SPECIFICALLY ARCHITECTURAL THEORY:

A Partial Account of the Ascent from Building as Cultural Transmission

to Architecture as Theoretical Concretion

Bill Hillier
Theories are forms of knowing that summarize experience into abstract principles, and thus transform the meanings we assign to experience and the way we act on the world. Architects use theories in design, knowingly or unknowingly, not only because the creation of forms must reflect how the designer understands the world, but also because architecture, unlike everyday building, seeks as yet unknown forms, whose nature cannot, by definition, be predicted from experience.

But what are architectural theories like? Are they intellectual styles, like semiotics or deconstruction, brought into architecture from outside and interpreted within architecture? Or is there also some harder-edged sense in which architectural theories are specific to architecture, aiming to explain architectural phenomena as well as to guide design? Are architectural theories, in short, theories applied to architecture or are there also theories of architecture?

In this article, I argue that theories of architecture exist, and that they are to be found not in the changing intellectual context of architecture as a bookish appendage to practice, but within the practice itself, guiding the answers to kinds of questions that arise at the point of design. Architecture, I will argue, is an intrinsically theoretical act. The key to architectural theory lies, I will suggest, not in the invocation of external abstractions, but in a proper understanding of the processes and products of architecture.

I will argue my case for specifically architectural theory using the problem of space as a specific instance. Architects and builders already use theory-like constructs in creating built space, and I will try to show that it is possible to develop a much fuller theory of space, one with some pretense to objectivity, capable of augmenting our intuitions in explaining and predicting forms, and also capable of refutation. I will argue that although such theories challenge architects with much more powerful and precise tools of analysis than they have had before, they lead not to constraint but to liberation.

Better theories of space mean more freedom for the designer because they bring the deep structures of architectural and urban space into the realm of rational debate and creative intuition.

In this article I will first try to distinguish architecture from building to show how theory is central to architectural practice. Then I will look at the issue of space, first as a philosophical problem, then as an aspect of buildings, and finally as an architectural phenomenon. I will then turn to the theory of space itself and suggest that space has its own internal laws, and that it is only when these are properly understood that space can be fully a part of architecture. Finally I will draw some inferences on how this view of theory affects our view of architecture as science and as art.

**SYSTEMATIC INTENT OF THE ARCHITECTURAL KIND**

First, how is architecture theoretical? Let us begin with some elementary semantics. If we try to unpack the ways we use the word architecture, it seems to refer both to an activity and a thing, that is, to the activity we call design and to buildings where we note evidence of this activity. Does this imply, as it seems to, that architecture is not really an objective property, but only a record of a certain kind of activity?

This is a difficult question, of a kind familiar to philosophers and aestheticians, who often ask whether words like beautiful refer to intrinsic properties of things, or are more akin to words such as appropriate which clearly do not refer to intrinsic properties of things, but to the judgments that we make by comparing things to other things.1 Putting the question their way, we might ask whether architecture is actually a property of architectural objects, or a judgment that we make about objects, aware that they are the result of architectural activity.

Let us try to throw light on this by examining cases where deciding what is and is not architecture is particularly difficult, as when looking at the origins of architecture, or at where to draw the line between architecture and the vernacular. A colleague of mine, in reviewing the archaeological record for the origins of architecture, suggests that we see architecture in the evolution of buildings when we see evidence of "systematic intent."2 By this she means deliberate abstract thought applied to construction, to space arrangement, or to visual organization, either at the level of the building or the settlement.

This is an interesting and persuasive definition. But if we try to generalize it we encounter problems. Suppose, for example, that we try to use it to distinguish architecture from the vernacular. It doesn’t work, because clearly the vernacular is full of systematic intent. To make the matter even more difficult, the demarcation between architecture and the vernacular shifts with time, in that aspects of the architecture of one generation may reappear as the vernacular of another, and vice versa. These difficulties really do begin to make it look as though architecture is not at all an intrinsic property of things but a judgment that we make about things in the light of other knowledge.

However, if we look a little more closely at the vernacular we find new possibilities. The outstanding work of Henry Glassie on vernacular housing adapts from Noam Chomsky a concept he calls “architectural competence,” which he argues, underlies the architectural consistencies and variations by which we recognize a vernacular tradition. For Glassie, “architectural competence” is a set of technological, geometrical, and manipulative skills relating form to use, which constitute “an account not of how a house is made, but of how a house is thought... set out like a program... a scheme analogous to a grammar, that will consist of an outline of rule sets interrupted by prose exegesis.”3 Glassie’s analogy with language is apposite. It suggests that the rule sets the vernacular designer uses are often tacit, taken for granted in the same way as the rule sets that govern the use of language. They are ideas we think with, rather than ideas we think of. The proposal that the evidence of systematic intent that we note in the vernacular might have its origins in
some such rule sets seems a compelling one.

The implication of Glassie's idea is that "architectural competence" provides a set of normative rules about how building should be done, so that a vernacular building reproduces a known and socially accepted pattern. The house built by a builder sharing the culture of a community comes out right because it draws on the normative rules that define the architectural competence of the community. Buildings become part of what Margaret Mead calls "the transmission of culture by artefacts."4 Through distinctive ways of building, aspects of the social knowledge of a community are reproduced.

Now whatever architecture is, it is clearly not just the transmission and reproduction of social knowledge through building, though it may include that. But this does suggest where the difference between architecture and building might lie. What we mean by architecture surely is not building by reference to culturally bound competences. What we mean, rather, is building by reference to a would-be universalistic competence based on general comparative knowledge of architectural forms and functions, and aimed (through understanding of principle derived from comparative knowledge) at innovation rather than cultural reduplication. The judgment we make that a building is architecture arises when the evidence of systematic intent is evidence of intellectual choice and decision making exercised in a field of possibility that goes beyond cultural idiosyncrasy and into the realm of principled understanding. It is when we see in buildings evidence of this concern for the abstract comparability of forms that building is transcended and architecture is named.

We may then generalize and say that building is transcended and architecture is named where we note as a property of buildings some evidence not only of systematic intent, but of theoretical intent, at least in embryonic form. In this sense architecture transcends building in the same sense that science transcends the practical arts of making and doing. Architecture introduces into the making of buildings a more abstract concern for the realm of possibility created through theoretical concern. In this sense, architecture is theory applied to building.

The demarcation between the vernacular and architecture is then no longer problematic. The reproduction of existing forms, vernacular or otherwise, is not architecture, because it requires no exercise of abstract comparative thought. But by the same criterion, the exploitation of vernacular forms in the creation of new forms can be architecture, because it does involve such thought. Architecture is thus both a thing and a judgment. In the form of the thing we detect evidence of systematic intent of the architectural kind. From the built evidence we can judge both that a building is intended to be architecture and, if we are so inclined, that it is architecture.

**SPACE AS A PHILOSOPHICAL PROBLEM**

Now space, I will argue, is one of the primary means by which the ascent from building as cultural transmission to architecture as theoretical intent is made, and is therefore one of the prime targets for architectural theory. This is to say that one aspect of the abstract comparability of forms in architecture centers on spatial form, which implies that space is, in some important sense, an objective property of buildings.

This is not obvious. Most of our common notions of space do not deal with space as an objective entity in itself but tie it in some way to human agency. For example, laymen tend to transcribe space as the use of space, or the perception of space, or concepts of space. Space as a thing in itself is harder to communicate. Common spatial concepts in architectural discourse are also similarly tied: personal space, human territoriality, spatial scale, and so on.

Even in architectural concepts of space where space is unlinked from direct human agency, we still find that space is not independently described. The concept of spatial enclosure, for example, describes space by reference to the physical forms that define it. Without them, the space vanishes. This tendency finds its extreme expression in writers such as Roger Scruton who think that the concept of space is a rather silly mistake made by rather pretentious architects, who have failed to understand that space in not an entity at all, but merely the obverse side of the physical object, the vacancy left by the physical building. For Scruton, it is self-evident that space in a field and in a cathedral are the same thing except insofar as the interior built surfaces of the cathedral create the impression that the interior space has distinctive properties.5 All talk about space is in error, because it can be reduced to talk about physical objects.

In fact, this is a quite bizarre view, since at a practical level, space is manifestly the saleable commodity in buildings. We build walls, but we sell and rent space. Are developers who advertise space at so much per square foot making a category mistake? Should they be offering to rent walls and roofs? Why then is Scruton embarrassed by the concept of space? Let me suggest that Scruton is making an educated error, one that he would not make if he had not been so deeply imbued with the Western philosophical tradition.6

The dominant view of space in Western culture has been one we might loosely call Galilean-Cartesian. By this I mean that the primary properties of objects are seen as their extension—length, breadth, width, and so on—which are also their measurable properties. Extensions are the indisputably objective properties of things, independent of observers, unlike secondary properties such as "green" or "nice," which seem to depend in some way on interaction with observers. If extension is the primary property of objects, then it is natural to infer that it is also the primary property of the space within which objects sit. We can see this by the fact that when we take the object away from its space its extension is still present as an attribute of space. Space is therefore generalized extension, and as such the framework within which the primary properties of objects are defined.7
But once we see space as a general abstract framework or background of extension, then we are doomed not to understand how it plays a role in human affairs, including architecture. Space is never simply the inert background of our material existence. It is a key aspect of how our social and cultural worlds are constituted in the physical world, and structured for us as objective realities. Space is not the neutral framework for social and cultural forms. It is built into those very forms. It is because this is so that buildings can carry within their spatial forms the kinds of social knowing that Glassie notes.

**Space as a Pattern Problem**

But because space is built so pervasively into social and cultural life, we tend to take it for granted, to the point that its forms become invisible to us, and so much so that we have no rational language for the discussion of these forms. The only language is that of the forms themselves. If we wish to build a theory of space, then, we must first learn this language—although in a sense we know it already—and learn to talk about space in a way that allows its form to become clear.

Let us begin by defining the problem clearly: as a pattern problem. Consider the two notional courtyard buildings of figures 1a and 1b, showing in black the pattern of physical elements. Figures 2a and 2b show in black the corresponding pattern of spatial elements. The basic physical structures and cell divisions of the two building are the same, and each has the same pattern of adjacencies between cells and the same number of internal and external openings. But the locations of cell entrances means that the spatial patterns are about as different as they could be from the point of view of the permeability of the layout. One is a near-perfect single sequence, with a minimal branch at the end. The other is branched everywhere about the strong central spaces.

The pattern of entrances would make relatively little difference to the building structurally or climatically, especially if we assumed a similar pattern of external fenestration, and inserted windows wherever the other had entrances onto the courtyard. But it would make a dramatic difference to how the layout would work as, say, a domestic interior. For example, it is very difficult for one person to use a single sequence of spaces. It offers little in the way of community or privacy, but much in the way of potential intrusion. The branched pattern, on the other hand, offers a more flexible set of potential relations between community and privacy, and many more resources against intrusion. These differences are inherent in the space patterns themselves in terms of the range of limitations and potentialities offered. They suggest the possibility that architectural space might be subject to limiting laws, not of a deterministic kind, but ones that set morphological bounds within which the relations between form and function in buildings are worked out.

We can capture the difference between the two spatial patterns by a useful device we call a justified graph (figs. 3a and 3b). In this we imagine that we are in a space that we call the root or base of the graph, and represent as a circle with a cross. Then, representing spaces as circles, and relations of access as lines connecting them, we align immediately above the root all spaces that are directly connected to the root. Then above the first row we align the spaces that connect directly to first-row spaces, and so on. The result is a picture of the depth of all spaces in a pattern from a particular point in it.
We can see that one is a deep tree form, and the other a shallow tree form. By tree we mean that the patterns lack any rings of circulation. All trees, even those as different as the two in figures 3a and 3b, share the characteristic that there is only one route from each space to the other—a property that is highly relevant to how building layouts function.

However, where rings are found, the justified graph makes them clear as depth properties (figs. 4a, 4b, and 4c). Using justified graphs, then, we can begin to make visible two of the most fundamental properties of spatial configurations: how much depth they have from each space (how many other spaces must be passed through to get to others); and how each space relates to the pattern of circulation rings in the configuration (how it relates to the choices of route available).

More significantly, we can now take the crucial step in understanding spatial configuration as a product of culture. The key to spatial configuration in buildings and cities is that within the same building or urban system, space has different configurational properties when looked at from different points of view. This can be shown by drawing justified graphs, because the differences have mainly to do with the way in which depth and rings are distributed in the spatial configuration when seen from different points of view (figs. 5a and 5b).

The depth and ring properties could hardly appear more different if they were different configurations. It is through the creation and distribution of such differences by the arrangement of physical constructions that space becomes such a powerful raw material for the transmission of culture through buildings and settlement forms, and also such a potent means of architectural discovery and creation.

**Society in the Form of the Object**

Let me now show how buildings can transmit cultural ideas through this aspect of spatial patterning. Figure 6 shows ground floor plans of three French houses, and their justified graphs drawn initially from the outside, treating it as a single space, then from three different internal spaces. Looking at the first graph (drawn from the outside), we see that in spite of the geometrical differences in the houses there are strong similarities in the configurations. We see this most easily by concentrating on the space marked sc, or salle commune. In each case, the salle commune lies on all nontrivial rings (a trivial ring is one that links the same pair of spaces twice), links directly to an exterior space, and acts as a link between the living spaces and the spaces associated in that culture with the domestic work of women.

The salle commune also has a more fundamental property, one that arises from its relation to the spatial configuration of the house as a whole. If we count the number of spaces we must pass through to go from the salle commune to all other spaces, we find that it comes to a total that is less than for any other space—that is, it has less depth than any other space in the complex. The general form of this measure is called integration, and can be applied to any space in any configuration: the less depth from the complex as a whole, the more integrating the space. This means that every space in the three complexes can be assigned an integration value. Other measures express how strong these differences are.

Now once we have done this we can ask questions about the distribution of functions in the house. In the three French houses, for example, we find that there is a certain order of integration among the spaces where different functions are carried out, always with the salle commune as the most integrated. In other words, we can say with quantitative rigor that there is a common pattern to the way in which different functions are spatialised in the house. We call such common patterns genotypes, because they refer not to the surface appearances of forms but to deep structures underlying spatial configurations and their relation to living patterns.

These results flow from an analysis of space-to-space permeability. But what about the relation of visibility, which passes through spaces? Figures 7 and 8 show what we call the convex isovists (that is, all that can be seen from a space in which all points are mutually visible, in this case drawn to omit the corners of rooms in a consistent way) from the salle commune and another space labelled salle. In each case the salle commune has a far more powerful visual field than the salle. These differences provide a basis for quantitative and statistical analysis and subsequent exploration of genotypical cultural patterns that lie embedded in the material and spatial objectivity of buildings.
This method allows us to retrieve what we might call Glassie properties from house plans, and to formalize the notion of cultural types. We have thus shown both how buildings can transmit social knowledge through their spatial form and how this can be retrieved by analysis. This is clearly useful knowledge for an architect to have. But it is not yet architecture, according to my definition, and certainly not a theory of architecture, even a partial one.

So how does this relate to the definition of architecture proposed earlier? Let me begin by referring to a study of selected houses by Adolf Loos and Le Corbusier by Dickon Irwin. I cannot do justice to the subtlety and complexity of Irwin’s argument in this brief text, but I would like to review some of his conclusions. Irwin’s analysis of five houses by each of the two architects showed that although in each house there was configurational differentiation of functions, there was no consistent pattern within either architect’s work. It was as though each recognized the principle that functions should be spatially differentiated, but regarded it as a matter of experiment and innovation, rather than as the reproduction of a culturally approved genotype.

However, Irwin was able to show that each architect had a distinctive spatial style, that in whatever each was doing with the functional pattern, distinctive spatial means were used to achieve the ends. For example, in the Loos houses, adding visibility relations to permeability relations increased the intelligibility of the space pattern (for a discussion of intelligibility see page 17), whereas in the Le Corbusier houses it did not. Similarly, in the Loos houses, the geometry of the plan reinforced aspects of the spatial structure of the plan, in that major lines of spatial integration coincided with focuses of geometric order, whereas again in the Le Corbusier houses it did not. Some of these differences were captured by Irwin in diagrams he called line isoostics, where he took the most integrated lines in the axial map of the house (see below) and drew all the space that could be seen from them. Figures 9 (Loos: Tristan Tzara House) and 10 (Le Corbusier: Villa Stein) show in order the isoostics from the two most integrated lines from the point of view of the permeability pattern in each house, followed by the visibility isoostics of the two most visibly integrating lines. If we imagine each isoostic as an episode in the spatial experience of moving through the houses, we can see that in Loos the isoostics are very rich, but relatively uniform, whereas in Le Corbusier the isoostics are more selective in the spatial relations they show from the line, but each episode is dramatically different from the others.

In this respect, Irwin argues, the two architects are adumbrating different fundamental—almost philosophical—programs through architecture: Loos creates a house that is a novel expression of cultural habitability, Le Corbusier creates a less habitable, more idealized domain of rigorous abstraction. Neither Le Corbusier nor Loos is denying the social and cultural nature of the domestic interior. But each, by satisfying the need to give space cultural meaning through functional differentiation—first one way then another, but with a consistent spatial style—is giving priority not to the functional ends of building but to the architectural means of expressing those functional ends. The genotype of these houses lies, we might suggest, not in the functional ends, as in the vernacular cases, but in the way architectural means are used to express the ends. The means modify the ends by reexpressing them as part of a richer cultural realm.

This distinction between ends and means is, I believe, fundamental to the definition of architecture offered earlier. It suggests that we can make a useful distinction, in architecture as elsewhere, between the realm of social meaning and the realm of the aesthetic—in this case the spatial aesthetic. The cultural and functional differentiation of space is the social meaning, the spatial means is the spatial aesthetic. The former conveys a clear social intention, the latter an architectural experience that recontextualizes the social intention. Meaning is the realm of constraint, the spatial aesthetic the realm of freedom. The spatial meaning of form expresses what architecture must be to fulfill its purpose as a social object, the spatial aesthetic expresses what it can be to fulfill its purpose as architecture.

But although space moves outside the realm of specific codes of social knowledge, it does not lose its social dimension. The relation between spatial and social forms is not contingent, but follows patterns that are so consistent we can hardly doubt that they have the nature of laws. The spatial aesthetic carries social potential through these laws. The autonomy of architectural means thus finds itself in a realm governed by general principles, with its freedom restricted not by the specific spatial demands of a culture but by the laws of space themselves.
These laws find one of their strongest expressions in urban space, where the social programming of space is much less closely defined than in building interiors. However, in looking for the operations and effects of these laws, we will find that certain attributes of urban space believed by many to be aesthetic in origin in fact arise from functional laws. What these functional laws of space might be like is the theme of the next part of my argument.

THE URBAN GRID AS AN OBJECT OF ARCHITECTURAL THOUGHT

There are two factors that make the analysis of urban space especially difficult for configurational analysis. First, urban space is continuous. There is no obvious division into elements. Second, with obvious exceptions, urban space usually has a good deal of irregularity. Most towns and cities have deformed grids, with no obvious geometry. Both factors are
aspects of the problem of representation: how do we define an element of urban space so that we can subject it to configurational analysis?

It will be useful to begin by looking at a familiar case and considering how we might think of urban grids as spatial patterns. Figure 11a shows in black the plan forms of all the open spaces and public squares in Rome, respecting orientation but not location. Figure 11b shows their location. Figure 11c shows the shapes, orientations, and locations, and adds a further element: the full spatial shape visible from each square, its isovist. From this we see that some subsets of the isovists of the spaces form interconnected clumps with more or less continuous visibility and permeability, while others do not. These are pattern properties, arising from the interrelationships of many distinct entities.

---

figure 7
Diagrams of the houses from figure 6 showing convex isovists from the sale commune.

figure 8
Diagrams of the houses from figure 6 showing convex isovists from the sale.

---

figure 10
Le Corbusier. Villa Stein. First floor: permeability isovist from the most integrated line. Second floor: visibility isovist from the visibly most integrated line.
How shall we analyze these Roman properties? The complexity of the situation is such that we must recruit the computer, and begin with some simple experiments. Figure 12 is a hypothetical arrangement of built urban blocks, that create by their disposition an arbitrary deformed grid with a major, squarelike space. Although deformed, it has a degree of continuity of space, which gives it an approximately urban look, unlike figure 13, where the same blocks have been re-arranged to create a pattern that is manifestly not urban. The difference is instructive. It tells us that the deformed grids we recognize as urban may have a good deal of internal order to them.

Like other deformed grids, however, neither hypothetical figure has obvious spatial parts or elements. What, then, does it have that can be modelled? The answer is that as we move about a deformed grid, it exhibits everywhere local properties that continually change. Just as the shapes of space that were experienced locally in the Le Corbusier or Loos houses changed as we moved through the house, so the shape of space we see as we move from point to point in an urban grid also changes.

The question is, how does it change? And can these changes be captured in a representation? The Roman case established several concepts that may be of use. For example, wherever we are in a deformed grid we are in some maximal convex element of space defined by the surfaces of building blocks. The property of convexity means that any two points that can be seen from a point can also see each other. Figure 14 is a computer analysis of figure 12 in which all such convex elements have been identified, allowing them to overlap as much as necessary, and then analyzed and coded in terms of how deep each is from all the others: the darker, the less depth, the lighter, the more depth. In other words, figure 14 shows the distribution of integration (as defined above) in the convex representation of the deformed grid of figure 12, with the darkest elements making up what we call the integration core.

Now let us carry out the same analysis on figure 13. We find that the pattern of integration has changed completely, with the core moving to the edge and much weaker integration in the central areas (fig. 15). The integration core, one feels, has a much less powerful effect in creating an intelligible pattern to the space structure.

This property of intelligibility can in fact be demonstrated quite formally. If we go back to imagining that we are moving around in the spaces of these two configurations, then we can easily see that the field we see from points in figure 15 will on the whole be a good deal less rich than the field in figure 14. It will be a great deal harder to learn about the space structure as a whole because we get much poorer information form the localized parts. Few points in the pattern give much clue to the overall structure of the pattern, and even less to its distribution of integration. In figure 14, in contrast, we get a good deal of global information from local parts, and what we can see from points gives a good indication of how each space fits into the overall system.

This in fact reflects one of the most important pattern characteristics of deformed grid urban space. The information you get locally from the visual field you experience as you move around gives plenty of clues about how the overall spatial system is structured. In intelligible urban space, one might say, you get global information at the same time as you get local information about spaces, as we saw with the Roman squares.
Intelligibility can be quantified by a simple statistical trick. Figure 16 is scattergram in which each point represents one of the overlapping convex elements of figure 12. The number of convex elements each point overlaps with is indicated by its position on the vertical axis, and its degree of integration in the overall pattern on the horizontal axis. The more the points form a straight line from bottom left to top right, then the more connections an element has, which can be seen from each line. This is a reliable guide to its integration in the system as a whole, a property that cannot be seen from a line.

The tight scatter in figure 16 shows that the first configuration has a high degree of intelligibility, which can be expressed as a number by taking the correlation coefficient of the scatter. A value of 1 would indicate a perfect straight line of points, and 0 a random scatter. If we now look at the scatter for the second configuration, shown in figure 17, we can see that the scatter is much less tight, meaning that it has a lower value and therefore a lower degree of intelligibility. This expresses formally what intuition suggests: that the visual fields you see locally as you move around are a poorer guide to the system as a whole. The space structure is too labyrinthine.

This analysis of the convex organization of urban space is more than a formal game. It relates to important functional aspects of how space is used. For example, studies have shown that the choices that people make in selecting urban spaces for informal activities, such as eating, drinking, talking and sitting, reflect proximity or adjacency to areas with strong visual fields that are well integrated into the system as a whole. Such spaces are ideally suited to what seems to be the favorite occupation of those using urban space informally: watching other people.

However, the most important and consistent functional effect of urban space follows from the configurational analysis of a different representation of its structure: one based on its one-dimensional, or axial, structure. We can again use the computer to explore the basics. The tangled skein of lines in figure 18 represents the maximal linear visibility available within the open space structure of figure 12, namely the set of all straight lines that are tangent to pairs of vertices of building blocks. That is, each line just passes by at least two such vertices, thus drawing a limit of a line of sight. Once the computer has found this set of lines, it can then subject them to integration analysis and code the results as before, with the darkest lines the most integrating, and showing the integration core of the pattern, and the lightest lines the most segregated (fig. 19).

Figures 18 and 19 thus represent different configurational views of the block arrangement in figure 12. Each says: seen in terms of this type of local element, and analyzed by that pattern parameter, the global structure of space looks like this. This is the essence of space syntax modelling. It is not a single technique but a set of techniques that allows two questions to be posed: how is the spatial system of interest to be represented as relatively localized elements, and how are the interrelationships to be analyzed to identify global patterns, so that we may understand the system’s underlying structure.
Once we have this understanding of structure, we can begin to ask questions about function in a new way. Because syntactic analysis assigns to each spatial element in a system numbers that index its pattern relations, we can investigate the relation between these patterns and function simply by seeing how far the syntactic numbers assigned to spaces correlate with numbers describing aspects of function in those spaces: movement rates, informal use, rents, land uses, plot ratios, and so on. We can thus pose questions about space and function in a new way. In the case of urban space, we can ask: what does function mean when space is universally public and more or less unrestricted? We will receive a resounding answer: urban space is about movement. Urban space creates a field of movement and thus copresence and potential encounters among people.

We can show this by using again the scattergram technique. Figures 20-23 analyze the pedestrian and vehicular movement for the Barnsbury area of North London. The high degree of correlation in figure 22 (the correlation coefficient is .85 on a scale of 0 to 1) shows that the number of people passing along each line is largely a function of the spatial pattern itself. The same is true of vehicular movement, whose scattergram shows a correlation of .81 in spite of the existence of a number of one-way systems (fig. 23). The fundamental result is that the pattern of movement in an urban system is determined in the main by the spatial configuration itself, and in particular by the distribution of spatial integration in the axial map of the system.16

These results are quite fundamental to our understanding of urban space, since they show that it is the architecture of the urban grid itself that is chiefly responsible for the pattern of movement, not the positioning of attractors and magnets, as has commonly been believed. These results have been repeated so often that we have little doubt that they are something like a law. However, the law does not simply say that movement in a grid is a function of the distribution of spatial integration in the grid. The relationship, it turns out, is subject to the degree to which the grid has the property of intelligibility, as defined earlier. If you make urban space unintelligible, then you are also likely to make it unpredictable. We call this the theory of natural movement. Natural movement is the proportion of movement determined by the architecture of the grid itself. Where there is no natural movement, then most space will be empty for most of the time, leading almost inevitably to one aspect or another of urban malfunction. This is the reason why we must once again learn to make the urban grid an object of architectural thought.

Because natural movement is fundamental, it is also reasonable to suppose that it accounts to a great extent for the way in which urban grids evolve. It is likely that over time a dynamic relation develops between the evolving urban grid, its natural movement patterns, and the developing pattern of land use. Certain types of use, for example retailing, survive best in locations that are accessible and have through-movement—that is, in locations that have both the spatial properties and functional effects of integration. The result is that over time, urban grids evolve not only to optimize patterns of mutual accessibility, but also to optimize the usefulness of the by-product of movement from place to place—that is, the spaces that must be passed through on journeys from all origins to all destinations. Through this mechanism, spaces that are accessible for to-movement also become those with strong through-movement, and these spaces then become the busy focuses of urban life. We call this the theory of the movement economy. If the theory is correct, it means that the architecture of the urban grid is of far greater significance in urban evolution than has been allowed in planning theory, and provides further reason for bringing back the urban grid as an object of architectural analysis and creativity.17
DESIGNING WITH SPACE SYNTAX: THE KING'S CROSS MASTERPLAN

What does all this imply for design? Let us proceed through a real case study: the design by Norman Foster Associates of the master plan for the King's Cross development in inner London for the London Regeneration Consortium. King's Cross is currently the biggest urban development project in Europe. Our published research using space syntax to predict pedestrian movement patterns, and the involvement of space syntax in public inquiries on major urban redevelopment schemes, had alerted first the community groups, then the planners and developers to the potential of using space syntax to help solve the fundamental problem of the King's Cross site: how to design the development in such a way that it continued and joined the urban structures of Islington to the east of the site and Camden to the west. Natural pedestrian movement to and through the site was seen as essential to this aim. Foster Associates, backed by the developers, asked us to make a study, and work with the design team in trying to build these relationships into the master plan.

The first step was to study the spatial structure, space use, and movement patterns in the existing contextual area. This study is documented in figures 24-30. From a design point of view, the key product of the study is a spatial model of the contextual areas of the site, verified by its power to "post-dict" the existing pattern of movement around the site. This allows us to add design proposals to the model, and to re-analyze in order to see how each proposal is likely to work within, and affect, the urban context.

We can therefore begin to explore intuitions as to what kind of master plan will most successfully adapt the existing structure of the area and create the levels of natural pedestrian movement requested by the designers. This will depend on the achievement of two spatial objectives: bringing adequate levels of integration into the site in a way that reflects and adapts the existing natural movement patterns in the area, and maintaining or if possible improving the grid's intelligibility.
There is, however, a technical problem with the formal definition of intelligibility. Because intelligibility measures the degree of agreement between the local and global properties of space, a small system is, other things being equal, more likely to be intelligible than a larger one. We can overcome this by bringing in a database of established London areas of different sizes to compare with King’s Cross as it is now and as it will be when it is developed (fig. 31). Figure 31 shows that not only is the King’s Cross area less intelligible than London areas in general, but also the small area is relatively less intelligible than the large. This is probably because the “urban hole” created by the King’s Cross site has a stronger impact on the area immediately around it than it does on the larger surrounding area.

We can now use the area axial map as a basis for design simulation and experimentation. In fact, what we will be doing in this text is conducting a number of experiments that explore the limits of possibility for the site.18

Let us first suppose that we impose a regular grid on the site, so that it has a local appearance of being ordered but makes no attempt to take advantage of the existing, rather disorderly pattern of integration in the area (fig. 32). In spite of its high degree of internal connection, the scheme acts as a substantial lump of relatively segregated spaces, rather like one of the local housing estates shown in figure 25, which freezes out virtually all natural movement and creates a quite unnerving sense of emptiness.

In other words, the grid scheme completely fails to integrate itself into the area or to contribute to the overall integration of the area. The effect on intelligibility is no better. We can see this by plotting the intelligibility scattergram and using the space syntax software to locate the spaces of the scheme on the scatter. Figure 33 shows that the scheme’s spaces form a lump (within the box) well off the line of intelligibility, occupying the segregated and rather poorly connected part of the scatter. We conclude not only that the scheme is far too segregated to achieve good levels of natural movement, but that its spaces are insufficiently integrated for their degree of connection and therefore worsen the intelligibility of the area as a whole.

Still in the spirit of experimentation, let us now try the opposite and simply extend integrating lines in the area into the site, and then complete the grid with minor lines more or less at will. This means that instead of imposing a new conceptual order onto the site regardless of the area, we are now using the area to determine the structure of space on the
site. We must stress that this design is impossible, since it would require, among other things, a ground-level train crossing at the exit of St. Pancras station!

In spite of its unrealism, the experiment is instructive. Figure 34 shows the integration structure that would result from such a scheme. In effect it shows that certain lines extended across the site would become the most integrating lines in the whole area, stronger even than Euston Road—the major east-west trunk road passing south of the site, which would be the major integrator with respect to an area expanded to the south and west. We also find a substantially greater range of integration values in the development, in contrast to the much greater uniformity of the grid scheme.

This is a "good" urban property. Mixing adjacent integration values means a mix of busy and quiet spaces in close association with each other, with the kind of rapid transitions in urban character that are very typical of London. Figure 35 shows a much improved intelligibility scattergram, with the lines of the scheme picked out in bold, showing that they not only improve the intelligibility of the area, but make a linear—and therefore intelligible—scatter themselves.

Now if we plot these two hypothetical solutions on the London Intelligibility Index (fig. 36), we find that whereas the grid leaves the area as poor in intelligibility as it was, still lying in more or less the same position below the regression line, the "super-integrated" scheme moves well above the regression line, and would even be above the line formed by Islington and the City. We might even conclude that we have overdone things, and have created too strong a focus on the site for the mixture of commercial and residential development that is envisaged.

The final Foster Associates master plan, working as it does within the concept of a central park to bring democratic uses into the heart of the site, is a much more subtle and complex design than either of these crude illustrative experiments. In developing the design, a protracted process of design conjecture and constructive evaluation through space syntax modelling took place, much of it around the drawing board. The final master plan (figs. 37-40) draws integration in and through the different parts of the site to a degree that matches the intended land-use mix, which goes from urban office and shopping areas, where levels of natural movement need to be high, to quieter residential streets, where levels of movement will be lower.
The intelligibility scattergram shown in figure 38, again with the master plan lines picked out in bold, shows that the scheme improves the intelligibility of the area, and also has high internal intelligibility, seen in the linear scatter of the master plan lines. But the scheme also has more continuous variation from integrated to segregated than the super-integrated scheme, with its markedly more lumpy scatter. This indicates that the local variation in the syntactic quality of spaces, arising from mixing integrated and segregated lines in close proximity, is also better achieved. This is confirmed by the overall intelligibility index, which shows that the scheme falls very slightly above the regression line, meaning that it continues the established level of intelligibility in the London grid (fig. 36).

Thus the design team may not only use space syntax to experiment with design in a functionally intelligent way, they may also use the system to bring to bear on the design task both detailed contextual knowledge and a relevant database of precedent. We think of this as a prototype graphical knowledge interface for designers—meaning a graphically manipulable representation that also accesses contextual knowledge and precedent databases relevant to both the spatial structure and functional outcomes of designs. The experience of using space syntax on King’s Cross and other urban master plans has convinced us that what designers need from research is theoretical knowledge, coupled to technique, not information or data or constraint. Furthermore, with theory and technique, much more of the living complexity of urban patterns can be brought within the scope of architectural intuition and architectural intent, without subjecting them to the geometrical and hierarchical simplification that have become the commonplace of urban design.

![Intelligibility scattergram](image)

**figure 28**
Intelligibility scattergram of the area as it stands, in which each line in figure 27 is represented as a dot and located on the horizontal axis according to its degree of integration (a global property that cannot be seen from the line) and on the vertical axis according to its degree of connectivity (a local property that can be seen from the line). The index of intelligibility is the square root of the number at the top right. The scattergram shows a rather poor level of intelligibility, partly due to the hole in the system formed by the King’s Cross site.

**figure 29**
Map showing 239 line segments in ten areas around the site (including three housing estates adjacent to the site that are not shown in the axial map) where pedestrian space use and movement was observed using a simple moving observer technique, and distinguishing only between moving and static pedestrians, and between men, women, and children.

**Space Syntax as a Partial Theory of Architecture**

If these are the implications for design, what then are the implications for specifically architectural knowledge and specifically architectural theory? There are two issues here. One concerns the forms that architectural theories and architectural knowledge take, the second how we conceptualize the relation of knowledge to design.

Regarding the first issue, it seems to me vital that space syntax theories are expressed in architectural form. By this I mean that theoretical knowledge is brought to bear on the design through a form of representation that is directly architectural, not only in the sense that it actually copies, and allows manipulation of, aspects of architectural forms, but also in the sense that it carries within itself, through theory, knowledge of functional consequences. Syntactic representations are *theoretical descriptions*, in that like buildings themselves, they are spatial forms with functional implications. Syntactic theories are architectural not only in the sense that they are about architecture, but also in the sense that they are in the language of architecture.

As for the second issue, the relation of knowledge to design, let us review the ascent from the vernacular to architecture. What we have seen is a series of levels at which we find theorylike entities in architecture. There is the level of the abstract social knowledge built into the “architectural competences” that underlie the vernacular. Next is the level of
the abstract typological comparison of forms. Then there is the level of general theoretical propositions, such as the theory of natural movement.

What is clear from the design application is that the most useful form of abstraction for design is the third level, that of general theoretical propositions. It is only at this level that strategic design thinking takes place—for example, about how a socially desirable functional outcome of design, such as the integration of a new neighborhood, might be achieved. It is also clear that theories generated by space syntax do not enter a theoretical void, but challenge theoretical ideas that already hold the field. Thus, in different ways, space syntax theory challenges notions like territoriality, defensible space, spatial enclosure, legibility through landmarks, geometrical theories, and a whole panoply of ideas about cities that currently play the role of theory in urban design.

Space syntax even challenges how design questions are defined. For example, a current topic of debate in Europe is the degree to which future development should be based on the past. In historic centers, for example, there is a widespread fear of doing anything except keeping the old street system, in spite of the obvious criticism that the street system to be conserved was created by a dynamic process of growth and change as each generation modified what it inherited to meet its needs and passed it on to the next generation. Conservation leads to the paradox that to freeze this process at one point in time to conserve a specific form would be antihistorical, since it would conserve a product but violate the process that gave rise to the product.

Space syntax redefines this question by making the issue one of genotype rather than phenotype. We can now ask not whether we should preserve specific forms, but whether we should preserve the underlying principles of specific forms in the light of present needs, or adapt them in the direction of a new genotype. History is replete with examples of both, in that, as cities evolve they can change their genotypes as well as their phenotypes. What history does not offer is a precedent for the current fashion of phenotype conservation.

By showing how we can understand urban space genotypes, space syntax does allow the genuine continuation of a historical tradition without necessarily copying its surface forms. It does so by suggesting what is essential and what is inessential in the structures of the past. The King’s Cross master plan is a genotypical continuation of the logic of London. Yet it resembles no known part of London. It extends the deep structure of the existing grid, not its surface structure.

The tighter forms of reasoning permitted by space syntax thus have a liberating effect, precisely because they allow us to oppose the superstitious following of an established vernacular with abstract reason about forms and their functional consequences within an evolving structure. The intervention of theory in effect permits us to set the argument about history at the level of the evolutionary processes that generate the architecture of the city, rather than at the level of its
specific products. The theoretical ascent from the vernacular as social reproduction to architecture as the knowledgeable exploration of form through theory—even partial theory—is thus also an ascent from social constraint to liberation. Design can seek its goals not within the stultifying constraints of particular forms of social knowledge (which nevertheless can be and must be understood) but within the limits posed by the laws of architectural and urban space, and their realization within a particular context.

**ARCHITECTURE AS SCIENCE**

This redefinition of theory in terms of liberation is not obvious. At first sight, theories seem to be abstract schemes of thought that constrain rather than liberate. They appear to fix the mind in a certain way of looking rather than opening up new possibilities. However, this is to misunderstand the nature of theories, and their potential in architecture.

For a scientist, a theory means an abstract model through which the phenomena available to experience can be related to each other in such a way that their nature and behavior as phenomena seem to have been accounted for. But scientific theories only count if they have two kinds of clarity: the internal structure of the theory must be clear, and the reference to phenomena must be clear. These two conditions create the possibility of refutation, and refutability is the morality of science. If a theory does not predict what can be seen to be the case, or fails to predict what is the case, then we must eventually give up the theory and try another. We must also give up a theory if a simpler one explains the same phenomena. There is an aesthetics as well as a morality in science.

At first sight, architectural theories appear to be rather different. An architectural theory is usually presented as a set of precepts that, if followed, lead to architectural success. The prime aim of an architectural theory thus seems not to be to explain architectural phenomena, but to guide design. We might therefore be tempted to conclude that architectural theories are normative rather than analytic—that is, they tell us how the world should be rather than how the world is—and are therefore not subject to the strict rules that govern scientific theories.

Although architectural theories do come in a normative mode, this by no means implies that they are not also analytic. On the contrary, it implies that they are. The only possible justification for a normative architectural theory is that the theory will work because this is the nature of architectural phenomena. Theories from Alberti to Le Corbusier in fact make profound and far-reaching assumptions about human nature, about perception, about behavior, as well as about the nature of architectural order. It cannot be otherwise. All normative architectural theories are also, perhaps covertly, analytic theories.
The difference between scientific theories and architectural theories, then, is not a difference in type but a difference in clarity. It has never been possible to have architectural theories that have the two kinds of clarity—of internal structure and of reference to phenomena—that are the precondition for refutability. This is why architectural theories can be refuted by life, but not by analysis. One useful effect of space syntax is that it takes certain aspects of architectural theory a little way in the direction of the two kinds of clarity. The structure of reasoning is clear, and the reference to phenomena is clear. The propositions of space syntax can therefore be shown to be wrong—and theoretically wrong—by reference to evidence. Life is right, of course, and only life can eventually decide. But it is possible that with theories that have the two kinds of clarity, more of life can be brought to bear on our theorizing at the design stage.

**Architecture as Art—That Is, as Theoretical Concretion**

Does this mean, then, that the line between architecture as science and architecture as art needs to be redrawn closer to science? I do not believe so. We can call on the beautiful ideas of Ernst Cassirer on the relation between art and science:

Language and science are the two main processes by which we ascertain and determine our concepts of the external world. We must classify our sense perceptions and bring them under general notions and general rules in order to give them an objective meaning. Such classification is the result of a persistent effort towards simplification. The work of art in like manner implies such an act of condensation and concentration. . . . But in the two cases there is a difference of stress. Language and science are abbreviations of reality; art is an intensification of reality. Language and science depend on one and the same process of abstraction; art may be described as a continuous process of concretion . . . art does not admit of . . . conceptual simplification and deductive generalization. It does not inquire into the qualities or causes of things; it gives the intuition of the form of things. . . . The artist is just as much the discoverer of the forms of nature as the scientist is the discoverer of facts or natural laws. 21

Those of us who believe, as I do, that science is on the whole a good thing, accept that science is in one sense an impoverishment—though in others an enhancement—of our experience of the world, in that it cannot cope with the density of situational experience. It has to be so. It is not in the nature of science to seek to explain the richness of particular realities, since these are invariably so diverse as to be beyond the useful grasp of theoretical simplifications.

Science is about the dimensions of structure and order that underlie complexity. Here the abstract simplifications of science can be the most powerful source of greater insight. Every moment of our experience is dense, and, as such, unanalyzable as a complete experience. But this does not mean that some of its constituent dimensions are not analyzable, and that deeper insight may not be gained from such analysis.

---

21 Cassirer, *Prolegomena to a Pure Philosophy of Culture*, 1923.
This distinction is crucial to our understanding of architecture. Architectural realities are dense, and as wholes unanalyzable, but that does not mean that the role of spatial configuration, for example, in architectural realities cannot be analyzed and even generalized. The idea that science is to be rejected because it does not give an account of the richness of experience is a persistent but elementary error. Science gives us quite a different experience of reality, one that is partial and analytic rather than whole and intuitive. As such it is in itself valuable. It needs to be accepted or rejected on its own terms, not in terms of its failure to be like life or like art.

It is in any case clear that the dependence of architecture on theories, covert or explicit, does not diminish its participation in Cassirer's definition of art. This is true both in the sense that architecture is, like art, a continuous process of concretion, and also in the sense that, like art, "its aspects are innumerable." But there are also differences. The thing "whose aspects are innumerable" is not a representation but a reality, and a very special kind of reality, one through which our forms of social being are transformed and put at risk. The pervasive involvement of theory in architecture, and the fact that architecture's continuous concretion involves our social existence, define the peculiar status and nature of systematic intent of the architectural kind: architecture is theoretical concretion. Architects are enjoined both to create the new, since that is the nature of their task, and to clarify and improve the theories that tie their creation to our social existence. It is this dichotomy that makes architecture distinct and unique. It is as impossible to reduce architecture to theory as it is to eliminate theory from architecture.

Architecture is thus both art and science, not in that it has both technical and aesthetic aspects, but in that it requires both the processes of abstraction by which we know science and the processes of concretion by which we know art. The difficulty and the glory of architecture lie in the realization of both: in the creation of a theoretical realm through building, and in the creation of an experienced reality "whose aspects are innumerable." This is the difficulty of architecture. And this is why we acclaim it.
13. For example, Camillo Sitte and Gordon Cullen. Even the Krier brothers are strongly influenced by this tradition.

14. All the computer programs used here form part of the Space Syntax software developed by N. Dalton of the Unit for Architectural Studies at the Bartlett School of Architecture and Planning, University College London, with funding from the Science and Engineering Research Council and our industrial partner, Q Solutions Ltd.

15. A full study of all open spaces in London was made for the Ministry of Housing and Construction in 1984, and reported in "A Pleasure of the Public Inquiry." A second study of open spaces in London, including some new ones, was made in connection with the Broadgate Development and made available in a report called "The Broadgate Spaces." (Both reports by Unit for Architectural Studies, Bartlett School of Architecture and Planning, University College London, 1988.)

16. An axial map is defined as the smallest set of straight lines that cover the open space of the area. See Miller, "The Nature of the Artificial"; and Hillier, Julianne Hanson, John Peponis, J. Hudson, and Richard Burdett, "Space Syntax," Architectural Journal (November 30, 1983): 47-63.


18. In the real situation, the experimentation took a rather different form, and was more orientated to pragmatic design ideas and constraints. The experiments here are therefore illustrative, not historical.


