Part two
Non-discursive regularities

2

Chapter four

Cities as movement economies

The human understanding is of its own nature prone to suppose the existence of more order and regularity in the world than it finds.
Francis Bacon, Aphorism XLV, p. 50

An axis is perhaps the first human manifestation; it is the means of every human act. The toddling child moves along an axis, the man striving in the tempest of life traces for himself an axis. The axis is the regulator of architecture.
Le Corbusier, 'Vers une Architecture'

The physical city and the functional city

It is a truism to say that how we design cities depends on how we understand them. In the late twentieth century, this truism has a disquieting force. Cities are the largest and most complex artefacts that humankind makes. We have learned long and hard lessons about how we can damage them by insensitive interventions. But the growth of knowledge limps painfully along through a process of trial and error in which the slow time scale of our efforts and the even slower timescale of our understanding, make it almost impossible to maintain the continuity of experience and study which we might hope, in time, would give rise to a deeper, more theoretical understanding of cities.

Even so, a deeper theoretical understanding is what we need. We are at a juncture where fundamental questions about the future of our cities – should settlements be dense or sparse, nucleated or dispersed, monocentric or polycentric, or a mix of all types? – have been raised by the issue of sustainability.[1] It is widely acknowledged that to make cities sustainable we must base decisions about them on a more secure understanding of them than we have now. What is unclear is what we mean by a better understanding. Physically, cities are stocks of buildings linked by space and infrastructure. Functionally, they support economic, social, cultural and environmental processes. In effect, they are means-ends systems in which the means are physical and the ends functional. Our most critical area of ignorance is about the relation of means to ends, that is, of the physical city to the functional city. The fact that sustainability is about ends and the controls largely about means has exposed our ignorance in this critical area.

One reason for this ignorance is the compartmentalisation that has developed over the past quarter century among the disciplines concerned with the city. There is now a deep split between those who are preoccupied with analysis and control of the social and economic processes which animate the city, and who for the most part call themselves planners, and those concerned with physical and spatial synthesis in the city, who call themselves urban designers. This split is now, in effect, a split between understanding and design, between thought and action.

From the point of view of our ability to act on the city, there are two consequences. The first is a form-function gap: those who analyse urban function cannot conceptualise design, while those who can conceptualise design guess about function. The second is a scale gap. Planning begins with the region, deals reasonably with the 'functional city', that is, the city and its 'dependences' (as the French say of outlying buildings) but barely gets to the urban area in which we live. Urban design begins with a group of buildings, gets to the urban area, but hesitates at the whole city for fear of repeating the errors of the past when whole city design meant over-orderly towns which never quite became places. Neither applies itself to our need to understand the city as a spatial and functional whole.

One effect of this disciplinary apartheid has been a complete failure to come to terms conceptually with what seems at first to be the simplest thing about the city: the fact that it is a large, apparently complex physical and spatial object, one which is at once a record of the functional processes which historically created it, and at the same time the strongest constraint on future development. Most attempts to use computers to model the ways in which cities work, for example, have dealt with the physical aspects of the city only at the grossest level, far above the level at which most interventions are made. Since the aim of an urban model is to try to bring the structural and dynamic complexities of cities as means-ends systems within the scope of reasoned decision-making about physical and spatial interventions, this has been a critical weakness.[2]

The fact that the physical city has proved most difficult to model effectively is probably due to two things. First, the physical and spatial structure of cities appears, for the most part, to be the rather disorderly outcome of a long history of small-scale, incremental changes, which accumulate over time to produce patterns with neither geometrical nor functional simplicity. Until recently, the types of pattern that result from these quasi-organic processes have not seemed tractable to any obvious method of analysis. Consequently they were neglected. Second, the incremental processes by which economic and social processes create the city's physical and spatial patterns seem in themselves to be quite complex, involving feedback and multiplier effects, and interaction between different scales. Processes of urban growth and change seem to exhibit both 'emergence', by which unforeseen macro changes result from a series of micro-changes, and the contrary effect, by which macro changes produce unforeseen effects at the micro scale. Again, until recently, there have not been obvious ways of modelling such processes.

The apparent intractability of the city as a physical and spatial object afflicts the synthesists as much as the analysts. If we look to urban designers for an analysis of the object of their design attention, we find much moral earnestness about such matters as the creation of 'places' as rich and complex as those found in traditional cities, but little analytic endeavour to understand how the physical and functional cities of the past gave rise to such 'places'. The current preoccupation with 'place' seems no more than the most recent version of the urban designer's preference for the local and apparently tractable at the expense of the global and intractable in cities. However, both practical experience and research suggest that the preoccupation with local place gets priorities in the wrong order. Places are not local things. They are moments in large-scale things, the large-scale things we call cities. Places do not make cities. It is cities that make places. The distinction is vital. We cannot make places without understanding cities. Once again we find ourselves needing, above all, an understanding of the city as a functioning physical and spatial object.

Multifunctionality and the part-whole problem

Where should we then find a starting point for an inquiry into the form and functioning of cities, in the hope of founding a theory of cities as means-ends systems? In situations where new theories are needed, there is a useful rule. At every stage in the development of our understanding of phenomena, we already have in our minds some conceptual scheme through which we interpret and interrelate the phenomena that we see.[3] Usually there are irritating anomalies and problems at the edges of these conceptual schemes. The rule is that instead of keeping these problems at the edge of our field of vision, and accepting them as anomalities, we should bring them centre stage and make them our starting point. We should, in effect, start from what we cannot explain rather than what we think we can.

There are two such great anomalies in our current ways of seeing cities. The first is the problem of multifunctionality. Every aspect of the spatial and physical configuration of the city form seems to have to work in many different ways – climatically, economically, socially, aesthetically, and so on – with the additional difficulty that form changes only slowly while function changes rapidly. The second is the part-whole problem, or as some might prefer, the place-city problem, that is, the fact that in most cities made up of parts with a strong sense of local place it is almost impossible to make a clear morphological distinction between one part and another, at least not at the level at which it could inform design.

If the theory set out in this chapter is anywhere near right, then it will become clear that these two issues are rather more than closely related: they really are the same problem, because all functions relate to the form of the city through two generic functional factors: how we as individuals find the city intelligible, and how we move around in it. These generic factors are so powerful that all other aspects of function pass through them and influence the urban form through them. They are so because in cities, as in buildings, the relationship between form and function passes through space. How we organise space into configuration is the key both to the forms of the city, and how human beings function in cities.

The theory to be set out in this chapter is based on one central proposition: that the fundamental correlate of the spatial configuration is movement. This is the case both in terms of the determination of spatial form, in that movement largely dictates the configuring of space in the city, and in terms of the effects of spatial form, in that movement is largely determined by spatial configuration. The principal generator of the theory set out here is the discovery, through recent research, that the structure of the urban grid considered purely as a spatial configuration, is itself the most powerful single determinant of urban movement, both pedestrian and vehicular. Because this relation is fundamental and lawful, it has already been a powerful force in shaping our historically evolved cities, by its effect on land-use patterns, building densities, the mixing of uses in urban areas and the part-whole structure of the city.[4]

The result now available suggests that socio-economic forces shape the city primarily through the relations between movement and the structure of the urban grid. Well functioning cities can therefore, it will be suggested, be thought of as ‘movement economies’. By this it is meant that the reciprocal effects of space and movement on each other (and not, for example, aesthetic or symbolic intentions), and the multiplier effects on both that arise from patterns of land use and building densities, which are themselves influenced by the space-movement relation, that give cities their characteristic structures, and give rise to the sense that everything is working together to create the special kinds of well-being and excitement that we associate with cities at their best.

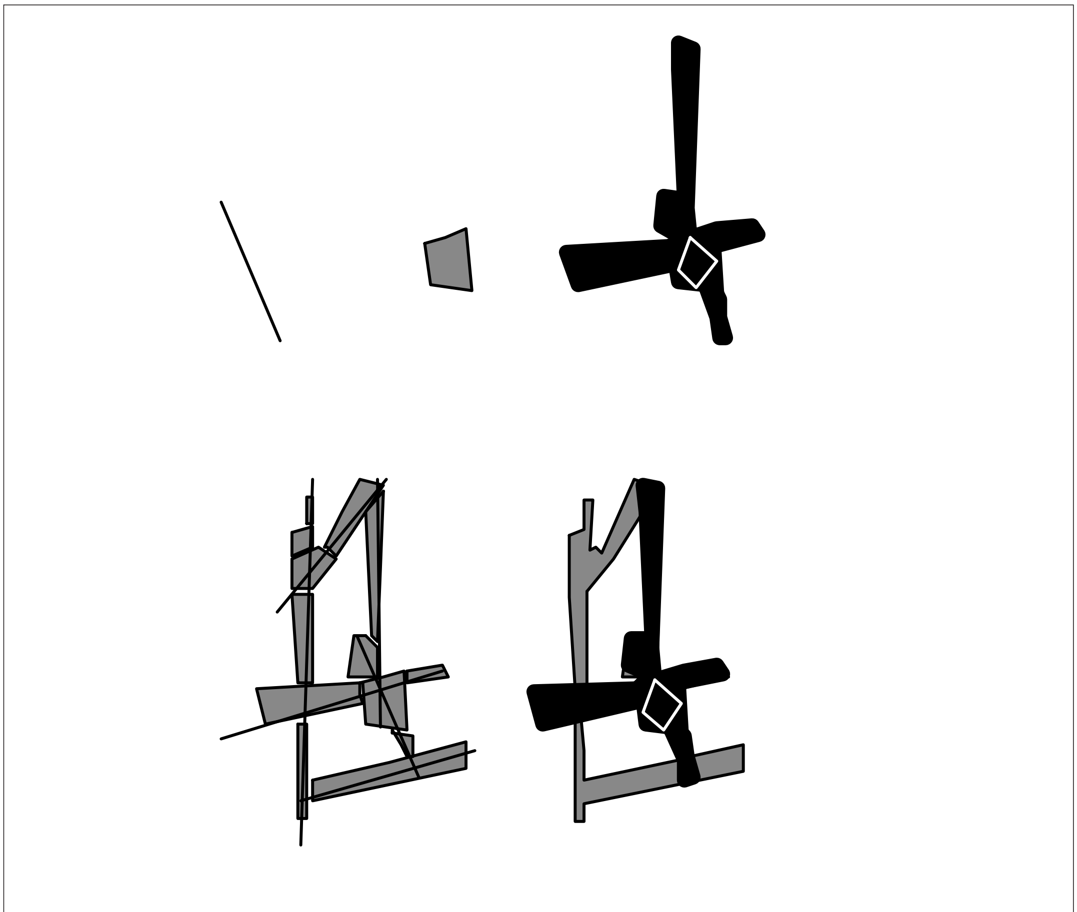
It will be suggested as a consequence of these arguments that our view of the city in the recent past has been afflicted by conceptions of space which are at once too static and too localised. We need to replace these with concepts which are dynamic and global. Both can be achieved through the configurational modelling of space, using the power it gives us both to capture the complexities of urban form, and bring these analyses to bear on design.

Form and function in space are not independent

We must begin by making a few basic observations about space and its relation to function. We tend to think of the form and function of space as two quite independent things. Space is a shape, and function is what we do in it. Set up this way, it is hard to see why there should be any relation between the two, and even harder to see how any relation could be a necessary one.

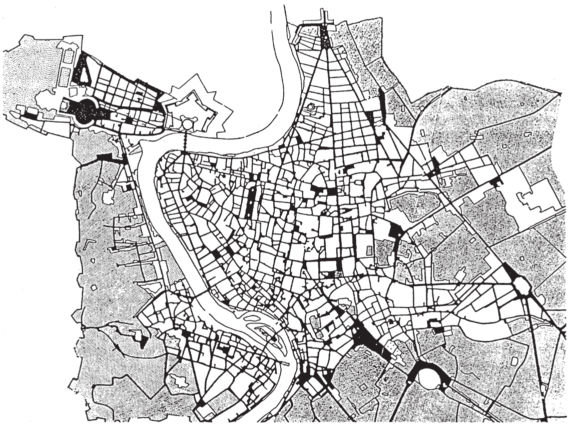
But if we think a little more carefully about how human beings operate in space, we find everywhere a kind of natural geometry to what people do in space. Consider, for example, figure 4.1. At the most elementary level, people move in lines, and tend to approximate lines in more complex routes, as in figure 4.1a. Then if an

Figure 4.1



individual stops to talk to a group of people, the group will collectively define a space (4.1b) in which all the people the first person can see can see each other, and this is a mathematical definition of convexity in space, except that a mathematician would say points rather than people. The more complex shape of figure 4.1c defines all the points in space, and therefore the potential people, that can be seen by any of the people in the convex space who can also see each other. We call this type of irregular, but well defined, shape a 'convex isovist'. Such shapes vary as we move about in cities, and therefore define a key aspect of our spatial experience of them.

There are relationships, then, between the formal describability of space and how people use it. These elementary relationships between the form of space and its use suggest that the proper way to formulate the relation is to say that space is given to us as a set of potentials, and that we exploit these potentials as individuals and collectivities in using space. It is this that makes the relation between space and function analysable, and to some extent predictable. By dividing up urban



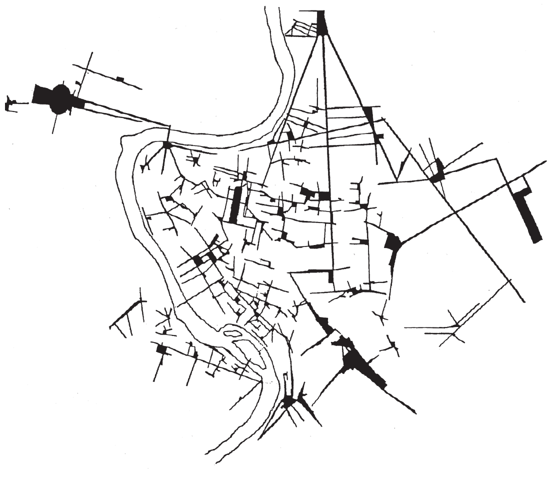


Figure 4.2a (top left)
Plan of Rome, Italy

Figure 4.2b (top right)
Axial map of Rome, Italy

Figure 4.2c (right)
Isovist map of Rome, Italy

space, which is necessarily continuous, in different formal ways we are likely to be dividing it up according to some aspect of how human beings function.

Consider, for example, figure 4.2a which is the plan of Rome, in which the customary representation with the buildings in black and the space white has been reversed to draw attention to the fact that it is the black structure of space that is our focus of concern.[5] Figure 4.2b is then one possible structure within figure 4.2, the fewest and longest lines that cover the open space of Rome, and therefore form its potential route matrix. figure 4.2c is another such structure: all the convex elements we call public open spaces together with their isovists. By definition, this includes all the lines that pass through the spaces and relate them in the urban structure as a whole. Note how they link up to form global clusters. We immediately see how mistaken we would be to see Roman squares as local elements. The isovists show they also form a global pattern.

All these ways of looking at space can be seen as layers of spatial structuring, co-existing within the same plan, each with its own contribution to intelligibility and function. A spatial layout can thus be seen as offering different functional potentials. What is it like to move around in it? Does it have potential to generate interaction? Can strangers understand it? and so on. All these questions are about the relationship of space as formal potentials to different aspects of function. A layout can thus be represented as a different kind of spatial system according to what aspects of function we are interested in.

The shape of space in the City of London

Let us now look in more detail at a case that is much closer to home: the City of London, for no better reason than that it has been as often criticised as 'haphazard' as praised as 'organic' – but never explained properly. The plan of the 'square mile' (in fact it is neither square nor a mile) is shown in figure 4.3a using the black on white convention to emphasise that it is space we are looking at. Figure 4.3b homes in on one of the allegedly 'labyrinthian' back areas of the City between Cornhill and Lombard Street, taken from the Rocque map of 1746. We say allegedly because although it looks so in plan, it does not seem in the least labyrinthian to the person moving at ground level. On the contrary, it seems highly intelligible. How does this happen? The technique is simple. The space structure is admittedly highly broken up into 'convex' spaces – but there are always lines which link the convex spaces together, usually several at a time. Sometimes the line 'just about' gets through the spaces formed by the buildings, sometimes more easily. But because people move in lines, and need to understand lines in order to know where they can go, this means that the space structure is easily intelligible from the point of view of movement.

In fact, the pattern is slightly subtler. There is for the most part a 'two-line logic' in that if you pass down a line that you can see from the main grid, the next line will take you either out of the back area again or to some significant spatial event – say a larger piece of space or a significant building – within the back area. This means that wherever you go, there is usually a point from which you can see

Cities as movement economies

Figure 4.3a
Black and white illustration of the public open space of the City of London as it is today

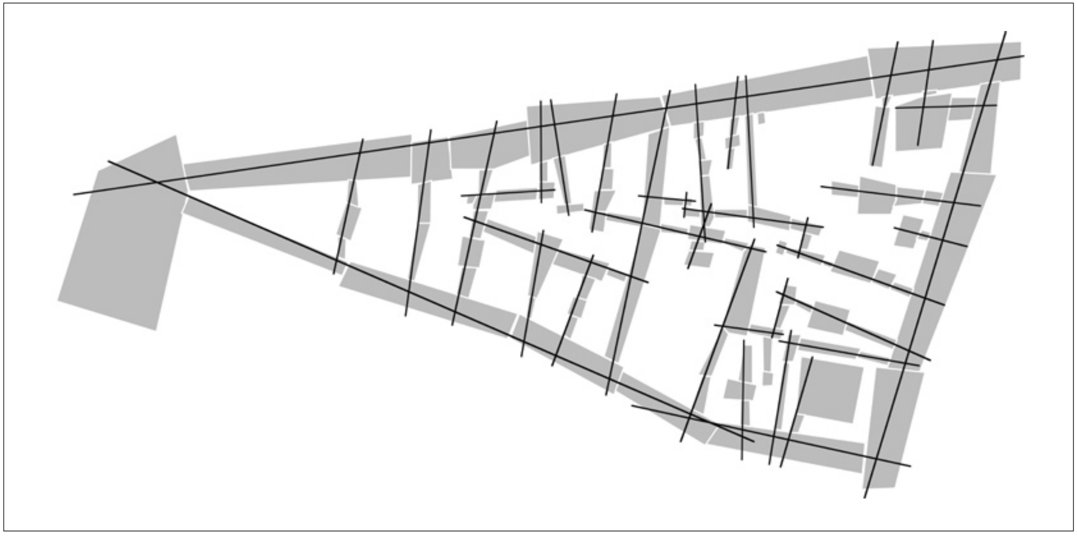


Figure 4.3b
Close-up of the one- and two-dimensional space structure of the area between Cornhill and Lombard Street in 1677.

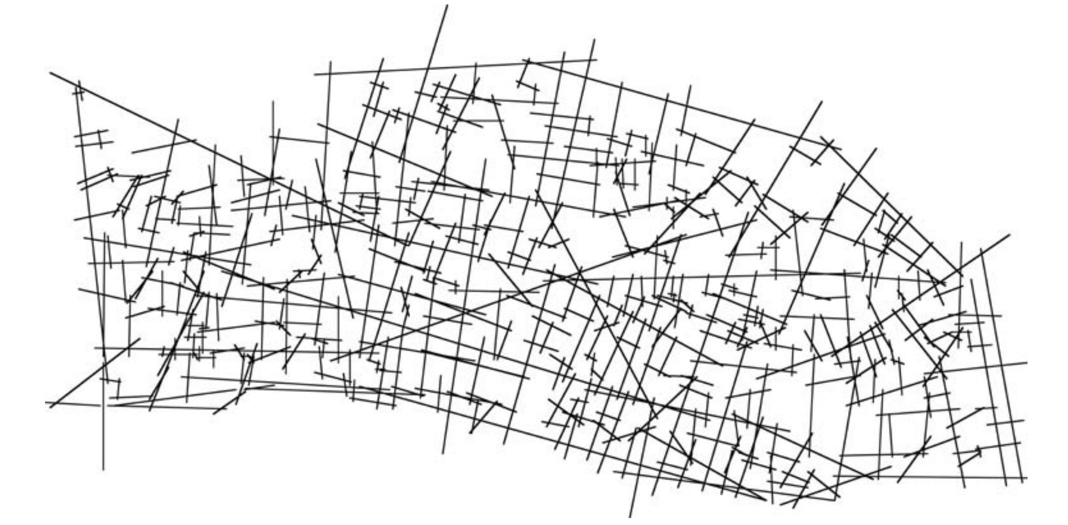


Figure 4.3c
Axial map of the City of London as it is today

where you have come from and where your next point of aim might be. This is the opposite of labyrinthian. As observation will confirm, the effect of this spatial technique is that the back areas become normally and naturally used for movement as part of the urban space pattern. There is no inhibition or sense of territorial intrusion in these areas.

This two-line logic is not the only constant property of these small-scale complexes. We also find that nearly every convex element, including the narrow ones that enter the back areas, as well as the fatter ones we find within the areas, has building entrances opening onto it. In the city, a fascinating cultural practice has augmented this: even in inclement weather, doors to buildings tend to be left open, often showing to the outside world one way up stairs or down and another into the ground-evel premises.

The effect of these apparent rules about how buildings relate to open space is to create two 'interfaces'. first, there is a close relation between those within the building, and those outside. Second, there is a natural mingling between those who are using the space outside the buildings, and those who are passing through. There is no sense of lack of privacy or intrusion. Nor is there any pressure to interact, though this is available if required. All we have is a relation of co-presence between groups doing different things. Such co-presence seems unforced, even relaxed. It is the product of a two-way relation from the convex spatial element: one into the building, the other to the larger scale through the line structure. The larger and smaller scales of a space are held together by this spatial technique.

Now let us zoom out to the larger scale. Figure 4.3c is an 'axial map' of the City as a whole, that is, the least set of straight lines that pass through all the open space in figure 4.3a. The first thing we see when looking at the larger scale – that is at the longer lines – is that the tendency of lines to 'just about' pass through convex space is still there. It is just possible, in spite of the sinuous curves of the buildings, to see down Lombard Street from one end to the other, and it is just about possible to see from the Bank interchange through the whole of Cornhill into Leadenhall Street as far as Billiter Street. In both cases the line ends by striking the façade of a building at a very open angle, and from this it seems natural to infer continuation of potential movement in that general direction.

These improbably extended 'just about' lines create another effect which one must search a little to find, and perhaps go back to the old map to verify. It is that if one enters any of the old City gates and proceeds following only a rule that requires you to take the longest line available at any time (without going back on yourself) then in each case from somewhere on the second line a line opens up from which the Bank interchange, the old centre of the City, can be seen. Again, we find a simple two-line logic underlying apparent complexity, and again we need have no doubt about its functional implication. It accesses the stranger to the heart of the city. An automaton could find the centre – so a stranger could.

However, when we compare the two levels at which we find this two-line logic, there is a geometric difference which we can summarise in a simple principle:

the longer the line the more likely it is to strike a building façade at an open angle, the shorter the line, the more likely it is to strike a building at a right angle. This is exactly the opposite of the current rather pompous urban fashion to end major axes at right angles on major building façades. Historically this usually occurs where urban space is taken over for the symbolic expression of power, whereas the City's urban space structure is about the movement required to create a dense encounter field. The right-angle relation of façade to line is used in the City to, as it were, illuminate the smaller-scale and spatially more complex areas, and to make them visible from the larger-scale grid. Thus we begin to see not only that there is an interior logic to the City's apparently disorderly grid, but that this inner logic is fundamentally about movement, and the potential that movement gives for creating co-presence. We see that many of the properties of urban space that we value aesthetically are a product of this functional shaping of space.

These consistencies in spatial patterning show how the City is put together locally, and how it therefore works as a series of experiences. But the City also acquires a global form. To understand this, and why it is important, we must begin to formalise our understanding a little. It will turn out that the line pattern of the City is the most important to its global structure, and we must therefore begin by examining this if we wish to move the focus of our analysis from the local to the global. We may begin by a simple observation: that to go from any line to any other one must pass through a certain number of intervening lines (unless of course the origin line directly intersects the destination line). Each line thus has a certain minimum line 'depth' from another, which is not necessarily a function of distance. It follows that each line has a minimum average line 'depth' from all other lines in the system. Because lines will always be shallow from some lines and deep from others, one might expect that this would average itself out. The surprising thing is that it does not. There are substantial differences in the mean depth of lines from all others, and it is these differences that govern the influence of the grid on movement in the system: roughly, the less depth to all other lines, the more movement; the more depth, the less.

These configurational pictures of the City from the point of view of its constituent lines can be measured exactly through the measure of 'integration' (See Chapters 1 and 3.) The 'integration value' of each line reflects its mean linear 'depth' from all other lines in the system. We can then map these integration values from red through purple, and produce a global integration map of the whole of a city, as in plate 2a. We can also produce another highly informative map, one in which we calculate integration only up to three lines away from each line in every direction, and which we therefore call 'local integration', or radius-3 integration, in contrast to 'global' or radius-n integration. (plate 2b)

Integration values in line maps are of great importance in understanding how urban systems function because it turns out that how much movement passes down each line is very strongly influenced by its 'integration value' calculated in this way, that is, by how the line is positioned with respect to the system as a whole.[6] In fact it is slightly more subtle and depends on the typical length of journeys.

Pedestrian densities on lines in local areas can usually be best predicted by calculating integration for the system of lines up to three lines away from each line (radius-3 integration), while cars on larger-scale routes (though not in local areas, where radius-3 is the best predictor) depend on higher radius integration because car journeys are on the whole longer and motorists therefore read the matrix of possible routes according to a larger-scale logic than pedestrians.[7]

The principle of natural movement

This relationship between the structure of the urban grid and movement densities along lines can be called the principle of 'natural movement'. Natural movement is the proportion of movement on each line that is determined by the structure of the urban grid itself rather than by the presence of specific attractors or magnets. This is not initially obvious, but on reflection does seem natural. In a large and well developed urban grid people move in lines, but start and finish everywhere. We cannot easily conceive of an urban structure as complex as the city in terms of specific generators and attractors, or even origins and destinations, but we do not need to because the city is a structure in which origins and destinations tend to be diffused everywhere, though with obvious biases toward higher density areas and major traffic interchanges. So movement tends to be broadly from everywhere to everywhere else. To the extent that this is the case in most cities, the structure of the grid itself accounts for much of the variation in movement densities.

We should then expect that the distribution of colours in axial maps will foreshadow densities of moving people. Because the colours are really rough indexes of precise numerical values, this proposition can of course be tested by selecting areas and correlating movement rates against integration values. However, because movement along a particular line is influenced in the main by its position in the larger-scale urban grid, we must take care to include enough of the whole urban grid in our analysis to ensure that each line in the area we are studying is embedded in all the urban structure that may influence its movement. We cannot then do better than to begin with the whole of an urban system, or at least a very much large-part of it in order to ensure that our study area is sufficiently well embedded.

In order to analyse an area in inner London, then, we begin with an axial representation of the very large part of London shown in figure 4.4, which covers the area approximately within the North and South Circular Roads. Plate 2c–e is then a series of analyses of integration at different radii. Plate 2c is the radius-n analysis, and as such shows the most global structure of London, with a strong edge-to-centre pattern centred on Oxford Street, which is the most integrated line. Plate 2d is the radius-3 analysis, which highlights a much more localised structure, including most local shopping streets, but also picks out Oxford Street as the dominant integrator. This implies that Oxford Street is not only the strongest global integrator in London as a whole, but also the strongest local integrator of its surrounding area. Plate 2e is then a radius-10 (or radius-radius) analysis, meaning that the integration analysis is set at the mean depth of the whole system from the main integrator,

Figure 4.4
Axial map of Greater London within the North and South Circular roads

which in this case is 10. The effect of setting the radius of analysis at that of the main integrator is that each line is analysed at the same radius which is at the same time the maximum radius possible without differences in radius between lines. The effect of a radius-radius analysis is to maximise the globality of the analysis without inducing 'edge effect', that is, the tendency for the edges of spatial system to be different from interior area because they are close to the edge. Taken together, the figures shows a remarkably true-to-life functional picture of London as a whole, highlighting all the main in and out routes and shopping high streets.

The reason that a spatial analysis can give such a true-to-life functional picture is due to the powerful influence that natural movement – the tendency of the structure of the grid itself to be the main influence on the pattern of movement – has on the evolution of the urban pattern and its distribution of land uses. To test this properly we must translate back from graphics to numbers. Figure 4.5a selects a small area within the system, more or less co-terminous with the named area of Barnsbury, and assigns precise 'integration values' to each line. Figure 4.5b then indexes observed movement rates of adult pedestrians on each line segment

Figure 4.5a
The integration value of each axial line in Barnsbury

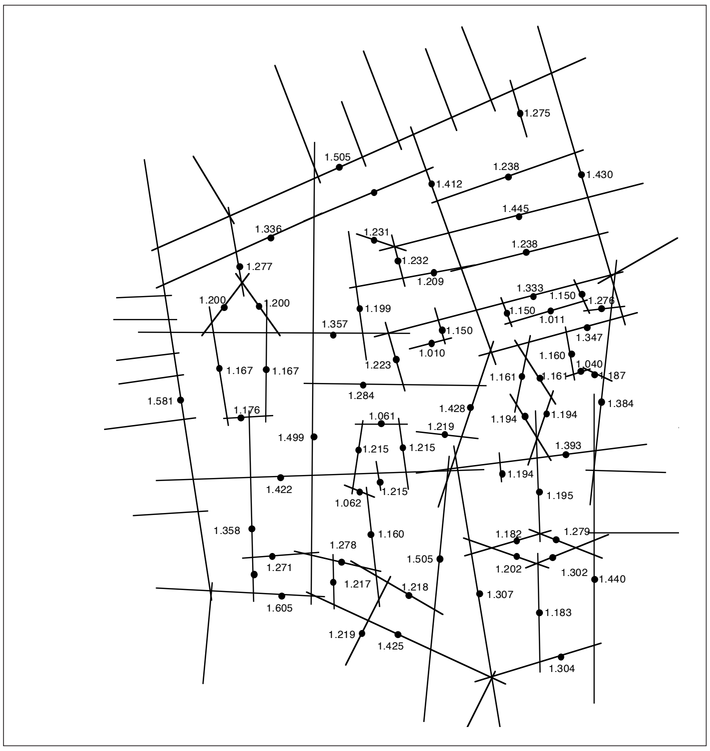


Figure 4.5b
Average number of pedestrians per hour for all periods

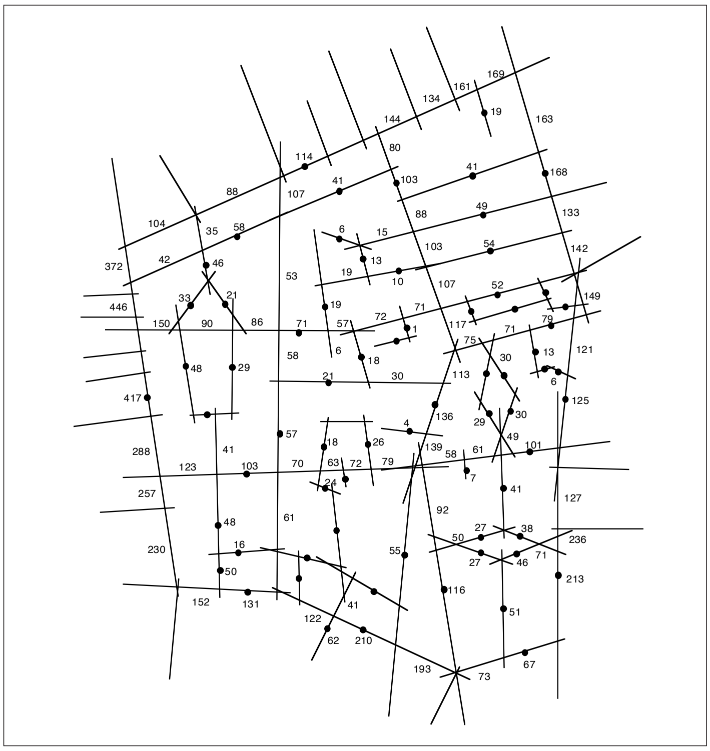


Figure 4.5c
RRA = 3V, pedestrian movement in Barnsbury

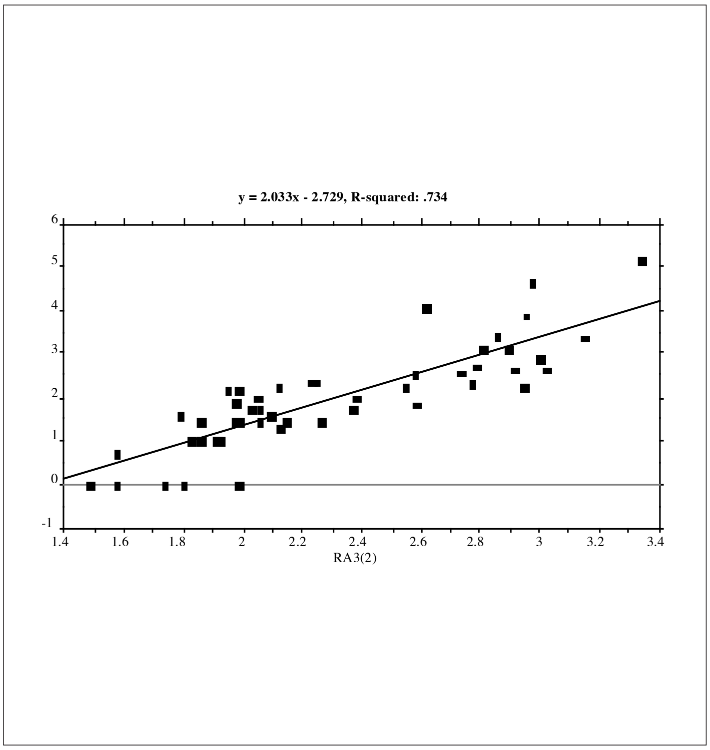
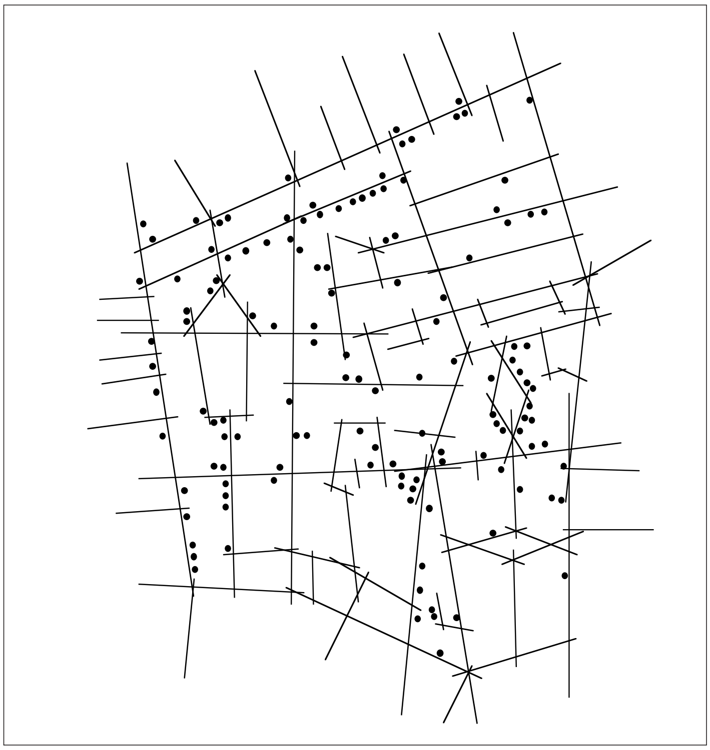


Figure 4.5d
Plot of burglaries in Barnsbury



throughout the working day.[8] Figure 4.5c is a scattergram plotting pedestrian movement rates against radius-3 integration. The R-squared value shows that about three-quarters of the differences between line segments in their movement rates are due to their configurational position in the larger-scale grid. Note, by the way, that we are still calculating integration with respect to a much larger system than shown in figure 4.5a. Movement is not only largely determined by configuration, but also by configuration on a fairly large scale.

Readers can consult published texts for detailed results, but similar results have been achieved across a great range of studies, and even better – though slightly different – results have been found from studies relating vehicular movement to spatial configuration.[9] These studies show that the distribution of pedestrian movement in the urban grid is to a considerable extent determined by spatial configuration, with the actual levels also strongly influenced by area building densities (though the effects of building density are not in general found at the level of the individual line), while vehicular movement is strongly influenced by spatial integration in association with net road width, that is, the width of the road less the permitted car parking. In the case of vehicular movement the second variable, net road width, does influence movement on a line-by-line basis and plays a more significant part in the larger scale road network.[10]

We may investigate another key component of successful urbanism, the informal use of open spaces for stopping and taking pleasure, by using a similar technique. Figure 4.6 is a 'convex isovist' representation of the City of London's few, rather informal open spaces, which vary remarkably in their degree of informal use. Attempts to account for the pattern of well and poorly used spaces in the City in terms of commonly canvassed explanations have been singularly unsuccessful. For example, some spaces hemmed in by traffic are several times better used than adjacent spaces without traffic, exposed spaces often perform better than spaces with good enclosure, some of the most successful spaces are in the shadow of tall buildings, and so on. The only variable that correlates consistently with the degree of observed informal spaces is, in fact, a measure of the 'Roman property', noted in figure 4.2c, which we call the the 'strategic value' of the isovist. This is calculated by summing the integration values of all the lines which pass through the body of the space (as opposed to skirting its edges). This makes intuitive sense. The primary activity of those who stop to sit in urban spaces seems to be to watch others pass by. For this, strategic spaces with areas close to, but not actually lying on, the main lines of movement are optimal. The main fault in most of the modern open spaces we have observed (with the most notable exception of Broadgate, which has the most successful spaces in the City of London) is that the designers have given too much attention to local enclosure of the space, and too little to strategic visual fields – yet another instance of an overly localised view of space. The general rule seems to be that a space must not be too enclosed for its size. The visibility field must be scaled up in proportion to the scale of the space.

Once we have the trick of correlating numbers indexing observed function with numbers indexing spatial patterns we can extend it to anything that can be represented as a number and located in space. When we do so, it turns out that everything seems to relate to space, and therefore to movement in some way: retail, building densities, indeed most types of land use seem to have some spatial logic which can be expressed as a statistical relation between spatial and functional measures. Even crime can be spatially correlated. Figure 4.5d plots burglaries within a twelve-month period in the Barnsbury area. Visually, it looks as though there may be some effect from configuration, in that the densest concentrations seem to be in less integrated locations, while some of the more integrating lines are relatively free. Is this true? By assigning each dwelling the integration value of the line on which it opens we can ask if burgled dwellings are significantly more segregated or integrated than unburgled dwellings. It turns out that burgled dwellings are significantly more segregated on average than unburgled dwellings.

Now let us look at other aspects of how things are distributed in the urban grid. Take, for example, the well-known Booth map of London, part of which is shown in plate 3, in which socio-economic classes are plotted from gold for the best off (there are none in the part of London shown), through red for merchant grade houses, then through pink to grey and black for the poorest. The most integrated streets are lined with red, and as you move into the less important, and less integrating streets, the grade of housing falls off, leaving the poorest most segregated areas. There is also a subtler organisation concealed in the Booth map, one which provides an important clue to one of the hidden secrets of urban space: how different uses and economic classes are mixed in the same area by using a principle that can be

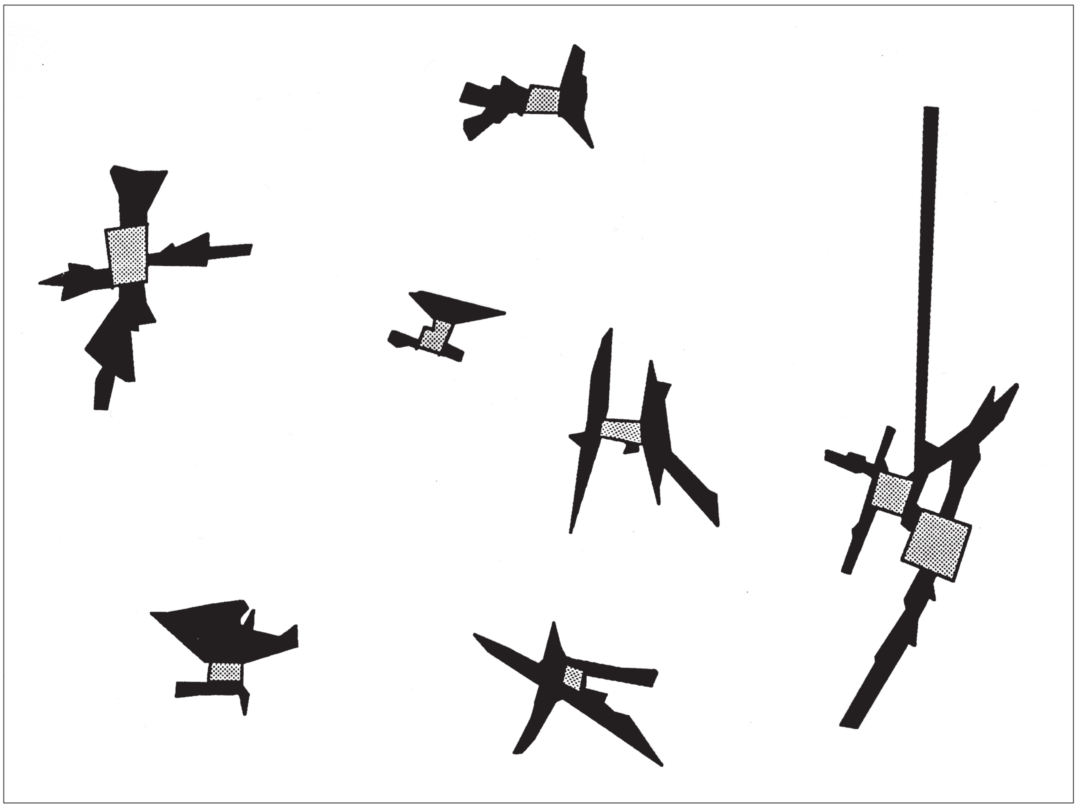


Figure 4.6
Convex isovists from eight city of London squares

summarised as ‘marginal separation by linear integration’. If we look carefully we can see that different grades of housing – and in other situations we will find different land uses – may often be in close proximity but separated effectively by being on different alignments, often as part of the same urban block. The fundamental land use element is not the zone or even the urban block but the line: land uses changes slowly as you progress along particular lines of movement, but can change quite sharply with ninety-degree turns onto different alignments. Since we know that the pattern of alignments is the fundamental determinant of movement, we can begin to see that the structure of the urban grid, the distribution of land uses, and built form densities are in the historically evolving city bound up with each other in a dynamic process centred on the relation of the grid structure to movement.

Which then is primary? Let us argue this through the spatial distribution of retail, the commonest non-residential land use. We may already have been suspected of having confused the effects of spatial configuration on movement with the effect of shops. Are not the shops the main attractors of movement? And do they not lie on the main integrators? This is of course true. But it does not undermine what is being said about the structure of the grid as the prime determinant of movement. On the contrary it makes the argument far more powerful. Both the shops and the people are found on main integrators, but the question is: why are the shops there? The presence of shops can attract people but they cannot change the integration value of a line, since this is purely a spatial measure of the position of the line in the grid. It can only be that the shops were selectively located on integrating lines, and this must be because they are the lines which naturally carry the most movement. So, far from explaining away the relation between grid structure and movement by pointing to the shops, we have explained the location of the shops by pointing to the relation between grid and movement.[11]

Now of course in a sense to say this is to say the obvious. Every retailer knows that you should put the shop where people are going to be anyway, and it is no surprise if we find that the structure of the urban grid influences at least some land uses as it evolves. It would be surprising if it were not the case. However, a little more than this is being claimed. It is being suggested that there is an underlying principle which, other things being equal, relates grid structure to movement pattern not only on the main lines in and out of a city, but also in the fine structure, and through this gives rise to a whole multiplicity of inter-relationships between grid structure, land uses, densities, and even the sense of urban well-being and fear.

Multiplier effects and the movement economy

We can pursue this by thinking carefully about what it would take to produce this degree of agreement between grid structure, movement, land uses and densities. We find ourselves unavoidably led towards a theory of the general formation of the city through the functional shaping of its space by movement. Let us begin by thinking about that. An urban system, by definition, is one which has at least some origins and destinations more or less everywhere. Every trip in an urban system has three elements: an origin, a destination, and the series of spaces that are passed through on the way from one to the other. We can think of passage through these spaces as the by-product of going from a to b. We already know that this by-product, when taken at the aggregate level, is determined by the structure of the grid, even if the location of all the a's and b's is not.

Location in the grid therefore has a crucial effect. It either increases or diminishes the degree to which movement by-product is available as potential contact. As we saw in the coloured-up maps, this applies not only to individual lines, but to the groups of lines that make up local areas. Thus there will be more integrating and less integrating areas, depending on how the internal structure of the area is married into the larger-scale structure of the grid, and this will mean also areas with more by-product and areas with less.

Now if cities are, as they were always said to be, 'mechanisms for generating contact', then this means that some locations have more potential than others because they have more by-product and this will depend on the structure of the grid and how they relate to it. Such locations will therefore tend to have higher densities of development to take advantage of this, and higher densities will in turn have a multiplier effect. This will in turn attract new buildings and uses, to take advantage of the multiplier effect. It is this positive feedback loop built on a foundation of the relation between the grid structure and movement this gives rise to the urban buzz, which we prefer to be romantic or mystical about, but which arises from the co-incidence in certain locations of large numbers of different activities involving people going about their business in different ways. Such situations invariably arise through multiplier effects generated from the basic relation between space structure and movement, and ultimately this depends on the structure of the urban grid itself. In other words, how the urban system is put together spatially is the source of everything else.

We may illustrate this negatively through a notorious case where the urban buzz does not occur, in spite of the co-existence in a small area of many major functions. The example is the area of the South Bank cultural centre in London, where, within a few hundred metres can be found Europe's largest and most diverse cultural complex, a major international railway terminus, extensive office development, significant residential development and a famous riverside walk. Why do all these facilities not add up into an urban area with the qualities called for by these high-level facilities? It can only be the way it is put together. This is indeed the case. Our studies have shown that each of the various constituencies of space users – travellers, residents, office workers, tourists, concert-goers and gallery visitors all use space in a different way and, as it were, move through the area largely on seperate routes passing each other like ships in the night. It is the failure of the configuration of space to bring these different constituencies into patterns of movement and space use where all are prioritising the same space, that deprive the area of the multiplier effects that occur when different constituencies of space use all spark off each other.

If these arguments are right, it means that all the primary elements of urban form, that is, the structure of the urban grid, the distribution of land uses and the assignment of development densities are bound together in the historical city by the principle that relates the structure of the urban grid to the by-product of movement. It means that under certain conditions of density and integration of the grid structure things can happen that will not happen elsewhere. Movement is so central to this process that we should forthwith cease to see cities as being made up of fixed elements and movement elements and instead see the physical and spatial structure as being bound up to create what we have called the 'movement economy', in which the usefulness of the by-product of movement is everywhere maximised by integration in order to maximise the multiplier effects which are the root source of the life of cities.

Urbanity, we suggest, is not so mysterious. Good space is used space. Most urban space use is movement. Most movement is through movement, that is, the by-product of how the grid offers routes from everywhere to everywhere else. Most informal space use is also movement related, as is the sense and fact of urban safety. Land uses and building density follow movement in the grid, both adapting to and multiplying its effects. The urban buzz, or the lack of it when it suits us, is the combination of these, and the fundamental determinant is the structure of the grid itself. The urban grid through its influence on the movement economy is the fundamental source of the multifunctionality that gives life to cities.

Parts and wholes

We can also show how the movement economy creates the part-whole structure of cities. We have already noted that movement occurs at different scales: some localised and some more globalised. Long journeys will tend to naturally prioritise spaces which are globally more integrated, more local journeys those which are more locally integrated. The space system is literally read – and readable – at a different scale. Since different radii of integration reflect different scales of the urban system, it will turn out that the key to understanding parts and whole is understanding the relations between the different radii of integration.

Consider, for example, the relation between the City of London and London as a whole. Figure 4.7a is a close up of the axial map of the City of London in context. Figure 4.7b is a scattergram plotting each line in the London axial map as a whole as a point located according to its degree of global (radius-n) integration on the horizontal axis and its degree of local (radius-3) integration on the vertical axis. The dark points are the lines which make up the City of London. The dark points form a good linear scatter about their own (invisible) regression line, and cross the main regression line at a steeper angle. The linearity implies a good relation between local and global integration, the steeper slope across the regression line implies that the most integrated lines within the city, which are the lines from the outside towards the centre, are more locally than globally integrated. Their local integration is, as it were, intensified for their degree of global integration. Repeating this experiment with all of the well-known named London areas, such as Soho,

Figure 4.7a
City of London within the context of Greater London

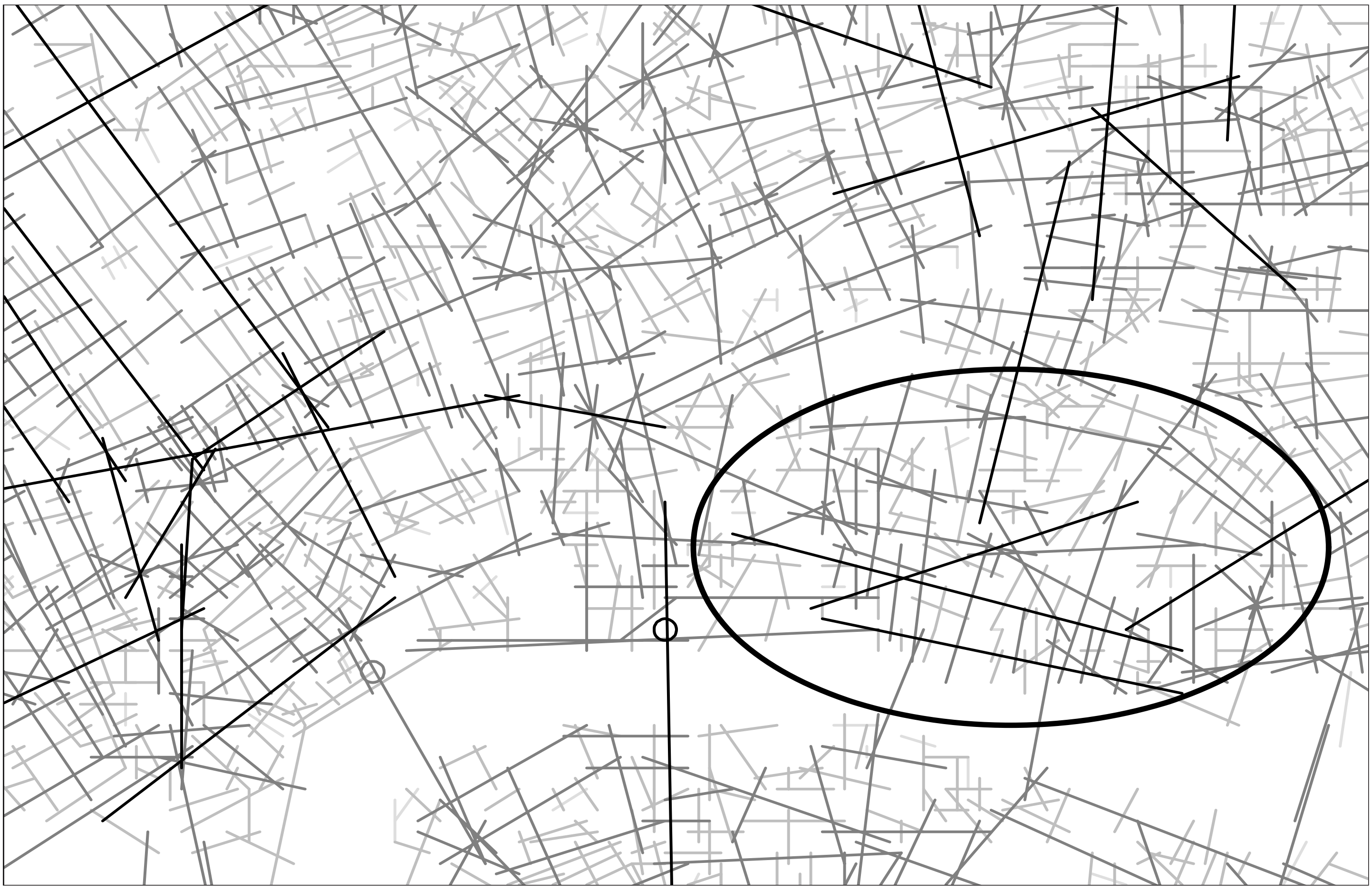


Figure 4.7b
Scatter of the City of London within the context of Greater London

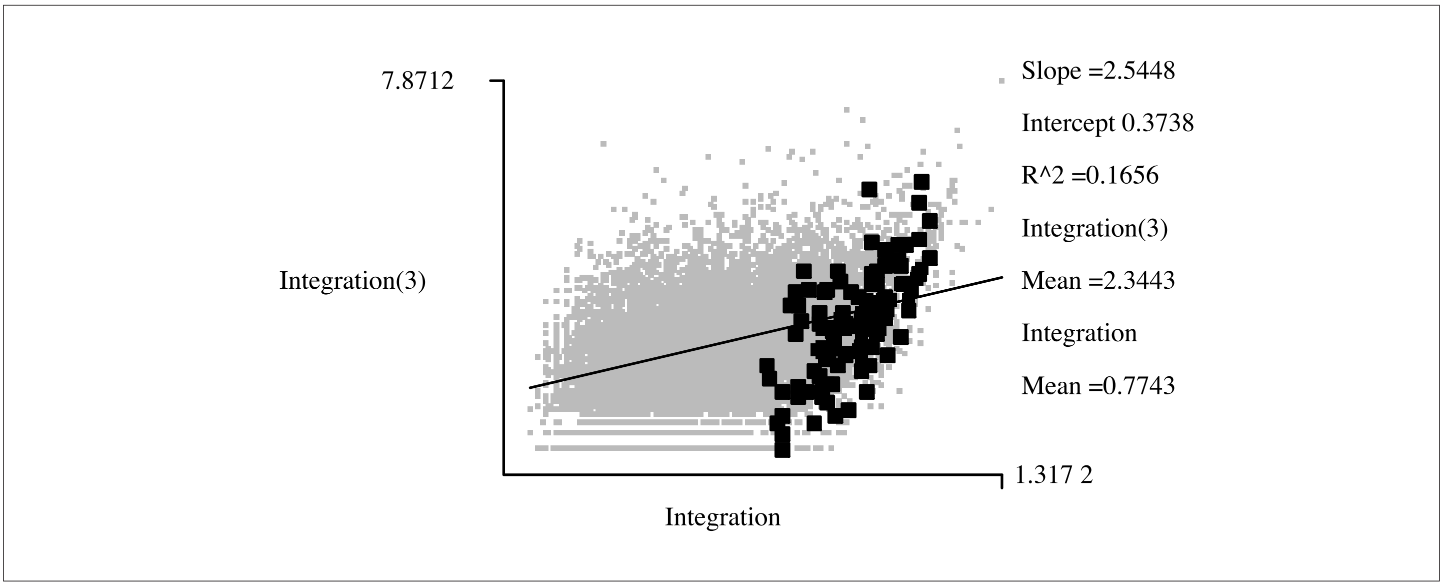
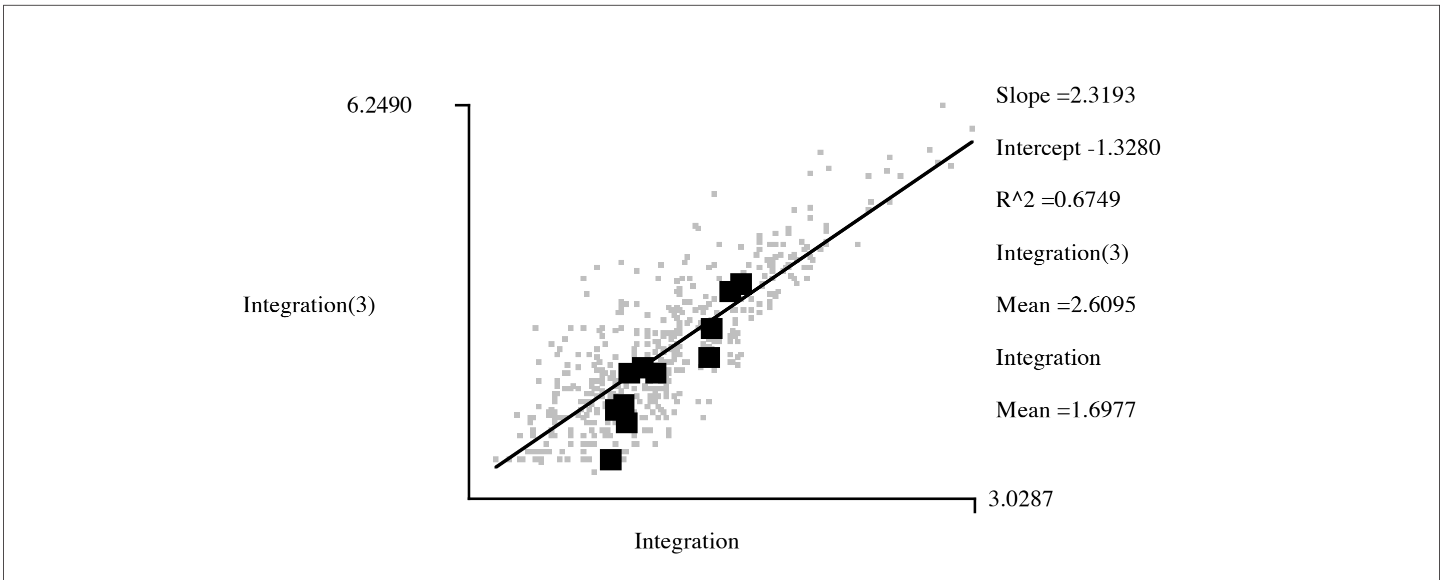


Figure 4.7c
Leadenhall Market, City of London

Figure 4.7d
Scatter (in black dots) of Leadenhall Market within the context of the City of London



Covent Garden, Bloomsbury, and even Barnsbury – yield this kind of scatter. In other words, the relation of part and whole in the axial map is made up at least in part of the relation between local and global integration. The reason this is so is that each local area has its heart linked to the supergrid lines that surround it by strong integrators. These form an edge-to-centre structure in all directions, and the less-integrated areas are within the interstices formed by the structure. The strong local integrators which define the slope of the dark points for the local area are invariably these edge-to-centre lines.[12]

Remarkably, we find exactly the same phenomenon a much smaller scale, for example within the City of London. Figure 4.7c homes in on the Leadenhall Market area, and figure 4.7d shows the City scatter with the Leadenhall Market area as the dark points. Once again we find the local area effect. The effect of this is that as you move down the supergrid lines – Gracechurch Street or Leadenhall Street – then Leadenhall Market is available as a well-structured local intensification of the grid, itself laid out in much the same way as the town is laid out. Once you are near it in the adjacent streets, it becomes a powerful attractor.

We can draw a simple conclusion from these results, one which I believe agrees with intuition: that the more the set of dark points forms a line crossing the regression lines for the whole city but tending to greater steepness, there is more that is local integration than global, then the more the sub-area is distinctive; while the more the dark points lie on the City regression lines, the more they are simply sets of smaller spaces related to the main grid, but not forming a distinctive sub-area away from it. This depends, however, on the dark points themselves forming a good line, since without that we do not have a good integration interface – that is, a good relation between the different scales of movement – in the first place, regardless of where it is in relation to the main City. It depends also on the dark points including points well up the scale of integration. A clutch of points bottom left will be very segregated, and not function as a sub-area. (Chapter 5 deals with this problem in detail.)

We have found an objective spatial meaning, it seems, to the areas we name as areas, and in such a way as to have a good idea of the functional generators of their distinctive urban patterns. We have a key to how at least some cities can be put together as cities of parts without losing the sense of the whole. Historically, it seems, cities exploited movement constructively to create dense, but variable, encounter zones to become what made them useful: to be ‘mechanisms for generating contact’. How they did this was by using space to generate multiplier effects on the relation between movement and encounter. This was achieved by quite precise spatial techniques, applied now this way, now that (for example, in Arabic cities we find a quite different development of the same underlying laws), but always having the effect of creating well-defined relationships between different levels of movement: between the movement within buildings and the movement on the street, between localised movement in less important streets and the more globalised pattern of movement, and between the movement of inhabitants and the movement of strangers entering and leaving the city. In a sense, cities were constructed to be, in the words of Dr John

Peponis,[13] interfaces between scales of movement.

The interface between different radii of integration was the spatial means to the functional end. It created a close relation between more localised and more globalised movement. It is therefore the key to the local by-product effect, and the means to create local advantage from global movement. The spatial technique by which this was done was to maintain a number of spatial interfaces: between building entrances and all spaces, at whatever scale; between smaller spaces and the larger urban scale through the relation between the convex and linear structures; and between different scales of the linear structure, especially between parts and the whole.

Disurbanism

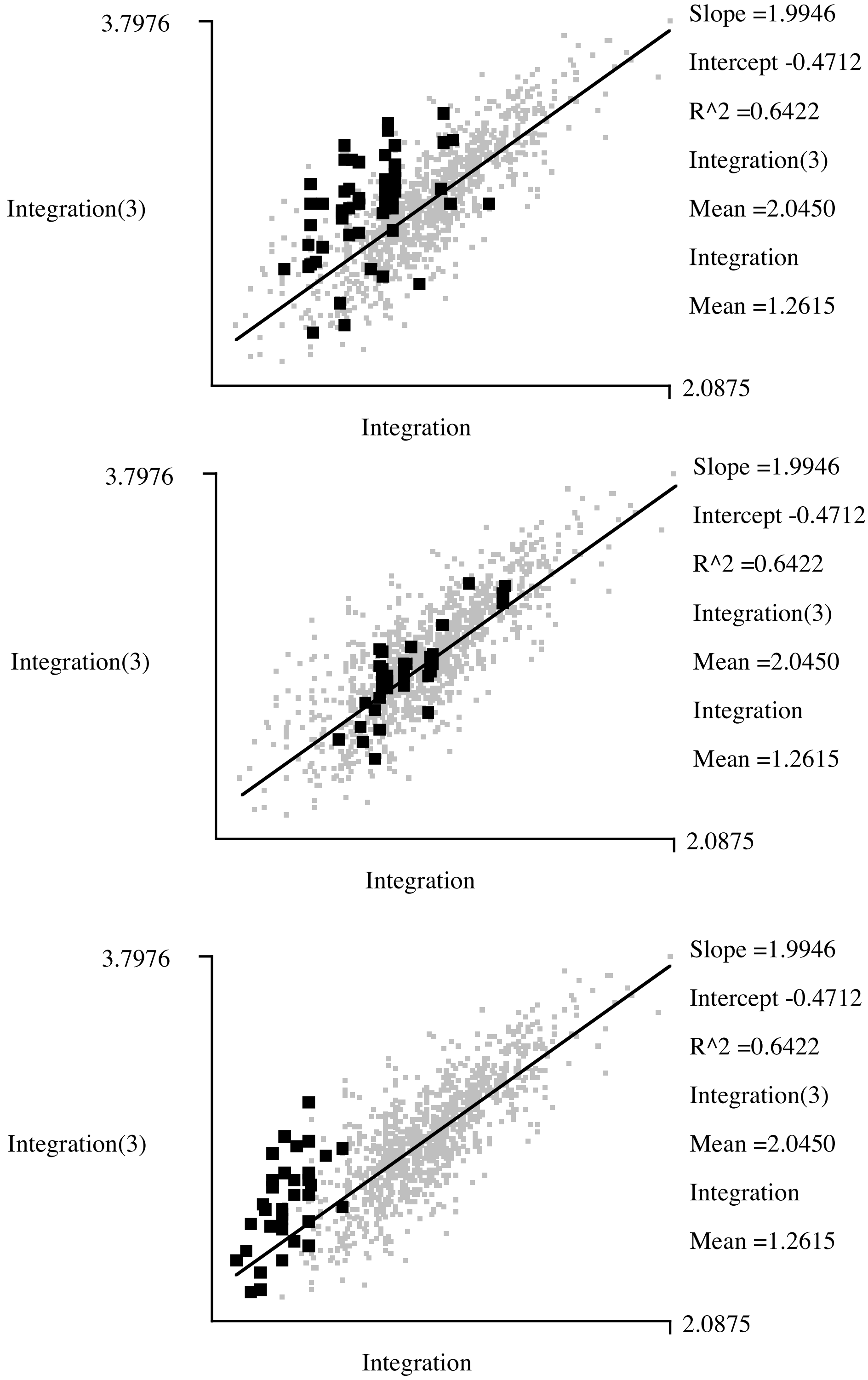
The urban movement economy, arising from the multiplier effect of space, depends on certain conditions: a certain size, a certain density, a certain distribution of land uses, a specific type of grid that maintains the interface between local and global, and so on. Once this is spelled out, it is easy to see how thoroughly some of our recent efforts have disrupted it, so much so that we must think of many developments of recent years as exercise in the spatial techniques of disurbanism. 'Disurbanism' is intended to convey the reverse of the urban spatial techniques we have identified: the breaking of the relation between buildings and public space; the breaking of the relation between scales of movement; and the breaking of the interface between inhabitant and stranger.

Consider, for example, the integration map of an area around Barnsbury, which includes three housing estates around the King's Cross railway lands site (the empty area), as in figure 4.8a The estates are easy to pick out: they are more complex and at a smaller spatial scale than the surrounding street-based areas, and each is marked by its density of light shaded, that is segregated, lines. If we try to plot these estates as dark point scatters of local against global integration, as in 4.8b, c and d then we find that in each case the estate scatter forms a series of layers, each distributed in a more or less vertical pattern. This phenomenon will be dealt with in detail in the next chapter. Here we note three consequences of this type of spatial design. First, the estate is substantially more segregated than the rest of the urban surface and, what is more problematic, segregated as a lump. Good urban space has segregated lines, but they are close to integrated lines, so that there is a good mix of integrated and segregated lines locally. Second, there is a poor relation between local and global integration, that means a very unclear relation between the local and global structure. Third, the scatter does not cross the line to create a well-structured local intensification of the grid.

What this means in functional terms is that all interfaces are broken: between building and public space; between localised and less localised movement; and between inhabitant and stranger. Of course life is possible in such place. But there is now evidence to suggest that we ought to be more pessimistic. Efforts to trace the path that such designs can have over a long period on the type of life that

Figure 4.8
Global integration map of King's Cross with three housing estates picked out in black and the scatters (in black dots) of the three housing estates within their larger context.

Figure 4.8
Global integration map of King's Cross with three housing estates picked out in black and the scatters (in black dots) of the three housing estates within their larger context.



goes on in them suggest that there is a pattern of long-term development in which spatial designs create serious lacunas in natural movement, which then attract anti-social uses and behaviours. As we will see in Chapter 5, in extreme cases, where the lacunas of natural movement are the integration core of the estate itself, then the situation may become pathological.

These 'disurban' places arise from a poorly structured local configuration of space as a consequence of which the main elements of the movement economy are lost. A similar pattern of loss can also arise through dispersion. If we move from an urban system that is dense and nucleated to one that is dispersed and fragmentary, it is obvious that the mean length of journeys will, other things being equal, increase. It is less obvious, but equally true, that the by-product effect will also be diminished. As dispersion increases, it becomes less and less likely that connected locations will benefit from the by-product of movement. In effect, as dispersion increases, the movement system becomes more like a pure origin-destination system. Instead of one journey accomplishing a number of purposes, more journeys, each one accomplishing fewer purposes, must be made to attain the same goals. These are the basic reasons why people travel farther in the country, and why most of this extra travel is in private cars.[14]

A similar effect can arise even in a comparatively dense urban system through an urban design policy of replacing continuous urban structure with specialised enclaves. This will also tend to eliminate by-product. Enclaves are, almost by definition, destinations which are not available for natural movement. They form discontinuities in the urban grid. Because this is so they are in many ways comparable in their effects to the physical dispersion, and similarly disruptive of the movement economy. Any tendency in an urban structure towards 'precinctisation' must also be a tendency to a lessening of the useful by-product, and therefore of the multiplier effect on which urban vibrancy depends.

These arguments suggest that the culturally sanctioned values that are embedded in attitudes towards urban design, that until quite recently were taken for granted – lowering densities wherever possible, breaking up urban continuity into well-defined and specialised enclaves, reducing spatial scale, separating and restricting different forms of movement, even restricting the ability to stop travellers from moving and taking advantage of the by-product effect – are fundamentally inimical to the natural functioning of the city and its movement economy. It is not density that undermines the sense of well-being and safety in urban spaces, but sparseness, not large spatial scale, but its insensitive reduction, not lack of order but its superficial imposition, not the 'unplanned chaos' of the deformed grid, but its planned fragmentation. Without an understanding of the spatial and functional nature of the city as a whole, we are in danger of eliminating all the properties of density, good spatial scale, controlled juxtaposition of uses, continuity, and integration of the urban grid on which the well-ordering and well-functioning of the city depends.

Cities as movement economies

Reflections on the origins of urbanism and the transformation of the city

These conclusions can only reinforce the thought with which we began: our interventions in the city can only be based on our understanding of the city. Where this understanding is deficient, the effects can be destructive, and this will be more the case to the degree that this false understanding is held in place by a value system. The value system according to which we have been transforming our cities over much of the past century has always appeared as a kind of urban rationality, but it was never based on the study of the city. Where then did it come from?

Let us first reflect a little on the nature and origins of cities, why we have them and what made them possible. Towns, as physical objects, are clearly specialised forms of spatial engineering which permit large numbers of people to live in dense concentrations without getting on each others' nerves, and minimise the effort and energy needed for face-to-face contact with each other and with the providers of needs. Towns, we suggest, were in fact made functionally possible in the first instance by a transmutation in the way energy flowed through society. It is most easily explained through the geographer Richard Wagner's distinction between two kinds of energy-related artefact: *implements* which transmit or accelerate kinetic energy, and *facilities* which store up potential energy and slow down its transfer.[15] For example, a flint knife is an implement, whereas a dam is a facility. Whatever else made towns possible, there is no doubt that they were usually marked by a radical increase in facilities, most especially irrigation systems and food storage facilities.

What made towns possible socially was an invention we are so familiar with that we tend to take it for granted and forget it is there: the urban grid. The urban grid is the organisation of groups of contiguous buildings in outward-facing, fairly regular clumps, amongst which is defined a continuous system of space in the form of intersecting rings, with a greater or lesser degree of overall regularity. Urban grids were never inevitable. In fact, the archaeological record reveals many proto-towns with quite different morphologies.

The urban grid was, however, the first powerful theorem of urban spatial engineering. Its crucial characteristic is that it is itself a facility – one that takes the potential movement of the system and makes it as efficient and useful as possible. The grid is the means by which the town becomes a 'mechanism for generating contact', and it does this by ensuring that origin-destination trips take one past outward-facing building blocks *en route*. That is, they allow the by-product effect to maximise contact over and above that for which trips are originally intended.

In the nineteenth century, however, under the impact of industrialisation and rapid urban expansion, two things happened. First, to cope with sheer scale, the urban spatial grid was thought of as more of an implement than a facility. That is, it was seen as a means to accelerate movement in order to overcome size. Alongside this it was envisaged as a set of point-to-point origins and destinations, rather than as an 'all points to all points' grid, which is the product of an urban movement economy.

Second, the city began to be seen not as a grid-based civilisation, but as the overheated epicentre of focal movement into and out of the city, and as such the most undesirable of locations. A social problem was seen in the disorderly accumulation, in and around city centres, of people brought in to serve the new forms of production. Big became synonymous with bad, and density became synonymous with moral depravity and political disorder. It was this that gave rise to much of the value system of nineteenth-century urban planning, as well as the the more extreme proposals for the dispersion and ruralisation of the city and its population.

Unfortunately, much of this nineteenth-century value system survived into the twentieth century, not so much in the form of consciously expressed beliefs and policy objectives as in assumptions as to what constituted the good city. For much of the twentieth century, nineteenth-century anti-urbanism provided the paradigm for urban design and planning. It would be good to believe that this has now changed, and that cities are again being taken seriously. But this is not the nature of human beliefs when they become embedded in institutional forms and structures. Many aspects of the nineteenth-century urban paradigm have not yet been dismantled, and are still to be found enshrined in such everyday policies towards density, in novel ways of breaking up urban continuity into well-defined and specialised enclaves, in continuing to reduce spatial scale, and in separating and restricting different forms of movement. These relics of an outdated paradigm do not derive from an understanding of cities. On the contrary, they threaten the natural functioning and sustainability of the city.

Notes

1 The best recent review of these issues is S. Owens, ‘Land-use planning for energy efficiency’, in *Applied Energy*, 43, 1–3, Special issue on the rational use of energy in urban regeneration eds. R. Hackett & J. Bindon, Elsevier Applied Science, 1992; an important source on settlement forms on which she draws is P. Rickaby, ‘Six settlement patterns compared’, *Environment & Planning B, Planning & Design*, 14, 1987, pp. 193–223; significant recent contributions include D. Banister, ‘Energy use, transport and settlement patterns’, in ed. M. Breheny, *Sustainable Development and Urban Form*, Pion, 1992, and P. Hall, Squaring the circle; can we resolve the Clarkian paradox?’ *Environment & Planning B: Planning & Design*, 21, 1994, pp. 79–94.

2 For a discussion see M. Batty, ‘Urban modelling and planning: reflections, retrodictions and prescriptions’, in B. Macmillan, ed., *Remodelling Geography*, Basil Blackwell, Oxford, 1989, pp. 147–169. See also M. Batty and P. Longley, Fractal Cities, Academic Press, London, 1994.

3 B. Hillier et al., ‘Natural movement: or configuration and attraction in urban pedestrian movement’, *Environment & Planning B, Planning & Design*, vol. 20, 1993; and A. Penn & N. Dalton, ‘The architecture of society: stochastic simulation of urban movement’, in eds. N. Gilbert & J. Doran, *Simulating Societies: The Computer Simulation of Social Phenomena*, UCL Press, 1994, pp. 85–125.

4 In this sense, it is an instance of what Ian Hacking calls ‘the creation of phenomena’, which then leads to the evolution of theory – I. Hacking, *Representing and Intervening*, Cambridge University Press, 1983 Chapter 13, ‘The creation of phenomena’, pp. 220–32.

5 The figures are taken from a case study carried out by Marios Pelekanos while a student on the MSc in Advanced Architectural Studies in the Bartlett School of Graduate Studies, UCL, in 1989.
6 B. Hillier, et al., 'Natural movement'.
7 A. Penn. et al., 'Configurational modelling of urban movement networks', 1995. Submitted for publication, but currently available from the Bartlett School of Graduate Studies.
8 In this study, each line segment was observed in total for about 50 minutes, spread during five different time periods: 8–10 am, 10–12 noon, 12–2 pm, 2–4 pm and 4–6 pm. The data is therefore of very high quality. Experiments have shown however, that comparatively short periods of observation can be sufficient where there are reasonable numbers of people to be observed. In sparse environments, more protracted observations are required.
9 See for example A. Penn & B. Hillier, 'Configurational modelling' (see 7).
10 Penn & Hillier (see 7).
11 This issue is discussed in greater detail in Hillier et al. 1993, 'Natural movement' (see 3).
12 This structure has also been found in small towns and called a 'deformed wheel', since there is always a semigrid, or hub, of lines near the centre, strong integrators which link this semi-grid to the edges, like spokes, and some edge lines are also integrated, forming a partial rim. This structure is usually the main public space structure, while less integrated residential areas form in the interstices form by the wheel. See B. Hillier B, The architecture of the urban object, *Ekistics* – Special issue on space syntax research, vol. 56, no. 334/5, 1989.
13 Dr John Peponis of the Georgia Institute of Technology and the Polytechnic University of Athens, in conversation.
14 See for example Department of Transport, National Transport Survey: 1978/79 Report, HMSO, Norwich, 1983, Table 10.4, p. 71. (See also NTS: 1975/76 Report, Table 3.17, p. 37.)
15 R. Wagner, The Human Use of the Earth, New York, Chapter 6, for a further discussion see K. Flannery, The origins of the village as a settlement type in Mesoamerica and the Near East: a comparative study', in eds. P. Ucko et al., *Man, settlement and urbanism*, Duckworth, 1972 pp. 23–53.

Chapter five

Can architecture cause social malaise?

Architectural determinism as a mind-body problem

There is a widespread belief that architecture can cause social malaise, either by directly bringing about anti-social behaviour, or by inducing stress and depression in individuals, or by creating vulnerability to crime.[1] In fact, little is known about these effects. We cannot even be sure if any of them genuinely exist. The long-term and large-scale studies that would be necessary to settle the questions have not been done. As a result, although these effects are widely believed in, they are equally widely discounted as incredible, either on common sense grounds – how could building possibly have such far-reaching effect on people's minds – or methodological grounds – how can the vast variety of factors that can affect social malaise be sorted out one from the other when they are all so inextricably bound up together in the lives of the alleged victims of bad design.

From a research point of view, there are good grounds for scepticism, at least on the basis of current evidence. There is a problem of method in establishing any kind of link between architecture and social outcomes, which studies have not usually convincingly broached. Housing is invariably a social process as well as a physical product. Both markets and bureaucracies assign poor people to poor housing, making bad housing a dependent variable in a process of social disadvantagement. How then can we ever hope to extract any effects there may be from architecture as an independent variable, when the social process in which architecture is embedded is already likely to be operating with architecture as a dependent variable? In short, if we do find bad design associated with social disadvantagement, how can we ever be sure that the former is determining – or even contributing to – the latter, when the broader social process is likely already to have brought about the association of both? Since all we can study are real cases, and every estate or housing area selected for study will already be a continuing social process, it is not clear how this difficulty can ever be circumvented.

If this were not enough, there is a second difficulty, no less fundamental, but theoretical – even philosophical – rather than methodological. Building is the creation of a physical and spatial milieu. If we are to believe that this physical milieu can somehow invade people's minds and have effects that are strong and systematic enough to influence behaviour, then we must have some conception of a plausible chain of sensorial or mental events through which this could come about. There are no credible models for such mechanisms. Even for individuals, it is hard to conceive of a process by which such effects could occur. The idea that they can be extended to the level of whole communities, is frankly incredible.

In fact, the very idea of 'architectural determinism' – that buildings can have systematic effects on human behaviour, individually or collectively – seems to lead directly into the quagmire of mind-body problems which have plagued philosophy for centuries. Whether we conceptualise minds as immaterial entities or as physical brain states, it is equally difficult to see how physical objects like buildings could affect minds in such as way as to produce durable and systematic behavioural effects. Without some conception of how such chains of events might come about,

Can architecture cause social malaise?

it is difficult to see how research can proceed.

The two difficulties taken together – the methodological and the theoretical – combine to make architectural determinism a surprisingly deep and complex issue. However, it is hard to see how it can be avoided. To argue in principle against any kind of architectural determinism, that is, any kind of positive or negative effects of architecture, leads to the odd proposition that it does not matter at all how environments are designed, since they are behaviourally neutral. This proposition seems even less credible than architectural determinism. We are, it seems, caught between two contrary and mutually exclusive possibilities, each of which seems as unlikely as the other. As a result, architectural determinism seems more paradoxical than problematic, in the sense that these rather abstruse difficulties stand in the way of a clear problem identification that would allow research to proceed.

Fortunately, when human thought finds itself in such situations, there is always a simple third possibility: that the problem has been set up in the wrong way. It is through this third possibility that both of these apparent difficulties will be addressed in this chapter. There are, it will be argued, perfectly credible mechanisms by which architecture can get into heads and come out as individual behaviour and equally credible mechanisms for generalising these to effects on communities. Moreover, in setting these mechanisms out with care, we can also show how the effects of architecture can be extricated from those of the social disadvantagement process. In other words, the methodological and theoretical problems can be solved together because they stand or fall together. The two can be reformulated, and converted from a form in which neither can be solved into one in which both are, if not obviously solvable, then at least tractable to systematic enquiry.

A careful look at methodology

The argument begins with methodology. We must first be a little clearer about the methodological difficulties that studies of the effects of architecture on people have always encountered. Strangely, perhaps, the key difficulty has not so much been one of investigating what goes on in human minds. Architectural and social psychologists have generally been quite adept at this. The difficulty has been one of controlling the architectural variable, that is, of arriving at descriptions of the differences between one built environment and another that are sufficiently precise and consistent to permit correlation with attitudinal or behavioural variables. Most studies have sought to solve this problem by physical descriptors at a the gross level of the estate or block – size of estate, numbers of stories per block, number of entrances, existence of walkways, and so on. Unfortunately, it is exactly at this gross level that the social process of disadvantagement is likely to be most active. The only level at which it might be be expected to be less active would be at the much smaller scale of the different types of location within the estate – this section of walkway, this cul-de-sac, this courtyard, and so on. However, the type of descriptors that have been used do not easily permit such disaggregation in a systematic way. It is partly as a result of the failure to control the architectural variable with sufficient precision that many suggestive results apparently linking architecture to social disadvantagement, are challenged. The gross level at which the architectural variables are handled makes it easy – and proper – to argue that studies have failed to distinguish architectural effects from social process effects convincingly, because it is exactly at this gross level that the social processes are most manifest and easiest to point to.[2]

This problem can be solved, if at all, only by treating both the architectural and social variables at a much finer level of resolution, so that the units of analysis are, at most, small groups of households – we can call them location groups – which are sufficiently large so that individual variation is not dominant, but not so large that social process differences between one location group and another are likely to be dominant. If it is the case that bureaucratic allocation processes and market forces alike tend to work most virulently at the grosser levels of the bad area; the notorious estate, or the unpopular block, then we may reasonably expect them to be much less obtrusive at the level of the numerous small groups of households which will be found on every estate or in every area.

It is exactly this finer level of resolution of both architectural and social data that can be achieved and made systematic by using configurational modelling of space, as the basic means for controlling the architectural variable. This allows parametric descriptors of spaces to be assigned at whatever level of resolution we choose. We have already seen that configurational properties of spaces are crucial to the ways in which space 'works' at the level of patterns of movement, and the knock-on effects these have over time on other aspects of urban form which are sensitive to movement, such as the distribution of certain types of land use, such as retail, and some types of crime, as well as the fear of crime. In the studies shown in Chapter 4, the ability to control the architectural variable parametrically through spatial modelling allowed us to distinguish the effects of spatial configurations on behavioural variables such as movement rates from other possible explanations of the same phenomena. It was simply a matter of doing the analysis carefully.

Architecture and the virtual community

From the point of view of our present interest in social malaise, however, the regularities between space and movement that we have noted are at a rather 'low level', in the sense that although they are clearly 'system effects' from architectural design to patterns of behaviour amongst collections of people, it is not clear that they have implications for the forming of communities, which are 'high level' in the sense that they involve more or less complex structures of interactions and relationships amongst collections of people. However, in the previous chapter we were able to look outwards from these low-level system effects and find that they were related to many other key features of urban structure, such as the evolution of the urban grid, land use distributions and building densities. In other words, at the level of the city as a complex physical and spatial structure we were able to find a way from low-level regularities linking space and movement to some quite high-level

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effects on the structure and functioning of the city as a whole.

In what follows, the argument will be taken in the contrary direction, and we will look for the possible implications of these low-level system effects on the microstructure of the urban spatial environment, that is, the immediate spatial milieu in which many people live out much of their everyday lives. The basis of the argument is simple. Spatial configuration influences patterns of movement in space, and movement is by far the dominant form of space use. Through its effects on movement, spatial configuration tends naturally to define certain patterns of co-presence and therefore co-awareness amongst the individuals living in and passing through an area. Co-present individuals may not know each other, or even acknowledge each other, but it will be argued that this does not mean to say that co-presence is not a social fact and a social resource. Co-present people are not a community, but they are part of the raw material for community, which may in due course become activated, and can be activated if it becomes necessary. However, even without conversion into interaction, patterns of co-presence are a psychological resource, precisely because co-presence is the primitive form of our awareness of others. Patterns of co-presence and co-awareness are the distinctive product of spatial design, and constitute, it will be argued, the prime constituents of what will be call the 'virtual community'. The 'virtual community' in a given area is no more nor less than the pattern of natural co-presence brought about through the influence of spatial design on movement and other related aspects of space use.

Because virtual communities are no more than physical distributions of people in space, careful observation can tell us a great deal about them. First, virtual communities have certain obvious properties such as density, but also less obvious properties such as a certain structure, that is, a certain pattern of co-presence between people of different categories and using space for different purposes; for example inhabitants and strangers, men and women, adults and children, and so on. Second, it is easy to establish that the density and structure of virtual communities is observably quite different in most housing estates compared with street-based urban areas, and seems to become more so in quite systematic ways as housing estates become 'worse'. Third, there seem to be clear associations between the nature of virtual communities in different types of environment and key outcome variables: how much vandalism and where it occurs, where crimes occur, where anti-social uses of space develop, and so on.

Through its low-level effects on patterns of movement, it will be argued that there are also high-level implications for space at the micro-level which come about through the creation – or elimination – by spatial design of the patterns of natural co-presence and co-awareness of individuals that make up virtual communities. Whatever the long-term effects of architecture are, it will be proposed that they pass through this central fact, that architecture, through the design of space, creates a virtual community with a certain structure and a certain density. This is what architecture does and can be seen to do, and it may be all that architecture does. If space is designed wrongly, then natural patterns of social co-presence in space are not achieved. In such circumstances, space is at best empty, at worst abused and a source of fear. If too much space in the local milieu is like this, everyday experience of others is an experience of a disordered 'virtual community'. It is this that links architecture to social malaise. The intervening variables between architecture and behaviour are, in effect, the design of space and the consequent use of space.

In this chapter it will be argued that through configurational analysis of space, coupled to careful observation of the use of space, we can isolate certain suggestive regularities in the structure of virtual communities, and show that these differences are the outcome of differences in the architectural design of space. Co-presence and co-awareness are therefore the the key operation concepts, and the virtual community the key theoretical concept. These differences, it will be argued, are both systematic effects of the design of spatial configuration, and also far more important to the long-term development of the spatial community than has hitherto been realised, not least because social scientists have normally seen social interaction as the elementary social unit, and co-presence as merely prior to social interaction. However, the pattern of co-presence does result largely from design and its analysis therefore offers the most promising path from architecture to its social effects.

The formula for urban safety

We may begin by considering the results in the last chapter a little more carefully from the point of view of the micro-structures of local space. From hourly rates of pedestrian movement in the area shown in the study of Barnsbury in Chapter 4, we can work out the rates of movement per minute, which is about the time it takes to walk 100 metres at normal speed. We can then take the average line length, and work out the probabilities of co-presence in space for individuals moving around the area. The comparatively long average length of lines, coupled with the fact that the average movement rate is around 2.6 adults per minute in this area, means that on average an individual will be in visual contact with at least one other person more or less constantly. In fact, for most of the time, a walking individual is likely to be in visual contact with more than one other person. The merits of this combination of numbers and length of lines of sight are obvious. It provides the moving individual not only with the security of more or less constant visual contact with more than one other person, but also with sufficient warning of encounter to take evasive action if necessary. The interface with others is both dense and to some extent controllable by the individual.

Now consider the parallel situation in one of the nearby housing estates shown in Chapter 4. Here the mean encounter rate in the estate interior is .272, an order of magnitude less than in the street area, even though the streets surrounding the estate approximate the rates in the street area. It is also the case that the mean length of sightlines within the estate is a great deal shorter than in the street area. From these two pieces of information we may easily calculate that an individual walking in the interior of the estate will be on their own for most of the time. The sparsity of encounters, coupled with the shortness of sightline, also means that most encounters, when they occur, will be relatively sudden, with little time to evaluate the coming encounter and take appropriate action.

In these conditions, individual behaviour changes. We may illustrate this with a thought experiment. Imagine an individual, X, living in an ordinary street. It is midday. X comes out of his or her front door. A stranger is about to pass by the door. Another is slightly farther away, but will also pass the door shortly. A third is passing in the opposite direction on the other side of the road. In these circumstances, the presence of strangers seems natural. X even finds it reassuring. Certainly X does not approach the person passing the door and ask what he or she is doing here. If X did this, others would think X's behaviour odd, even threatening. Unless there were special circumstances, someone might even send for the police if X persisted.

Now consider Y, who lives on a short upper-level walkway remote from the public street within a housing estate. Like X, Y comes out of his or her front door, and looks down the walkway. Suddenly a stranger appears round the corner in exactly the same position relative to Y's doorway as in the previous case the stranger was to X's. Due to the local structure of the space, of course, it is very likely that no one else is present. Unlike X, Y is nervous, and probably does one of two things: either he or she goes back inside the house, if that is easiest, or if not asks the stranger if he or she lost. The encounter is tense. Both parties are nervous. Y is being 'territorial', defending local space, and the stranger is being asked for his or her credentials.

Now the curious thing is that in the prevailing spatial circumstances, Y's behaviour, which, if it had occurred on the street, would have seemed bizarre, seems normal, even virtuous. In different environmental conditions, it seems, not only do we find different behaviours, but different legitimations of behaviour. What is expected in one circumstance is read as bizarre in another. So what exactly has changed? There seem to be two possibilities. First, the overall characteristics of the spatial configuration – not the immediate space which is more or less the same – of which the space Y was in is a part has changed, compared with X's. Second, Y's expectation of the presence of people has changed.

These two changes are strictly related to each other. Changes in configuration produce, quite systematically, different natural patterns of presence and co-presence of people. People know this and make inferences about people from the configuration of the environment. An environment's configuration therefore creates a pattern of normal expectation about people. These expectations guide our behaviour. Where they are violated, we are uncomfortable, and behave accordingly. What is environmentally normal in one circumstance is unexpected in another. This is both an objective fact of environmental functioning, and a subjective fact of 'description retrieval',[3] that is, of the mental processes by which we read objective circumstances and make inferences from them.

The behavioural difference we have noted is therefore environmentally induced, not directly, but via the relation between configurational facts and configurational expectations. One effect of this is that it can induce environmental fear, often to a greater degree than is justified by the facts of crime, because

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Figure 5.1a
Figure ground of space of the housing estate.

Figure 5.1b
Global integration of housing estate within its urban context.

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Figure 5.1c

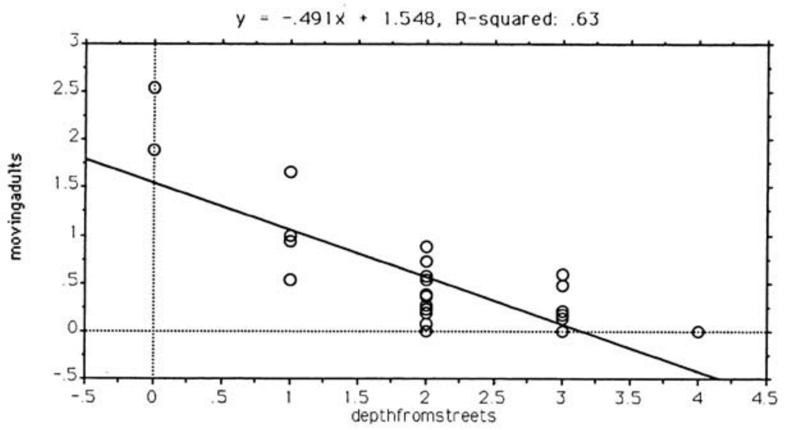
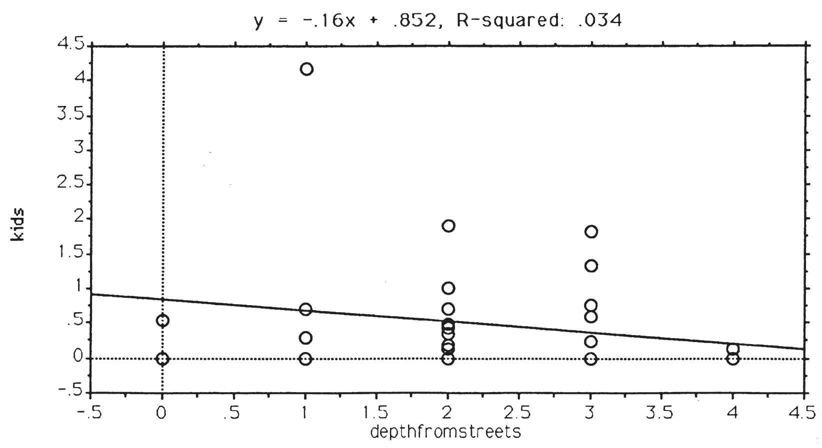


Figure 5.1d



it takes the form of an inference from environment rather than from an actual presence of people. It is these inferences from the structure of space to the pattern of probable co-presence that influences behaviour and are also responsible for the high levels of fear that prevail in many housing estates. This is the fundamental reason that the urban normality of street-based systems usually seems relatively safer than most housing estates.

Let us then reflect on how the reduction of the mean encounter rate by an order of magnitude in the housing estate when compared with the street-based system actually occurs. Figure 5.1a shows a black on white of the space of the housing estate in question within its urban context, and figure 5.1b shows its global integration into its urban context. There are two aspects to the answer. The first is that the complexity and down-scaling of the spatial design of the estate ensures that natural movement is virtually eliminated. The simplest way to show this is simply to correlate movement with axial depth from the outside into the estate. Figure 5.1c is the scattergram.[4] This fall off of movement from the edge of the estate towards the interior is common to the majority of housing estates, most of which down-scale and destructure estate space in a similar way. It is noteworthy that in this case, as in other cases, the movement pattern directly reflects the layered local spatial system shown in figure 4.8 in Chapter 4.

The second reason has to do with the number and distribution of dwelling entrances. In this estate, as in most others, entrances only occur on certain lines, and most of these are relatively deep from the outside. Each line will have perhaps ten or twelve dwellings opening onto it, and it will be connected to the outside not by other lines with dwellings opening onto them, but in general by lines without dwellings. In other words, even lines with dwellings will only have the movement on them generated by the dwellings themselves. Suppose there are two adults per dwelling and each makes, say, to be generous, four movements a day. This means less than ten per hour, or about one every five minutes – that is, the observed encounter rate. Since the residential lines are relatively short, the probability of encounter on any trip on that line will be no more than ten per cent. In other words, the encounter rates on the estate, with all their implication for the generation of fear and nervous behaviours, are implicit in the design.

We can now see that the formula for urban safety must depend, for simple numerical reasons, on the presence of strangers as well as inhabitants, and is therefore a little more complex than 'defensible space'. We need to replace a static conception of space by a movement-based one. The main idea behind defensible space was that inhabitants who were static and in their dwellings had to be put into a position, by design, to have natural surveillance of the spaces leading to their doors in order to see and deter potential wrongdoers, who were strangers and moving. Our results suggest that what really happens is that the natural movement of moving strangers maintains natural surveillance on space, while the static inhabitants, through their dwelling entrances and windows, maintain natural surveillance of moving strangers. This formula clearly depends on the spatial configuration creating a strong probabilistic interface between inhabitants and strangers. In short, it is the mix of inhabitants and strangers in space that is the source of safety. Environments will tend to lack of safety and environmental fear to the extent that they separate the two. Put more succinctly, the formula for urban safety is a certain aspect of the structure of the virtual community – that is, the pattern of probabilistic interfaces – created by spatial design.

Social structures of space and the L-shaped problem

Now the heart of my argument is that through more complex effects on virtual communities, these still rather low-level effects of space reach much further into our social lives than we realise. They can create or fail to create certain subtle and complex system effects, which are so suggestive that we might even think of them as the 'social structures' of space – though at some risk of criticism from social scientists would not think of these effects as social at all. These social structures of space are simply generalisations of the ideas we have so far developed on how space interfaces inhabitants and strangers to different categories of people, in general: men and women, adults and children, the young and the old, and so on.

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These 'multiple interfaces' in space can be objectivised by using, as before, the simple statistical technique of the scattergram, though now we will be more interested in the visual pattern of the scatter than in correlation coefficients. Figures 5.2a and 5.2b are scattergrams in which instead of setting functional against spatial parameters, we set two functional parameters against each other, in this case the movement of men against the movement of women. By checking the axes for the average degree to which each space is used by each category, we can work out the probability of co-presence in each space. The correlation co-efficient thus indexes something like a probabilistic interface between two different categories of people.

Now the point of the pair of scattergrams is that the first represents the situation in the street pattern area shown in Chapter 4, which is near the housing estate under consideration, while the second shows the situation within the housing estate. It is easy to see that the 'probabilistic interface' between men and women is much stronger in the street area than within the estate. In the street area, the linearity of the scatter shows that men and women are using space more or less in the same way, and are more or less equally likely to be co-present in all space. There are no spaces in which men are more likely to be present than women, and *vice versa*. Within the estate, the situation is quite changed. The irregularity of the scatter shows that many spaces prioritised by men are poorly used by women, and *vice versa*.

By using this simple technique to explore interfaces between different categories of people using space, we can show that ordinary urban space, even in predominately residential areas, is characterised by multiple interfaces: between inhabitant and stranger, between men and women, between old and young and between adults and children. We can be confident that these multiple interfaces are produced by spatial design, because they are essentially a product of the natural movement patterns which we have already shown are predominantly produced by the structure of the urban grid. This is such a consistent phenomenon, that it is difficult to see it as purposeless or accidental. In fact, the more we find out about how space works socially and economically, the more these multiple interface patterns seem implicated in all the good things and the loss of multiple interfaces in all the bad.

One of the most critical of these interfaces – because it may be implicated in socialisation – is that between adults and children. Figure 5.2c is the interface between moving adults and 'static' children (i.e. those who are more or less staying in the same space) in the urban areas and figure 5.2d the same for the housing estate. The scatter for the urban area is far from perfect, but it shows unambiguously that moving adults and children are present in spaces in a fairly constant ratio, with adults outnumbering children by at least five to one, and more commonly ten to one. Wherever there is a child or a group of children, there are also likely to be significantly more adults in the space. This is not deterministic, but it is a powerful enough probabilistic regularity in the system to be a fairly reliable experiential property.

Within the estate, the scatters show a dramatically different picture. The L-shaped scatter shows that adults and children are completely out of synchronisation

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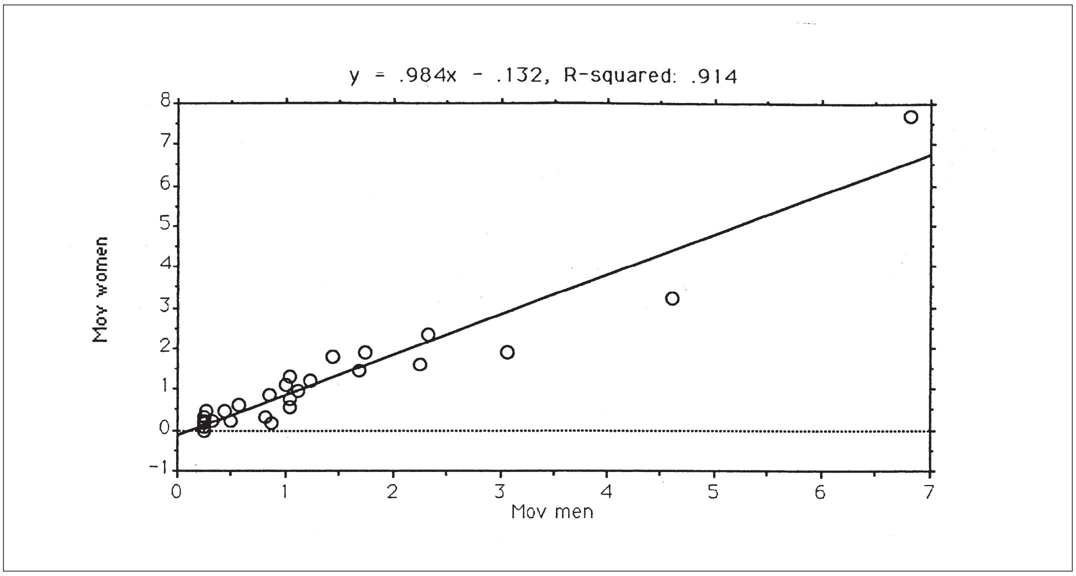

Figure 5.2a
Street pattern

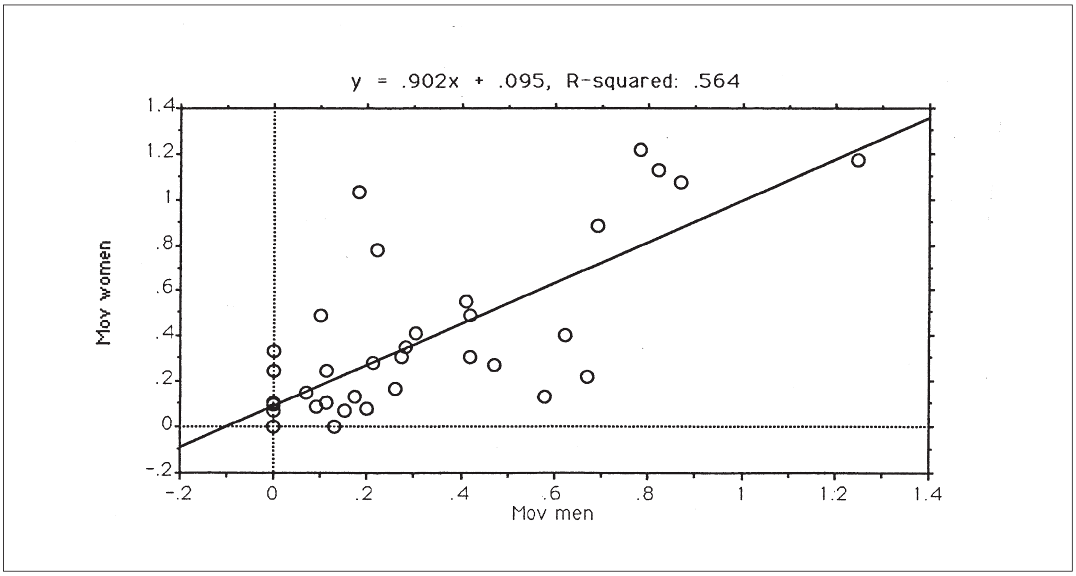

Figure 5.2b
Street pattern

with each other. This is not a random relation, but a highly structured non-relation. Spaces prioritised by adults are in general not well used by children and spaces prioritised by children are usually poorly used by adults for movement. This means that the probabilistic interface between the two categories is very poor indeed. This is why we call this the L-shaped problem. L-shaped distributions mean ruptured interfaces between different kinds of people. The more the scatter moves from a linear scatter to an L-shape, the less there is a natural probabilistic interface between those categories of people through the effects of the space pattern on everyday movement.

This effect may also be shown graphically in the plan. Figures 5.3a and 5.3b plot the presence of adults and children respectively in the plan of the housing estate by recording one dot per individual present during an average ten-minute time period during the working day – hence the name 'ten minute' maps. For adults the pattern is clear. Movement densities fall off rapidly with linear depth into the

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Figure 5.2c
Street pattern

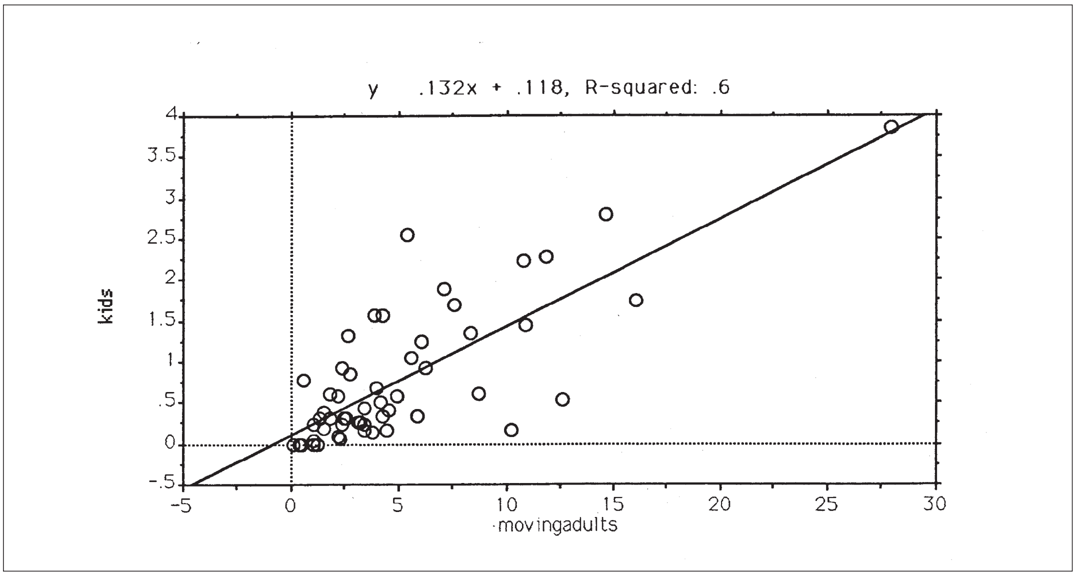
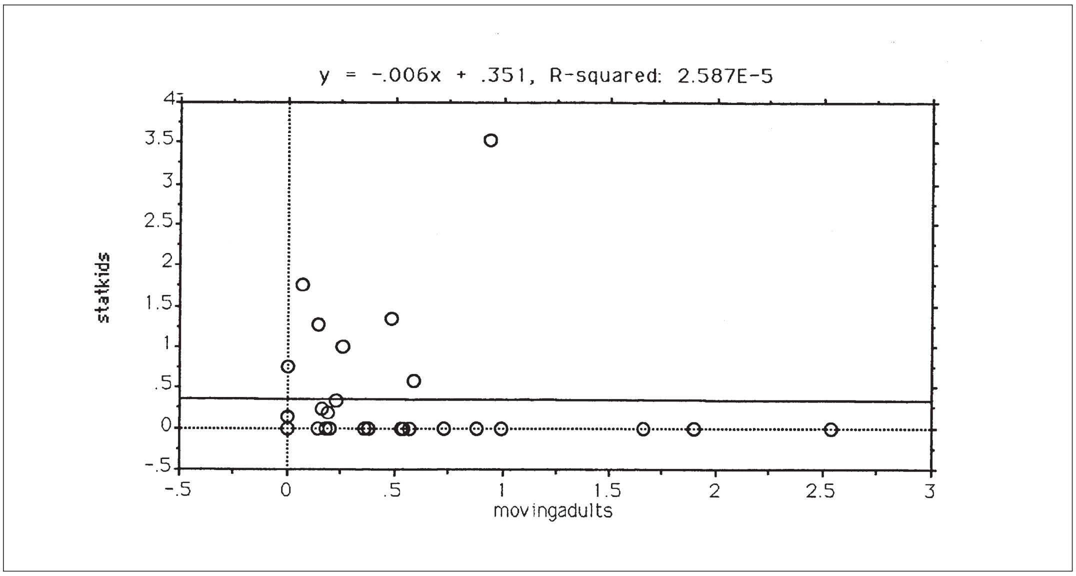


Figure 5.2d
Street pattern



estate, so that in the deepest lines towards the centre of the estate, there is very little movement indeed. In particular, the north-south lines where most dwelling entrances are located have very low rates of movement. The children's ten minute map is quite different. The main concentrations of children are in exactly the north to south lines that are so poorly used for adult movement. In fact, the younger children use the constituted (with dwelling entrances) north-south spaces off the main east-west axis, while teenagers, especially boys, use the more integrated, largely unconstituted spaces on the upper levels just off the integration core. In general, we see that children tend to occupy spaces with low adult movement one step away from the natural movement spaces (such as they are).

The pattern becomes clear if we plot the presence of children against linear depth from the outside of the estate, as in figure 5.1d. The peak is not near the edge as with adults but a good deal deeper. This can be checked numerically by first

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Figure 5.3a
A 'ten minute' map plotting numbers of adults on a route with each dot representing one adult per ten minute period.

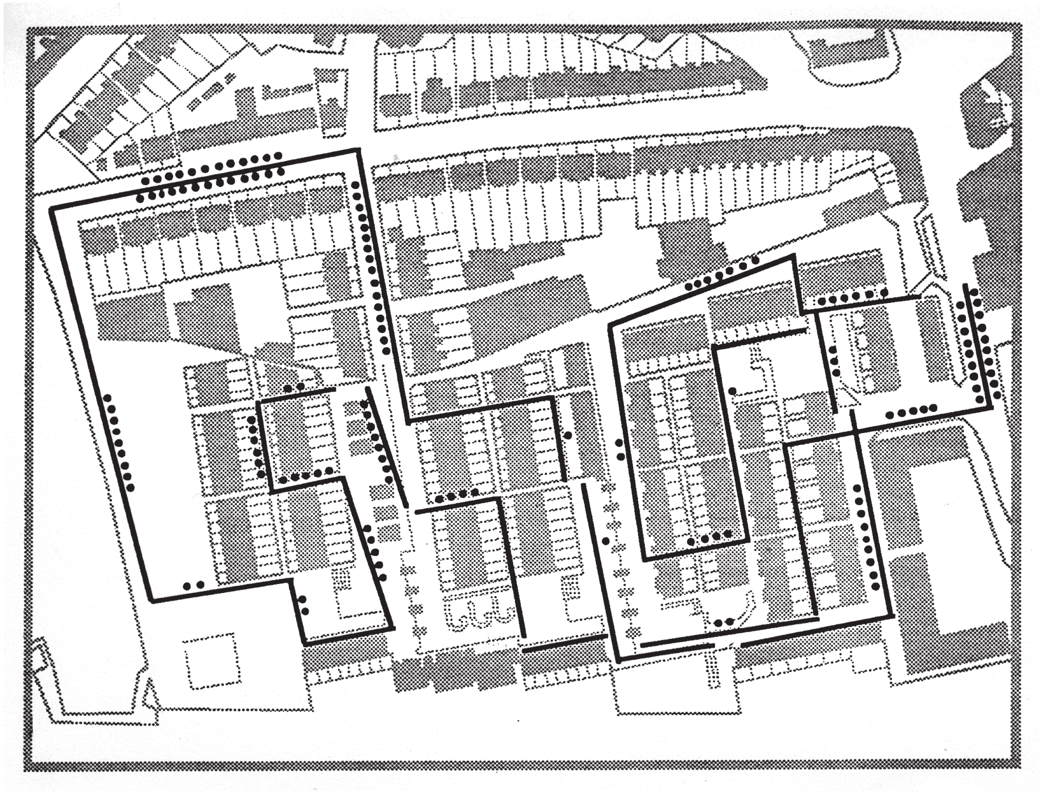
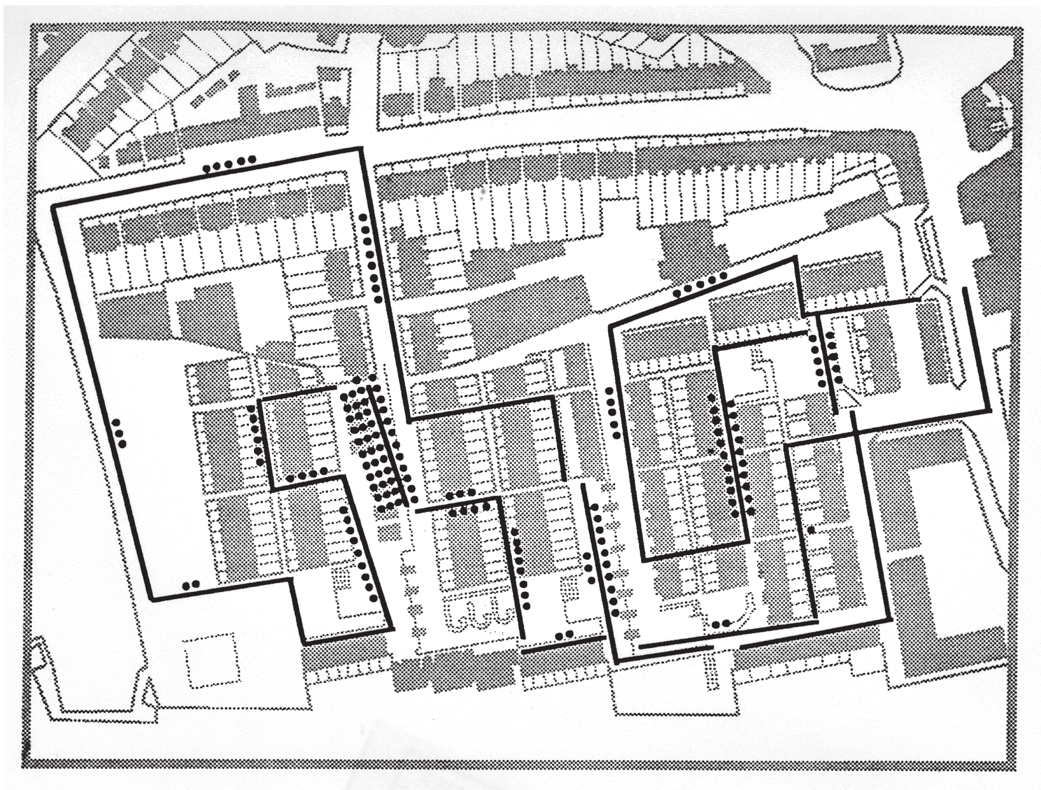


Figure 5.3b
A 'ten minute' map plotting numbers of children on a route with each dot representing one child per ten minute period.



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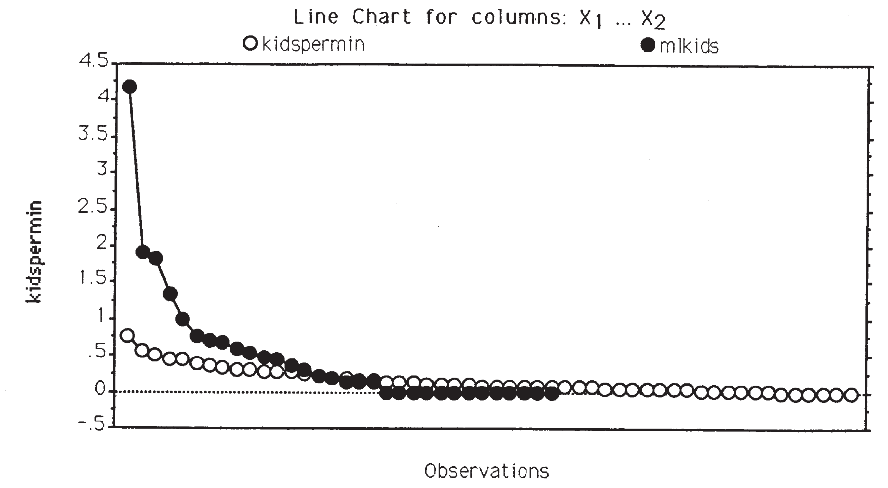
calculating the mean axial depth of adults from outside the estate, which is .563, and then children which is .953. We can then recalculate subtracting one axial step per observed child. This yields .459, which is more or less the same as for adults. In other words children are on average one step deeper than adults. Because the effect of spatial complexity on such estates is such that every axial step into the estate means greater segregation from the surrounding area as a whole this

Figure 5.4



means that children are, on average, a little less integrated than adults, but about as integrated as they could be without occupying the natural movement spaces most used by adults. They are in effect as integrated as they can be without being where adults are. This is what we sense moving about the estate. We are very aware of children, but we are not among them. Again, by checking the same distributions across housing estates, we find that this is a fairly general pattern. Children do not seek out segregated spaces. They seek out the most integrated spaces that are not used by adults for natural movement. The loss of interface between adults and children in effect depends on the availability of such spaces. In urban street systems, such spaces do not exist because all spaces are used to a greater or lesser extent for adult movement.

This is not the end of the matter. If we look at the actual counts of children in the various spaces of the urban street area and the estate then we find a very high degree of diffusion among the children in the urban area. This can be seen in figure 5.4 which plots the numbers of children found in each space from the most to the least with circles representing the pattern in the urban area, and dots for the housing estate. In the urban area, there are no significant concentrations, and very few spaces are without children altogether. Numerically, there are no spaces without adults and only 11 per cent of spaces without children. In the housing estate, in contrast, children are much more concentrated. 41 per cent of the spaces have no children and the much higher overall average number of children are concentrated in a very much smaller proportion of the spaces, with some very large peaks, so much so that some spaces are dominated by children or teenagers. As we have seen, these spaces are lacunas in the movement system for smaller children and lacunas in the movement and related-to-entrances system for older kids. In other words, we can see clearly that children on the estate spend more time away from adults and in larger groups in spaces which they control by occupying them unchallenged. We might describe such a process as emergent, or probabilistic, territorialisation, and note that it is a system effect; the outcome of a pattern of space use, rather than the product of a hypothetical inner drive in individuals. At present, we can only speculate on the effects of these spatial regularities on the long-term socialisation of children into the adult world. At this stage, we can only note that children spend longer times in larger groups, well away from natural surveillance by adults. Not surprisingly perhaps these patterns have also been correlated with patterns of petty crime and vandalism.[5]

More worryingly, observations of other 'interfaces', admittedly less rigorous than the one reported above, have suggested that other, more obviously anti-social uses of space also follow similar patterns, in that these uses tend to concentrate not on the most integrated lines of natural movement, nor on the most segregated lines, but on the most integrated lines available that are not dominated by natural movement. Anti-social uses of space seem to seek out the most integrated spaces available after those taken up by natural movement.

Other estates

What is clear is the generality of the loss of interfaces and the relation of this to the degree of integration of an estate. These findings are due to the work of a doctoral student in the Bartlett, Xu Jianming. He studied ten housing estates, including the one above, selected to cover a range of morphological types and historical periods since the second world war. He divides his types in to three main historical phases. His early period covers the typical mixed high- and low-rise estates of the early modern post-war period, his second the 'streets in the air' phase, when designers, following the criticism of early modern solutions by Team 10 and others, sought to recreate above the ground the space and space use types characteristic of traditional streets, and his third the neo-vernacular phase, when designers retreated from above-ground solutions and tried to recreate traditional space at ground level, though usually with over-complex, labyrinthian designs imitating imaginary small town and village space types.

The full range of this still incomplete study will not be reviewed here. However, as part of his research Xu observed space use and movement patterns, and plotted scattergrams of interfaces between all major constituencies of space users. The results are quite remarkable, from two points of view. First, the L-shaped scatter for the moving adults to static children relation is highly general, though occurring to a different degree, as shown in the series of scatters for the ground level of estates in figure 5.5. Second, the degree to which the L-shaped scatter is present, as indicated

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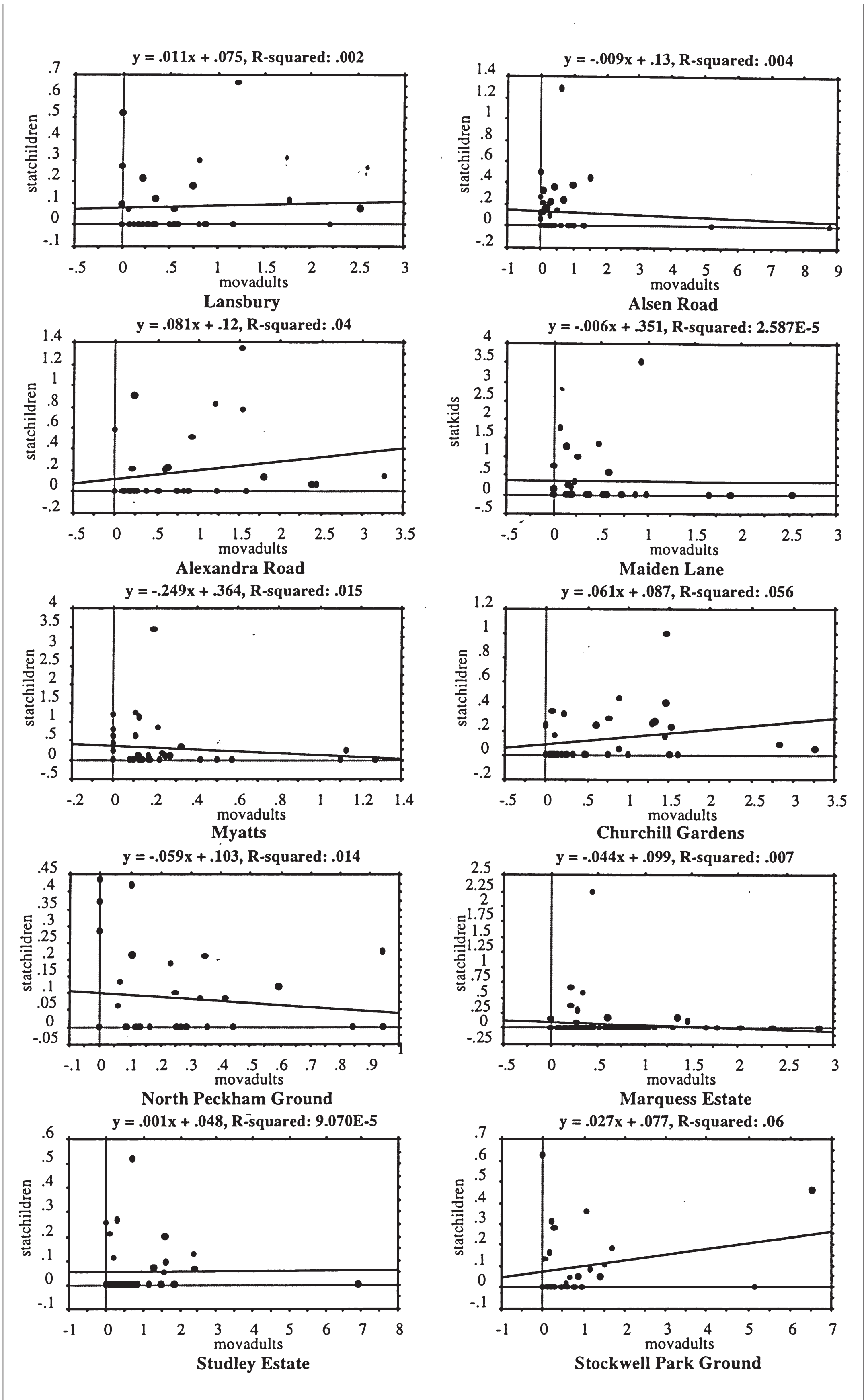
Figure 5.5



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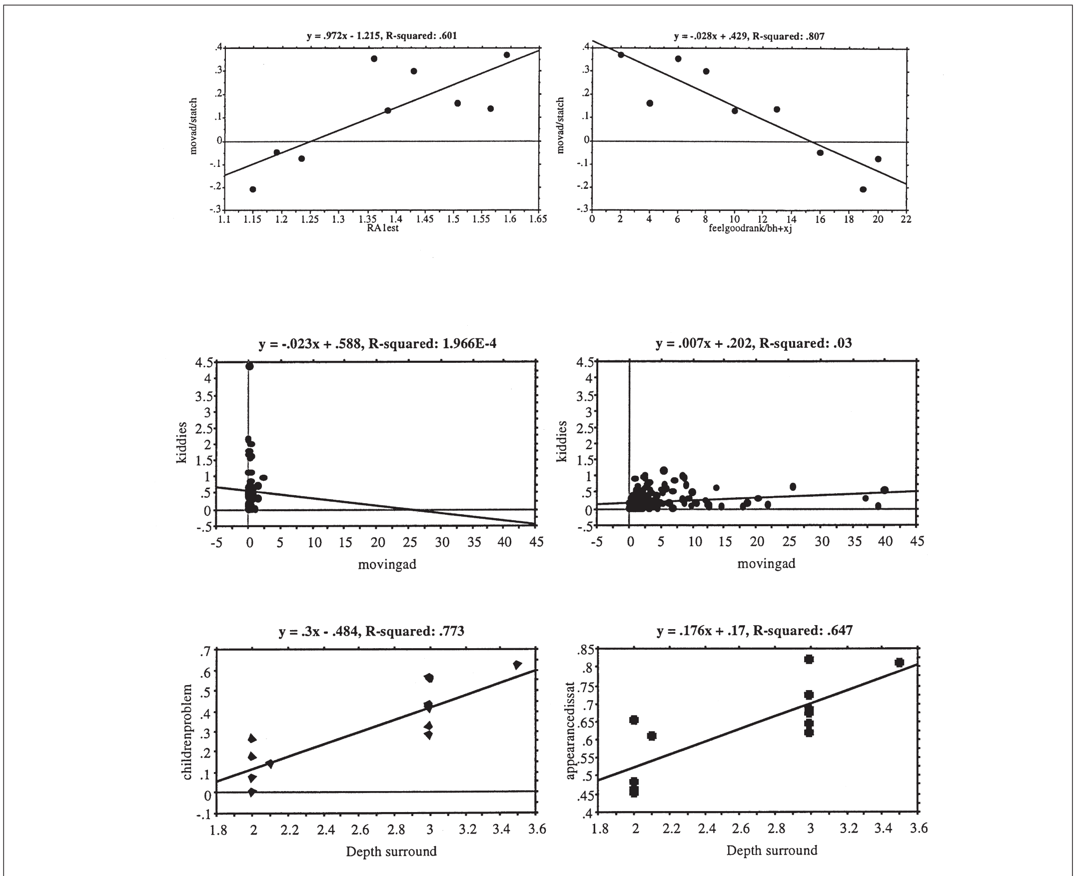
by a poorer correlation coefficient (the effect can also be checked visually), is strongly correlated with the degree of internal integration of the estate, that is, not with its degree of integration into the surrounding area, but with the degree of integration of the internal structure, as shown in figure 5.6a. The L-shaped factor was also correlated against the average 'feelgood' rank of the estates, an admittedly dubious measure obtained by asking researchers familiar with all the estates to rank them in 'feelgood' order. The correlation is strong, as in figure 5.6b, and does correlate well with common reaction to the estates noted by observers.

Even more remarkably, in another study of the King's Cross area[6] in which seven housing areas and three housing estates were studied, again (including the present estate), adult movement against static children was plotted separately for all street areas and estates. The results are shown in the scattergrams in figures 5.6c and 5.d. Nothing could more graphically express how dramatically the interface between adults and children changes from ordinary streets to housing estates. Without exception, the spaces in the estates have concentrations of children where there are few adults, while in streets this is never the case.

Citizens and space explorers

How can we generalise these results? The evidence suggests that the users of space naturally tend to divide themselves into two kinds: ordinary citizens, who use space as an everyday instrument to go about their business; and space explorers, like children,

Figure 5.6



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who are not so intent on everyday goals, and whose spatial purposes are essentially about discovering the potential of space – just as children's games like hide and seek explore potentials of space.[7] Now in ordinary urban space children are constrained by the spatial pattern to use space in ways which is not too dissimilar to that of adults. There simply is no other space available, except space specially provided like parks and playgrounds, and so children in the streets tend to remain within the scope of the multiple interfaces. When presented with exploration opportunities, however, children quickly find the lacunas in the natural movement system, creating probabilistic group territories which then attract others, and this usually occurs in the most integrating lacunas in the natural movement system.

Children are not the only space explorers. Junkies and methsheads are also space explorers, as in their way are muggers and burglars. Junkies and methsheads, however, like children, are social space explorers, and use space to create and form localised social solidarities. I suggest that all social space explorers tend to follow the same principle of occupying the most integrating lacunas available in the natural movement system. On an admittedly all too cursory examination of evidence it may even be conjectured that it is where the design of space is such that the lacunas in the natural movement system occur in the local integration core itself that an explosive potential is created. In spite of their huge differences in spatial geometry and density, from a syntactic point of view both the Broadwater Farm estate in north London and the Blackbird Leys estate in ex-urban Oxford, both loci of notorious, and notoriously sudden riots, share this structural feature in common.

It seems a characteristic of such space structures that when natural movement retreats from the integration core, as it does in both after the closing of shops, then the integration core becomes dominated not by multiple interfaces, but by its opposite: the domination of space use by a single category of user, in these cases teenage boys and youths. It is in such cases that confrontations seem to develop which easily turn into worse disorder. This is not to say of course that spatial design causes the eventual explosion into riot. It does not. But it does seem likely that badly designed space can create a pathology in the ways in which space is used, which a random spark may then ignite. Space does not direct events, but it does shape possibility. We should perhaps be no more surprised at the form anti-social events take in Blackbird Leys or Broadwater Farm than we should be surprised if people windsurf on open water or skateboard under the South Bank walkways.

The more common outcome of such unwelcome effects of spatial design is however chronic rather than acute. The pattern of space use in itself creates unease, untidiness and in due course fear, but not riot. We do not then need to invoke the deficiencies of state education, or the welfare state, or the decline in family life to understand these phenomena. They can be produced among ordinary families provided they live in extraordinary spatial conditions. They are systematic products of the pattern of space use arising in specific spatial conditions.

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Distinguishing social from architectural effects

Before drawing too many premature conclusions, let us look again at the original housing estate from the point of view of distinguishing the effects of architecture from those of social processes. We may do this because it is one of the few cases where we have not only spatial and space use data, as we have seen, but also extensive social data gained from a study[8] carried out by others and aimed at diagnosing the cause of the estate's apparent precipitate decline from wonder estate to 'problem estate' in a little over four years.

The estate is a visually striking, all white and low rise, the last throw, it has been said, of the Camden school of modernism. It opened in 1983 to praise not only from critics but also from the new residents, 80 per cent of whom approved the hyper-modern white architecture, using words from 'palace, paradise, fantastic' to 'modern, clean, bright'. Less than five years later, the social survey commissioned under urgent pressure from local police reports, reported that '71 per cent (of residents) give descriptions of the estate in negative terms, often with a menacing element: prison, concentration camp, forbidden city, criminal dreamland, battery farm, mental institution in southern Spain...' How had such a change in reported attitudes come about?[9]

In fact, a closer examination of the evidence[10] showed that one thing that had happened was that those who had interpreted the evidence provided by the social survey had indulged in a certain amount of 'architectural licence'. Most of the negative comments about the estate turned out to be about 'rubbish and dirt' and other management failures, and only about 30 per cent had made negative comments on the architectural appearance of the estate, and of these only a small minority were as readily headlinable as the ones quoted. 69 per cent in fact approved the appearance of their dwelling, and opinion was about evenly divided on the appearance of the estate as a whole. It seems in fact a matter of some research interest that those who were commissioned to survey social breakdown on an estate reported exactly that, with all the trimmings, even where the data did not support it. It will be suggested shortly that this tendency to overstatement may itself be no small aspect of the processes by which estate stigmatisation and degeneration typically occurs.

A careful reanalysis of the survey data, coupled with the results of the spatial analytic and space-use study, in fact showed a much more instructive story. Figure 5.7a is a matrix showing the correlation of various attitudes on the estate distributed according to small 'location groups' defined by the lines that make up the syntactic analysis. There are in fact two quite separate clusters of attitudes. Negative attitudes to the estate such as 'not liking the estate' formed a dominant cluster, which we might call the 'affect' cluster. But these do not correlate with other attitudes where we might expect a correlation, such as feeling unsafe, or fear of crime. These form a quite separate cluster. Factors like finding the estate friendly were not correlated with either major cluster, but only with having children, nor was 'being on the transfer list', which correlates only with not having wanted to come to the estate in the first place.

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Figure 5.7a

Correlation Matrix for Variables: X1 ... X8

	6 adequa...	pepl/bed...	10 est li...	14 home...	16a dwe...	feelunsafe	lotanxbu...	lotanxatt
6 adequate bedrm	1							
pepl/bedrm	-.999	1						
10 est like sum	.837	-.836	1					
14 home satis	.981	-.981	.925	1				
16a dwell app sat	.983	-.977	.892	.983	1			
feel unsafe	-.083	.073	.453	.113	.001	1		
lot anx burglary	.102	-.065	.199	.098	.256	-.086	1	
lot anx attack	-.054	.091	.12	-.036	.111	.025	.983	1

Figure 5.7b

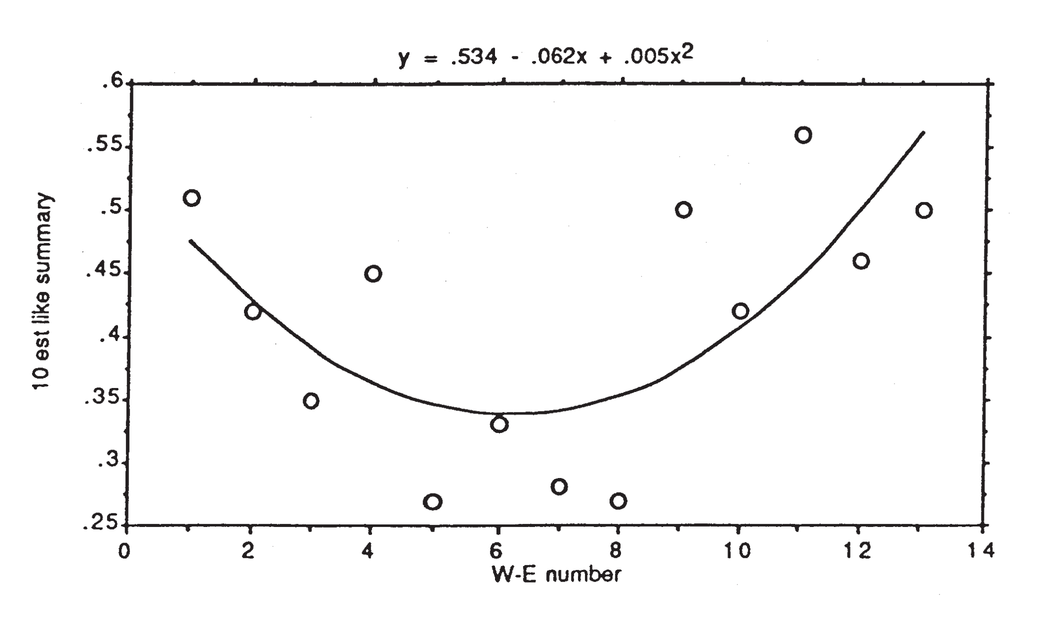
Correlation Matrix for Variables: X_1 ... X_6

	Depth su...	lotanxbu...	feelunsafe	21s dirty	children...	appeara...
Depth surrou...	1					
lotanxburg	.755	1				
feelunsafe	.572	.716	1			
21s dirty	.741	.823	.604	1		
childrenprob...	.879	.708	.649	.742	1	
appearancedi...	.804	.755	.669	.68	.932	1

The 'affect' variables were not on the whole well correlated with spatial variables such as integration or depth in the estate, but the 'fear and crime' cluster were so correlated, most strongly with depth from the outside which, because co-presence falls with depth, is the prime determinant of the structure of the virtual community. The 'fear and crime' cluster were also correlated strongly with 'finding children a problem', which was itself correlated with depth in the estate, as shown in figure 5.7b. In contrast to the 'fear and crime' cluster, the 'affect' cluster was spatially distributed, but not according to integration or depth in the estate. In fact it showed a most curious distribution. If this group of attitudes among location groups was plotted from west to east in the plan, that is, according to the order of building the blocks on

Can architecture cause social malaise?

Figure 5.8



the estate, then the result is always the inverted U-shape distribution shown in figure 5.8. Examination of the date shows that this closely follows the changing policies pursued by the local authority as building progressed on the estate.

This can be shown most clearly by considering the 'affect' cluster of attitudes alongside two other variables with which they also cluster, namely the subjective perception of overcrowding and the objective calculation of the number of people per bedroom in the dwelling making up each location group. In fact, these two latter variables correlate so exactly that we may treat them as one. As figure 5.7a shows, both subjective and objective overcrowding increase as each block is built successively, and both are correlated exactly with attitudes. The agreement between subjective and objective factors shows in fact that as building progressed, the same-sized dwellings were being allocated to larger families, clearly reflecting the pressures on the local authority to respond to housing needs first and foremost. After first phase was complete, the 'affect' cluster of attitudes begins to pick up, following the U-shaped curve shown in figure 5.8, and in fact following the elimination of further overcrowding on the estate by building flats and single person accommodation, rather than houses for families.

In short, the concentration of negative attitudes to the estate in the central areas of the estate is clearly related to increasing overcrowding (both real and perceived) as larger families who didn't ask to come to the estate were allocated to the same-sized houses. In fact, in this case we are able to distinguish the effects of the social process from the effects of spatial design. The social process – that is, the changing allocation policies which sent larger and more single-parent families to the same-sized houses as the estate progressed – governs the dominant negative attitude cluster, but not fear and crime, which are largely determined by the patterning of space, and its consequent effects on the pattern of co-presence and co-awareness.

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The contrast between the two dominant attitude clusters is then most striking. One group, which is less spatial in that there would be no obvious grounds for expecting these attitudes to correlate with space, but which do express the most general stated attitudes, are clearly the outcome of the social process. The other group, which we would expect to be correlated with space because fear and crime are spatially located events, are correlated with space, and in the way we would expect. Attitudes to children are also critical. That spatial factors are implicated in finding children a problem lends further support to the possibility that the spatial design of the estate and the objective facts of co-presence, that is, the dramatic reduction in natural co-presence and the elimination of social interfaces with depth in the estate, are related to this attitude cluster. Other studies suggest that in general this is the case. Environmental fear is in the main an effect of the de-structuring of the virtual community. Such fear is an inference about people drawn from the structure of space. Fear, it seems, can be designed into estates, but only through the effects of spatial configuration on the virtual community.

Are the symptoms then the causes?

We may then in this case be fairly clear about the respective roles of space and social process in estate degeneration. How can the two be fitted together? It may be quite simple. First, the effects of spatial design are both systematic and quick to operate. Because they are systematic products of design, we must accord them some independence and probably some logical priority in the process. We do not require a pathological community to create a pathological use of space. It arises from consistent and predictable patterns of behaviour in particular spatial circumstances. However, we must also remember that the pathology of space produced by design is complex and social in nature, rendering many patterns of spatial relationship abnormal. Put simply, we can say that spatial design, operating independently, can create symptoms – that is, the external manifestation of what appears to be a disorder.

What could be more natural than that people should infer the disease from the symptoms – infer, that is, a pathological community from the appearances of pathology in the use, and subsequent abuse, of space. Now the heart of my argument is that such inferences, though as natural as inferring internal disease from surface symptoms, are usually illegitimate. The symptoms we see are a pathological product of an innovative and poorly understood spatial design. Unfortunately, they can all too easily appear to be signs of an underlying disorder in the community itself. In most cases, these inferences are probably an insult to communities who are struggling against the odds. Even so, sometimes the inference will also be made by the community itself, as well as by outsiders. A process of social demonisation can begin, instigated by the spatial process.

The people most likely to infer a pathological community from pathological appearances are those with responsibility for controlling the estate: local authority estate managers, social workers, the police, and so on. If an estate begins to acquire a bad name with any or all of these, then it is very likely that this in itself

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will initiate, engage, accelerate or even precipitate the policies and signs of the unpopular, then sink, estate: allocation of problem families, increased, though probably sporadic, police attention, public expressions of concern, and so on. One must ask: when the managers in the local authority began to assign unwilling 'problem families' to the Maiden Lane estate in significant numbers, did they believe that they were assigning them to the pristine paradise of the first occupants of the estate, or to an estate that was already acquiring a dubious reputation? If the latter was the case to any significant extent, then it seems likely that the appearance of spatially determined symptoms might actually help to activate the very social processes of labelling and social stigmatisation which will in due course ensure that the pathology of the community on the estate does eventually come to pass. To assign the socially weak and disadvantaged to places where the visual signs of disorder are already present, is a further event confirming the inferences that people are already making from the visible signs of disorder.

The apparent decay of the estate, we might suggest, initiates a process of stigmatisation which is then multiplied by the actual assignment of problem families. Theoretically, this implies that in a non-trivial sense the symptoms cause the disease. The outward and visible signs of pathology are the preconditions and perhaps sometimes the initiators of the social process of degeneration. If this is right then we must conclude that architecture should be seen more as a set of preconditions in which social processes can trigger social pathology, than a fully fledged cause of social pathology in itself. But nevertheless the independent effects of architecture are powerful, predictable, logically prior – and remediable. Probably they don't work without the social process. But without architectural effects, perhaps, the social process will tend less to pathology. Spatial design, we may suggest, lowers the thresholds of social pathology.

We may reasonably infer from this that the ordering and use of space is the linking mechanism between buildings and social effects. The use of space is determined by the ordering of space to a far greater extent than has been realised, and space use is more complex than has been realised, embodying subtle social patterns which become a pervasive feature of the experience of others in everyday life. Through architectural design, the use of space can either develop in a well-ordered way, or in a pathological way. Where it is pathological then it tends to become implicated in, and even to spark off, the social process by which estates degenerate. As such, space is neither necessary or sufficient for social decline, but it is is nevertheless frequently a strong contributing or initiating mechanism.

Architectural determinism and the virtual community

If the sole effect of spatial design is to create some kind of – virtuous or pathological – virtual community, then it seems that this would be enough to account for all the apparent effects of architectural determinism. At the very least, we no longer have a problem with a credible mechanism by which architecture and society might in general be related. All the relations between space and society that we have noted

Plate 1

Plate 1

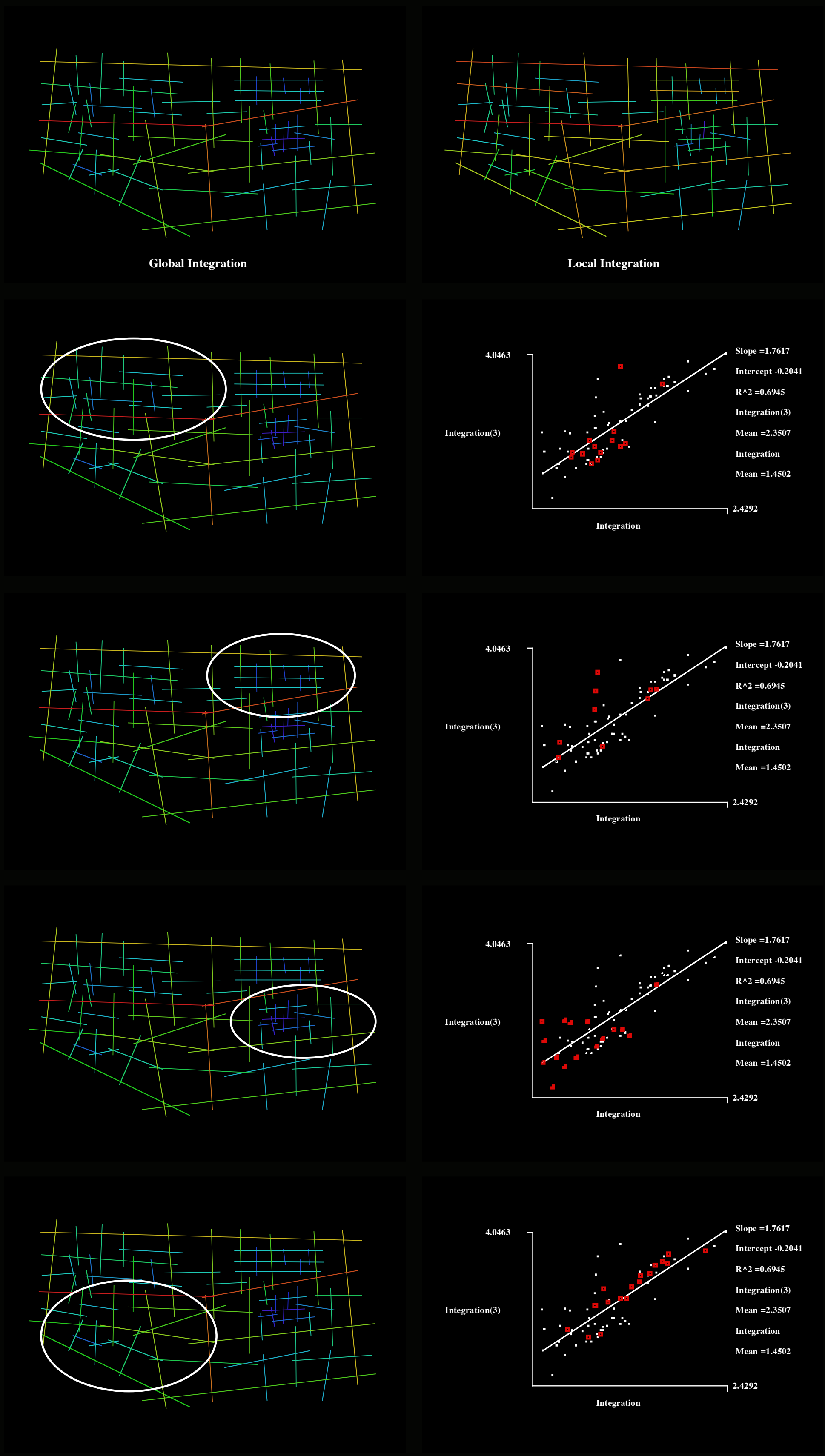


Plate 2

a
Distribution of global integration (Radius = n) in the City of London

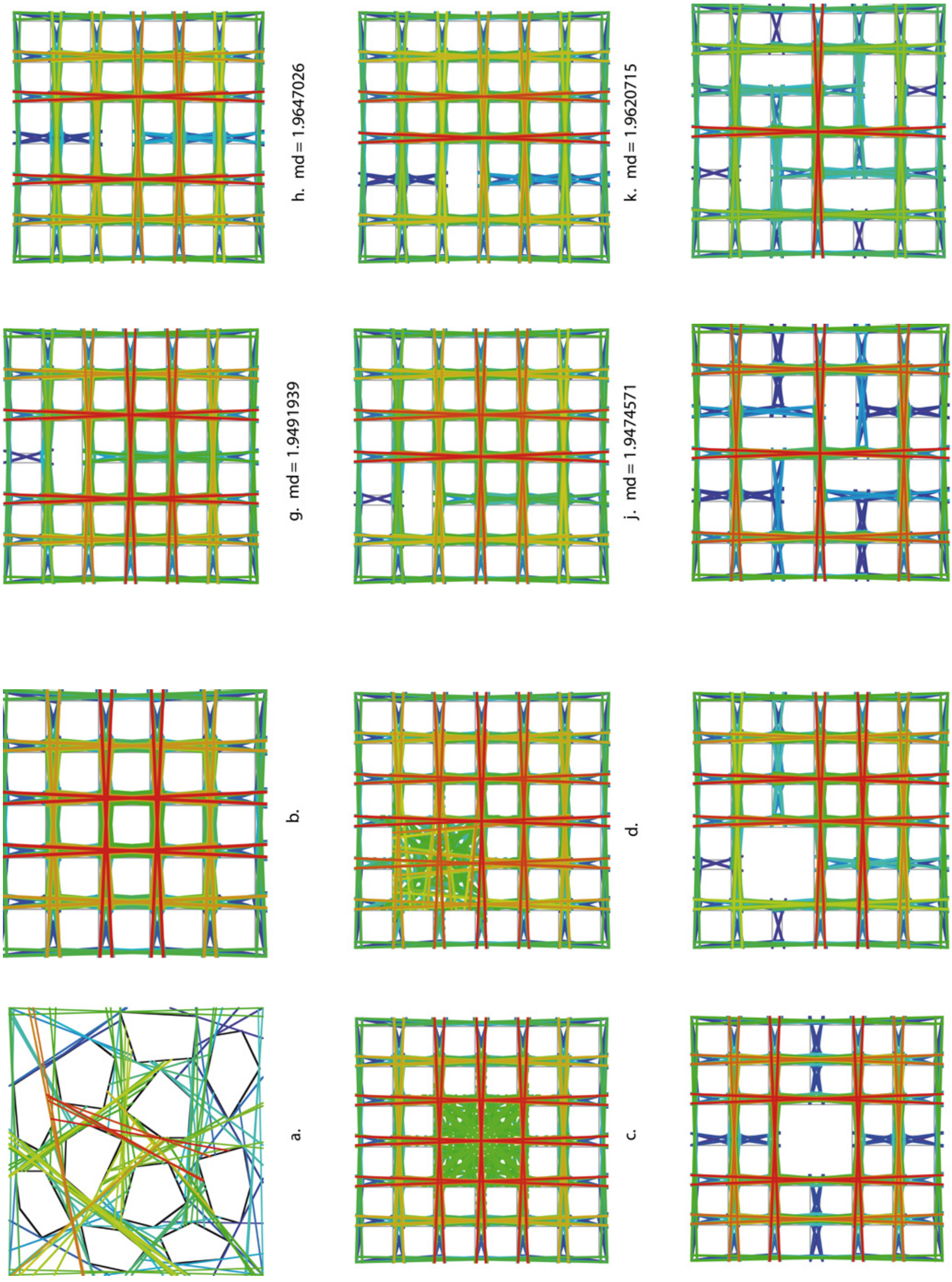
b
Distribution of local integration (Radius = 3) in the City of London

c
Global integration (Radius = n) of Greater London

d
Local integration (Radius = 3) of Greater London

e
Radius-Radius integration (Radius = 10) of Greater London

Plate 3



h. md = 1.9647026
k. md = 1.9620715
m. md = 2.0290259
g. md = 1.9491939
j. md = 1.9474571
l. md = 2.0638574
b.
d.
f.
a.
c.
e.

Plate 3 (continued)

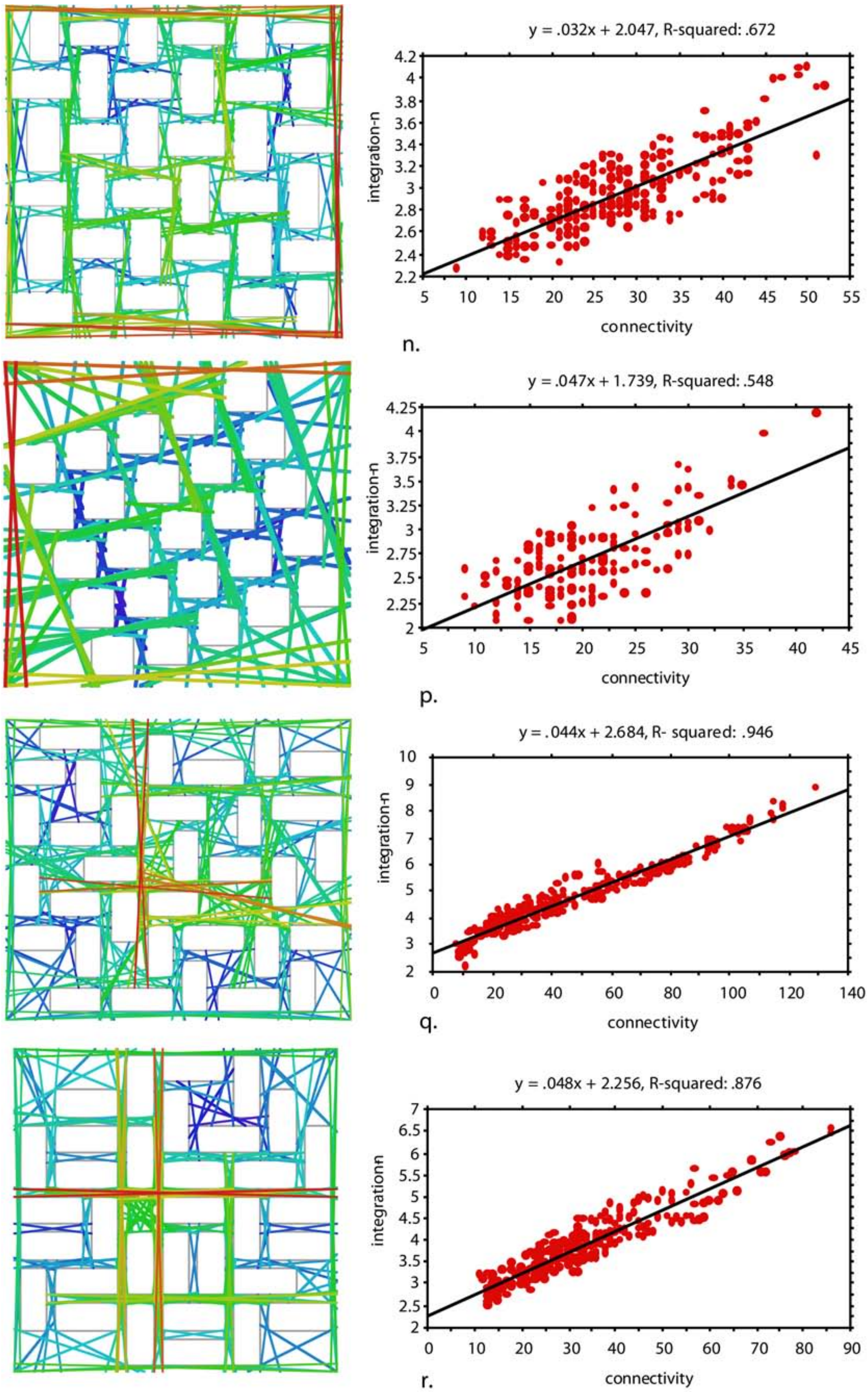
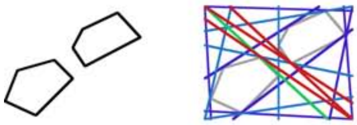
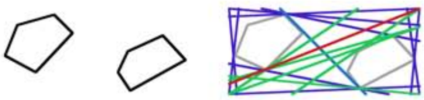


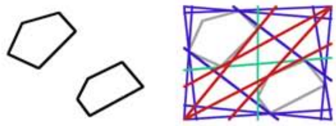
Plate 4



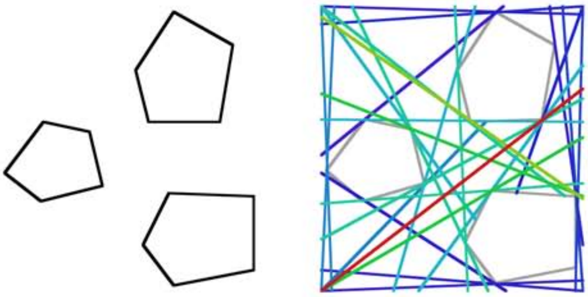
a.



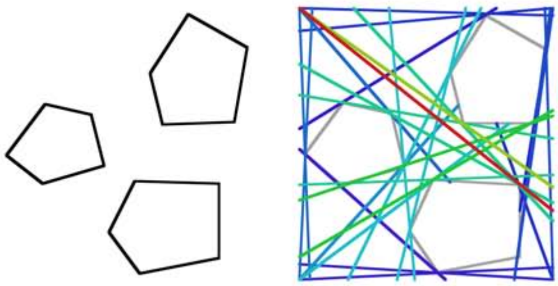
b.



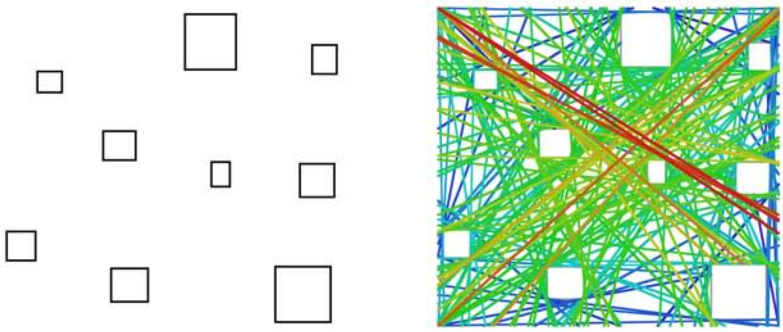
c.



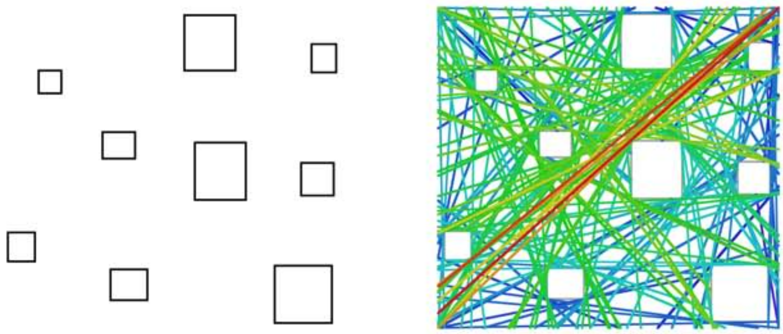
d.



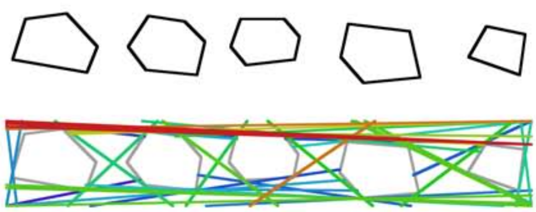
e.



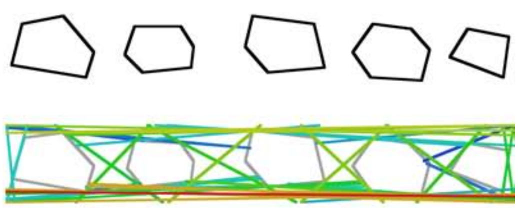
f.



g.



h.



i.

Plate 5

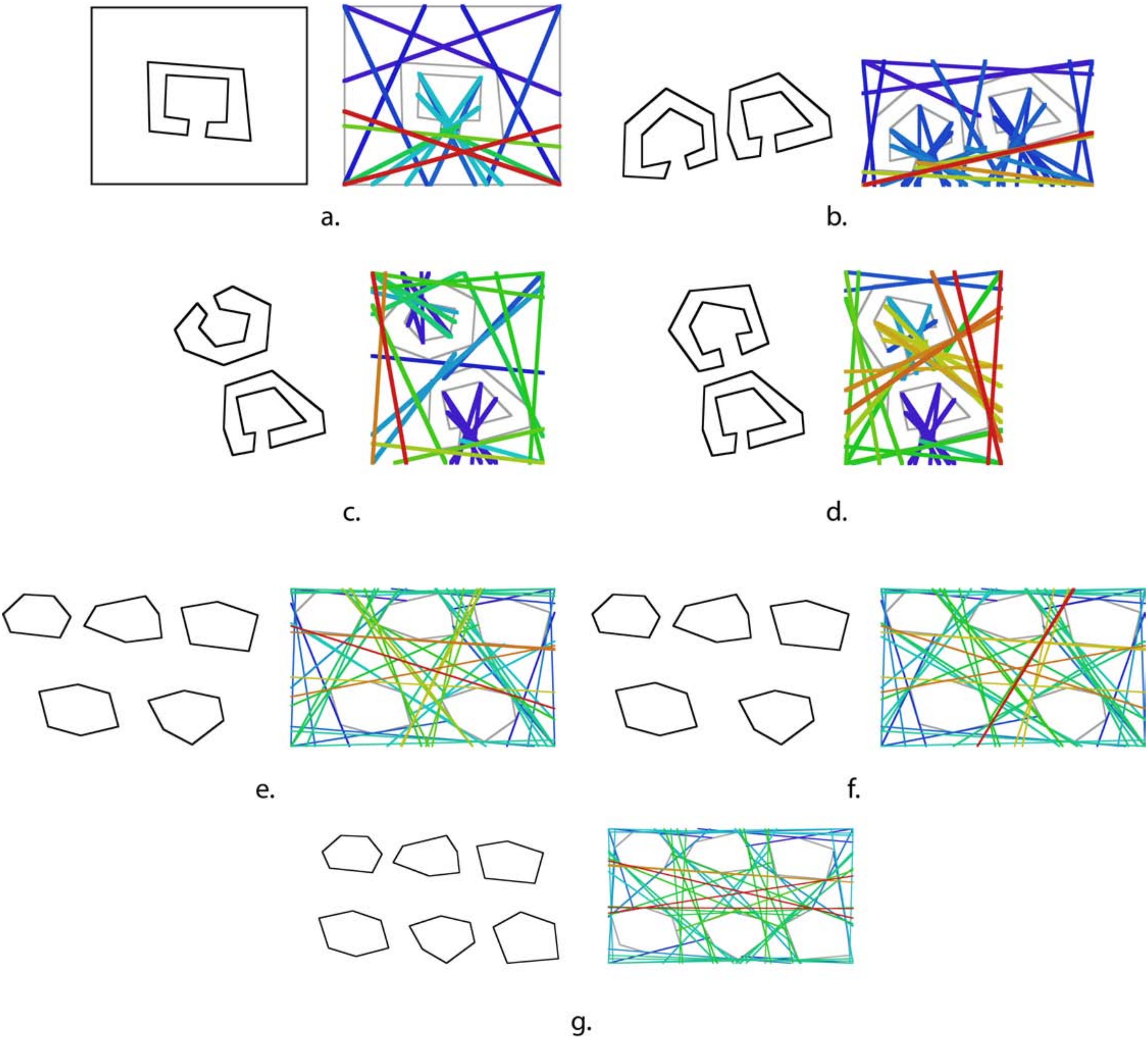
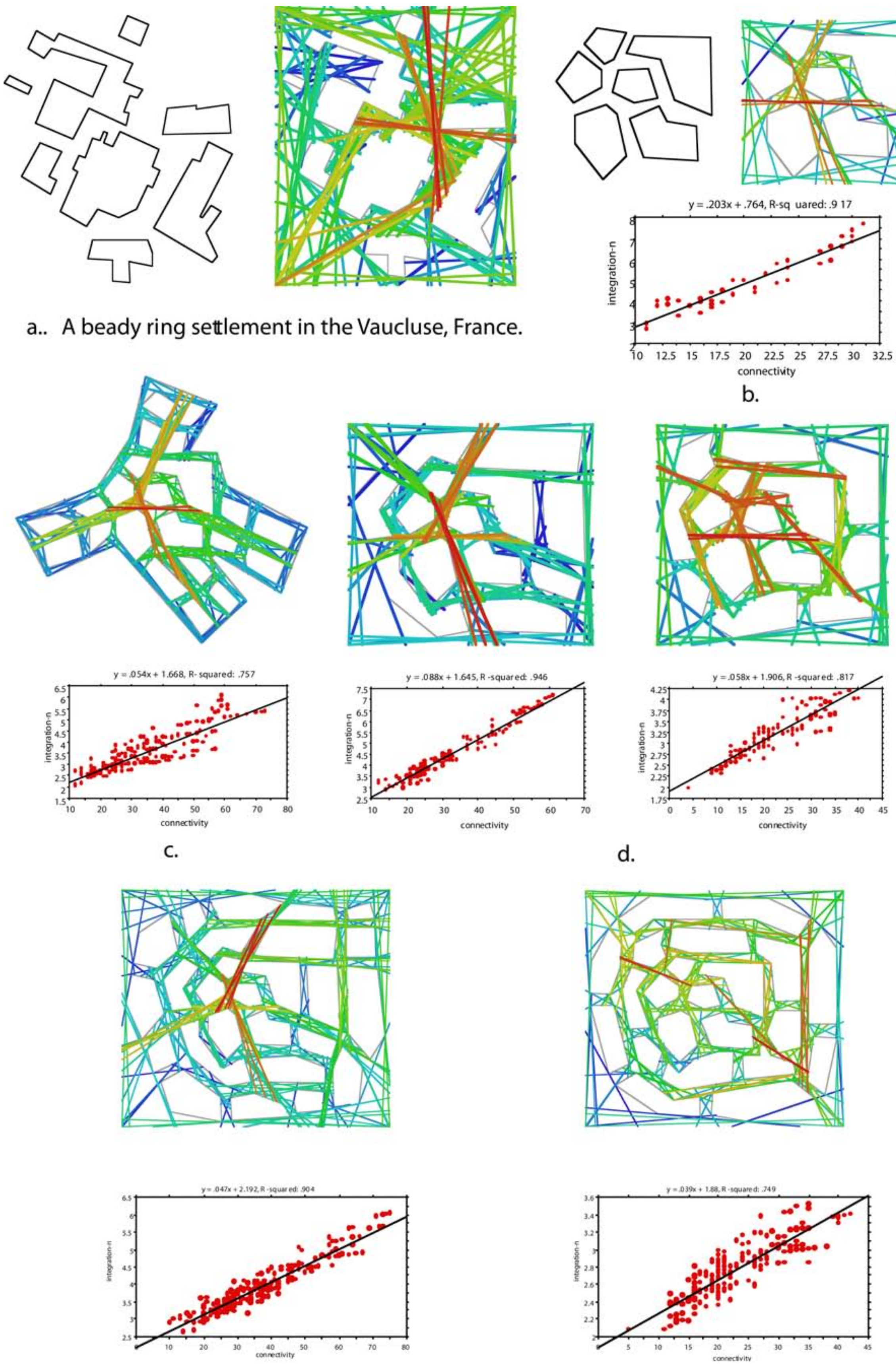


Plate 6



a.. A beady ring settlement in the Vaucluse, France.

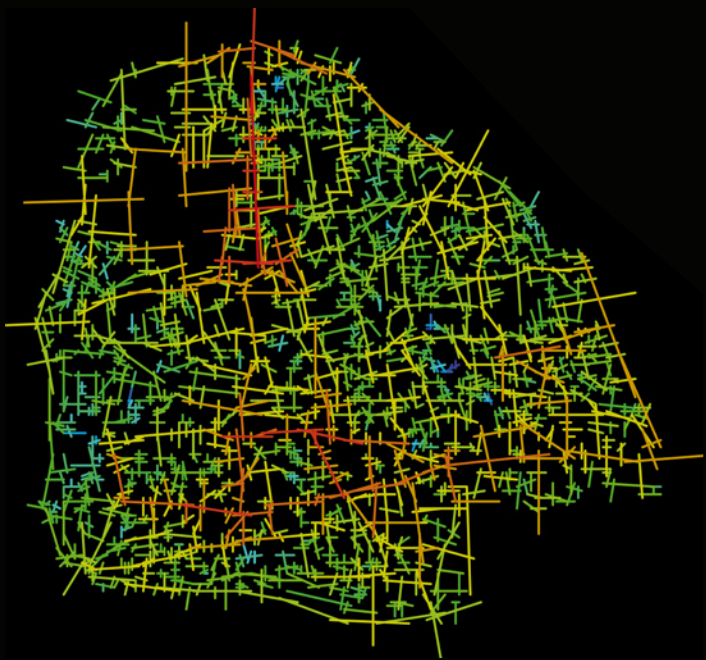
b.

c.

d.

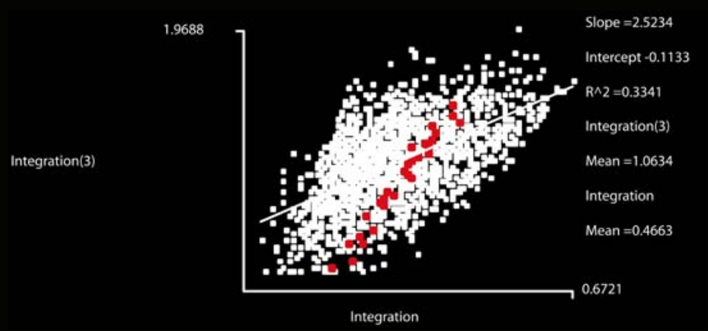
Plate 7

a
Radius-radius integration map (radius = 12) of Shiraz, Iran in 1920

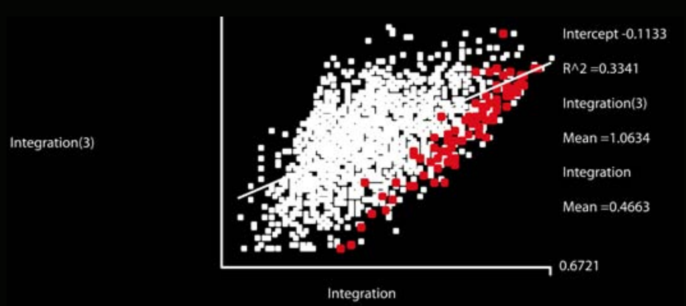


b
Shiraz, Iran (1920) integration, Radius = 6 with scatters of two local areas which are picked out in white.

b
Scatter of area one (in red dots)



b
Scatter of area one (in red dots)



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as regularities seem to pass through this basic fact. This does not mean that space is a determinant of society, though it could come to that. A virtual community is the product of space and is an as yet unrealised community, that is, it has not yet become the field of encounter and interaction which most social scientists would take as the most elementary of social phenomena. Because it is prior to interaction, the virtual community falls outside what social scientists have conceptualised as society.

However, there are now strong grounds for believing that the virtual community, and how it is structured, may be a far more significant social resource than has been realised until now. The first set of reasons stem from the effects of spatial design on the structure and density of the virtual community which seem to be involved in the pathology of spatial communities. These effects are powerful not because space is a strong determinant of society but because space and its effects on the virtual community are pervasive and insistent. In their very nature they are never absent. They come to be built into the very detailed patterns of everyday life so that although they are rarely obtrusive, they are never absent.

In the last analysis, then, all of the apparent effects of architecture on social outcomes seem to pass through the relation of spatial configuration and natural co-presence. This is perhaps because movement is not simply the unintended by-product of spatial organisation but its very reason for existence. By its power to generate movement, spatial design creates a fundamental pattern of co-presence and co-awareness, and therefore potential encounter amongst people that is the most rudimentary form of our awareness of others. As we have shown, virtual communities have a certain density and structure, and are made up of probabilistic interfaces between many different types of person: inhabitants and strangers, relative inhabitants and relative strangers, men and women, old and young, adults and children, and so on.

Spatial design can change the structure of these patterns of co-awareness, and lead to such pathological phenomena as the radical reduction in the density of the virtual community so that people live in space which makes them aware of almost no one (earlier we called this the ‘perpetual night’ syndrome, since in some housing estates awareness of others during the day was little better than normal residential areas during the night), and which changes the structure of patterns of co-presence and co-awareness, leading to fear, the domination of some spaces by single categories of user and the emptying out of other spaces. The long-term effects of these ‘social structures of space’ are perhaps the key to the spatial pathology of communities. We see now also that they were all changes in the structure of the virtual community.

Can architecture cause social malaise?

Notes

1 For a recent review see H. Freeman, *Mental Health and the Environment*, Churchill Livingstone, 1984.

2 The two best known studies, Oscar Newman's *Defensible Space*, Architectural Press, 1972 and Alice Coleman's *'Utopia on Trial'*, Shipman, 1984 have both been criticised on these grounds.

3 B. Hillier & J. Hanson, *The Social Logic of Space*, cup, 1984.

4 The movement pattern correlates strongly with integration, but only when the estate is embedded in the larger scale surrounding area and integration values within the estate are read from the whole system. With spatial designs of the type found on this estate, this has the effect that integration values fall off with depth into the estate, as shown by the layers in the dark point scatter. If analysed on its own as an isolated system, the correlation between integration and movement is poor. All these effects are common for housing estates.

5 Hillier et al., *The Pattern of Crime on a South London Estate*, Unit for Architectural Studies, ucl, 1990.

6 Reported in Hillier et al., 1993, referred in Chapter 4.

7 See *The Social Logic of Space* Chapter 1.

8 See Hunt Thompson Associates, Maiden Lane: *Feasibility Study for the London Borough of Camden*, 1988.

9 Hunt Thompson.

10 B. Hillier et al., *Maiden Lane: a second opinion,* Unit for Architectural Studies, 1990.

Chapter six

Time as an aspect of space

How can space be ideological?
Frederic Jameson

Strange towns

Let us first establish the phenomenon which we will address in this chapter: the phenomenon of 'strange towns' – towns that seem to contradict all the orthodoxies for the construction of urban forms set out in Chapter 4. Here, towns and cities were defined as variations on certain common themes. Buildings are arranged in outward facing blocks so that building entrances continuously open to the space of public access. The space of public access is arranged in a series of intersecting rings which are regularised by a greater or lesser degree of linearisation of space to form the – more or less deformed – grid of the town. Through this linearisation the larger-scale structure of the town is made intelligible both to the peripatetic individual moving about within the town and to the stranger arriving at its edges. The linear structure links the building entrances directly to a pattern of space which also links closely to the edges of the town. The effect of this control of the linear organisation of space is to create a structure in the 'axial map' of the town, that is, a distribution of local and global 'integration', which becomes the most powerful functional mechanism driving first the pattern of movement and, through this, the distribution of land uses, building densities and larger-scale spatial and physical elements such as open spaces and landmarks. The essence of urban form is that it is spatially structured and functionally driven. Between structure and function is the notion of intelligibility, defined as the degree to which what can be seen and experienced locally in the system allows the large-scale system to be learnt without conscious effort. Structure, intelligibility and function permit us to see the town as social process, and the fundamental element in all three is the linear spatial element, or axis.

Strange towns are towns – and proto-towns in the archaeological and anthropological record – which appear to flout all these principles. Historical examples from pre-Columbian America include Teotihuacan, figure 6.1a, and Tikal, figure 6.1b, and modern examples would include Brasilia figure 6.1c. How should we seek to understand these towns, morphologically, functionally and as expressions of social processes? First, we must address the question of how we should describe them at the same level as we have described more orthodox towns. Only when we understand exactly how they are different can we hope to find an answer to the question as to why are they different – in some ways almost the inverse, one suspects – of the towns we are familiar with.

The answer will, I suggest, tell us something quite fundamental about the potential of space to express human intentions and to relate to social forms. This in turn will suggest a more familiar distinction: between towns which act as centres for the processes by which society produces its existence by making, distributing and exchanging goods, and those which act as centres for governing institutions, regulating bureaucracies and dominant ceremonial forms, and through which society reproduces its essential structures. Just as the axial structure is the key to understanding the first, more common type of town, so in quite another sense, it is also key to understanding the second type – the strange town. Let us then begin with some thoughts about the axis.

Time as an aspect of space

Figure 6.1a

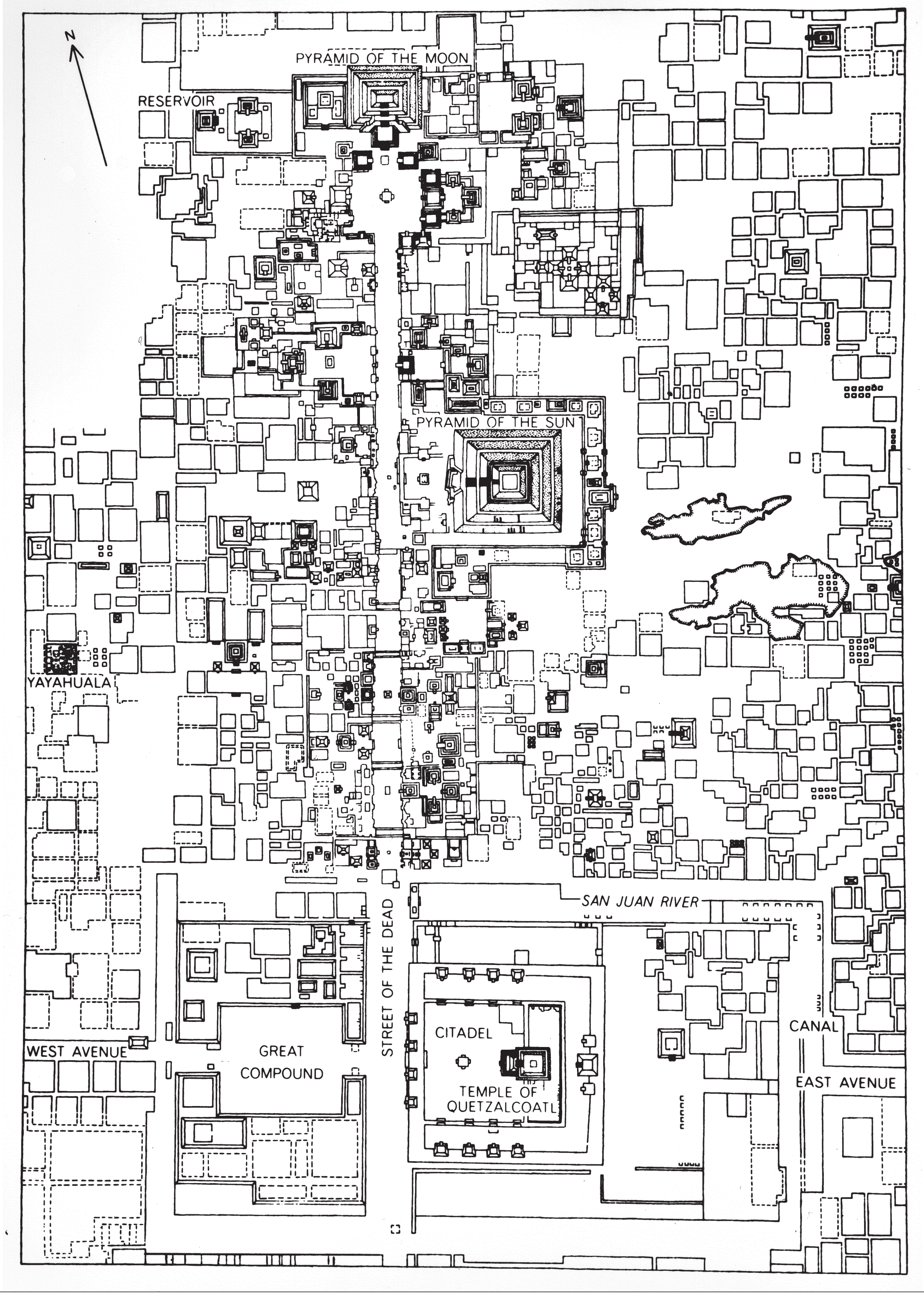


Figure 6.1b
Tikal

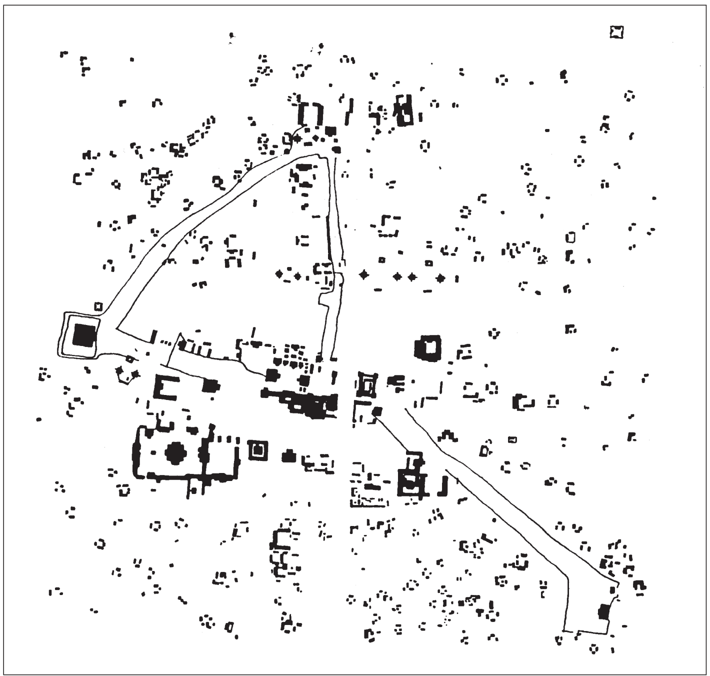
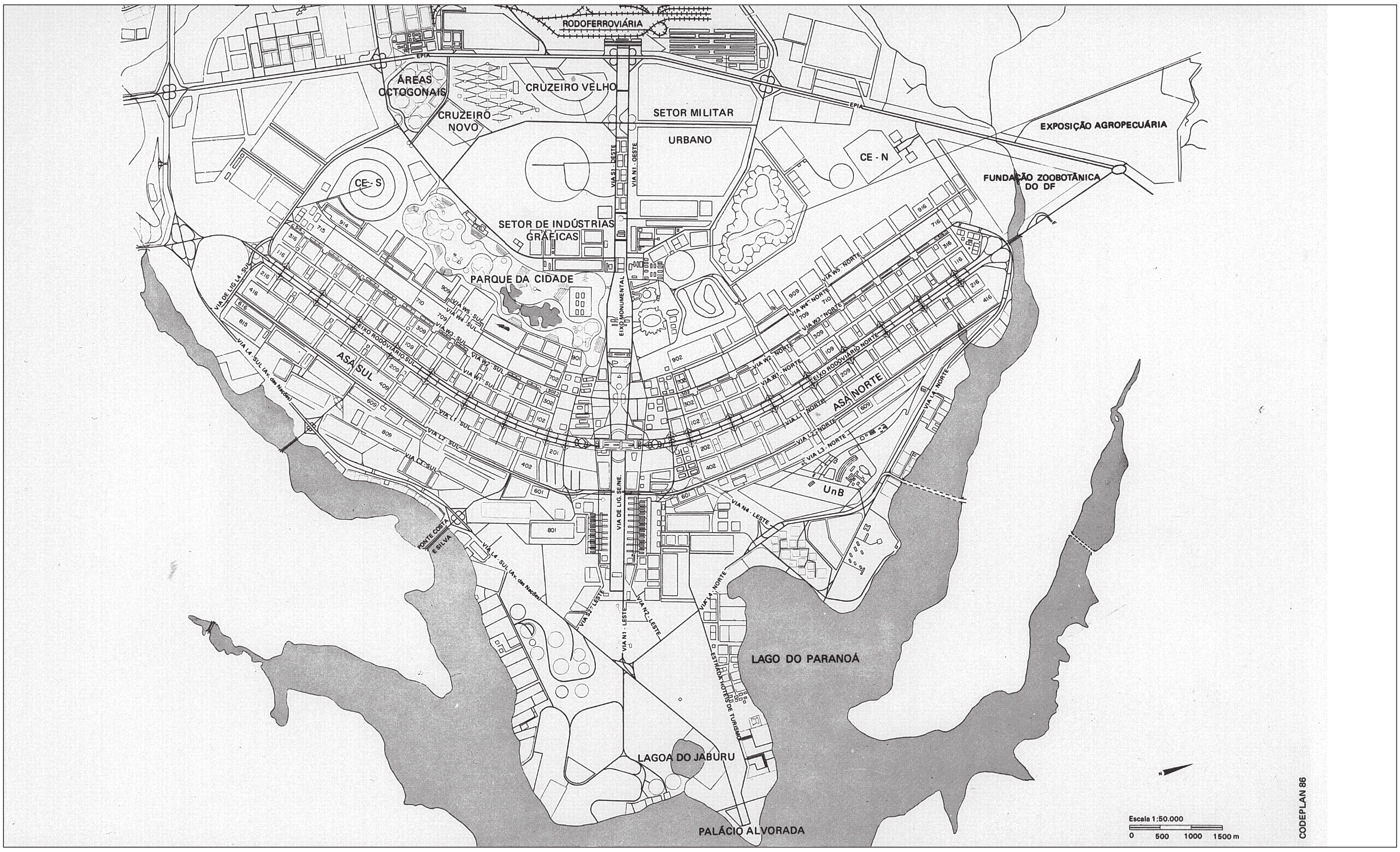


Figure 6.1c
Brasilia



The axis as symbol and as instrument

In common urban space, the most familiar property of the axis is that it usually passes through a series of convex spaces. This is the means by which towns create a more global awareness of the urban form in the peripatetic observer than is available from the convex organisation. We associate this property therefore with the practicalities of understanding towns well enough to move around them effectively. Paradoxically, an almost identical description can be given to the use of the axis in quite different circumstances: to express the relation between the sacred and the profane in religious buildings. For example, figure 6.2 shows three ancient Egyptian temples, from a collection illustrated in Banister Fletcher.[1] In each case, as in the others in the Banister Fletcher set, the religious epicentre of the buildings is in the deepest space, that is, at the limit of a sequence of boundaries. In each case also there is a single direct line of sight passing through each boundary and linking the innermost sacred space to the most public space of the entrance. In *The Social Logic of Space* it was noted that the same phenomenon common in European churches and cathedrals can also be detected in such an arcane type as the Ashanti 'abosomfie'.[2]

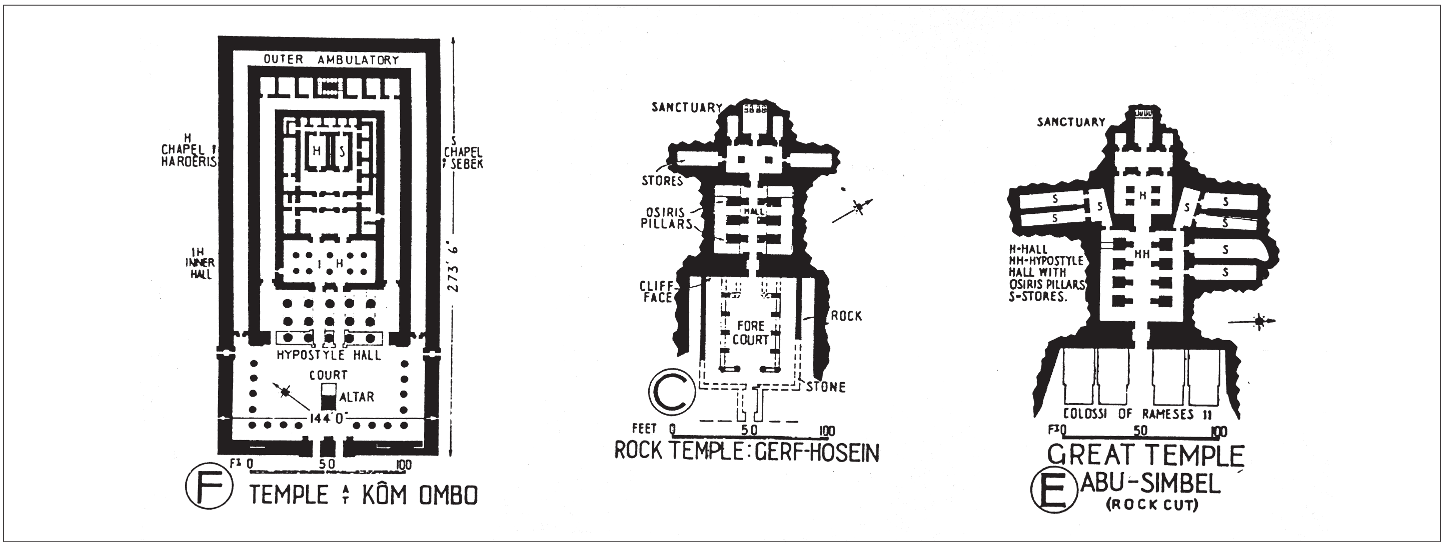


Figure 6.2

When such common themes are detected we might of course be attracted by a diffusionist explanation. In this case, it is barely conceivable that diffusion could make links across such vast tracts of space and time. The 'genotype' in question arises, surely, from the discovery of the same potentials in space to solve a certain kind of commonly occurring architectural problem: how to combine the need for the sacred to be separated from the everyday by spatial depth, as it always seems to be, with the need to make this depth visible and therefore intelligible to the people to whom the sacredness is addressed, that is, the 'congregation' of that particular sacredness. The fact that it is common practice for this distant visibility to be replaced by concealment at certain times of the ritual calendar supports this analysis.

Time as an aspect of space

What then do profane urban spaces, in which lines pass through a series of spaces to guide movement and to make them intelligible, have in common with sacred spaces where the same axial device is used to express the sacred? Are the spatial phenomena really the same and dependent entirely on the context for their interpretation? Or are they in some more subtle sense distinct spatial phenomena? In one sense, they are of course the same phenomenon. What we see in both cases is a certain potential in space, the potential to use lines of sight to overcome the physical separation of metric or topological distance. It is the same phenomenon in that one of the two most fundamental of all spatial devices is being used to overcome what we might call the metric limits of our presence in space. If our visual presence was limited to our metric presence, then there is no doubt towns and buildings would not be as they are. They are as they are because we can use the convex and axial superstructures to provide visual extensions to our metric presence, and through them make available locations to which we might wish to go. Convex and axial structures, built on the basis of the metric geometry of space, are the fundamental means through which we make the structure of space intelligible, and pretty well the only means. We can hardly be surprised when similar elementary strategies are deployed in different cultures.

However, although the two types of case – the urban and the sacred – are using the same potential in this respect, in most other respects they are quite different. One is enclosed, the other open. In one the line of sight strikes the building at an open angle, suggesting continuity, in the other at a right angle suggesting that the line stops at that point. In one the line makes us aware of a whole series of potentials, space as well as buildings; in the other it seems to point to one thing only. In one there is no relation between any order present in the façades of the building and the shape of the space defined by the façade; in the other there is often a clear relation between the bilateral symmetry of the line and the bilateral symmetry of the sacred object. These distinctions show that the same spatial device is only being used in a very limited sense. If we view the whole 'configuration' of the situation, then it is clear that certain common elements are being embedded in quite different configurations. The same syntactic elements, we might say, are being used in different contexts. We must then expect them to express different meanings.

Symbolic axiality in urbanism

Now consider the first of our strange towns, Teotihuacan. If one thinks about its plan in relation to the types of axial organisation found in ordinary towns, then it seems in most respects to be exactly the opposite. In spite of the fact that there is an underlying geometrical organisation in the plan – according to archaeologists, there is a 57-metre grid underlying the block structure – there is an almost complete absence of the types of improbably extended axiality that is the norm in most towns. In the evolution of the town plan, it is clear that, in most parts of the town, no attention at all is given to extending axiality much beyond the individual block-compound. The same is true of the convex organisation, and of the relation between the convex and axial organisation.

However, there is axiality in the plan of Teotihuacan: the single axis passing almost from one side of the town centre to the other, and directly linking the Great Compound-Citadel complex with the Pyramid of the Moon. Axiality, which is a generic and diffused property in most towns, is here concentrated into a single axis. At the same time, the space through which the axis passes is expanded laterally and more or less uniformly to create an elongated convex strip more or less as long as the axis.

But in spite of its dominance, the main axis has very little relation to the rest of the axial organisation of the plan. The line is more or less isolated. It gathers no significant laterals. It connects to no significant continuities. It is on its own, the only case of significant axis in the plan. Similarly, it has no relation to building entrances. The edifices with which it is lined are not buildings, but for the most part interiorless monuments. Not a single one of the large number of compounds opens onto the main axis. All entrances are, as it were, axially concealed in the labyrinthian complexity of the bulk of the plan.

If we were to compare this to the plan of Brasilia in figure 6.1c, we would find certain striking similarities. Brasilia has no formal or geometrical resemblance to Teotihuacan, yet in many respects the genotypical resemblance is considerable. It too has a single dominant axis, one which does not organise the plan by connecting to significant laterals (apart from the 'road axes') or continuities, one which has no everyday buildings opening onto it, and one which does not link edge to syntactic centre but is end-stopped near the edge of the town, having passing through almost its entire length. The rest of the plan is not as axially complex as Teoti-huacan but it is complex in a way quite unlike most traditional towns.
Now consider the third case, the proto-town of Tikal, figure 6.1b, a major centre of the ancient Maya. In this town we discern no global spatial organisation at all apart from the 'causeways' linking the various parts of the ceremonial complex together. There is of course a local logic governing the aggregation of built forms at the very localised level. But this serves to point out the complete lack of global concern in how these elements are arranged on the larger scale.

Some comparisons and consistencies

How can we give a theoretical explanation of these strange phenomena? First, we must note one obvious commonality. All three of our strange towns are centres which are in some way concerned with social reproduction. Teotihuacan is dominated by symbolic monuments and ceremonial buildings, while its domestic arrangements appear to be geared to a quite substantial priestly caste. Brasilia is a purpose-built centre of government, intended to express the structure and continuity of Brazil. Tikal is described by archaeologists as a 'ceremonial centre' – though one whose role in the functioning of its parent society remains largely mysterious.

Spatially, however, the three towns appear remarkably heterogeneous. They seem to have in common only that they lack the spatial properties common to most normal towns. However if we look a little more carefully we will find that there is a certain consistency and even a certain structure in these differences, one which when explicated will be seen to have as natural a relation to the spatial requirement of social reproduction as the spatial themes of normal towns do to the needs of production. Social reproduction, we might say, requires symbolic forms of space, social production instrumental forms of space. Both express themselves fundamentally through how the axis is handled. The axis can be symbol, or it can be instrument. The key to strange towns is the conversion of the axis from instrument to symbol.

How is this done? And are there invariants in the way in which symbolic axiality is used to express the various aspects of social reproduction? Let us explore this first by looking carefully at some more familiar, closer to home examples. Figure 6.3a is the ground plan of the City of London as it was around the year 1800.[3] The most obvious thing one would notice about it in comparison with some of the previous examples is its lack of any underlying geometry. If is irregular, then it is so in quite a different way to Teotihuacan. From the point of view of symbolic axiality, there seems to be little to speak of. The façade of St Paul's Cathedral, close to the western edge of the City, does have a tentative visual link in the direction of Fleet Street, away from the main body of the City, but it is half-hearted compared with what we have seen.

On reflection, we might take the view that it is the very lack of axial lines striking the façades of major buildings at anything like a right angle which is rather puzzling. St Paul's is a case in point. Apart from its vague axial gesture towards the west, the cathedral is axially disconnected from the surrounding city in all other directions – a property which many planners and urban designers have identified as a deficiency and sought to rectify by 'opening up views to St Paul's', as though the axial disconnection of the cathedral were an error of history. In fact, in the City shown by the 1800 map not only the façades but also the dome of St Paul's are more or less invisible at ground level from anywhere in the City. Such consistencies are unlikely to happen by chance. The axial and visual isolation of St Paul's seems, prima facie, to be a structural property of the City plan.

The group of major buildings in the centre of the City, the Royal Exchange, the Mansion House and the Bank of England, which are the only free-standing buildings in the City, are equally distinctive in their lack of right-angle relations to major axes. The most prominent of these, the Royal Exchange, in spite of its location at the geometric heart of the City where several strong lines intersect, does not stop any of these lines. On the contrary, the lines slip by leaving the building almost unnoticed. The Bank of England is even more axially obscured. Even the more prominent Mansion House is neatly avoided by the mesh of lines intersecting directly in front of its portico. More remarkably, in the modern plan after the Victorian modifications to the street structure of the city increased the number of lines meeting at this point from four to seven,[4] all seven major axes avoid end-stopping themselves on any of the major building façades (see figures 4.3 a and c). Again, this can hardly be accidental. On the contrary, to assemble so many axes and so many façades without anything remotely resembling a right-angle relation between façade and line is a significant feat of spatial engineering.

Equally puzzling is the consistency with which we find that minor public buildings, such as the many guild buildings, are unobtrusive in the axial structure of the plan. Take for example the Apothecaries Hall, marked in black in the south-east corner of figure 6.3a. Not only is it located in a spatially segregated part of the City, but, also its axial relation to the street is so unobtrusive as to lead the exploring visitor to be taken by surprise when he discovers the beautiful court that intervenes between the building and the outside world. Why is so much symbolic expense in architecture invested in spaces which are almost invisible from the public domain, especially as it is in these highly localised spaces that one does after all find the right-angle relation between façade and axis which seems to be a hallmark of symbolic axiality? It seems that symbolic axiality is only applied on the most localised level, remote from the main axes where public life takes place, and confined to out-of-the-way corners in the urban complex.

After prolonged inspection, an exception to this rule can be found, though it is far from obvious. The façade of the Guildhall (to be found just south-east of the right-angle of the indent on the north boundary) has, in spite of being buried deep in the backlands of an urban block well to the north of the City, a more or less right angle axial line linking its façade directly to the riverside area, perhaps even to the river itself, though it is hard to be sure if this was actually the case at the time. The reason why this is hard to decide lies in the extraordinary nature of the line. Several times on its route from the Guildhall building to the 'Vintner's Quay', which lies at the point where the line appears to strike the river, the line just manages to squeeze through, past buildings which would break the line if they protruded even a short distance further. Such a series of narrow escapes, again, can hardly be an accident. But why should such length in a line be achieved so unobtrusively, as though the line had to exist but not really be noticeable?

Once seen, the Guildhall line looks as though it might actually be the longest axial line in the City, until we notice that it intersects with Upper Thames Street just short of the river, which turns out to be substantially longer. Again our ideas about urban normality are thwarted, because this line combines considerable length with surprising narrowness. It is of course the line that in earlier times linked all the quays together. We might then expect that it would follow the line of the river. But it does not. The river curves, but the line does not. Here as elsewhere it does not appear possible to explain axial structure through either of the common explanations of symbolisation or topography.

What then are the axial properties of the City of London? Is, for example, the property of 'just-about' axiality that we noted for the Guildhall line (and which was discussed in Chapter 4) exceptional, or is it the general rule? We have only to look carefully at the main and secondary street structures to see that this property is present to a quite remarkable degree. Take, for example, the line that goes from Poultry (at the eastern end of Cheapside) to half way down Leadenhall Street in the east part of the plan, skimming the surfaces of buildings both to the south and to the north of the line as it goes. Or the line that links the lower end of Bishopsgate to its wider market area in the south. Or the line that links Smithfield to Ludgate Hill. Or the narrow alley line that links Birching Lane the the interior of the block bounded by Cornwall and Grace Church Street. 'Just about' axiality is, it seems, a consistent property of the spatial structure of the City at several scale levels. Nor does it quite end there. Where we do not find 'just-about' lines linking key places, then we often find that there are two 'just-about' lines making the link. This is particularly true in the smaller-scale back areas and the system of allegedly 'labyrinthian' back alleys, which for this reason are not in fact labyrinthian at all. This 'two-step' logic of 'just-about' axial lines imparts a natural intelligibility to these seemingly complex sub-areas.

The social reasoning behind this 'two-step, just-about' axial logic is not hard to conjecture. It has the simple effect that when you are going from one 'place' – be it a slightly larger space, or a major line, or a key building – to another, then there is always likely to be if not a point from which both origin and destination can be seen then at least a section of line from which both are visible. Since we can also see that each line passes through a series of convex spaces, and that each convex space, however small, will usually have building entrances opening onto it,[5] we can see that the axial organisation and convex organisation of space combine with the location of building entrances to create a consistent type of pattern yielding both intelligibility and order out of what might otherwise seem a formless aggregation of buildings.

Once we see this, then it is easy to see that the City has everywhere if not a two-step axial logic then at least a few-step axial logic. Axial organisation is consistently used to make larger-scale links from one place to another than the apparent irregularity of the plan would initially suggest. Axiality is used, we might say, coupled to the convex and building entrance properties we have noted, as the general means to provide larger-scale intelligibility and spatial orientation in a system that appears from other points of view to be rather freely growing. 'Just-about' axiality is the product of this minimalist approach to to the problem of global form in urban layouts. Even more strikingly, it is the means of linking the local 'place' to the global structure and through this of achieving that compression of scales – the sense of being in a locally identifiable 'place' and part of a much larger 'city' at one and the same time and by the same spatial means – which is the distinctive excellence of good urban design.

But this axial compression of scales goes beyond the creation of internal coherence in the space of the City. It is also the means by which interior and exterior, heart and periphery, are brought into a direct relation. Distance from edge to centre is, as it were, obliterated by the repetition of the 'few step' trick on the fatter spaces that define the the major routes into and through the City – Cheapside, Bishopsgate, Aldgate High Street, Grace Church Street, and so on. It is notable that these edge-to-centre fatter spaces do not, as we have already noted, contain the longest lines in the City. Intelligibility through axiality is not simply a matter of length. These fatter spaces by their very amplitude lend emphasis to the marginal axial displacement and the shading of building surfaces which is the architectural essence of the two step logic and the means by which the abstract principle of axial connection is converted into a style in the architecture of urbanity. These larger spaces stand for this style because it exemplifies it most clearly in the overall structure of the City.

As we saw in Chapter 4, it is also this profound architecture underlying the plan that creates the pattern of natural movement in the city. And of course this is the key to its logic. Space in the city is about movement. It does not seek to express the relations of major buildings to each other. It seeks to minimise the effect of buildings, even the largest and most public, on the pattern of movement on which the life of the city as a centre of business always crucially depended. In the city therefore space is fundamentally instrumental, and the axis its primary instrument. Its symbolic and ideological role is subordinated – though never eliminated – by the dominance of the practical. The axis is – can be – both symbol and instrument. Here, it is primarily instrument.

Does this mean then that axiality is doomed to the ambiguity that renders so much of architecture opaque to analysis. I do not believe so. The ambiguity is a structured ambiguity and the architectural conditions in which axiality takes on a predominantly symbolic or instrumental form are, I suggest, quite strictly defined. To understand this, we must look closely not only at the axiality of space itself, but at the buildings and their façades which are, in the last analysis, the only means by which these spatial differences are created.

Consider for example London's other city, the centre of government in Westminster, again as it was around 1800 before the Victorian 'modern-isation' of the plan (see figure 6.3b). At first sight, the plan appears rather less irregular than the City of London, largely due to a sense of greater rectilinearity underlying the block structure. This should not, however, lead us to misread its axial structure. If we look for long lines, then there turn out to be relatively few, and their extension seems much less pronounced than in the City of London. Looking more closely, we see that more links just fail to be axially direct, and in many cases this appears to be directly related to the greater rectilinearity of the plan. In retrospect we can see that the greater geometric deformity of the City of London plan gave a greater sinuousness to the space which in turn gave rise to greater rather than less axial extension. In Westminster, lines are on the whole shorter than in the City. This all but eliminates any sense of a two-step logic, and this in turn increases the sense that the parts of Westminster are more separated from each other. This can be confirmed by an 'integration' analysis, which shows that Westminster is in fact substantially less integrated than the City of London.

The longer lines that we do find are, however, very interesting. One of them, Tothill Street, is both the most integrated line in Westminster and the line which strikes the main façade of the Abbey, albeit slightly off centre. It is also, in the sense that was common in the City of London, a 'just-about' line. Another 'just about' line, King Street, strikes the northern façade of the Abbey, this time full centre. This line is not an integrator within Westminster, but it is a critical integrator of the Westminster street pattern to the areas to the north and east. In other words, the

Figure 6.3a

Abbey, instead of being axially cut off from the main City as was the case in the City of London, acts as a kind of pivot for the most important internal line and the most important internal-to-external line in Westminster. Neither line slips past the façade. Each is fully end-stopped. The Abbey literally holds the structure together by occupying its key syntactic location, while also of course creating a disjunction from a purely spatial point of view. The major building has, it seems, intervened in the urban structure in a dramatic way.

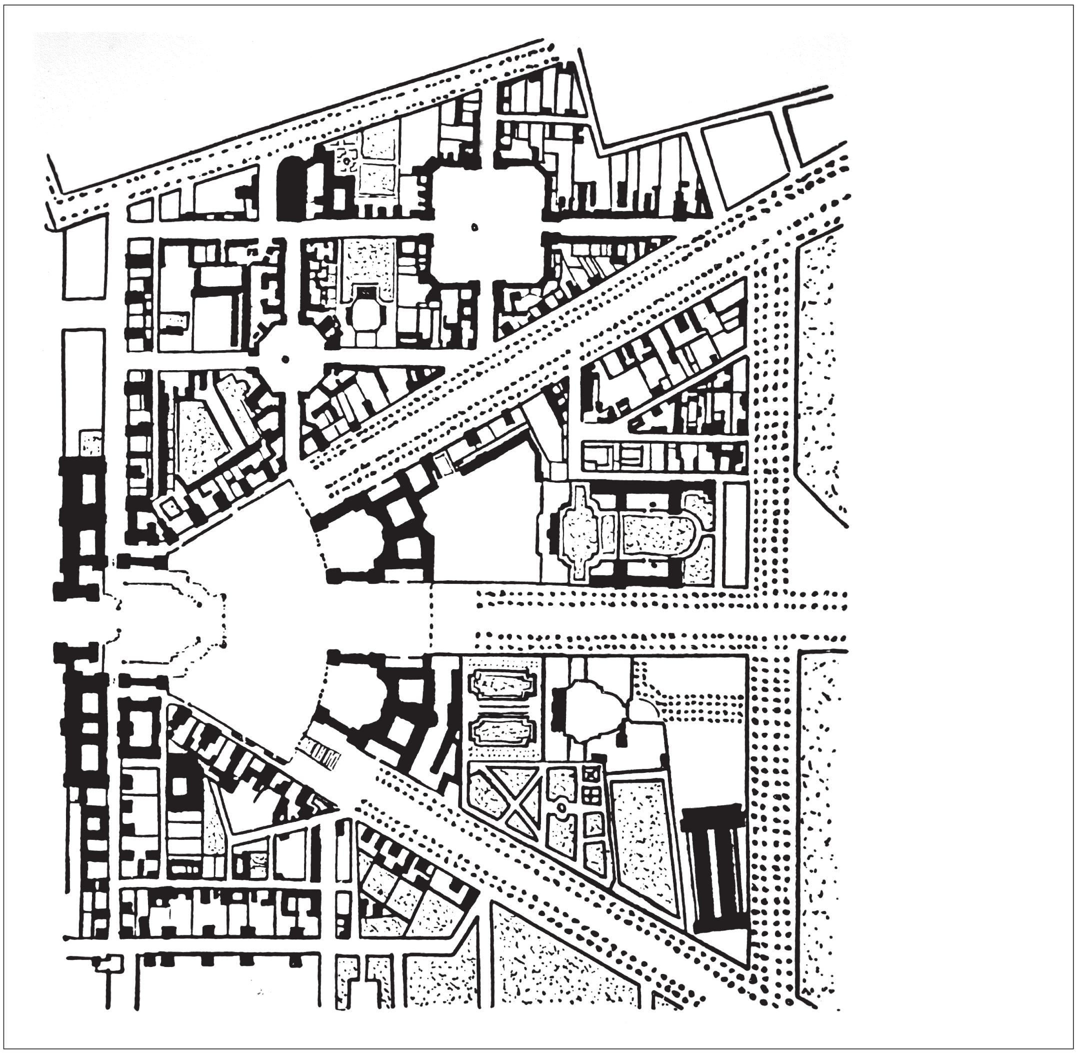
Now this axial disjunction by means of major public buildings is an architectural commonplace, but its very obviousness should remind us that it is exactly what did not happen in the City of London. The dominant axial structure was 'constituted' not by the façades of major buildings but consistently by the façades of the everyday buildings, which, wherever possible, opened directly onto the axes. Where major public buildings occurred they were treated no differently from the point of view of the axial structure. Even the famous City churches received no special treatment, but are embedded in the urban fabric and related to the axial structure in exactly the same way as the everyday buildings. The

Figure 6.3b

global, few-step logic of the City of London is created almost exclusively by the arrangement and orientation of the ordinary buildings. Responsibility for the space structure is as it were 'distributed' – and distributed more or less equally – amongst the largest possible number of buildings. Where major buildings received special axial treatment, it was usually to bury them unobtrusively in the urban fabric. In Westminster the public buildings are much more obtrusive, in spite of the overall reduction in spatial scale and axial integration.

Time as an aspect of space

Figure 6.4



But they do not yet dominate the urban structure in the sense we find in, say, eighteenth-century downtown Versailles, shown in figure 6.4. Here we find three powerful axes striking the palace head on, one at right angles, two at about forty-five degrees. All therefore lead essentially nowhere but the Palace. In terms of natural movement, the Palace acts as a negative attractor. The effect of this is immeasurably increased by two further spatial devices. First, the width and uniformity of the spaces through which the major axes pass, so that axiality is quite the contrary to 'just about'. Axiality is equal everywhere in the space. Second, the everyday buildings – thinking of these mainly in terms of their size and larger numbers – are unlinked as far as possible from the major axes. Following this logic to its extreme, of course, we end up with a space structure in which only the public buildings and monuments constitute the major axial structure, while everyday buildings are removed as far as possible. We are in effect back in Teotihuacan.

This formulation even helps us to begin to make sense of Tikal (figure 6.1b) surely one of the strangest proto-urban objects in the record. This we can now see to be an extreme case of such a spatial logic. All that can be termed a global urban structure lies in the complex of causeways and ceremonial centres that lie at the heart of the area. The scatter of everyday buildings is distributed, apparently randomly, in and around this global complex. They have no consistent spatial relation to the complex (apart from a consistent randomness), no relation to each other, and above all no relation to a system of space which might begin to constitute an overall urban structure. The disjunction of the ceremonial and the everyday, and of the local and the global, is in this case about as complete as it could be.

We may then attempt to summarise the complex of properties that seem to be associated with the axis as symbol rather than as instrument. There seem to be four headings: first, the degree to which axiality is 'just- about' rather than filled out into continuously fat spaces; second, the degree to which there is a few-step logic throughout the system rather than a one-step logic in some parts combined with a many-step logic in others; third, the degree to which strong and weak axiality is related to the entrances of buildings, everyday or public; and fourth, the angles of incidence of axial lines on building façades, varying from striking full on to glancing off.

Let me first suggest that there seems to be a rigorous social logic to these spatial choices. This social logic shows itself in the ways in which we find these properties concatenated in real cases. For example, the City of London combined 'just-about' axiality everywhere, with few-step (rarely one-step) logic, constitution of space by everyday buildings and glancing off angles of incidence of axial lines on façades. This is the opposite of the Teotihuacan or Versailles kind in which fatness is made greater and evened out along the length of the axis, one-step logic for public buildings and many-step logic for everyday buildings, constitution of major axes by major buildings and elimination of everyday buildings, and angles of incidence which are usually orthogonal, both creating the large-scale one-step logic and the small-scale many-step logic. We thus find a natural tendency for greater geometry in the plan – presumably implying a power able to conceive of a form all at one – to be associated with less integration of space and a greater tendency towards the symbolisation of the axis.

We easily associate the first type of concatenation with instrumental axiality and through this with urban situations in which the exigencies of production and distribution are the dominant social requirements. The latter concatenation is just as easily associated with what we may call symbolic axiality which prevails where bureaucracies or religious hierarchies, with their primary concern for symbolic expression rather than movement and communication, are the dominant forces shaping space, that is, where the needs of social reproduction are dominant over the needs of social production. It is through the use of the axis as symbol that forms of social power most naturally express themselves through domination of the urban landscape. This is fundamentally why we have two types of city: the common type of working city, and the more exceptional type of city specialised by the need to reproduce the formal structure of a society.

Time as an aspect of space

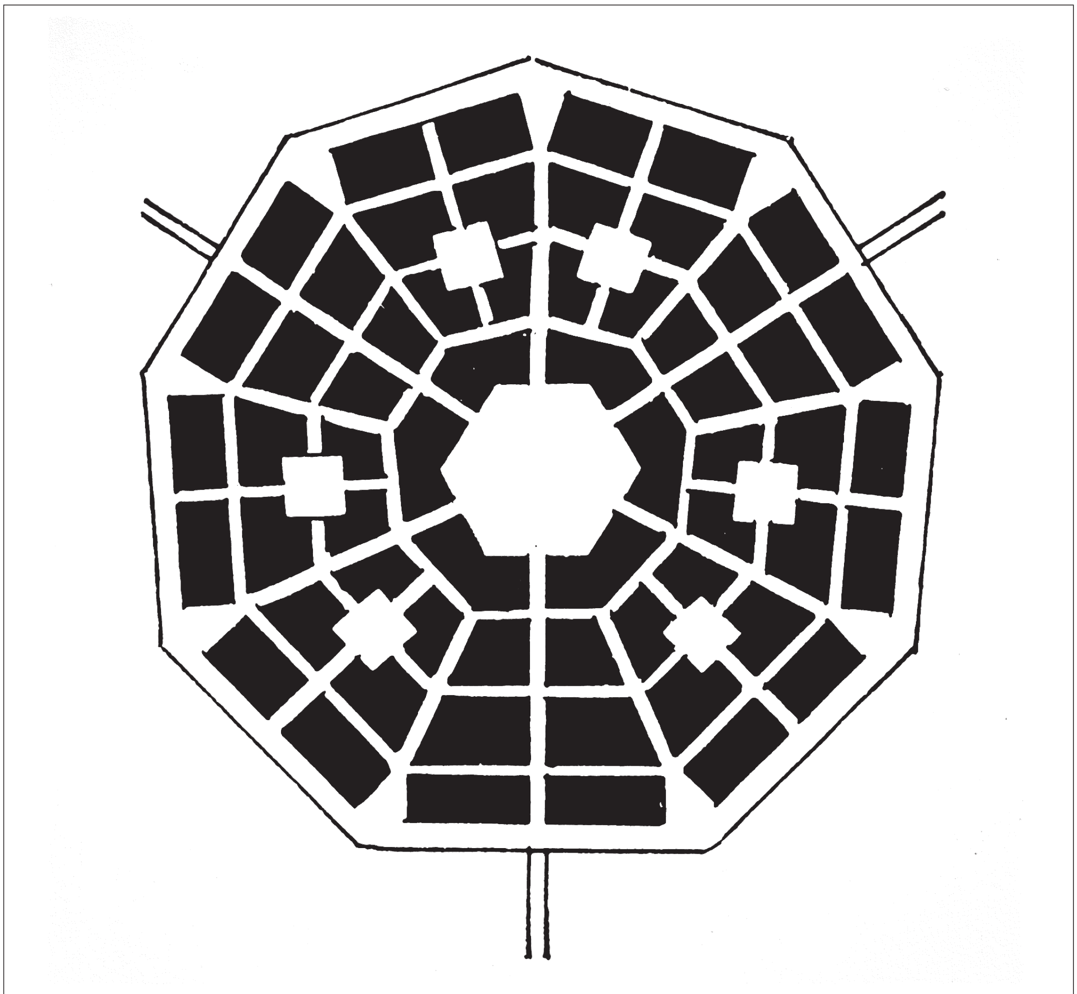
Time as an aspect of space

But why these spatial forms rather than others? To answer this we must build a small armoury of concepts. In *The Social Logic of Space*[6] it was suggested that the concept of time is useful, even necessary, to the description of space. Two concepts were suggested. The description of a space was the set of relations – or as we would say now, the configuration – in which that space was embedded, that is, which described how that space fitted into a complex of space: its relations to building entrances, its convex structure, the lines that pass through it, its convex isovist, and so on. The *synchrony* of that space was then the quantity of space invested in that description. These concepts were a response to the problem of finding a way of saying how two identical spaces with different named functions might be formally different from each other. The motivating case was a pair of hypothetical spaces, identical in shape and size, but one a military parade ground, the other a market place. Are the spaces the same other than in how they are used?

The answer proposed was that the spaces have identical synchrony – they have the same area in the same shape – but different descriptions – that is, the identical spaces are embedded in quite different syntactic contexts. The parade ground has the spatial relations of a military camp, that is, it is related to certain military buildings which are likely to be free standing and have a certain geometrical layout reflecting military statuses, and relations to camp entrances and ceremonial routes, symbolic objects like flagpoles, and so on. The market has the spatial relations of a certain location in a street complex and the buildings which constitute it. The description of the space is its social identity. The synchrony, or quantity of space invested in that description, is the degree of emphasis accorded to that description in the complex. Synchrony, we may say simply, reinforces description. The synchrony of the parade ground and market place may be identical, but the descriptions are different. Therefore a different description is being emphasised. Therefore the spaces are different.

Intuitively, it seems reasonable to use the term 'synchrony' to describe metric scale in space, since we must use movement, which occupies time, to overcome space, and since visibility substitutes for movement in this sense, expanding space metrically brings more of it into a single space-time frame. Underlying this there is a model of space in which space is seen and understood by a human subject who is essentially peripatetic. Any spatial complex is a system which can only be seen one part at a time and which requires movement to see and understand as a whole. To the peripatetic subject, to say that spatial relations are synchronised is to say that they are simultaneously present to the peripatetic observer within the same space-time frame. Therefore the fact of progressively moving through a spatial complex such as a town or building successively synchronises different sub-complexes of spatial relations. In these sub-complexes, the larger the convex space or the longer the axial space then the stronger this synchronising effect will be. Hence synchrony as the descriptor of the quantity of continuous space within which the same relations prevail.

Figure 6.5



Now consider another distinction, due to a colleague of mine,[7] between *structure* and *order*. Spatial complexes are intelligible to us in two ways: as artefacts we move about in, and learn to understand by *living* in; and as overall rational *concepts*, which can be grasped all at once, and which often have a geometrical or simple relational nature. The first we may call *structure*; the second *order*. Town plans make the distinction particularly clear. Ideal towns are dominated by rational *order*, and can be grasped as a single concept. Most real town plans, however, lack such simplicities. They appear irregular, almost disordered – though they are not so when we live in them and move around them. On the contrary, it is the ordered town that is usually confusing 'on the ground'. Real towns, as we have seen, have 'structure' which we discover by living and moving, but not an obvious rational 'order'.

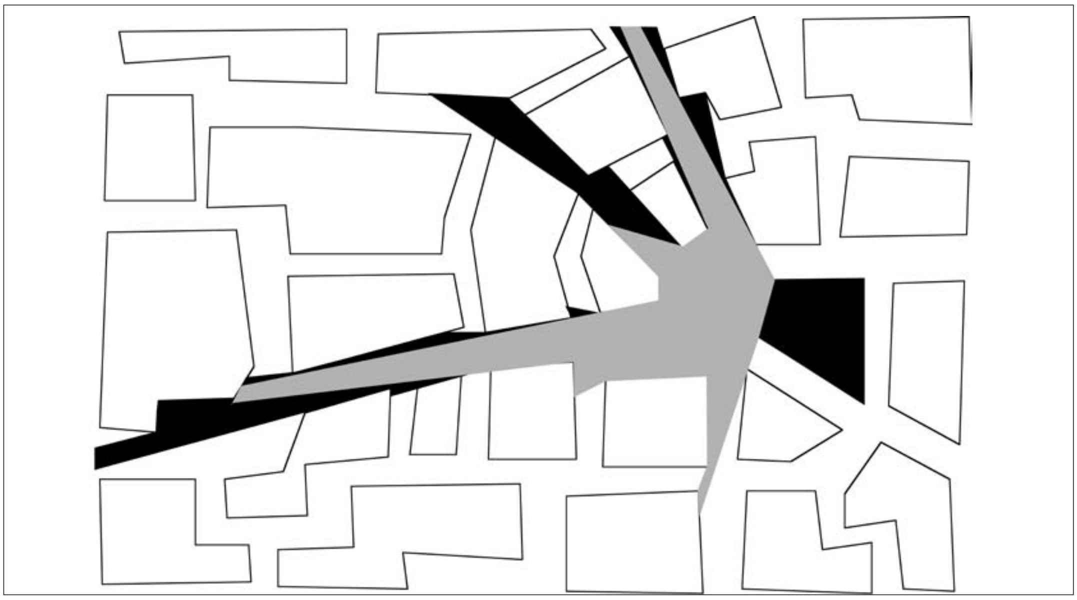
Now consider this definition in terms of the time concepts we have introduced in relation to two town plans. One the 'ideal' town plan of Palmanova, shown in figure 6.5, and the 'organic' layout of the plan shown in figure 4.3a. The ideal town can be grasped as a pattern *all at once*, or *synchronously*, provided we are in a position to see it all at once, as we are if we consider it as a plan on the page or from the air. The reason it can be grasped all at once is not so much because it has a regular geometry, but for a simpler and more basic reason: it is made up of *similar parts* in *similar relations*. Such compositions immediately reveal their nature because the mind easily grasps the repetitivity of the elements and relations that make up the form. It is this property of being made up of similar parts in similar relations we call *order*. We tend to associate it with the constructive activity of the human mind. Order is fundamentally rational. It can be grasped all at once because it is imposed all at once.

The 'organic' town has no such order. Elements can scarcely be identified, let alone repetitive elements. The same is true of relations. Very little repetition can be identified, if any. However, we now know that such 'organic' towns have powerful spatial patterning which appears to originate in function. For example, the distribution of integration in the axial map defines an 'integration core' which generates not only a movement pattern but also a distribution of land uses such as shops and residences which are sensitive to movement. We can call such patterns *structures*, and contrast them with *orders* because they have quite different, almost contrary, properties. Structures cannot be seen all at once, nor are they imposed all at once by minds. They are *asynchronous* both in their genesis and in the way we experience them. They arise from a lived process, and are intelligible through the processes of living in the town, and, most especially, by the process of movement. Without movement, an asynchronous system cannot be seen, let alone understood.

It is an empirical fact that, regardless of their relative prevalence in geographical or planning texts, by far the great majority of towns and cities in human history display more structure than order. The reasons are not hard to find. For the most part, towns arise for essentially functional reasons, and, naturally enough, evolve according to a functional logic. However, if we consider another aspect of urban intelligibility, that is, the formal configuration of built forms, and especially of their façades, then we find that, intriguingly, matters are more or less reversed. Façades typically display a good deal of order, and anything we might call structure by analogy to the semi-regular patterns of the organic town is rare, if it can be identified at all. There is a simple reason for this, centred about the relations between space, form and time. Unlike urban space structures, which are asynchronous because they require the passage of time required for movement in order to see them piece by piece, building façades are, in their very nature, synchronous. They are intended to be read and understood all at once. They therefore do not require time for their understanding. Order, we might suggest, is as prevalent over structure in built forms as structure is prevalent over order in space. In both concepts, both kinds of case exist, but order is natural to form because it is intended to by read synchronously just as structure is natural to space because of its essentially asynchronous nature.

How forms, and especially façades, relate to space is then likely to be of interest. Let us then consider space from the point of view of the façades of buildings. It is clear that every façade will be partly visible from certain points in urban space and wholly visible from others. Both sets of points form a shape, defined by all that can be seen from the façade. We can draw both shapes, and call the first the 'part-façade isovist' and the second the 'full-façade isovist'. To

Figure 6.6
Façade isovist



draw them we first project each vertex of the façade as far as possible in all directions from which any part of the façade can be seen. The combination of the shapes swept out by the two vertices is then the part-façade isovist, and their intersection is the full-façade isovist. Figure 6.6 shows a hypothetical case, in which the part-façade isovist is lightly shaded and the full-façade isovist darkly shaded. Evidently, the full-façade isovist will be the region of space from which the façade is synchronously visible for the peripatetic observer.

Now let us consider the effects on façade isovists of different kinds of axiality. First let us look at the City of London again, but this time from the point of view of its façade isovists. Two points can be made. The guild buildings are available to the street from rather short isovists, usually ending in right angles, and also usually ending in an enclosed space. Interestingly, the only exception to the short line rule is the Guildhall, and here the long axis also ends in an enclosed space, suggesting some consistency in the rule for that type of building. Public buildings are in general on larger-scale spaces, but have very restricted isovists which we can for the most part only see sideways, and with a relatively small-scale isovist. This is particularly true of the three major buildings at the heart of the city: the Mansion House, the Bank of England and the Royal Exchange. Major buildings do not seem to occur at the points where major axes strike whole building façades.

This quasi-concealing of the public buildings has three marked effects. First, the degree to which their views are axially synchronised is very restricted. One comes across them rather suddenly. Second, one usually approaches them at an angle so that whatever order is present on the façade is obscured by perspective. Third, and perhaps most important, the effect of approaching the building sideways is that what one sees changes quite rapidly as one first arrives at the building and then proceeds beyond it. One might say that the effect of this type of façade isovist is that from the point of view of movement, the order in the façade of the building is never freeze-framed, but is constantly shifted and distorted.

Time as an aspect of space

Now consider how the contrary can be achieved. The most effective means would be a single long 'tunnel' isovist striking the building at a right angle. This would mean that the longer this tunnel isovist, the more protracted the time during which, for the moving observer, the façade of the building would be freeze-framed, and the more invariant would be any symmetry that façade possessed. By placing an observer moving through space on the axis of symmetry of the building façade, and extending the spatial axis as far as possible away from the building at a right angle, the presence of the symbolic buildings becomes more pervasive and more invariant. The more convex the axis, then, the more invariant would be this effect throughout the region passed through by the line.

We can also relate this to the global urban structure by bringing integration into the picture. The more integrating the 'symbolic axis', the more whatever is freeze-framed by the line would be dominant in the urban structure. The effect of converting space from instrument to symbol would be amplified by the fact that a large-scale object at right angle to a key axis will act as a negative attractor in the urban form, that is, whatever its degree of integration, natural movement rates will fall away in the direction of the negative attractor, though this may of course be compensated by the numbers of people attracted to the building for other reasons. In short, the logic of the symbolic axis is in its way as consistent as that of the instrumental. Its object is not to organise a pattern of movement and through this to generate encounter, but to use the potential of urban space for another kind of emphasis: the communication throughout space of the symbolic importance of certain buildings or locations. The role of the symbolic axis tends to be focussed in certain locations rather than diffused throughout the form, but its role in creating the overall urban structure is no less powerful.

We can see then that Teotihuacan is built according to a 'formula' no less than the city of London, but the formula is different. In spite of initial doubts, its internal logic, and presumably its social logic, are just as consistent. Just as London is the expression of one kind of social logic, so our strange towns are consistent expressions of another.

Notes

1 Banister Fletcher's *A History of Architecture* (edited by Professor John Musgrove), Butterworth London, 1987.
2 Hillier & Hanson, 1984, Chapter 5.
3 The plan is by Horwood.
4 See Figure 4.3a in Chapter 4.
5 See *The Social Logic of Space*, Chapter 3.
6 Hillier & Hanson, Chapter 3, pp. 95–7.
7 J. Hanson, Order and structure in urban design: the plans for the rebuilding of London after the Great Fire of 1666', *Ekistics*, Special Issue on space syntax research, vol. 56, no. 334/5, 1989.

Chapter seven

Visible colleges

The problem of space according to Lévi Strauss

The previous chapters have studied urban space, the space that is, formed by the relations amongst buildings. But what of the building interior? How far can the techniques used and the lessons learned in the study of urban space inform studies of the interiors of buildings more complex than the house, where by definition, a more structured organisation than an urban community is at work? It turns out that to study these relations we must build a more complex model of what we are seeking, one which takes into account how structured an organisation is, and how it is structured. Once we do this, we find that many of the principles learned can be applied to the complex building interior. A crucial case is the research laboratory, where until quite recently, spatial group dynamics were thought to be entirely absent.[1] To begin our task of building a more complex model, we must look into some anthropological ideas about space.

In 1953, Lévi-Strauss formulated the problem of space as follows:

> It has been Durkheim's and Mauss's great merit to call attention for the first time to the variable properties of space which should be considered in order to understand properly the structure of several primitive societies ... [But] there have been practically no attempts to correlate the spatial configurations with the formal properties of the other aspects of social life. This is much to be regretted, since in many parts of the world there is an obvious relationship between the social structure and the spatial structure of settlements, villages and camps ... These few examples (camps of Plains Indians, Ge villages in Brazil, and pueblos) are not intended to prove that spatial configuration is the mirror image of social organization but to call attention to the fact that, while among numerous peoples it would be extremely difficult to discover any such relation, among others (who must accordingly have something in common) the existence of a relation is evident, though unclear, and in a third group spatial configuration seems to be almost a projective representation of the social structure. But even the most striking cases call for critical study; for example, this writer has attempted to demonstrate that, among the Bororo, spatial configuration reflects not the true, unconscious social organization but a model existing consciously in the native mind, though its nature is entirely illusory and even contradictory to reality.[2]

A little later he adds:

> Problems of this kind (which are raised not only by the consideration of relatively durable spatial configurations but also in regard to recurrent temporary ones, such as those shown in dance, ritual, etc.) offer an opportunity to study social and mental processes through objective and crystallized external projections of them.[3]

It may seem natural that a 'structuralist' of Lévi-Strauss' stripe would see the spatial forms of settlements as 'projections' or 'reflections' of 'mental processes' and be puzzled when he finds it in some cases and not in others. But we find a curious blindness in his view. A short while previously in the same paper Lévi-Strauss had proposed a fundamental distinction in the analysis of social structure between what he calls 'mechanical' and 'statistical' models.[4] In a mechanical model, according to Lévi-Strauss, the elements of the model are 'on the same scale as the phenomena' they account for. In a statistical model the elements of the model are 'on a different scale' from the phenomena.

Lévi-Strauss illustrates the difference through marriage laws in 'primitive' and modern societies. In primitive societies, the laws of marriage can often be 'expressed in models calling for actual grouping of the individuals according to kin or clan'. Individuals are thus categorised and brought into well-defined relationships with individuals in other categories. This degree of determination is characteristic of a mechanical model. Modern societies, in contrast, specify no such assignment of individuals to categories, and therefore no such relations to other categories. Instead, 'types of marriage are determined only by the size of primary and secondary groups'. A model of the invariants of such a system could therefore determine only average values, or thresholds, and therefore constitute a statistical model.

What we find curious is that in using such terms as 'projection' and 'reflection' to formulate the problem of space, Lévi-Strauss seems to be taking for granted that spatial phenomena will be on the same scale as the mental processes that (so he imagines) must govern them, and therefore be expressible through a mechanical model. It is far from obvious that this should be so. On the contrary, everyday experience suggests that it is rarely so, and that space more commonly possesses the attributes of Lévi-Strauss' statistical model. The differences between the type of spatial mechanical models Lévi-Strauss has in mind for such cases as the circular villages of the Ge Indians of Brazil and the type of space characteristic of modern cities seems to have much in common with the differences he has already noted between types of marriage systems. Modern urban space is for the most part interchangeable and lacks well-defined correspondences between social categories and spatial domains. Insofar as such distinctions exist, they appear to be exactly of a statistical kind and are generated by a process of social action rather than simply reflecting a mental process. Considering the full range of cases with which ethnography and everyday life presents us, in fact, space seems to be vary on a continuum with mechanical and statistical models as its poles.

The reason for Lévi-Strauss' unexpected conceptual blindness is perhaps that he lacks any concept of what a statistical model of space would look like. The need to formulate such a model underlies the attempted resolution of Lévi-Strauss problem in *The Social Logic of Space*.[5] In that text it is argued that leaving aside issues of sheer scale, which are themselves morphologically significant, the investment societies make in space varies along three fundamental dimensions: the degree to which space is structured at all, the degree to which space is assigned specific social meanings, and the type of configuration used. Across the range of known societies, the first gives a continuum from non-order to order; the second gives a continuum from non-meaning to meaning; and the third gives fundamental differences in actual spatial form across a range of spatial variables.[6]

Morphogenetic models

The only type of model that might succeed in showing a field of phenomena with these dimensions of variability to be a 'system of transformations' (to use a favourite expression of Lévi-Strauss) is, it was argued in *The Social Logic of Space*, a model in which rules are conceived of not as mental entities producing projections or reflections of themselves in the real world, but as restriction imposed on an otherwise random generative process – say, a cell aggregation model, or a model generating relationships in a graph. In such a model, rules and randomness can interact to produce not only known outcomes, but also new outcomes or *morphogenesis*. Cases were shown in which a morphogenic model based on cell aggregations randomised apart from purely local rules (i.e. specifying only relations of cells to an immediate neighbor) was able to generate – and by direct inference to 'explain' something about – common global topological properties of groups of apparently random settlement forms.[7]

But computer experimentation has shown that such morphogenesis occurs only where the rules restricting the random process are few, and local in their scope. The more the rules become too many or too global (i.e. specifying relations beyond those with immediate neighbors – for example by requiring lines of sight covering groups of a certain size) - the more the generative process will tend to produce reflections or projections of those rules. Morphogenesis in such systems requires, it seems, the co-presence of randomness and rules restricting that randomness.

Such co-presence can arise only to the extent that the number of possible relations that cells can enter into in an aggregation process is significantly more than those specified by rules. The higher the proportion of possible spatial relations specified by the rules, and the more global those rules, the less the process has morphogenetic potential, and the more it will conserve the form given by the rules. Conversely, the lower the proportion of possible relations specified by rules, the greater the morphological potential. More succinctly, we can say that short descriptions, or 'short models' as we have come to call them, inserted in random processes tend to morphogenesis, while long descriptions, or 'long models', tend to conserve.

We also find that the shorter the model the larger the equivalence class of global forms that can result, and the more these forms will, while sharing 'genotypical' similarities, be individually different. The longer the description required, the smaller the equivalence class and the more individuals will resemble one another. In other words, short models tend to individuation as well as morphogenesis, whereas long models tend to conformity as well as conservation.

A further refinement of this theoretical model can incorporate another significant dimension: that of social meaning. In what has been described so far, it has been assumed that the elements of a generative process are interchangeable and do not have individual identities. If we now assign individual identities – or even group identities – to individual cells, and assign individuals or categories to specific relations with other individuals or categories within the system, then the description required to restrict randomness is still further lengthened, since relations between specific elements or groups of elements need to be specified – though this time by *trans-spatial* or conceptual rather than purely spatial rules.

This is most economically conceived of as the imposition of 'non-interchangeability' on the elements of the generative process. While appearing initially to be the addition of entities of an entirely different kind – those associated with social 'meaning' – the concept of non-interchangeability shows that these can be brought within the theoretical scope of long and short models. The limiting case of such a non-interchangeable system is one in which every cell has a specified relation to all others in the system. This limit seems to be approached in the famous case of the Bororo village used (though not originated) by Lévi-Strauss.[8]

The continuum of long and short models is, we believe, the general form of Lévi-Strauss' distinction between mechanical (long) and statistical (short) models. Unifying both into a single scheme of things, one is able to see that the statistical and the mechanical, while appearing to characterise quite different research approaches to human affairs (in that sociology tends to the statistical while anthropology tends to the mechanical), are in fact aspects of an underlying continuum of possibility that runs right through human affairs in all societies.

Simple examples can be set within the model and clarified. For example, a ritual is a set of behaviours in which all sequences and all relations are specified by rules – that is, it is a long-model event. Of its nature, a ritual eliminates the random. Its object is to conserve and re-express its form. A party, on the other hand, while it may be casually described as a social ritual, is a short-model event. Its object is morphogenetic: the generation of new relational patterns by maximising the randomness of encounter through spatial proximity and movement.

Not the least interesting property of long and short models for our present purposes is that they appear to give good characterisation of both spatial patterns and types of human encounter (encounter being the spatial realisation of the social), so that one can begin to see possible generic relationships among them. Short models, it seems, require space to be compressed because they depend on the random generation of events, and this becomes more difficult to the degree that distance has to be overcome. Long models on the other hand tend to be used to overcome distance and to make relationships that are not given automatically in the local spatial zone. Societies typically use ceremonies and ritual to overcome spatial separation and reinforce relationships that are not naturally made in the everyday spatial domain. Informality, in contrast, is associated exactly with the local spatial zone and is harder to retain at a distance. Greater space, as Mary Douglas once observed, means more formality.[9]

Looked at this way, one can see that society actually has a certain rudimentary ‘spatial logic’ built into it, which links the *frequency* of encounters with the *type* of encounters. By the same logic, the typing of encounters between short and long models generates a need to pattern the local spatial domain to structure the range of encounter types. In this way, space as a physical arrangement begins to acquire a social logic.

This reformulation of the problem of space leads to a research programme in which the object of investigation is how the two morphologies of space and encounter are patterned. Research can thus proceed without any presumption of determinism. If social encounters have their own spatial logic and space has its own social logic, and the task of research is to understand how they relate morphologically, then the naïve paradigm of cause and effect between environment and behaviour can be avoided. Indeed one can see that the term ‘environment’ used in this context is in danger of itself setting up this false paradigm of the problem it seeks to address,[10] since it presupposes an ambient circumstance with some specific influential relation to the behaviours it circumscribes. This paradigm is unrealistic, and it has been criticised at length elsewhere. Even so it is worth uttering a word of warning that the fallacies of what has been called the ‘man environment paradigm’ can also be present in the notion of the ‘setting’.[11]

These theoretical ideas have been set out at some length because we believe that the analysis of the relationship between ‘the spatial setting and the production and reproduction of knowledge’[12] can proceed effectively only within this type of theoretical framework. It is this theoretical framework that the methodology of ‘space syntax’ seeks to convert into a programme of empirical investigation, by first investigating space as a pattern in itself, then analysing its relationship to the distribution of categories and labels (non-interchangeabilities), then systematically observing its use.

Before explaining something of the method and the modelling concepts it gives rise to, however, some careful distinctions must first be introduced about the way we use the word ‘knowledge’, since these have a direct bearing on how the reproduction and production of knowledge relates to space.

Ideas we think with and ideas we think of

To study space and knowledge, we must begin by making a fundamental distinction between two everyday senses of the word ‘knowledge’. The first is when we talk of knowing a language, or knowing how to behave, or knowing how to play backgammon. The second is knowing projective geometry, or knowing how to make engineering calculations, or knowing the table of elements.

Knowing in the first sense means knowing a set of *rules* that allow us to *act* socially in well-defined ways: speaking, listening, attending a dinner party, playing backgammon, and so on. Knowing in this sense means knowing something *abstract* in order to be able to do, or relate to, something *concrete*. Knowledge of abstractions is used to generate concrete phenomena. Let us call this kind of knowledge *knowledge A*, or *social knowledge*, since it is clear that the ubiquity of knowledge A is one of the things that make society run.

Knowledge A has several important characteristics. first, we tend to use it *autonomically*. We are not aware of it when we use it, in the sense that when we are speaking sentences, the last thing we wish to give attention to is our knowledge of the rules of language. The rules of language are *ideas we think with*, whereas the concepts we form through language are, for the most part, *ideas we think of*. It is necessarily so. To be effective as speakers, we must take it for granted that we know, and others share, the rules of language.

Second, in spite of the evidently abstract nature of such knowledge, we normally acquire it by *doing*, rather than by being explicitly taught. As we learn words and sentences, we are not aware we are learning abstract rules. On the contrary, what we are learning seems fragmentary and practical. Nevertheless, as linguists have so often noted, such knowledge must be abstract in form since it allows us to behave in novel ways in new situations – the familiar 'rule-governed creativity'.

Third, we should note that knowledge A works so effectively as social knowledge precisely because abstract principles are buried beneath habits of doing. Because they are so buried, we become unconscious of them, and because we are unconscious we also became unaware that they exist. Ideas we think with are everywhere, but we do not experience them; they structure our thoughts and actions, but we have forgotten their existence. The trick of culture, it might be observed, lies in this way of making the artificial appear natural.

Knowledge B, in contrast, is knowledge where we learn the abstract principles consciously and are primarily aware of the principles both when we acquire and when we use the knowledge. Thus we learn and hold projective geometry, or how an engine works, or the table of elements, in such a way that abstract principles and concrete phenomena seem to be aspects of each other. We might very loosely call this *scientific knowledge*, making the only criterion for this term the fact that principles as well as cases are explicit and can be written down in books and taught as aspects of each other.

Now it is unimportant to our argument that there is no clear demarcation between knowledge A and knowledge B. On the contrary, the lack of clarity as to what belongs where is often an important debate. For example, in the field of space there is a theory called territoriality, which claims scientific status. We believe this theory not only to be wrong but also to be knowledge A masquerading as knowledge B. That is, we believe it to be in the main a projection into a quasi-scientific language of normative beliefs and practices that are deeply ingrained in modern Western society – ideas that have indeed become ideas we think with in architecture (Hillier 1988) and now need the reinforcement of scientific status.

The reason we need the distinction between knowledge A and knowledge B for our purposes here is that all human spatial organisation involves some degree of knowledge A. How much knowledge A is involved is indexed by the length of the model that structures space. But it is not a one-way process in which space *reflects* knowledge A. In short-model situations, space can also be *generative* of knowledge A.

Examples of this range of possibilities are given in the next section. However, knowledge A is not our principle subject here. We are interested in space and knowledge B, trivially in its reproduction, non-trivially in its production. The essence of our answer is that the conditions for the production of knowledge B are likely to exist to the extent that knowledge A is absent in spatial complexes, and that the short-model conditions that permit the generation of knowledge A also have a bearing on the generation of knowledge B.

This does not mean that the absence of knowledge A in space will always lead to the production of knowledge B, or that knowledge B can be produced only when knowledge A is absent. What it means is that in the absence of knowledge A the spatial conditions exist for all kinds of generation – new relationships, new ideas, new products, and even knowledge – just as in the presence of knowledge A, the spatial conditions exist for all kinds of *conservation* – of roles and positions, of social praxes and rituals, of statuses and identities.

More briefly, the proposition put forward in this paper is that buildings, which insofar as they are purposeful objects are organizers of space, can act in either a *conservative* or a *generative* mode. The place of the spatial reproduction of knowledge lies in the conservative mode. The place of the spatial production of knowledge lies in the generative mode. What this means in practice may surprise the proponents of scientific solitude.

Space and knowledge A

The argument can be made more precisely by illustrating the presence of knowledge A in some simple examples of domestic space. Social knowledge is built into domestic space in many ways, but one of the most important is through *configuration* – that is, through the actual layout of the plan.

A key syntactic measure of configuration is *integration*. This is initially a purely spatial measure, but it gives a configurational analysis of function as one simply looks at the integration values of the spaces in which functions are located. As soon as we can identify common patterns in the degree of integration of different *functions* or *labels* in a sample of dwellings, then it is clear that we are dealing quite objectively (i.e. in terms of the properties of objects) with cultural genotypes acquiring a spatial dimension – that is, with social knowledge taking on a spatial form.

In Chapter 1 this notion was illustrated by three examples. The order of integration of the different functions was similar in all three cases. In other words, the way in which spaces are categorised according to the ways in which culture arranges activities – what goes with what, what is separated from what, what must be adjacent and what separate, and so on – finds a repeated form. This we saw as one of the 'deep structures' of the configuration. We called this kind of configurational repetition across a sample an 'inequality genotype', since it is an abstract underlying cultural form, assuming many different physical manifestations, and expressing itself through integrational inequalities in the ways that different functions feature in the domestic-space culture.

Visible colleges

This would seem to be a clear case where knowledge A is embedded in spatial configuration. It could even be said that the spatial configuration *constitutes* rather than *represents* social knowables. It belongs in the domain – largely unconscious, because habitual – of the lived pattern of everyday life, rather than in the representation of these patterns through symbols.

The list of invariants in an inequality genotype can be extended by analysing more subtle spatial properties, such as the relation between permeability and visibility among the spaces. The more the list can be extended and remain invariant – or approximately so – across a sample, the more it can be said that the genotype is a long model or a Lévi-Straussian mechanical model. In the case of the French farmhouses, the genotype is far from being a mechanical model. There is much that varies, apparently randomly, among the houses, ensuring that each retains its individual spatial character.

Set into the general theoretical scheme we are proposing, we might say that the list of invariants over the list of possible invariants across the sample would be the length of the model. For our present purposes, we will not pursue precise measurement too far, since to show the possibility in principle is sufficient. But it can easily be seen that a more stereotyped housing type – say the English suburban house, where most spatial and function rules are invariant across very large samples – will have a much longer model than the French farmhouses, where much individuation still prevails over an underlying genotypical pattern.[13] We can also say, therefore, that the length of the models indexes to the degree to which the houses, through their configuration, reproduce knowledge A. English suburban houses reproduce more social knowledge than do the French rural examples.

Strong and weak programs

Let us now consider two more complex examples, which take the model to its extremes. To do this we need to invoke movement. In architectural terms, movement is a very dull word for a very critical phenomenon. Although we are accustomed to taking a static view of buildings by being concerned primarily with the aesthetics of their façades, there is no doubt that from the point of view space, buildings are fundamentally about movement, and how it is generated and controlled. The type of 'inequality genotype' just discussed may be present in, say, a factory (through the different degree of integration of managers, foremen, supervisors, workers, different departments, and so on,[14] but it is rather shadowy and far from being the most important feature of the spatial layout and its dynamics. To understand these more complex situations we must internalise the idea of movement into our theoretical model.

Let us begin with an example of what we call a ''strong-programme' building. The programme of a building is not the organisation it houses. An organisation, by definition, is a list of roles and statuses that has no necessary relation to a form of space, and its description – although not necessarily how it functions – would be the same regardless of its spatial configuration. We must give up the idea that it is the organisation that is reflected in the layout (another Lévi-

Straussian case of a mechanical expectation that is usually unfulfilled) and look for some aspect of the organisation that does have some kind of spatial dimension.

'Programme' is the name we give to the spatial dimensions of an organisation, and the key element in any programme is the interface, or interfaces, that the building exists to construct. An 'interface' is a spatial relation between or among two broad categories of persons (or objects representing persons) that every building defines: *inhabitants*, or those whose social identity *as individuals* is embedded in the spatial layout and who therefore have some degree of control of space; and *visitors*, who lack control, whose identities in the buildings are collective, usually temporary, and subordinated to those of the inhabitants. Thus teachers, doctors, priests, and householders are inhabitants, while pupils, patients, congregations, and domestic visitors are visitors. An interface in a building is a spatial abstraction associated with a functional idea. It can vary in its form – think, for example, of the many ways in which the interface between teachers and pupils in a school can be arranged – but the building does have to construct its key interfaces in some form or other. The notion of interface thus extracts from the idea of organization the spatial dimensions that must be realized in some way in the spatial form of the building.

A strong programme exists in a building when the interface or interfaces constructed by the building have a *long model*. Take a court of law, for example, which has probably the most complex strong-program interface of any major Western building type. The complexity of the programme arises from the fact that there are numerous different categories of persons who must all be brought into the same interface space in well-defined relations. The length of the model arises from the fact that spatial configuration must ensure that each of these interfaces happens in exactly the right way, and that all other possible encounters are excluded.

The interface in a court of law is, of course, static and 'synchronised' – meaning that all parties are brought into the same space-time frame. But the way the interface is brought about has to do with movement. The court of law has as many entrances as categories of participant, and all entrances have the property of non-interchangeability. Usually each independent entrance is associated with an independent route, or at least with a route that intersects only minimally with others. Each category is likely also to have an independent origin and destination in and around the courtroom space.

The essential characteristic of the court of law, considered as a system of movement and stasis, is that everything that happens is programmed in advance in order to structure the interfaces that must occur and inhibit all others. Movement is thus constructed by the programme, and the role of spatial configuration is primarily to permit the necessary movements and inhibit others. A strong-programme building is one in which it is not the layout that generates the movement pattern but the programme operating within the layout. In terms of the model, it can be said that the whole space structure for stasis and movement is controlled by knowledge A: its aim is to reinforce certain categoric identities and create strongly controlled

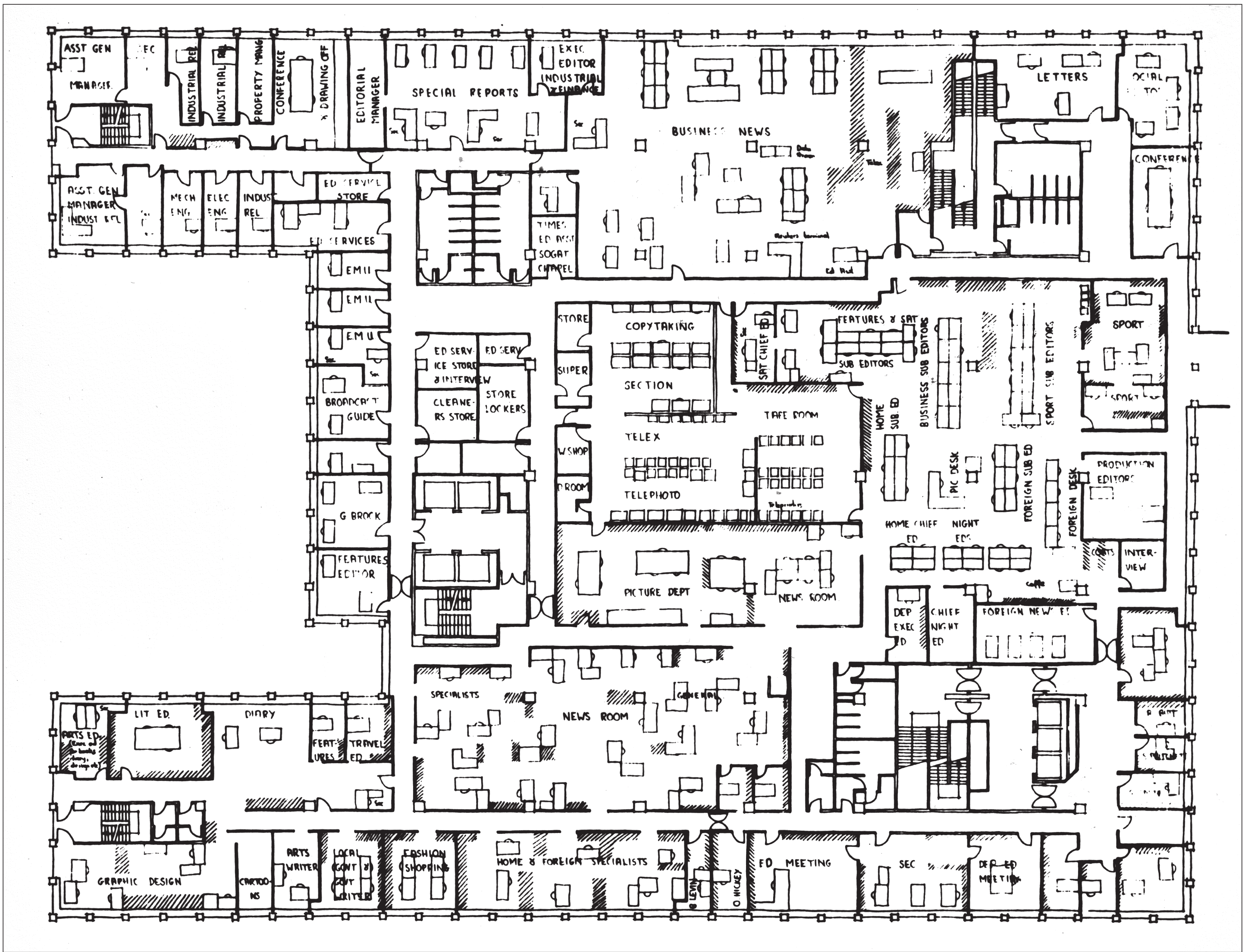


Figure 7.1a
The editorial floor of a leading London daily newspaper, including the main items of furniture and equipment.

interfaces between them.

Now let us consider a contrary case: the weak-program building. Figure 7.1a shows the editorial floor of a leading London daily newspaper. Impressionistically, it is the opposite of the courtroom. It appears to be a hive of activity, with a high degree of apparently random movement and static encounter. If we now analyse the space structure using the axial convention (in which the longest and fewest lines of sight and access are drawn through all the open space), then analyse its integration pattern, we find that it has an integration core (the 10 per cent most integrating lines) of a type familiar from syntactic studies of urban grids (figure 7.1b): a semigrid near the heart of the system links to strong peripheral lines by a series of routes, keeping it shallow from the outside as well as across its width. If we carefully observe the pattern of movement and stasis, we find that integration values of axial lines are powerful predictors of the degree to which space will be used (figure 7.1c). We see here what we believe to be a general principle: as the program of the building becomes weaker and moves toward an all-play-all interface, the distribution

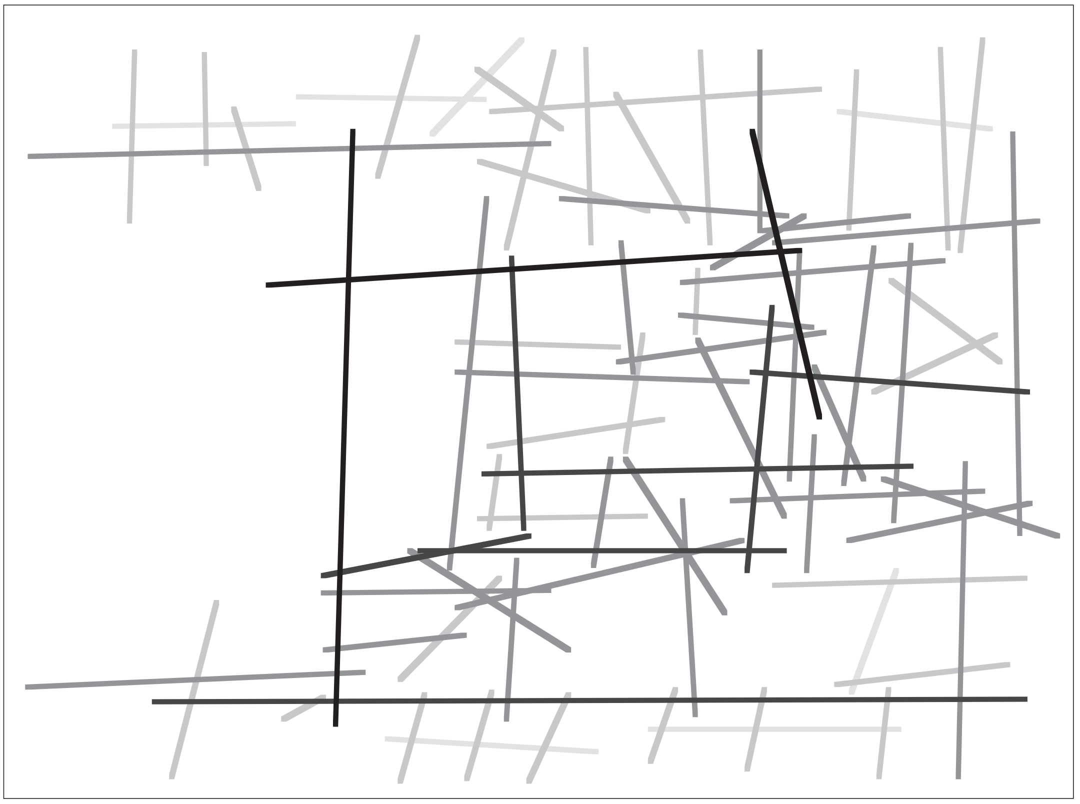


Figure 7.1b
The axial integration map of the open space structure of the editorial floor.

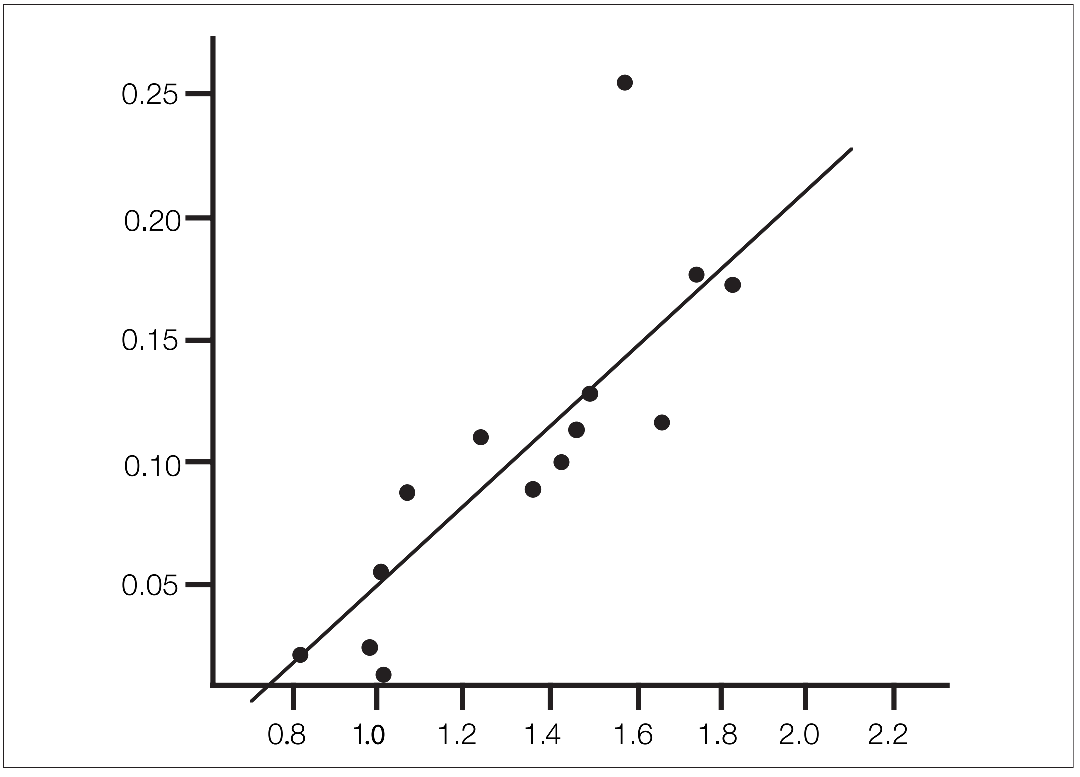


Figure 7.1c
Scattergram showing the correlation between the integration value of a space on the horizontal axis and the observed density of space use on the vertical axis averaged over twenty observations at different times of the day. The outlying point (highest use) is the photocopy space. The degree to which it is removed from the regression line of the remainder of the points indicates the degree to which it attracts use due to its function rather than to its spacial location. This shows how it is possible to detect the “magnet” effect of facilities against the background of the use pattern of the spacial milieu, r = .83, p<.001.

of space use and movement is defined less by the program and more by the structure of the layout itself. This is because the high number of origin/destination pairs coupled to the integrated nature of the layout means that the by-product of movement – moving through intervening spaces – reflects the pattern of routes from all points to all other points. In this way the editorial floor comes to resemble an urban system, where movement and space use also have a weak programme. In this case we can say that the grid is behaving generatively: it is optimising and structuring a dense and random pattern of encounter, rather than simply restricting it to reflect a pre-existing social knowledge pattern.

Theoretically it can be said that the editorial floor is a short-model setup; and through its integrating layout, its density of movement, and its structuring of the by-product of movement, it is generating new encounter patterns – that is, it is acting morphogenetically at the level of social encounter. Its content of social knowledge and non-interchangeability is weak and ever changing. The function of space is to be creative by facilitating and extending the network of unprogrammed encounters necessary to the efficient running of a newspaper. Space in this sense is generative, or creative of knowledge A. It is generating new patterns of social relationship, which might not exist outside the spatial milieu.

This same construct can be applied to the type of social structure described by knowledge A. When we look for social structure in an organisation one of the first things we pick on as an indicator is the division of labour, and important for our purposes here, the more obvious the division of labour, the more strongly we consider an organisation to be structured. In this sense we can consider a social structure in terms of the length of the model needed to describe its division of labour. The shorter the model, the more the social structure required to carry out actual tasks will be generated through changing day-to-day needs. The longer the model, the more the division of labour itself will serve to reproduce the status quo. In relation to knowledge A, therefore, both spatial structure and the organisation division of labour can act in either a *conservative* (reproductive) or *generative* (productive) mode, and by and large this will be determined by the length of the model governing the degree of randomness in the system.

Strong and weak ties, local and global networks

But what about the *production* of knowledge B – the key question? Can space influence the advance of science? Here there are no answers, but there are suggestive studies. Before describing them, we would like to present two pieces of research that, while not concerned with space, have a bearing on the matter.

The first is the seminal work of Tom Allen[15] on communication and innovation in R & D organisations in engineering. To quote his own summary:

> Despite the hopes of brainstorming enthusiasts and other proponents of group approaches to problem solving, the level of interaction within the project groups shows no relation to problem-solving performance. The data to this point lend overwhelming support to the contention that improved

> communication among groups within the laboratory will increase R & D effectiveness. Increased communication between R & D groups was in every case strongly related to project performance. Moreover, it appears that interaction outside the project is most important. On complex projects, the inner team cannot sustain itself and work effectively without constantly importing new information from the outside world ... such information is best obtained from colleagues within the organization ... In addition, high performers consulted with anywhere between two and nine organizational colleagues, whereas low performers contacted one or two colleagues at most. (pp. 122–3)[16]

The second piece of research is Granovetter's work on strong and weak ties, presented under the title 'the strength of weak ties'.[17] The argument is that any individual has a close network of strong ties – that is, friends who tend to know one another – and a more diffused network of weak ties – that is, acquaintances who normally do not know one another. Weak ties thus act as bridges between localised clumps of strong ties and hold the larger system together. The wrong balance can be disadvantageous. For example:

> Individuals with few weak ties will be deprived of information from distant parts of the social system and will be confined to the provincial news and views of their close friends. This will not only insulate them from the latest ideas and fashions, but may also put them at a disadvantaged position in the labor market ... Furthermore, such individuals may be difficult to organize or integrate into politically based movements of any kind, since membership in movements or goal-oriented organizations typically results from being recruited by friends. (p. 106)[18]

Granovetter's work focusses primarily on social networks in the broader community, but he also reviews work on the role of weak ties in schools by Karweit et al.[19], and in a children's psychiatric hospital by Blau.[20]

Although Granovetter's work refers in the main to the generation of knowledge A, while Allen's refers to the generation of knowledge B, the two arguments are similar, in that both cast doubt on the long-assumed benefits of spatial and social localism (small communities, small organisations, small groups of neighbours) and point to the need for a more global view of networks. I have put forward similar arguments about urban space.[21] Recent architectural and urban theory has been dominated by social assumptions of the benefits of small-scale communities, and spatial assumptions of the benefits of localised 'enclosure' and 'identification'. The effect of both, however, seems to be to fragment the urban space structure into overlocalised zones that become empty of natural movement through their lack of global integration, and often show signs of physical and social degeneration in a comparatively short time.

All our analytic studies of the structure and functioning of urban space suggest that it is the global scale that is critical, whether to the structuring of co-presence through movement, the sense of safety, the development of social networks, or the distribution of crime. The local sense of place arises not from the existence of segregated local zones, but from different types of deformity in the global grid. The same applies to social networks. Good urban networks are not self-contained groups but distributions of probabilities within a larger, continuous system. The key to 'urbanity', we have concluded, lies in the way the local and global scales of space and networks relate to each other.

All of these suggest that what is needed is a theory of space in which the relations between local and global scales and the dialectic of strong and weak ties and of structure and randomness (through long and short models) all interact. Because any spatial structure has the capability to generate patterns of co-presence through movement, it also has the potential to generate ties. Spatially generated ties will clearly in the first instance be weak ties. The more localised the tie, the more one might expect space to have the potential to help turn a weak tie into a strong tie. Indeed, in the local spatial milieu, one might well expect the spatial strategies of individuals to be concerned with the avoidance of the overstrengthening of ties – in much the same way as there are special forms of social and spatial behaviour to resist the spatial pressure to make relations with one's neighbours stronger than is comfortable. The ability of space to generate weak ties lies, we suspect, in the middle ground between the immediate neighbouring group and the larger-scale trans-spatial network that is more or less independent of space.

Probabilistic inequality genotypes in two research laboratories

We can now look at cases. Figure 7.2a is the open space structure of Lab X and figure 7.2b the same for Lab Y. Lab X was constructed in two phases according to a single planning system, but the Lab Y building is divided into the 'old building' (horizontal in the plan) and the recently added 'new building' (vertical in the plan).

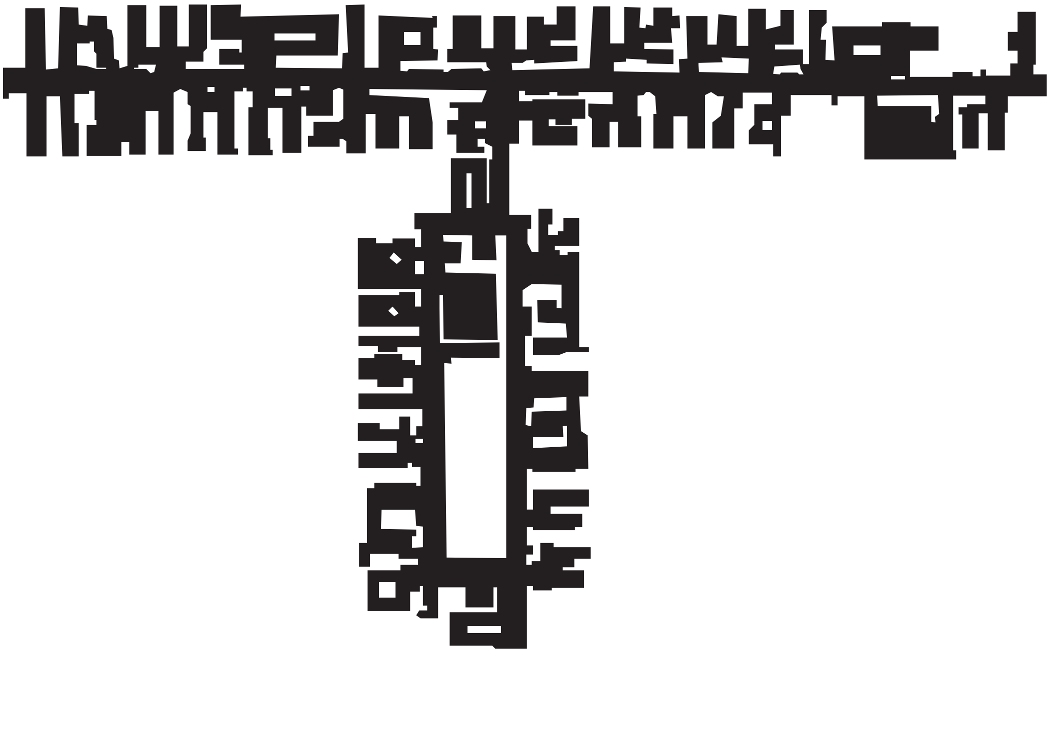
Both Lab X and Lab Y belong to well-known organisations, but each has a distinctive research style and management structure. Lab X is the lab of a large, well-established public charity specifically concerned with a certain range of diseases. Its director sets up and funds (according to reputation, often lavishly) teams led by eminent research leaders, whose task is to pursue specific goals laid down by the charity. The research programme is thus geared to specific medical and therapeutic goals. Lab Y is oriented more to the academic production of knowledge and has a less goal-directed, more individually entrepreneurial form of organisation; its members for the most part define their own research programs. Both are highly successful, but in terms of top-level performance (as measured by, for example, the number of Nobel prizes) there is little doubt that Lab Y would have to count as the higher flier.

What figures 7.2a and b show is a useful way of representing the difference in the spatial layout of the two labs. In each figure, all the 'free space' – that is, the space in which people can work and move freely – is coloured black. This shows that in spite of the basic cellular form of each building, there are fundamental

Visible colleges

Figure 7.2a
The open space structure of Lab X

Figure 7.2b
The open space structure of Lab Y



Visible colleges

Figure 7.2c
The axial integration map of Lab X. The axial map passes the fewest and longest straight lines of access through the free floor space.

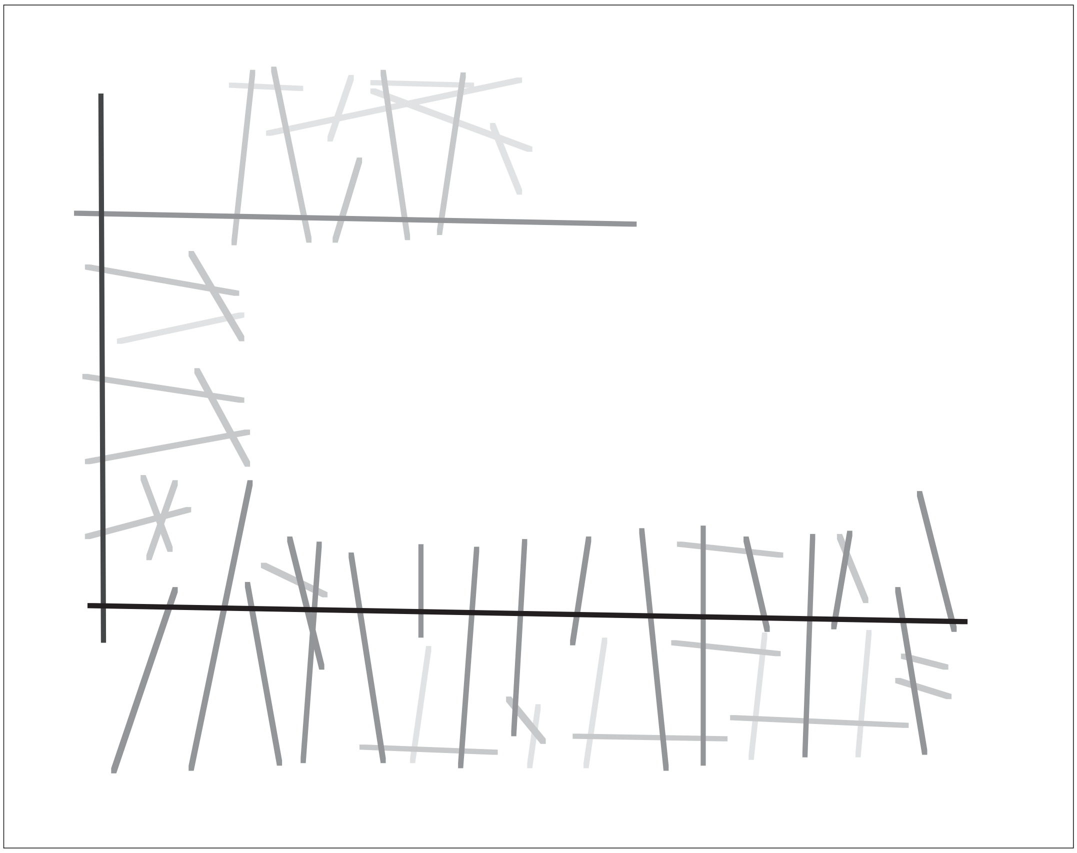
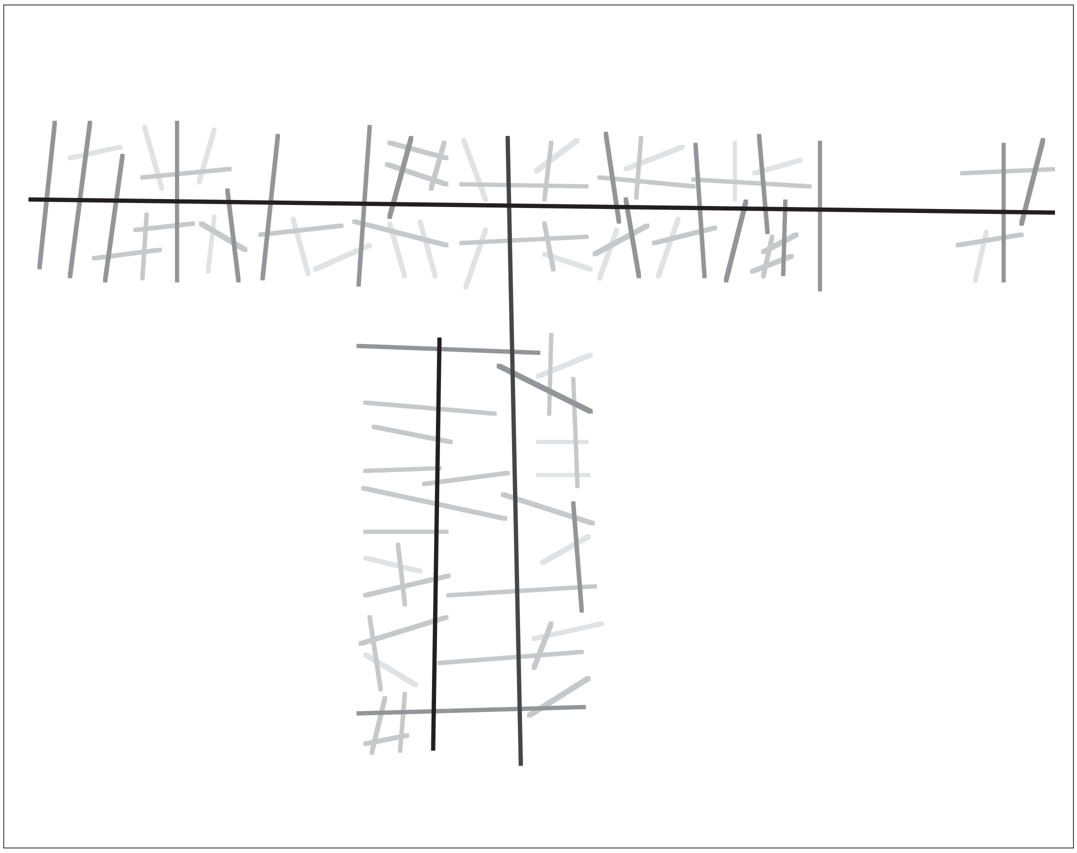


Figure 7.2d
The axial integration map of Lab Y.



configurational differences between the spatial layouts of the new and old parts of Lab Y, and between Lab X and the old part of Lab Y. In the latter case, the differences have arisen from a protracted process of spatial mutation and adaptation.

The most important configurational difference between Lab X and the old part of Lab Y is that while both have created internal permeabilities between groups of cells, links are deep (on the window side) in Lab X and shallow (on the corridor side) in Lab Y. The new part of Lab Y, however, seems to combine properties of both. These differences are shown more clearly in the 'axial' maps of each lab, given in figures 7.2c and 7.2d, showing the differences in the location of the intercell links. There are no discoverable technological reasons for this difference. However it is repeated on other floors of the same buildings. Even more strikingly, in a new building housing new labs of both organisations, the floor layouts adopted by each show exactly the same type of differentiation.

There also seem to be fundamental differences in the space use patterns of Lab X and the old part of Lab Y. The old part of Lab Y seems to the causal observer to be a hive of activity, whereas the new part and Lab X seem to be scarcely occupied at all until one leaves the corridor and enters the lab itself. This initial impression seems to be contradicted by the actual densities of use. In terms of number of persons divided by the full lab area, or the quantity of free floor area (the total area minus that occupied by benches and equipment) per occupant, average densities are almost identical in the two layouts.

However, the *pattern* of use is quite different, in each case following the pattern of spatial adaptation. The most obvious difference is that Lab Y has space use and movement rates in the main corridor about five times as high as those in Lab X, with a substantial component of interaction between two or more people occurring in the corridor.

We can make the pattern differences clear by dividing activities into four broad kinds: contemplative activities (such as sitting, writing), practical activities (such as working at the bench, which usually involves a certain degree of local movement), interactive activities (such as conversing or taking part in discussions) and non-local movement (i.e. movement that is basically linear and on a larger scale rather than describing a local convex figure, as would usually be the case for movement involved in working at a lab bench). We will describe an activity as occurring deep in the lab insofar as it occurs toward the window side of the lab and away from the corridor, and shallow insofar as it occurs toward the corridor side. Obviously since both buildings are corridor-based, most non-local movement will be in the shallowest space – that is, the corridor itself.

In Lab X, contemplative activity concentrates deep in the lab, by the windows (almost never in the offices provided for this!), practical activities are usually spread over the full depth of the lab, and interactive activities concentrate in the region of the axial lines linking the lab bays together (see table 7.1). These links occur deep in the lab, which means that interaction tends to occur in the same areas as contemplative activities, close to local movement but maximally far from non-local movement.

Visible colleges

In Lab Y, contemplative activities again occur deep in the lab by the windows, practical activities tend to concentrate toward the center and shallow areas, and interactive activities concentrate strongly in the shallow areas close to the corridor – as in the previous case, hugging the axial line linking the lab bays together (see table 7.1). This means that interaction occurs both close to local movement within the lab, as in the previous case, and close to non-local movement in the corridors, where a significant degree of interaction also occurs.

Put simply (and inevitably simplifying the real situation somewhat), we can say that in Lab Y, contemplative activities are deeper than practical activities, while interaction is shallow and close to non-local movement. Using the symbol ‘<’ to mean ‘shallower than’ we can say that in Lab Y: *movement* < *interaction* < *practical* < *contemplative*. In Lab X, both contemplative activities and interaction are deeper than work, and remote from non-local movement, so we can say that in Lab X: *movement* < *practical* < *interaction* = *contemplative*.

Table 7.1 below gives the mean distance (in metres) of each of the activity types from the local intercell links in each building. Since the distance is the mean of a large number of observations of individual workers, it provides a ‘statistical’ picture of activity in the two buildings. This picture shows that interaction stays close to the intercell links in both buildings, but that this leads to its being close to global movement in Lab Y and removed from it in Lab X.

Table 7.1

	Movement	Interactive	Practical	Contemplative
Lab X	4.9	.93	2.85	1.09
Lab Y	1.3	1.17	1.41	2.03

These formulae summarising the spatial dynamics of each organisation resemble the ‘inequality genotypes’ noted in domestic space. But whereas the domestic inequalities were an association of function labels with integration values, and were therefore more like a Lévi-Straussian mechanical model, in the case of labs the inequalities are purely probabilistic, representing activity types rather than social categories, and therefore resemble a Lévi-Straussian statistical model.

We might call these formuale expressing differential spatial dynamics ‘probabilistic inequality genotypes’ and note that while both are short-model they affect the dynamics of the organisation differently. In Lab X, the probabilistic inequalities would seem to work to reinforce local ties and make them stronger, thus reinforcing the local group at the expense of the larger group. In Lab Y the inequalities seem to act more to create weak ties at the larger scale and link the local group to a larger-scale level of between-group contact.

We cannot yet demonstrate that these have effects on research productivity. What we can say is that the pattern exists, giving rise to a morphological concept of work organisations as something like ‘space-use types’, with suggestive relations both to organisational objectives and also to the theories of Allen and Granovetter.

Visible colleges

In terms of the organisational nature and objectives of each lab, it would seem to be a matter of how the boundaries of knowledge are to be drawn in space – that is, how the reproduction of knowledge is to be organised in support of the production of knowledge. In Lab X, the objectives are focussed and defined for the group by the organisation as a whole. The spatial structure of the lab and the spatial dynamics within it thus both mirror this structure and work to concentrate the efforts of a local, organisationally determined unit. In Lab Y, the more fluid organisation, based more on individual initiative than on group objectives (although defined by a commonality of academic interests), has created an intensively interactive spatial milieu at the scale of the floor as a whole. In both cases, specific forms of sociality are built into the work process itself, rather than being simply added on by special-event socialising – such as going to shared coffee locations or having joint seminars (although these also occur).

So far as the production of scientific knowledge – that is, knowledge B – is concerned, we might propose that the two forms of spatial layout have radically different implications. Whereas the statistical effect of the layout in Lab X has led to the separation of interaction within a lab from large-scale movement between labs, in the old building of Lab Y the two are brought into close probabilistic contact. However, the existing state of knowledge B is defined to some degree by the organisational divisions into different research groups studying particular defined areas and physical scales of science. In the case of Lab X it is tempting to suggest that the predominant spatial milieu leads to the reinforcement of these local, pre-existing boundaries of knowledge. In the old building of Lab Y, however, the tendency would be to break the existing boundaries through the random action of the spatial milieu at the large – between existing boundaries – level.

More generally – more speculatively – we might suggest that while organisations always tend to localism, the statistical tendency of the building will be either to reinforce this or to weaken its boundaries. Everything depends on the level at which the spatial structure of the building introduces randomness into the encounter field. Our instinct is to suggest that the more fundamental the research, the more it will depend on the globalising of the generative model. In contrast to organised events, weak ties generated by buildings may be critical because they tend to be with people that one does not know one needs to talk to. They are, then, more likely to break the boundaries of the existing state of knowledge represented by individual research projects, organisational subdivisions, and localism.

We might suggest that the morphogenesis of knowledge B – like all morphogenesis – requires randomness. How can randomness be inserted into the process by which knowledge B is generated? Obviously, since science is done by human beings, it must be by randomising the knowledge A inputs. It is at this level, it seems, that a building can operate to generate or conserve. Space is morphogenetic of knowledge B precisely because it can randomise knowledge A.

Visible colleges

Synthesis: creating phenomena and visible colleges

There is a debate as to whether basic science is an individual or a collective activity. The evidence we are finding (and which we have presented only as examples) is that it is how the one relates to the other that is critical, at least as far as the study of space is concerned. Space, we would suggest, articulates exactly this double need for the individual and the collective aspects of research: how to combine the protection of the solitary with the natural generation of more randomised co-presence with others – the need for which seems to grow the more the objectives of research are unknown.

But it is not just that the nature of scientific work requires this kind of socialisation. There is something else, we suggest, intrinsic to the nature of scientific research that gives it a special dynamic. It is customary to see science as a dialectic between theory and experiment, with (psychologically incompatible) theoreticians working in one corner and experimenters in another. Under the influence of such theorists as Popper and Lakatos, the late twentieth century has been preoccupied with theory (correcting an early failure to understand the deep dependence of phenomena on theory), seeing experiment increasingly as no more than the servant of theory.

Hacking (1983) disagrees, and sees experiment and theory as bound up in a quite different way. 'One role of experiments', he writes, 'is so neglected that we lack a name for it. I call it the creation of phenomena. Traditionally scientists are said to explain the phenomena they discover in nature. I say they often create the phenomena which then become the centrepieces of theory' (p. 220).[22] Phenomena, according to Hacking, are not the sense data of phenomenalism. Science is not made of such. Phenomena, for scientists, are significant regularities that are useful to speculation.

Phenomena are therefore not 'plentiful in nature, summer black-berries just there for the picking'. On the contrary, they are rare. 'Why', Hacking asks, 'did old science on every continent begin, it seems, with the stars? Because only the skies afford some phenomena on display, with many more that can be obtained by careful observation and collation. Only the planets, and more distant bodies, have the right combination of complex regularity against a background of chaos' (p. 227).[23] Because phenomena are so rare, they have to be created. This is why the creation of significant phenomena plays such a central role in the advance of theory.

Hacking, like most people in the philosophy of science, is working on big science. We are not philosophers of science and cannot offer useful comment on his propositions at that level. But we can apply his strictures to our own situation. Speaking as researchers who are trying to run a lab setup in a soft science, we know that the creation of phenomena is the center of what we do, even though we see our objectives as the creation of theory. Global spatial complexes with well-defined morphological properties, generated by a computer on a restricted random process, are created phenomena. So are inequality genotypes, integration cores, and scattergrams showing correlations between integration values and observed movement or crime frequencies.

Visible colleges

Of course, much of our discussion is theoretical. But theoretical debate centres on created phenomena, and it is created phenomena that continually destroy and generate theory. Theoretical debate survives distance. The creation of phenomena is harder to share at a distance. It is not because one discusses theories but because one creates phenomena that people cannot be absent for long without beginning to lose touch. The creation of phenomena, it seems, is more spatial than is theory. We suspect it may also underlie the more localised spatial dynamics of the laboratory. 'What's so great about science? Hacking asks. He then suggests it is because science is 'a collaboration between different kinds of people: the speculators, the calculators, and the experimenters'. 'Social scientists', he adds,

> don't lack experiment; they don't lack calculation; they don't lack speculation; they lack the collaboration of all three. Nor, I suspect, will they collaborate until they have real theoretical entities about which to speculate – not just postulated 'constructs' and 'concepts', but entities we can use, entities which are part of the deliberate creation of stable new phenomena.[24]

The locus of this collaboration is, we suggest, the research lab. A lab is where thoughtful speculators are close to the creation of phenomena. To be absent from the lab is not to be unable to theorise, but it is not to know quickly enough or precisely enough what to theorise about. This is not of course to say that the collaboration between theory and the creation of phenomena cannot proceed at a distance. On the contrary, it is obvious that it often does. But what science cannot do without, we suggest, is the existence of lab-like situations somewhere, where the creation of phenomena and speculation – and probably calculation too, if our experience is anything to go by – feed off each other.

Such *visible colleges* are, we suspect, the precondition for the existence of science's ubiquitous *invisible colleges*. Where they occur, a spatial dynamic will be set up, which will mean that, for a while at least, a good place will exist in which science can happen. That good place is, probably, a *generative* building. Only when such concrete realities exist somewhere within the abstract realm of the invisible college can that peculiar form of morphogenesis that we have called the creation of knowledge B become a collective phenomenon.

Appendix

The full study of laboratories, of which the results reported in this chapter were a preliminary, eventually produced an even more striking spatial outcome. The design of the study was informed by some of the results from Allen's study[25] of factors influencing success in innovation. In paired studies of defence research projects in the USA where routinely two independent teams are commissioned with the same brief and the performance of their design solution tested, Allen studied the information and communication networks used by the successful teams in arriving at innovative solutions. The most important contacts from the point of view of innovative problem solving were not those within the project team, but those between people working on entirely different projects. It was conjectured that it was these relations between groups that might be affected by building design.

The main phase of research which followed the pilot study therefore took a sample of twenty-four building floors in seven sites in different parts of the United Kingdom. The sample spanned public, private and university sectors, and covered a range of scientific disciplines. All the laboratories selected were considered 'good' within their field. The study itself addressed a wide range of spatial and environmental issues, and included detailed surveys of spatial and equipment provision, observations of space-use patterns and a questionnaire survey to determine the strength of communication networks. The questionnaire listed by name all, or a large sample, of the people who worked in the survey area. Respondents were asked to score on a five-point scale the frequency with which they had contact with each individual name on the list. They were also asked whether or not they found that person useful in their work. Although the questionnaires were confidential they were not anonymous, since we needed to know for each respondent which contacts were within their research group and which were between groups. We expected that within the research group everyone would know everyone else, see them daily, and find them useful in their work, and this turned out to be the case, without variation attributable to spatial structuring.

Between group contacts, however, we thought might show spatial variation. To investigate this we looked at the data not from the point of view of each individual, but counting how often each name on the list was cited by every other respondent. The intention of this 'reversed citation' method was to eliminate possible effects from different interpretations of the questions by different respondents. Each name on the list had an equal chance of being cited by each respondent. Using this method to investigate between group contacts, the findings were interesting. For example, respondents who were found most useful outside their own research groups were neither the most or least frequently seen. Usefulness and frequency of contact were clearly not the same thing.

But the most striking findings were spatial. First, the mean rate of inter-group contacts on each floor correlated with the mean degree of spatial integration of the floor considered as a spatial complex on its own, rather than in terms of its embedding in the whole building. The rates of 'useful' contacts, on the other hand, were strongly related to building integration for the floors considered in terms of their embedding in the whole building. More spatially integrated buildings, it seemed, increased the level of useful work-related inter-group communication that Allen had found to be so important for innovation. In other words, local integration predicted network density, but global integration predicted network usefulness. A still more significant finding resulted from relating the local and global measures together. The more global integration – which we might expect to be less than floor integration, due to the effect of vertical divisions or division of the building into zones following the enveloped shape – approached local integration, the better the ratio of useful to all contacts.

These are strong findings and suggest that spatial configuration in laboratory buildings can affect patterns of communication amongst researchers. However, it does raise a question regarding the precise mechanism that could give rise to these effects. Light has recently been cast on this through the work of Paul Drew and Alan Backhouse at the University of York.[26] In a study of large open-plan professional design offices they used careful observations and video recordings to look at the behaviour of workers engaged in work-related interaction. They found that when an individual is at his workstation he is usually regarded by others as engaged in work and should not be disturbed. However, should that individual leave his workstation to move to some other area, whether or not that movement is dictated by the needs of work, he is regarded as 'free' and so available for 'recruitment' into interaction. They write:

> In plotting the movements of individuals when away from their workstations, we found a markedly high incidence of 're-routings' – cases where a person notably deviated from his route of prior intention at the behest of another, or in order to recruit another person into interaction. As an individual moved into the vicinity of a 'significant' other, he would be (a) engaged or 'recruited', (b) his task orientation would be altered from the planned to the contingent, and (c) his prior task would become relegated to become a task 'pending' attention. The evidence for this was found in the high incidence of individuals responding to verbal and non-verbal recruitments, and altering their intended course of action to accommodate such recruitment. Interestingly, not only does the recruited undergo a task-reorientation, but the recruiter must also change his task as he cannot have planned or expected the appearance of the recruited. In this sense a clear division is apparent between the organisation of planned immediate work and the unplanned, contingent achievement. As such the accomplishment of 'work' is often a contingent and unplanned process. (pp. 16–17)[27]

This micro-scale mechanism suggests that movement in buildings may be more intimately involved in the work process than has hitherto been recognised or allowed for. If, as Backhouse and Drew suggest, a certain proportion of work-related interaction arises in this 'contingent' and unplanned manner, then providing the opportunity for movement and recruitment, and the recruitment which results, may be the key to maximising work-related communication. The model has other attractive properties. To the degree that movement takes people from one part of the organisation past workstations of people from other parts of the organisation, the opportunity for recruitment will serve to create contacts between organisational segments. If as Allen has suggested, these are the important contacts from the point of view of innovative problem solving, we can begin to imagine the way that this might work.

We can also imagine what will happen if we set out to design our buildings and organisations simply with efficiency in mind. Let us assume that the state of knowledge in the task area covered by an organisation is broadly understood by management and that pains have been taken to structure the organisation in a relatively rational way. It follows that groups within the organisation will reflect the current understanding and existing state of knowledge of the task area. People who this understanding gives us to believe need to interact often will be located within a group, those between whom there seems to be no rational need for communication may be separated. Steps may even be taken in the interests of organisational 'efficiency' to minimise the intrusion of unrelated groups on each other and to minimise the need for movement on the part of staff by making sure that all facilities required for work are conveniently located near to each group. These would seem to be reasonable steps to take in order to produce a rational and efficient building plan.

What would be the effect of such a plan on the progress of the state of knowledge in the organisation? By and large the existing state of knowledge in a field is a pretty good starting point for problem solving, but slowly it would become apparent that other organisations were making the innovative breakthroughs. These breakthroughs are so rare in any case that their lack may never be noticed. The solutions to problems in the 'efficient' organisation would largely be produced as a result of the people put together for that purpose by the organisation on the basis of current knowledge, and because the opportunity to interact with people outside that definition of knowledge would be reduced in the interests of efficiency, the boundaries of knowledge would seldom be challenged or broken.

In this sense, organisational efficiency and true innovation may sometimes run counter to each other. Innovation requires probabilistic interaction and the opportunity to recruit provided by bringing the larger-scale movement structure closer to the workstation. Moreover it requires that the larger-scale movement takes people with knowledge in one field past people with problems to solve in another. In this way it seems possible that spatial configuration of buildings and the disposition of the organisations that inhibit them are actively involved in the evolution of the boundaries of scientific knowledge itself.

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