Space is the machine
Bill Hillier

Space Syntax

1   Introduction

In 1984, in *The Social Logic of Space*, written in collaboration with Julienne Hanson and published by Cambridge University Press, I set out a new theory of space as an aspect of social life. Since then the theory has developed into an extensive research programme into the spatial nature and functioning of buildings and cities, into computer software linking 'space syntax' analytic tools with graphical representation and output for researchers and designers, and into an expanding range of applications in architectural and urban design. During this time, a large number of articles, reports and features have appeared, theses have been written in many universities using the theory and methods of 'space syntax', and research has been initiated in many parts of the world into areas as diverse as the analysis of archaeological remains and the design of hospitals.

During this time, many theoretical advances have also been made, often in symbiosis with the development of new techniques for the computer representation and analysis of space. One key outcome of these advances is that the concept of 'configuration' has moved to centre stage. Configuration means, put simply, relations taking into account other relations. The techniques of 'configurational analysis' - of which the various 'space syntax' techniques are exemplars - that have been built from this idea have made it possible to bring the elusive 'pattern aspect' of things in architecture and urban design into the light of day, and to give quantitative expression to the age-old idea that it is 'how things are put together' that matters.

This has in turn led to a clear articulation of a philosophy of design. Architectural and urban design, both in their formal and spatial aspects, are seen as fundamentally configurational in that the way the parts are put together to form the whole is more important than any of the parts taken in isolation. The configurational techniques developed for research can, in fact, just as easily be turned round and used to support experimentation and simulation in design. In linking theoretical research to design in this way, we are following a historical tradition in architectural theory which has both attempted to subject the pattern aspect of things in architecture to rational analysis, and to test these analyses by embodying them in real designs. The difference now is only that the advent of computers allows us to bring a much great degree of rigour and testing to theoretical ideas.

The aim of this book is to bring together some of these recent developments in applying configurational analysis to issues of architectural and urban theory into a single volume. The surprising success of configurational ideas in capturing the inner logic of at least some aspects of the form and functioning of built environments, suggests that it might in due course be useful to extend these ideas to other areas where similar problems of describing and quantifying configuration seem to be central, including some aspects of cognitive psychology, but also perhaps sociology itself. At present we are encouraged by the current interest in these ideas across a range of disciplines and, just as the last decade has been devoted to the development and testing of techniques of configurational

analysis within architecture and urban design, so we hope that the coming decade will see collaborations amongst disciplines where configuration is identified as a significant problem, and where some development of the configurational methodology could conceivably play a useful role.

The immediate context of the book is the changing theoretical debate within and around architecture. Looking back, it is easy to see that in spite of the attention paid to theory in architecture in the twentieth century, and in spite of the great influence that theories have had on our built environment, architectural theories in the last decades have in general suffered from two debilitating weaknesses. First, most have been strongly normative, and weakly analytic, in that they have been too much concerned to tell designers how buildings and environments should be, and too little concerned with how they actually are. As a result, theories of architecture have influenced our built environment enormously, sometimes for good, sometimes for ill, but they have done little to advance our understanding of architecture.

Second, there has been an explosion of the historic tendency to form architectural theories out of ideas and concepts borrowed from other disciplines. As a result, architectural discourse has been dominated by a series of borrowings, first from engineering and biology, then from psychology and the social sciences, then from linguistics and semiology, and most recently of all from literary theory. Each of these has had the merit that it allowed architecture to become part of wider intellectual debate. But there has been a price, in that very little attention has been given to the internal development of architecture as a discipline. Through this turning away, architecture has increasingly ignored the lessons waiting to be learned from the intensive study of experimental twentieth-century architecture, and acquired what now amounts to a hidden history in which key aspects of recent architectural reality have been suppressed as though they were too painful to talk about.

The aim of this book is to begin the process of remedying this bias towards overly normative theories based on concept borrowing from other disciplines, by initiating the search for a genuinely analytic and internal theory of architecture, that is, one based on the direct study of buildings and built environments, and guided by concepts formed out of the necessities of this study. The guiding belief is that what we need at the end of the twentieth century is a better and deeper understanding of the phenomenon of architecture and how it affects people's lives, and how this relates to innovative possibility in architecture, and the central role of the architectural imagination.

This book is therefore concerned with what buildings and cities are like, why they are as they are, how they work, how they come about through design, and how they might be different. The word 'theory' is used not in the common architectural sense of seeking some set of rules which, if followed, will guarantee architectural success, but in the philosophical and scientific sense that theories are the abstractions through which we understand the world. An architectural theory, as we see it, should deepen our grasp of architectural phenomena, and only subsequently and with great modesty, suggest possible principles on which

to base speculation and innovation in design. Such a theory is analytic before it is normative. Its primary role is to enquire into the puzzle that we see and experience architecture, but we do not understand what we see and experience. However strongly we may feel that architecture may be wrong or right, we rarely understand the architectural grounds on which such judgments are made. This book therefore seeks an understanding of the theoretical content of architecture.

The book is in four parts. The first, *'Theoretical Preliminaries'*, deals with the most basic of all questions which architectural theory tries to answer: what is architecture, and what are theories, that they can be needed in architecture? In the first chapter, 'What architecture adds to building', the key concepts of the book are set out on the way to a definition of architecture. The argument is that in addition to functioning as bodily protection, buildings operate socially in two ways: they constitute the social organisation of everyday life as the spatial configurations of space in which we live and move, and represent social organisation as physical configurations of forms and elements that we see. Both social dimensions of building are therefore configurational in nature, and it is the habit of the human mind to handle configuration unconsciously and intuitively, in much the same way as we handle the grammatical and semantic structures of a language intuitively. Our minds are very effective in handling configuration in this way, but because we do work this way, we find it very difficult to analyse and talk rationally about the configurational aspects of things. Configuration is in general 'non-discursive', meaning that we do not know how to talk about it and do not in general talk about it even when we are most actively using it. In vernacular buildings, the configurational, or non-discursive, aspects of space and form are handled exactly like the grammar of language, that is, as an implication of the manipulation of the surface elements, or words and groups of words in the language case, building elements and geometrical coordinations in building. In the vernacular the act of building reproduces cultural given spatial and formal patterns. This is why it seldom seems 'wrong'. Architecture, in contrast, is the taking into conscious, reflective thought of these non-discursive and configurational aspects of space and form, leading to the exercise of choice within a wide field of possibility, rather than the reduplication of the patterns specific to a culture. Architecture is, in essence, the application of speculative and abstract thought to the non-discursive aspects of building, and because it is so, it is also its application to the social and cultural contents of building.

Chapter 2, 'The need for an analytic theory of architecture', then takes this argument into architectural theory. Architectural theories are essentially attempts to subject the non-discursive aspects of space and form to rational analysis, and to establish principles to guide design in the field of choice, principles which are now needed as cultural guidance is no longer automatic as it is in a vernacular tradition. Architectural theories are both analytic in that they always depend on conjectures about what human beings are like, but they are also normative, and say how the world should be rather more strongly than they say how it is. This means that architecture can be innovative and experimental through the agency of theories, but

it can also be wrong. Because theories can be wrong, architects need to be able to evaluate how good their theories are in practice, since the repetition of theoretical error - as in much of the modernist housing programme - will inevitably lead to the curtailment of architectural freedom. The consequence of this is the need for a truly analytic theory of architecture, that is, one which permits the investigation of the non-discursive without bias towards one or other specific non-discursive style.

Chapter 3, 'Non-discursive technique', outlines the prime requirement for permitting architects to begin this theoretical learning: the need for neutral techniques for the description and analysis of the non-discursive aspects of space and form, that is, techniques that are not simply expressions of partisanship for a particular type of configuration, as most architectural theories have been in the past. The chapter notes a critical difference between regularities and theories. Regularities are repeated phenomena, either in the form of apparent typing or apparent consistencies in the time order in which events occur. Regularities are patterns in surface phenomena. Theories are attempts to model the underlying processes that produce regularities. Every science theorises on the basis of its regularities. Social sciences tend to be weak not because they lack theories but because they lack regularities which theories can seek to explain and which therefore offer the prime test of theories. The first task in the quest for an analytic theory of architecture is therefore to seek regularities. The first purpose of 'non-discursive technique' is to pursue this task.

Part II of the book, *'Non-discursive Regularities'*, then sets out a number of studies in which regularities in the relation between spatial configuration and the observed functioning of built environments have been established using 'non-discursive techniques' of analysis to control the architectural variables. Chapter 4, 'Cities as movement economies' reports a fundamental research finding: that movement in the urban grid is, other things being equal, generated by the configuration of the grid itself. This finding allows completely new insights into the structure of urban grids, and the way these structures relate to urban functioning. The relation between grid and movement in fact underlies many other aspects of urban form: the distribution of land uses, such as retail and residence, the spatial patterning of crime, the evolution of different densities and even the part-whole structure of cities. The influence of the fundamental grid-movement relation is so pervasive that cities are conceptualised in the chapter as 'movement economies', in which the structuring of movement by the grid leads, through multiplier effects, to dense patterns of mixed use encounter that characterise the spatially successful city.

Chapter 5, 'Can architecture cause social malaise?' then discusses how this can go wrong. Focussing on specific studies of housing estates using configurational analysis coupled to intensive observation as well as social data it is shown how the overly complex and poorly structured internal space of many housing estates, including low-rise estates, leads to impoverishment of the 'virtual community' – that is, the system of natural co-presence and co-awareness created by spatial design and realised through movement - and this in turn leads to anti-

social uses of space, which are the first stage in decline towards the 'sink estate'. Because the role of space in this process is to create a disorderly and unsafe pattern of space use, and this is then perceived and experienced, it is possible to conceptualise how architecture works alongside social processes to create social decline. In a sense, the creation of disorderly space use through maladroit space design creates the first symptoms of decline, even before any real decline has occurred. In a sense then, it is argued, we find that the symptoms help to bring about the disease.

Chapter 6, 'Time as an aspect of space' then considers another fundamental difference between urban forms: that between cities which serve the needs of production, distribution and trade, and those which serve the needs of social reproduction, that is of government, major social institutions and bureaucracies. A series of 'strange towns' are examined, and it is shown how in their spatial properties, they are in many senses the opposite to the 'normal' towns considered in Chapter 5. The detailed spatial mechanisms of these towns are examined, and a 'genotype' proposed. An explanation is then suggested as to why 'cities of social reproduction' tend to construct these distinctive types of spatial patterns.

Chapter 7, 'Visible Colleges', then turns to the interiors of buildings. It begins by setting out a general theory of space in buildings, taking into account the results of settlement analysis, and then highlights a series of studies of buildings. A key distinction is made between 'long and short models', that is, between cases where space is strongly governed by rules, and therefore acts to conserve given social statuses and relationships and cases where space acts to generate relations over and above those given by the social situation. The concept of long and short models permits social relations and spatial configuration to be conceptualised in an analogous way. A ritual is a long model social event, since all that happens is governed by rules, and a ritual typically generates a precise system of spatial relationships and movements through time, that is, a spatial 'long model'. A party is a short model event, since its object is to generate new relationships by shuffling them in space, and this means that rules must be minimised by using a spatial 'short model'. In a long model situation space is adapted to support the rules, and behavioural rules must also support it. In a short model situation, space evolves to structure, and often to maximise, encounter density.

Part III of the book, *'The Laws of the Field'*, then uses these noted regularities to reconsider the most fundamental question of all in architectural theory: how is the vast field of possible spatial complexes constrained to create those that are actually found as buildings? First, in Chapter Eight, 'Is architecture an ars combinatoria?', a general theory of 'partitioning' is proposed, in which it is shown that local physical changes in a spatial system always have more or less global configurational effects. It is the laws governing this passage form local physical moves to global spatial effects that are the spatial laws that underlie building. These local-to-global spatial laws are linked to the evolution of real buildings through what will be called 'generic function', by which is meant the

spatial implications of the most fundamental aspects of human use of space, that is, the fact of occupation and the fact of movement. At this generic level, function imposes restraints on what is spatially viable, and this is responsible for what all buildings have in common as spatial designs. Generic function is the 'first filter' between the field of possibility and architectural actuality. The second filter is then the cultural or programmatic requirement of that type of building. The third filter is the idiosyncrasies of structure and expression that then distinguish that building from all others. The passage from the possible to the real passes through these three filters, and without an understanding of each we cannot decipher the form-function relation. Most of all, without a knowledge of generic function and its spatial implications we cannot understand that what all buildings have in common in their spatial structures is already profoundly influenced by human functioning in space.

In Chapter 9, 'The fundamental city', the theory of generic function and the three filters is applied to cities to show how much of the growth of settlements is governed by these basic laws. A new computer modelling technique of 'all line analysis', which begins by conceptualising vacant space as an infinitely dense matrix of lines, containing all possible structures, is used to show how the observable regularities in urban forms from the most local to the most global can be seen to be products of the same underlying processes. A fundamental settlement process is proposed, of which particular cultural types are parameterisations. Finally, it is shown how the fundamental settlement process is essentially realised through a small number of spatial ideas which have an essentially geometrical nature.

Part IV of the book, *'Theoretical Syntheses'*, then begins to draw together some of the questions raised in Part I, the regularities shown in Part II and the laws proposed in Part III, to suggest how the two central problems in architectural theory, namely the form-function problem and the form-meaning problem, can be reconceptualised. Chapter 10, 'Space is the machine', reviews the form-function theory in architecture and attempts to establish a pathology of its formulation: how it came to be set up in such a way that it could not be solved. It then proposes how the configuration paradigm permits a reformulation, through which we can not only make sense of the relation between form and function in buildings, but also we can make sense of how and why buildings, in a powerful sense are 'social objects' and in fact play a powerful role in the realisation and sustaining of human society. Finally, in Chapter 11, 'The reasoning art', the notion of configuration is applied to the study of what architects do, that is, design. Previous models of the design process are reviewed, and it is shown that without knowledge of configuration and the concept of the non-discursive, we cannot understand the internalities of the design process. A new knowledge-based model of design is proposed, with configuration at its centre. It is argued from this that because design is a configurational process, and because it is the characteristic of configuration that local changes make global differences, design is necessarily a top down process. This does not mean that it cannot be analysed, or supported by research. It shows however that only configurationally biased knowledge can really support the design

process, and this, essentially, is theoretical knowledge. It follows from this that attempts to support designers by building methods and systems for bottom up construction of designs must eventually fail as explanatory systems. They can serve to create specific architectural identities, but not to advance general architectural understanding.

In pursuing an analytic rather than a normative theory of architecture, the book might be thought by some to have pretensions to make the art of architecture into a science. This is not what is intended. One effect of a better scientific understanding of architecture is to show that although architecture as a phenomenon is capable of considerable scientific understanding, this does not mean that as a practice architecture is not an art. On the contrary, it shows quite clearly why it is an art and what the nature and limits of that art are. Architecture is an art because, although in key respects its forms can be analysed and understood by scientific means, its forms can only be prescribed by scientific means in a very restricted sense. Architecture is law governed but it is not determinate. What is governed by the laws is not the form of individual buildings but the field of possibility within which the choice of form is made. This means that the impact of these laws on the passage from problem statement to solution is not direct but indirect. It lies deep in the spatial and physical forms of buildings, in their genotypes, not their phenotypes.

Architecture is therefore not part art, and part science, in the sense that it has both technical and aesthetic aspects, but is both art and science in the sense that it requires both the processes of abstraction by which we know science and the processes of concretion by which we know art. The architect as scientist and as theorist seeks to establish the laws of the spatial and formal materials with which the architect as artist then composes. The greater scientific content of architecture over art is simply a function of the far greater complexity of the raw materials of space and form, and their far greater reverberations for other aspects of life, than any materials that an artist uses. It is the fact that the architect designs with the spatial stuff of living that builds the science of architecture into the art of architecture.

It may seem curious to argue that the quest for a scientific understanding of architecture does not lead to the conclusion that architecture is a science, but nevertheless it is the case. In the last analysis, architectural theory is a matter of understanding architecture as a system of possibilities, and how these are restricted by laws which link this system of possibilities to the spatial potentialities of human life. At this level, and perhaps only at this level, architecture is analogous to language. Language is often naïvely conceptualised as a set of words and meanings, set out in a dictionary, and syntactic rules by which they may be combined into meaningful sentences, set out in grammars. This is not what language is, and the laws that govern language are not of this kind. This can be seen from the simple fact that if we take the words of the dictionary and combine them in grammatically correct sentences, virtually all are utterly meaningless and do not count as legitimate sentences. The structures of language are the laws

which restrict the combinatorial possibilities of words, and through these restrictions construct the sayable and the meaningful. The laws of language do not therefore tell us what to say, but prescribe the structure and limits of the sayable. It is within these limits that we use language as the prime means to our individuality and creativity.

In this sense architecture does resemble language. The laws of the field of architecture do not tell designers what to do. By restricting and structuring the field of combinatorial possibility, they prescribe the limits within which architecture is possible. As with language, what is left from this restrictive structuring is rich beyond imagination. Even so, without these laws buildings would not be human products, any more than meaningless but syntactically correct concatenations of words are human sentences.

The case for a theoretical understanding of architecture then rests eventually not on aspiration to philosophical or scientific status, but on the nature of architecture itself. The foundational proposition of the book is that architecture is an inherently theoretical subject. The very act of building raises issues about the relations of the form of the material world and the way in which we live in it which (as any archaeologist knows who has tried to puzzle out a culture from material remains) are unavoidably both philosophical and scientific. Architecture is the most everyday, the most enveloping, the largest and the most culturally determined human artefact. The act of building implies the transmission of cultural conventions answering these questions through custom and habit. Architecture is their rendering explicit, and their transmutation into a realm of innovation and, at its best, of art. In a sense, architecture is abstract thought applied to building, even therefore in a sense theory applied to building. This is why, in the end, architecture must have analytic theories.