

Space syntax: consolidation and transformation of an urban research field

Dr Kayvan Karimi
Senior Lecturer, Space Syntax Laboratory,
The Bartlett School of Architecture, UCL
22 Gordon Street, London WC1H 0QB, UK
tel +44 (0)20 3108 9017
email k.karimi@ucl.ac.uk
twit @Kayvan_Karimi

Keywords: Space syntax, spatial network analysis, evidence-informed urban design and planning

Space Syntax is a set of theories and methods for modelling and analysing cities, using *space* as the fundamental generator of the city. A major virtue of this approach is that it is supported by a powerful social theory of space. Founded in the 70s and 80s by Bill Hillier and his colleagues (Hillier & Hanson, 1984; Hillier *et al.*, 1987), and developed further in the following decades, Space Syntax theory describes the logic of society through its manifestation in spatial systems: how the way spaces are put together - or the configuration of space - relates directly with how people perceive, move through and use spatial systems of any kind, ranging from small domestic spaces to large-scale cities (Penn *et al.*, 1998). This sounds like a commonsensical way of understanding cities, but yet has been overlooked in many urban theories, particularly in the recent decades, when rapid growth and urbanisation have demanded new ways of dealing with cities.

The configuration-function relationship, or the space-society paradigm in more general terms, has a direct consequence for design and planning. Since there is a direct relationship between spatial configuration and urban functions, analysis of spatial configuration provides a powerful tool for designing, shaping, maintaining and changing urban functions. Based on this assumption, which is strongly supported by research, a series of methods and modelling techniques have been developed for analysing spatial configuration (Penn, 2008). These techniques are predominantly based on very fundamental concepts of human behaviour, such as movement, visual perception and human occupation, which directly link physical space with people. The models use simple geometrical attributes, such as lines of sight and movement or visual fields of perception, to create a network of spatial elements. This network is then turned into a pattern of relationships, or a graph representation (Freeman, 1977), which can be quantitatively analysed to determine the relative role that each space plays in the configuration of the system, as a whole or in its parts.

Due to the nature of the elements used in simulation, any analysis of spatial configuration by space syntax methods relates directly to how the urban system functions. This simply turns a set of analytical spatial models into a useful method for measuring how movement, activity and behaviour are distributed within the system (Karimi, 2012). These methods are simple in nature, but they have the capability to become more complex by linking spatial configuration with other spatial attributes, such as movement, land use, density, social interactions and practically any attribute of the city that has a spatial nature. The model is also multi-scalar, since the

configuration can be analysed in different contexts and is multi-disciplinary, since spatial attributes are embedded into various disciplines. The product is an analytical tool that can be used effectively to understand complex spatial systems and design them more effectively using analytical evidence.

Under the overarching theoretical framework of space syntax, further sub-theories have been developed to explain and underpin various aspects of urban systems. The theory of 'natural movement' argues that it is the movement generated by the spatial grid that creates the life of the city, rejecting the commonly-thought idea of place as one thing and movement between places as another (Hillier *et al.*, 1993). Complementary to that, the theory of 'movement economy' explains that the activities in the city adapt to take maximum advantage of the movement (Hillier & Penn, 1996). The 'pervasive centrality' theory implies that centrality functions diffuse throughout the network, generating a pattern that is far more complex than envisaged in theories of poly-centrality, but can be captured by the configurational analysis of the spatial network (Hillier, 2001). Further theoretical propositions have been developed to deal with various facets of urbanity, including: urban migration and ethnic clustering (Vaughan & Arbaci, 2011), behaviour and interaction in working places (Penn, Desyllas & Vaughan, 1999), linking accessibility, density and diversity to explain the 'spatial capitals' (Marcus, 2010), on informal settlements and organic cities (Hillier, 1996; Karimi, 2002). These inter-connected sets of theories create a diverse yet unified platform for space syntax research.

In parallel, academic researchers have pushed the boundaries of the field by developing new tools and methods, such as *segment-angular spatial network analysis* (Hillier & Iida, 2005), *Visual Graph Analysis, or VGA* (Turner *et al.*, 2001), *vision-guided Agent-Based Modelling* (Turner & Penn, 2002), *origin-destination weighted network analysis* to advance the methods of spatial accessibility analysis (Ferguson, Fridrich & Karimi, 2012), GIS-linked tools and software to generate and use the space syntax analysis within a GIS environment (Gil *et al.*, 2015), *Place Syntax*, a combined accessibility and the urban environment elements analysis tool (Stahle, Marcus & Karlstrom, 2008), and many other methods, techniques and software that follow the principles of the overarching space syntax theory.

In the late 1980s and early 1990s, when Space Syntax research was heavily under way in University College London (UCL), and indeed in many other universities around the world, an increasing demand emerged for using this approach in real life urban and architectural design projects. The very early projects undertaken by Space Syntax Laboratory, a research centre at the Bartlett, demonstrated great potential for using the methodology in consultancy. The desire to use this approach was shared by various groups. Designers, developers and local authorities were all interested, since analytical tools could help optimise the plans and avoid risk in urban developments. Currently, there are a growing number of urban consultancy firms that utilise space syntax research in their projects, or provide specialised space syntax consultancy services.

Today, space syntax research cannot be considered a specialised or novel field anymore. The research is extending in various ways and links with other disciplines or research areas. This is happening in many directions, to develop further research on: evidence-based design approaches and tools (Sailer *et al.*, 2008), transport planning and public transport systems (De Koning *et al.*, 2017), resilience and urban planning for hazards and disasters (Maureira & Karimi, 2017), social media and co-presence (Shen & Karimi, 2016), environmental and spatial cognition (Conroy-Dalton, 2003)(Marcus, Giusti & Barthel, 2016), urban sprawl and regional planning,

walkability studies (Dhanani, Tarkhanyan & Vaughan, 2017), cycling studies (Raford, Chiaradia & Gil, 2007; McCahil & Garrick, 2008), urban regeneration and slum upgrading (Karimi & Parham, 2012), Transport-Orientated Design (TOD) and other major infrastructural studies, urban lighting and high economies (Dwimirnani & Karimi, 2017), and many other areas of research that have not conventionally been part of the morphological or architectural research. This shows that while the research field is maturing and consolidating, it also becomes more accessible and useful to the other fields of research.

In this special issue, three papers are presented which attempt to push the boundaries of the space syntax field further and connect with the other fields. In *"Space syntax investigation of Lubbock, a grid-like American city and some insights into isotropic layouts"* the authors apply the old and new space syntax methods of analysis to an American city to explore the applicability of the methods to a perfect grid structure. Their work proves an important concept in this type of spatial grids: local structure is more appropriately defined by metric distance, but the global structure follows a topo-geometric logic. In their article, *"Combining multi-criteria and space syntax analysis to assess a pedestrian network: the case of Oporto"*, the authors describe a GIS-based integrated method to assess a pedestrian network by combining multiple criteria and linking them with space syntax analysis. They use this approach to evaluate the 'walkability' of the routes within the City Centre of Porto; a method which could be applied to other types and conditions of urban centres. Finally, in *"Urban evolution as a spatio-functional interaction process: the case of central Shanghai"*, the authors explore the transformation of urban centrality structures by the shifting the interdependence between spatial centrality indices and delivered urban function connectivity metrics, generated in tandem by spatial network and land-use patterns. The study shows that the complex interrelationships between the spatial network and land-use patterns are the major determinants of the formation of the urban function regions.

These three articles, published in this special issue of the Journal of Urban Design, present an interesting sample of the ways the space syntax research is developing and connecting with the other fields such as morphological, planning, transport and urban design studies. The term space syntax should today be considered an umbrella for socio-spatial studies that employ configurational spatial network tools and intend to bring analytical, evidence-based rigour into urban design and planning.

References

- Conroy-Dalton, R. (2003) The secret is to follow your nose. Route path selection and angularity. *Environment and Behavior*. 35 (1), 107–131.
- De Koning, R.E., Van Nes, A., Ye, Y. & Roald, H.-J. (2017) Strategies for Integrated Densification with Urban Qualities: Combining Space Syntax with building density, land usage, public transport and property rights in Bergen city. In: *Proceedings of the 11th Space Syntax Symposium*. July 2017 Lisbon.
- Dhanani, A., Tarkhanyan, L. & Vaughan, L. (2017) Estimating pedestrian demand for active transport evaluation and planning. *Transportation Research Part A: Policy and Practice*. 103, 54–69.

- Dwimirnani, P. & Karimi, K. (2017) Space after Dark: measuring the impact of public lighting at night on visibility, movement, and spatial configuration in urban parks. In: *Proceedings of the 11 th Space Syntax Symposium*. July 2017 Lisbon.
- Ferguson, P., Fridrich, E. & Karimi, K. (2012) Origin-destination weighting in agent modelling for pedestrian movement forecasting. In: *Eighth International Space Syntax Symposium*. January 2012 Santiago, Chile.
- Freeman, L.C. (1977) A Set of Measures of Centrality Based on Betweenness. *Sociometry*. 40 (1), 35–41.
- Gil, J., Varoudis, T., Karimi, K. & Penn, A. (2015) The space syntax toolkit: Integrating depthmapX and exploratory spatial analysis workflows in QGIS. In: *The Proceedings of the 10th International Space Syntax Symposium*. 13 July 2015 London, Space Syntax Laboratory, The Bartlett School of Architecture, UCL. p. 148: 1–12.
- Hillier, B. (2001) Centrality as a process: accounting for attraction inequalities in deformed grids. *Urban Design International*. 4 (3), 107–127.
- Hillier, B. (1996) *Space is the Machine: A Configurational Theory of Architecture*. Cambridge University Press.
- Hillier, B., Burdett, R., Peponis, J. & Penn, A. (1987) Creating Life: or, does architecture determine anything? *Architecture & Behaviour*. 3 (3), 233–250.
- Hillier, B. & Hanson, J. (1984) *The Social Logic of Space*. Reprint. Cambridge University Press.
- Hillier, B. & Iida, S. (2005) Network and Psychological Effects in Urban Movement. In: Anthony Cohn & David Mark (eds.). *Spatial Information Theory*. Springer Berlin / Heidelberg. pp. 475–490.
- Hillier, B. & Penn, A. (1996) Cities as Movement Economies. *Urban Design International*. 1 (1), 49–60.
- Hillier, B., Penn, A., Hanson, J., Grajewski, T., et al. (1993) Natural Movement: or configuration and attraction in urban pedestrian movement. *Environment and Planning B: planning and design*. 20, 29–66.
- Karimi, K. (2012) A configurational approach to analytical urban design: ‘Space syntax’ methodology. *Urban Design International*. 17 (4), 297–318.
- Karimi, K. (2002) Iranian Organic Cities Demystified; a unique urban experience or an organic city like others. *Built Environment*. 28 (3), 187–202.
- Karimi, K. & Parham, E. (2012) An evidence informed approach to developing an adaptable regeneration programme for declining informal settlements. In: *Eighth International Space Syntax Symposium*. January 2012 Santiago, Chile.
- Marcus, L. (2010) Spatial Capital. *Journal of Space Syntax*. 1 (1), 30–40.
- Marcus, L., Giusti, M. & Barthel, S. (2016) Cognitive affordances in sustainable urbanism: contributions of space syntax and spatial cognition. *Journal of Urban Design*. [Online] 21 (4), 439–452. Available from: doi:10.1080/13574809.2016.1184565.

- Maureira, V. & Karimi, K. (2017) The Everyday and the Post-disaster Urban Systems as one Thing: a configurational approach to enhance the recovery and resilience of cities affected by tsunamis. In: *Proceedings of the 11th Space Syntax Symposium*. July 2017 Lisbon.
- McCahil, C. & Garrick, N. (2008) The Applicability of Space Syntax to Bicycle Facility Planning. *Transportation Research Record: Journal of the Transportation Research Board*. [Online] 2074, 46–51. Available from: doi:10.3141/2074-06.
- Penn, A. (2008) Architectural Research. In: Andrew Knight & Les Ruddock (eds.). *Advanced Research Methods in the Built Environment*. Wiley-Blackwell. pp. 14–27.
- Penn, A., Desyllas, J. & Vaughan, L. (1999) The Space of Innovation: interaction and communication in the work environment. *Environment and Planning B*. 26, 193–218.
- Penn, A., Hillier, B., Banister, D. & Xu, J. (1998) Configurational modelling of urban movement networks. *Environment and Planning B: Planning and Design*. 25 (1), 59–84.
- Raford, N., Chiaradia, A. & Gil, J. (2007) *Space Syntax: The Role of Urban Form in Cyclist Route Choice in Central London*. [Online] Available from: <http://escholarship.org/uc/item/8qz8m4fz#page-3> [Accessed: 17 June 2012].
- Sailer, K., Budgen, A., Lonsdale, N., Turner, A., et al. (2008) *Evidence-based design: theoretical and practical reflections of an emerging approach in office architecture*. [Online] Available from: <http://drs2008.designinquiry.wikispaces.net/> [Accessed: 2 December 2011].
- Shen, Y. & Karimi, K. (2016) Urban function connectivity: Characterisation of functional urban streets with social media check-in data. *Cities*. 55 (June 2016), 9–21.
- Stahle, A., Marcus, L. & Karlstrom, A. (2008) Geographic accessibility with axial lines in GIS. In: *Proceedings 5th Space Syntax Symposium*. 2008 Delft.
- Turner, A., Doxa, M., O' Sullivan, D. & Penn, A. (2001) From isovists to visibility graphs: a methodology for the analysis of architectural space. *Environmental and Planning B: Planning and Design*. 28, 103–121.
- Turner, A., Penn, A. & Alasdair (2002) Encoding natural movement as an agent-based system: an investigation into human pedestrian behaviour in the built environment. *Environment and planning B, Planning and design*. 29 (4), 473–490.
- Vaughan, L. & Arbaci, S. (2011) The Challenges of Understanding Urban Segregation. *Built Environment*. 37 (2), 128–138.