
Space is the machine

Bill Hillier

Since *The social logic of space* was published in 1984, Bill Hillier and his colleagues at University College London have been conducting research on how space features in the form and functioning of buildings and cities. A key outcome is the concept of 'spatial configuration' – meaning relations which take account of other relations in a complex. New techniques have been developed and applied to a wide range of architectural and urban problems. The aim of this book is to assemble some of this work and show how it leads the way to a new type of theory of architecture: an 'analytic' theory in which understanding and design advance together. The success of configurational ideas in bringing to light the spatial logic of buildings and cities suggests that it might be possible to extend these ideas to other areas of the human sciences where problems of configuration and pattern are critical.

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**A configurational theory
of architecture**

Space Syntax

'A house is a machine for living in...'
Le Corbusier (1923)

'But I thought that all that functional stuff
had been refuted. Buildings aren't
machines.' *Student*

'You haven't understood. The building isn't the
machine. Space is the machine.' *Nick Dalton,
Computer Programmer at University College
London (1994)*

Space Syntax



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Preface to the e-edition

Space is the Machine was first published in 1996 by Cambridge University Press. The book built on the theory of society and space set out in *The Social Logic of Space* (Cambridge University Press 1984), to outline a configurational theory of architecture and urbanism. Unfortunately, although *The Social Logic of Space* is still in print after 23 years, when the initial print-run of *Space is the Machine* was exhausted, the number of colour plates forbade the use of the cheap reprinting technology that would have made a succession of reprints economically viable. So, although the book was selling well at the time, it fell out of print. As demand for the book has continued, for several years copies of the book have either been impossible to find or prohibitively expensive.

I am now immensely pleased that Space Syntax Limited, with support from University College London (UCL), have decided to rectify this situation by creating a new e-edition of the book and making it available for free on the web. I am particularly grateful to Tim Stonor for the initial decision to fund the project, to Tim, Chris Stutz and Shinichi Iida for organizing and managing the project and acting as effective editors of the new edition, and to Laura Vaughan and Suzanne Tonkin of UCL for their encouragement throughout the process. Thanks and appreciation are also due to Christian Altmann for the new design of the publication; to Rodrigo Mora for preparing electronic images from the original artworks; to Marco Gandini, Joseph Laycock, Sacha Tan, and Saussan Khalil for proofreading; to Molly Hall for creating a new index; and to Christian Beros for image manipulation and creation of the web distribution pages for the e-edition.

Looking back on *Space is the Machine*, as on *The Social Logic of Space*, I find myself pleasantly surprised that the foundations set out there for the 'space syntax' approach to human spatial phenomena still seem robust. At the same time, the developments in the subject since 1996 have been substantial, not least through the inauguration of the bi-annual space syntax symposia in 1997 (originally the brainchild of Mark David Major). These have created a resource of several hundred papers on developing the theory, methodology and applications of the space syntax approach and now constitute one of its most important resources. To me personally, it is most gratifying that a set of ideas created by a small group of people working together at UCL in the nineteen seventies has now flowered into a large and coherent body of work belonging to a world-wide research community.

At the risk of being unfair to others, however, it does seem to me that certain contributions to the theory and method of space syntax have been so significant as to deserve review in this preface to what is now an eleven-year-old text. For example, on the theoretical foundations of space syntax, the three papers published by John Peponis and his colleagues of the Georgia Institute of Technology in Atlanta in *Environment and Planning B* in 1997 and 1998 (Peponis et al 1997, Peponis et al 1998a, b) on the geometrical foundations seems of permanent significance, as do the two papers of Mike Batty of CASA at UCL (Batty 2004a, b) on the graph theoretic

foundations. I would also hope that my own attempts to show that the effects on ambient space of the placing and shaping of physical objects are systematic and can be mathematically expressed will prove similarly robust. The importance of these effects both for the understanding of urban form (Hillier 2002), and human spatial cognition (Hillier 2007) will, I hope, lead to a more unified understanding of the link between these two realms.

On the methodological side, there has been a remarkable flourishing of new syntactic methods from many sources and locations. From UCL, the most significant of these have been the 'syntacticising' of visibility graph analysis by Alasdair Turner in his Depthmap software (Turner & Penn 1999, Turner et al 2001) and the development of segment based axial analysis with angular, metric and topological weightings, initially through the pioneering work of Shinichi Iida and his Segmen software with subsequent implementation in Depthmap. It was these more complex and disaggregated forms of line analysis that allowed us to show not only that human movement was spatially guided by geometrical and topological rather than metric factors but also to clarify why a powerful impact of space structure on movement was to be mathematically expected (Hillier & Iida 2005). Other key methodological developments include the pioneering work of Dalton on angular analysis (Dalton 2001), now available in the WebMap and WebMapatHome software; the work of Figueiredo and Amorim of the University of Pernambuco in Brazil on 'continuity lines' in the Mindwalk software (Figueiredo & Amorim 2005), which extend lines by discounting angular changes below a certain threshold; and the Spatialist software development by Peponis and his colleagues in connection with the three papers referred to above. Other significant software developments focus on linking space to other urban factors such as land use patterns and densities, notably the Place Syntax software from Marcus and his colleagues at the Royal College of Technology in Stockholm, Sequence software developed by Stegen at ARSIS in Brussels, and the Confeego software pioneered by Stutz, Gil, Friedrich and Klaasmeyer for Space Syntax Limited.

In the more substantive areas of theory, my own research has explored the inter-relations of space, movement at different scales and land use patterns, and it can now arguably be seen to be pointing in the direction of a design-level (meaning precise enough for the ideas to be usable in design) theory of cities as self-organising systems. The theory is in two parts: on the one hand, a theory of how the spatial form of cities is shaped by spatial laws linking the emergence of characteristically urban space patterns to cognitive as well as to social and economic factors; on the other, a theory of how the emergent patterns of space shape movement, and through this shape land use patterns, leading through feedback and multiplier effects, to the generic form of the city as a foreground network of linked centres at all scales set into a background network of largely residential space. Critical to the emergence of this theory was the paper "Centrality

as a process” (Hillier 1999) which showed how local processes with an essentially metric nature combined with the larger scale geometric and topological properties of the spatial network to create the processes by which centres and sub-centres emerge in the network through the logic of the network itself - though each is of course also affected by its relation to others.

Taken together these developments in space syntax suggest that it offers a powerful complement to traditional methods for modelling cities, not least transport modelling methods. These have conceptual foundations quite different from syntactic models and seek to explain different things, but they could be brought into a symbiotic relation with syntactic models to the benefit of both. A key research priority in the immediate future will be to explore their inter-relations. In fact, following the pioneering work of Penn on the configurational analysis of vehicular movement (Penn et al 1998) work by Chiaradia, Raford and others in Space Syntax Limited has already suggested that configurational factors can contribute insights into other kinds of movement networks, including cycles, buses, and overground and underground rail networks.

One aspect of the deepening relation between space syntax and the wider spatial research community has been the debate as to how far space syntax’s basic tenets, such as the representation of cities as line networks and the setting aside of Euclidean metric factors at the larger spatial scale in favour of topological and/or geometric ones, are theoretically valid and methodologically viable. From the syntactic point, certain points of criticism, such as that axial maps are ‘subjective’ and measures should be metricised, seem to have been answered. Turner et al (2005) have showed that least line graphs (allowing random selection among syntactically equivalent lines) are rigorously defined and indeed are objects of great theoretical interest in themselves, as is shown by recent work suggesting they have fractal properties (Carvalho & Penn 2004). Likewise the criticism that syntax disregards metric information has been answered by showing clearly that in terms of functionality this is a scale issue. As shown in (Hillier 1999) referred to above, at a sufficiently localised scale space works in a metric way, perhaps reflecting the scale up to which people can make reasonably accurate judgement about distance in complex spaces, so an account of the metric properties of space is necessary to a functionally sensitive and predictive analysis of space at this level. But at the non-local level, it seems that the functionality of space reflects people’s use of a geometrical picture of the network connectivity rather than a metric picture in navigating the urban grid, and at this scale introducing metric weighting into the measures is positively misleading (Hillier et al 2007).

The study of space within buildings using space syntax methods has also much advanced since 1996, not least of course through the publication of Julienne Hanson’s *Decoding Homes and Houses* (1999), the third of the syntax books from Cambridge University Press. Also notable has been the work of Penn

and his colleagues on spatial form and function in complex buildings, in particular the influential work on spatial design and innovation in work environments. Although not strictly within the syntax context, the highly original work of Steadman (Steadman 1998, 2001) on the enumeration of built forms through a clarification of geometric, constructional and environmental constraints both answers questions about enumerability raised in *Space is the Machine*, and offers a platform for a new approach to spatial enumerability which could and should be taken up within the syntax community.

Against the background of these theoretical and methodological developments, and cross-disciplinary exchanges, space syntax research is now becoming much more interdisciplinary. Following a special issue of *Environment and Behaviour* in 2003 edited by Ruth Conroy Dalton and Craig Zimring bringing together papers on space syntax and cognition from the 2001 Atlanta Symposium, the 2006 conference on Spatial Cognition at the University of Bremen organised a well-attended all day workshop on space syntax. The link between space syntax and cognitive studies is now becoming a well-established branch of syntax research. At the same time the pioneering work of Laura Vaughan and her colleagues is taking syntax in the direction of a greater engagement with social studies, and a special issue of *Progress in Planning* will shortly appear on the use of space syntax in the study of space as a dimension of social segregation and exclusion (Vaughan (ed.) 2007).

Overall, space syntax is becoming a flourishing paradigm for spatial studies, increasingly well integrated with other approaches and increasingly expanding its scope and scale of investigation. But the real test of theory and method is application in the real world of projects and development. Here the contribution of Space Syntax Limited cannot be overestimated. Since its foundation as an active company offering spatial design and spatial planning consultancy under the leadership of Tim Stonor, it has tested the theory and technology on a wide range of projects, many of them high profile. There are now a significant number of projects in which Space Syntax has exerted a key spatial design influence, including of course in the redesign of Trafalgar Square (with Norman Foster) and Nottingham's Old Market Square (with Gustafson Porter), arguably the two most famous squares in the UK, both now functioning in a new and highly successful way following their respective re-designs. Other up and running projects include the Brindley Place development in Birmingham, Exchange Square and Fleet Place in London, and of course the Millennium Bridge, where Space Syntax showed not only how well the bridge would be used but also how strong and beneficial its long term effects would be on the areas on both sides of the river. Equally interesting to space syntax are cases where aspects of space syntax advice was not followed, since in each case problems have appeared that were clearly foreseen by syntax at the design stage.

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Carefully and responsibly used, it is clear that syntax works as a design and planning tool. One consequence of its success in relatively small-scale design and planning problems is that syntax is now increasingly being used as the foundation for the space-based master-planning of whole parts of cities or even of whole cities, and so in effect as a new way of modelling cities. It is increasingly well understood that a syntactic model of a city has two great advantages as a complement to an orthodox model. First, a syntactic model allows the designer or planner to work across all urban scales using the same model, so that one form of analysis will identify the large scale movement networks and its land use effects, while another will similarly identify micro-scale features and land use potentials of the local urban grid. Second, exactly the same model that is used in research mode to investigate and understand how the city is working now can be used in design and planning mode to simulate the likely effects of different design and planning strategies and schemes, allowing the rapid exploration of the long term consequences of different strategies.

Space Syntax Limited also constitutes an experiment in how the relations between a university and a spin-out company can be organised. Although Space Syntax Limited carries out its own research, it maintains a very close relation to the university research department, feeding problems into it and testing new ideas and new technologies. Collaboration is both at the strategic research level, but also reaches down to the level of individual projects where necessary. The experience of a working collaboration between the university and the company has convinced us all that in this field even the most basic research cannot be separated from the demands and questions raised by practice. Many theoretical developments have been sparked by questions raised by projects, and at the same time projects have provided a superb early testing ground for turning research ideas into workable and proven technologies. The fact that it is Space Syntax Limited which is now re-publishing one of the basic theoretical texts of space syntax is an emblem of the closeness with which theory and practice, and the university and the commercial world, have developed collaboratively over the past decade.

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June 6th 2007

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