. They can be geometrically derived (for example, point, axial line, segment, convex space and isovist) or functionally defined (for example, rooms in building)

#### b. Analysis of spatial relations

Relationships between spatial elements result from their configuration. These relationships can be objectively analysed using various measures, included among which are integration and choice. These two measures reflect the two fundamental elements in human movement: firstly, the selection of a destination, and secondly, the selection of a route. One measures the ease of access (integration) and the other measures the passing flow (choice).

#### c. Interpretive models

Spatial models are developed to analyse, describe, explain and forecast different kinds of spatial and socio-economic phenomena. Practically, models are created to investigate empirical phenomena such as urban movement, urban crime, and centrality as a process as well as for general processes such as spatial intelligibility.

#### d. Theories

Theories of the relations between spatial and social patterns are established to explore whether and how space is internalised into socio-economic processes through which the built environment is created. This has been done in two ways. Firstly, theories can be used to look for commonalities in the pattern of models across

functions and cultures. One example is the theory of the generic city. Secondly, theories can use space syntax tools to explore what happens to spatial patterns if objects in space are deployed and shaped in different ways.

The configurational approach has led to a key discovery about cities: that the architecture of the street network shapes movement flows. Research shows that between 60% and 80% of the movement flows on streets are due to the structure of the network itself, that is to the potential flows identified mathematically. This does not mean that space determines individual movement. It means that if people go under their own volition from everywhere to everywhere else, some spaces get more used than others. The relation between grid structure and movement is an emergent effect.

But by examining real movement patterns in cities, shows that people move by reading the angular geometry of the network, not actual metric distances. By analysing the network in terms of its least angle change paths from all street segment to all others, we can approximate movement potentials from the architecture of the network, and of course for new designs inserted into the network. But more importantly, once the influence of the grid on movement is understood it opens then way for a new theoretical understanding of the city as a self-organising system through what we call the city-creating process.

Because the network structure shapes flows, it also shapes land use patterns, in that movement-seeking land uses seek locations that the grid has already made movement-rich, while others, often including residence, migrate to less-movement rich parts of the network. Economic values follow this process. With feedback and multiplier effects – once one shop appears, others follow -this is the fundamental ‘city creating process’ by which cities evolves from collections of buildings to living cities, with busy and quiet zones, often in close juxtaposition, and with differentiation of areas according to the detail of how they are embedded in the larger scale grid. The pattern of centres is shaped by the structure of the urban grid.

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This leads to a definition of the spatial form of cities. Cities in general – not just ‘organic’ ones – self-evolve into a foreground network of linked centres at all scales, from a few shops and a café through to whole sub-cities, set into a background network of largely residential space. The two networks have different geometric and metric properties. The foreground network has longer lines, nearly straight connections and route continuity, the background network shorter lines, right angle connections and more local grid-like structures. Good cities, we suggest, have pervasive centrality in that centrality functions diffuse throughout the network. The pattern is far more complex than envisaged in theories of polycentrality. Pervasive centrality is spatially sustainable because it means that wherever you are you are close to a small centre and not far from a much larger one.

### 3.2. Methodology

The street network is a continuous spatial network. Space syntax seeks to provide an objective way of representing it. Many urban spaces are linear (e.g. streets, boulevards and alleys) and can be represented as axial lines and segments.

#### 3.2.1 Axial map

An axial line is defined as the longest line representing the maximum axial extension of any point in a straight line. An axial map is the least set of the axial lines which pass through each convex space (Hillier & Hanson, 1984: p91-92; Turner, A., Penn, A., & Hillier, B., 2005: 432-7).

The key principle of drawing an axial map is to minimize the number of lines and the angular change between any pairs of lines.

#### 3.2.2 Segment map

Segment maps enable us to represent the continuous open space in a finer scale. It can be generated by breaking axial lines into segments at the intersections of the axial lines. It can be generated from a road centre line map. Road centre line map is recommended to be simplified before it is converted into a road centre line segment map.

#### 3.2.3 Other methods

These include convex maps, visibility graphs, isovists, agent analysis.

##### o Convex maps

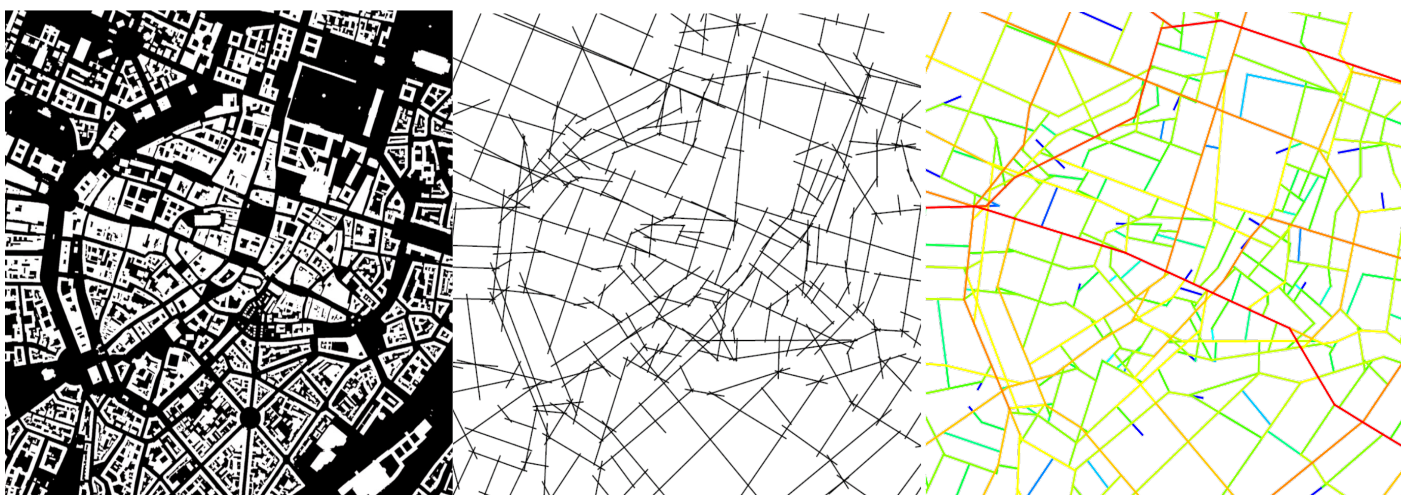
Convex space is one in which no straight line drawn between any two points goes outside the space.

##### o Visibility graphs

Visibility graph is the graph of mutually visible locations in a spatial layout.

##### o Isovists

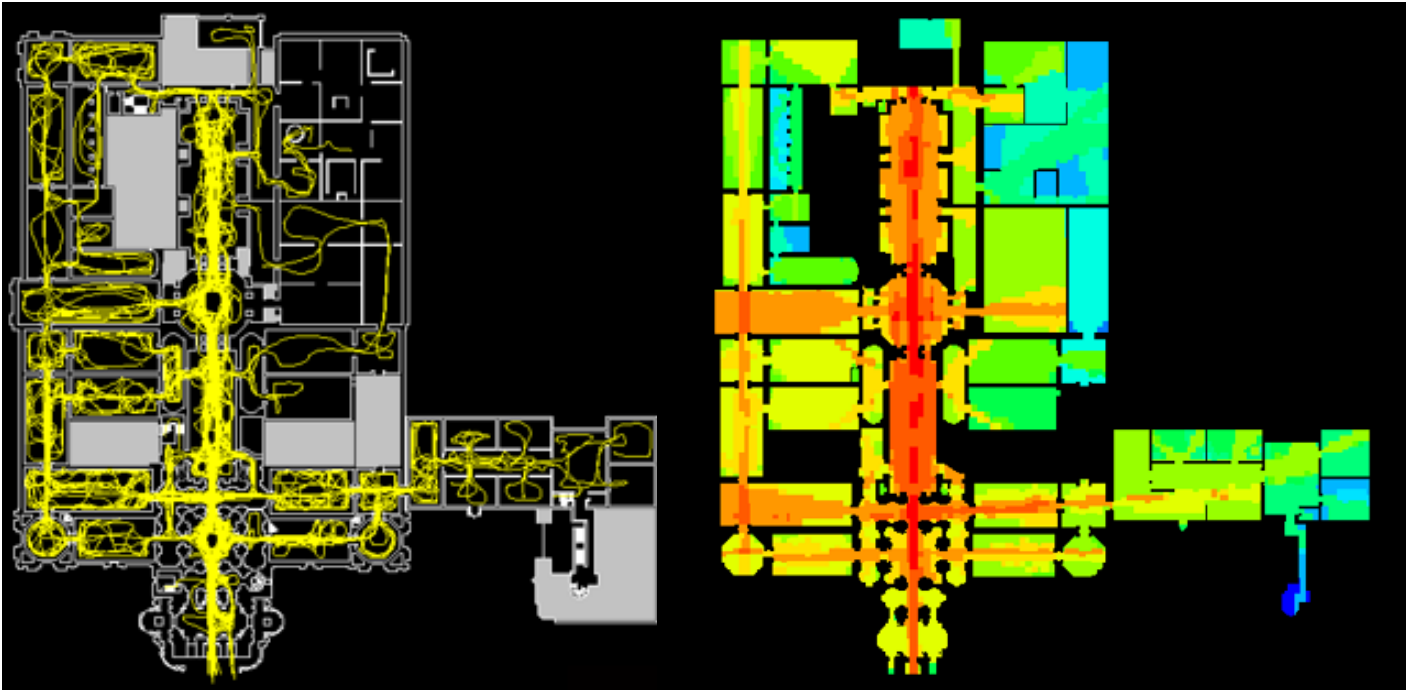
An isovist is a set of all points visible from a given vantage point in space and with respect to an environment. The shape and size of an isovist is liable to change with position.





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### o Agent analysis

An agent is a computer simulation of an individual who acts autonomously with a form of exosomatic (outside the body) memory common to all the other agents in the simulated environment. The agent encodes not only object locations, but also information about the accessibility structure of the environment being traversed.

### 3.2.4 Software

DepthMap software can be used to show how space syntax techniques identify configurational structure in urban street networks through the analysis of axial and segment maps. The fundamental element is the street segment between junctions. This is the graph element, and the software analyses its relations to all other segments in the system. The Space Syntax toolkit is also available for QGIS which allows the users to process segment and axial maps by remotely connecting to Depthmap, while continuing to work in an GIS environment.

DepthMap allows 3 definitions of the distance between each segment and each of its neighbours: metric, that is the distance in metres between the centre of a segment and the centre of a neighbouring segment; topological,

assigning a value of 1 if there is a change of direction between a segment and a neighbouring segment, and 0 if not; and geometric - assigning the degree of the angular change of direction between a segment and a neighbour, so straight connected are 0-valued and a line is a sequence of 0-valued connections, so that the linear structure of cities is captured. It then uses these 3 concepts of distance to calculate two measures: syntactic integration, or mathematical closeness, which measures how close each segment is to all others under each definition of distance; and syntactic choice or mathematical betweenness, which calculates how many distance-minimising paths between every pair of segments each segment lies on under different definitions of distance. So, using the metric definition of distance, we find the system of shortest paths for integration and choice, with the topological definition we find the system of fewest turns maps, and with the geometrical definition we find the system of least angle change maps. So, using the metric definition of distance we find the system of shortest path maps for integration and choice, with the topological definition we find the system of fewest turns maps, and with the geometrical definition we find the system of Each of these measures can then be calculated at any radius from each segment,

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using any of the three definitions of distance to define the radius.

Each measure will identify structure in the network which can be made intuitively clear by using colours to represent mathematical values, as usual from red for high through to blue for low. The most powerful measures are those based on least angle distance, metric radius and a combination of integration and choice called 'normalised choice'. We can think of this measure as indexing the 'movement potential' of each space, reflecting both through- and to-movement. We can use it, for example - least angle normalised choice at radius n, meaning no radius restriction - to compare the global structures of cities.

### Further reading

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EPUM is an international research project which aims at the integration of different urban form research and teaching approaches through pedagogic innovation and Information and Communication Technology (ICT). The activities of this 28 months project (2017-2020) are funded by Erasmus+ and focus on the development of an innovative, open and inclusive system of teaching and training in urban form from a multidisciplinary perspective, capable of enabling the current and future generation of planning and design professionals to address comprehensively and effectively the variety of issues and challenges faced by contemporary cities. This website provides information about the project activities to partners and to other parties interested in the work of the project.

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