The Spatial Syntax of Urban Segregation

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This issue of Progress in Planning, edited by Laura Vaughan, includes the following chapters:

1 *The city as one thing* by Bill Hillier and Laura Vaughan
2 *The spatial form of poverty in Charles Booth's London* by Laura Vaughan
3 *Social housing and segregation in Sweden* by Lars Marcus
4 *Social exclusion and transportation in Peachtree City*, Georgia by Ruth Conroy Dalton

Abstract

Space syntax is a set of theories and techniques about buildings and cities and how they function, rooted in a theory of society and space that originated at the UCL Bartlett School of Graduate Studies in the 1970s. The ability of space syntax methods to objectively measure the physical and spatial attributes of cities in relation to patterns of human activity has led to hundreds of projects, covering subjects as diverse as the relationship between burglary and housing layout, the architecture of Inuit snow houses and visitor movement in museum layouts. This special issue of Progress in Planning will focus on some of the contributions made by 'space syntax' to a subject that is becoming of increasingly wide interest: the relationship between urban form and social segregation.

The issue begins with an overview by Bill Hillier and Laura Vaughan of space syntax as a theory of the city and a set of techniques for analysing its spatial form. This is followed by a chapter by Laura Vaughan that analyses poverty and spatial form in Charles Booth's maps of 19th century London, describing new findings relating to the persistence of poverty areas and immigrant 'ghettos' and proposing a spatially defined line of poverty, distinguishing between poor, spatially segregated streets and more prosperous, spatially integrated streets. Following this, a chapter by Lars Marcus suggests that segregation is inherently a spatial problem. He demonstrates this through a detailed analysis of residential segregation and social integration in public space of housing estates constructed through the Swedish Million Homes Programme. In the penultimate chapter Ruth Conroy Dalton discusses segregation in the US context, through a study of social exclusion, transportation equality, transit equity and leisure trail use in Peachtree City, Georgia, showing that the accessibility of leisure trails coupled with the flexibility and relative affordability of electric golf carts, means that the level at which families and individuals are disadvantaged through their lack of access to public/private transport is effectively lowered. The issue ends with conclusions regarding the future of segregation in the urban context and some recommendations for policy makers and urban planners.

1 The City as One Thing

By Bill Hillier and Laura Vaughan

Abstract

This paper summarises the latest theories in the field of space syntax. It opens with a discussion of the relationship between the form of urban grids and the process of how cities are formed by human activity; this is done by a comprehensive review of space syntax theory from its starting point in the 1970s. The paper goes on to present research into how cities balance the micro-economic factors which shape the spatial structure of cities with the cultural factors that shape the underlying form of residential areas. It goes on to discuss the relationship between activity and space and how this relationship is formed by the way different activities make different demands on movement and co-presence. The paper ends with a discussion regarding the manner in which patterns of spatial integration influence the location of different classes and social groups in the city and contribute to the pathology of housing estates. The paper concludes that spatial form needs to be understood as a contributing factor in forming the patterns of integration and segregation in cities.

Is The City One Thing Or Two?

On the face of it, the city is two things: a large collection of buildings linked by space, and a complex system of human activity linked by interaction. We can call them the physical city and the social city. Urban practice and theory must connect one to the other. But the reflective disciplines which support and nourish both - roughly the morphological disciplines on one side and the social sciences on the other - in their nature take an asymmetric view, foregrounding one city and backgrounding the other, in effect seeing the 'other' city *through* the foregrounded one, and so at best as a shadowy set of patterns and forces. It is no surprise then that, at the start of the twenty first century, we have many partial theories *about* the city, but no theory *of* the city as both of the things that it seems to be.

But is the city in any case two things or one? It will be one to the degree that the physical and social cities act conjointly to produce significant outcomes. There are good reasons why in principle we might expect it to be one thing. The social city is *either side* of the physical city: it brings it into existence, and then acts within the constraints it imposes. It seems unlikely that either is a wholly contingent process. But both relations raise uncomfortable issues of *determinism*: how can a *physical* process in the material world relate to a *social* process in a non-trivial yet systematic way. This places philosophical as well as methodological obstacles in the path of reflection and research.

In practice, we also find that any time, intervention in the city is governed by a consensus of beliefs and practices about the city as one thing: that small scale inward looking residential developments promote community, for example, or that mixed use reduces crime, or that lower densities lessens the danger of social malaise. But these beliefs shift over time, often dramatically, and it is hard to think of a case where a one thing proposition has acquired the status of a tested – or even testable – scientific proposition. The beliefs and practices allow us to act as though the city were known to be one thing, because this provides a rationale for our interventions, but all our formations and paradigms make the tacit assumption that the cities can safely be treated as two.

Paradoxically, the real challenge to our two city paradigms comes not from the well-formed, well-functioning city, but from its - real or apparent - pathology. Where cities seem to go wrong, often as a result of belief-based interventions which come in time to appear mistaken, the problem of one city confronts us with immediacy and urgency by demanding to know if there is any sense in which the physical and spatial form of our interventions has contributed to their apparent failure. The challenge was posed in the second half of the twentieth century by the precipitate decline of many ambitious social housing schemes, and the widespread public belief that the physical and spatial form of these experiments was somehow involved. Today it is posed in a more general form as the problem of the social segregation in the city, its nature, its causes and its consequences. We can easily formulate ideas about segregation purely in terms of social and economic factors without invoking space. But segregation is a spatial term and the way in which patterns of segregation and exclusion cluster in the city leads us back to the one city question: does urban segregation

have a significant physical meaning over and above its social meaning? Can segregation be, or become, a *one city* phenomenon?

The idea of space syntax

Space syntax was conceived in the nineteen seventies as an attempt to address this kind of *one city* question. Its genesis was in the remarkable architectural changes which began to appear in cities like London in the nineteen sixties, and the increasing sense which they engendered of a contradiction between – as seemed at the time - their striking architecture and the discomfiting and un-urban nature of their spaces. Space syntax began from the observation that space is the common ground of the physical and social cities. The physical city is a complex pattern of space, while all social activity and interaction happens in space. In itself, of course, this leads to an impasse. All social activity leaves spatial traces in the form of recursive patterns, but how can these relate to a physical and spatial context whose essential patterns were in all likelihood laid down long ago, under the influence of quite different social circumstances? On reflection, the radically different rate of change of the physical and social cities seems *in itself* to forbid anything but a contingent relation between the two.

But space syntax added to the existing panoply of spatial concepts a new one that potentially reshapes research questions: spatial *configuration*. The hope was that by learning to describe and analyse different kinds of spatial configuration, or pattern, in the city – for example the differences between the new social housing and traditional urban areas, which seemed *prima facie* to be critically different – it would be possible to detect any influence there might be of social factors in the construction of the these spatial patterns and also to explore any consequences there might be in terms of how social life could and did take place. By learning to control the spatial variable at the level of the complex patterns of space that make up the city, we might begin to gain insight into both the social antecedents and consequences of spatial form, and so detect signs of the social city *either side* of the physical city.

In syntax terms, spatial *configuration* means relations between spaces which take into account other relations, and so in effect relations between all the various spaces of a system. Space syntax, in effect, takes certain common measures of relationality in graphs, and first theorises them in terms of their potential to embody or transmit social ideas, and then turns them into measures and representations of spatial structure by linking them to geometric representations of the system of spaces under examination (Hillier and Hanson 1984). These measures are essentially formal interpretations of the notion of spatial integration and segregation, and it was the formalisation of these terms which first seemed to identify structures which linked the social and the spatial. Providing a measurable scale from *segregation* to *integration*, enabled statistical comparison of different spatial forms across cultures, and so provide a platform from which social origins and consequences might be investigated.

This was an unfamiliar idea. It was, in effect, being suggested that space has its own formal logic prior to acquiring a social logic, and indeed that it was this logic of space that was exploited in order to render space *social*. This is the core argument of 'The Social Logic of Space'. The autonomous potential of space to form patterns was, in effect, seen as the means through which it is able to give expression to social meanings. This challenged paradigms on both side of the two city divide. But it also suggested that there could be a one city approach to urban research which was both quantitative and informed by the search for social and cultural influences and meanings.

From these beginnings, space syntax has evolved into a set of tools linked to a set of theories, the two together giving rise to a set of interpretative models for different socio-spatial phenomena. Interpretative models are schemes of analysis which work for particular phenomena. For example, we have an urban movement model, a land use model, a crime model, even a social segregation model, and most important of all a general urban model in which the integration-segregation dimension is shown to be a primary spatial dimension on which cities are organised. These models are quite unlike the more familiar engineering models, since they seek to be *explanatory in themselves* of the phenomena they address. They show that by clarifying space in a particular way the social origins and consequences of the spatial patterns can be brought into clear view. It is because they seek to be explanatory in themselves that syntax models have proved to be so applicable in design.

In what follows we first explain the foundations of space syntax, and go on to give an overview of the range of techniques that are now available, and what questions can be addressed with them. We then outline the general theory of the city to which this has given rise, which shows why the issue of integration-segregation

is close to the heart of what cities are when considered as one thing. We then outline a series of characteristic research problems that have been addressed with space syntax, and the kinds of models we have developed to try to solve them. We follow this with sketches of a few of the hundreds of projects on which space syntax has been applied in recent years, and introduce the other parts of this special issue.

Foundations

Space syntax is built on two formal ideas which try to reflect both the objectivity of space and our intuitive engagement with it. The first is that we should think of space not as the background to human activity, as we think of it as the background to objects, but as an *intrinsic* aspect of everything human beings do (Figure 1.1) in the sense that moving through space, interacting with other people in space, or even just seeing ambient space from a point in it, all have a natural and necessary spatial geometry: movement is essentially linear, interaction requires a *convex* space in which all points can see all others, and from any point in space we see a variably shaped, often spiky, visual field we call an *isovist* (Benedikt 1979).

Each of these geometric ideas describes some aspect of how we use or experience space, and this makes it useful to try to see how buildings and cities are organized in terms of these geometric ideas. For example, it seems to matter that space in cities is for the most part linear – streets, boulevards, avenues, alleys and so on are all linear concepts - with occasional convex elements we call squares or public open spaces, each the centre of a variable isovist. In fact, urban space has all three properties, and by being clear about this geometry we can begin to see why urban space is the way it is.

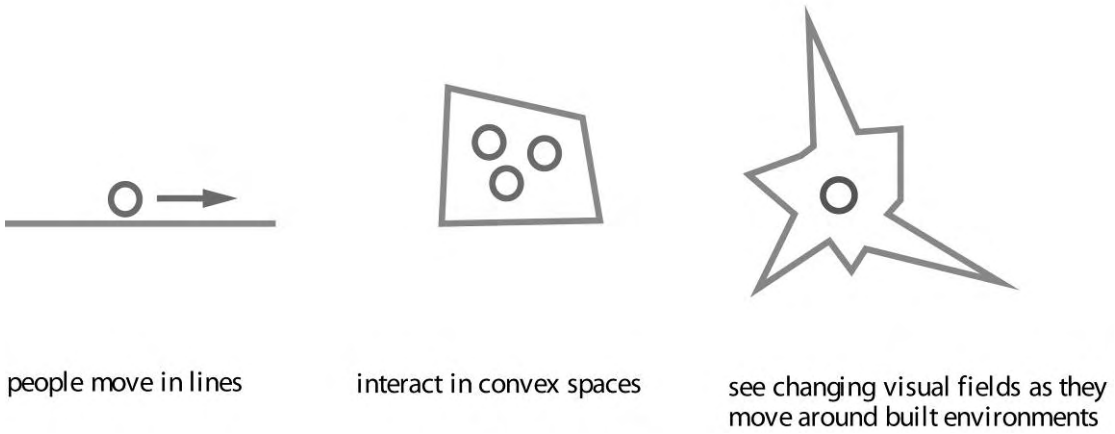

Figure 1.1 Space is not a background to activity, but an *intrinsic* aspect of it

The second idea is that human space is not just about the properties of individual spaces, but about the inter-relations between the many spaces that make up the spatial layout of a building or a city. This is what we formally call the *configuration* of space, meaning the *simultaneously existing* relations amongst the parts which make up the whole. It is notable that language has terms for spatial configurations, but insofar as these are precise, they describe at most relations between three entities. English prepositions such as between, beyond or inside all fall into this category. For more complex patterns of space, the undoubted competence that people have in understanding them seems to be, like the structure of language, at the unconscious level of ideas we think *with* rather than *of*, since we do not have precise terms for more complex patterns of space.

The reason configuration matters is that it is able to express the property of space that, more than any other, is the means by which space both acquires social meaning and has social consequences: that a spatial configuration not only looks but *is* different when seen from different points of view in the layout. We can make this visually clear by taking the layout in Figure 1.2, and drawing *justified graphs* (in which each circle is a room and each linking line a door, and the graph is aligned upwards in layers from each space in turn) from spaces 5 (left) and 10 (right) to show what the pattern of space looks like from each. The two graphs look quite different, in that one is shallow and the other deep, but are of course the same graph looked at from different points of view. But although different, each graph gives a true picture of what the layout looks like from that space, and so expresses a real property of the layout.

The shape of the justified graph, or *j-graph*, then leads us to our measure of integration-segregation. The shape of each graph shows the degree to which we must pass through other spaces to go from a particular space to all others. This will be high or low according to whether we have a shallow graph, as on the left, or a deep graph, as on the right. To the degree that the graph from a space is *shallow* we say it is *integrated*, and to the degree that it is *deep*, *segregated*. So we can index each space in the layout in terms of the degree to which it integrates the complex, and the average for the whole will be the degree of integration or segregation of the whole complex[1].

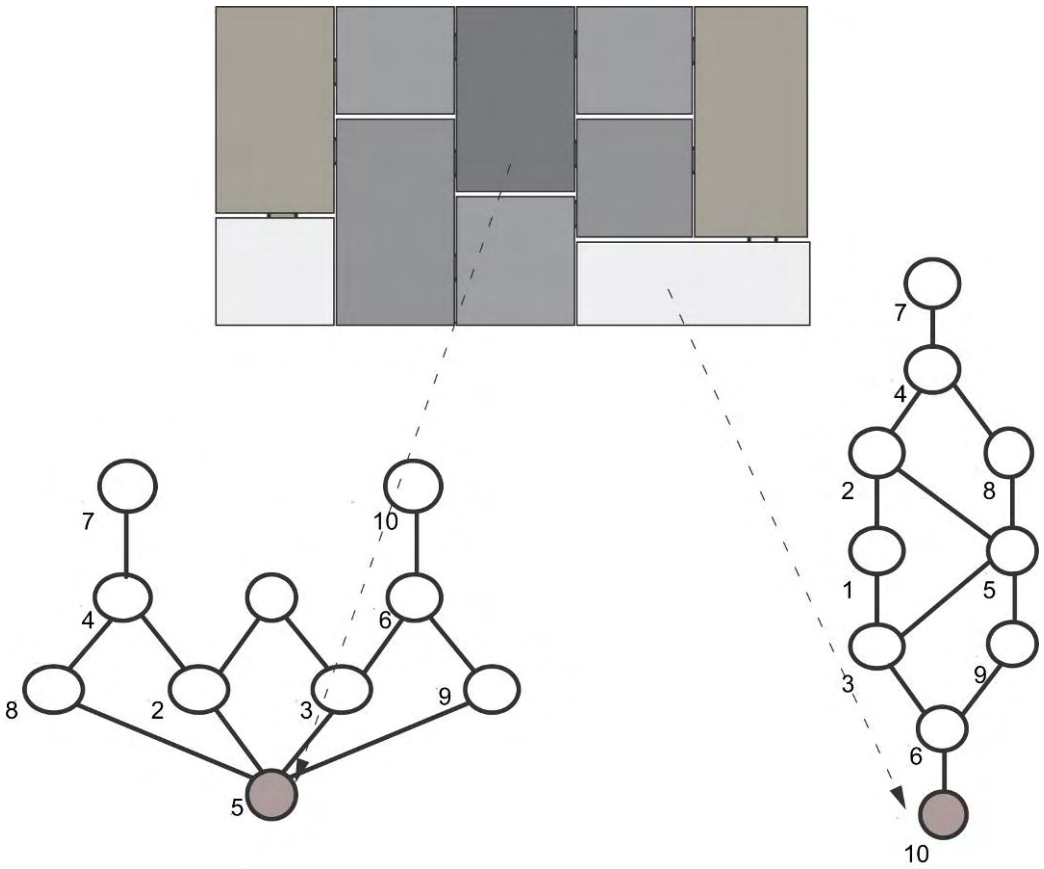

Figure 1.2 A spatial layout both looks and is different when seen from different spaces within it

Space syntax is about applying configurational measures to the patterns of different geometric elements that are created by buildings and cities. Whether we choose lines, convex spaces, isovists, or even points as the elements for our analysis depends in what aspect of functionality we are investigating, that is, what aspect of human spatiality we are investigating.

Making buildings speak

By looking at space in this way, we can begin to see both how social and cultural patterns are imprinted in spatial layouts, and how spatial layouts affect functioning. For example, at the simplest level, we can show how cultural differences are expressed through the layout of rooms in domestic space. If we take the French farm house in Figure 1.3, we find the *salle commune* (the space of everyday living and reception of informal visitors) is the most integrated internal space and the *grande salle* for formal reception the one of the most segregated, along with the *bureau* of the male owner. We can show such patterns visually by using colours to index numerical values, always using darker greyscale for the most integrated through to light greyscale for least. ‘Colouring-up’ is a vital aspect of space syntax research, since it allows us to search for patterns visually, and therefore intuitively, as well as using simple mathematics. We also find that the salle commune lies on all rings of circulation, so that if you remove it, the layout becomes virtually a single sequence of spaces. This is not always the case in French houses with 'salles communes'. Sometime a transition space - say a hallway or corridor - is the most integrated space, and where this is so, the salle commune loses is dominant spatial role. Our studies suggest that this may be to do with gender roles, since the integrated salle commune is a space dominated by female activity (Hillier, Hanson & Graham 1987).

This is one example of the ways in which spatial configuration is shaped by culture. In general, to the degree that integration values for different activities in the house are in the same or a different order, we can see evidence of cultural commonalities or differences across a sample. What we are seeing is the constructive effect of society and culture on spatial patterning; by giving function a configurational meaning in the layout, in addition to expression through equipment, furnishing and decorative style.

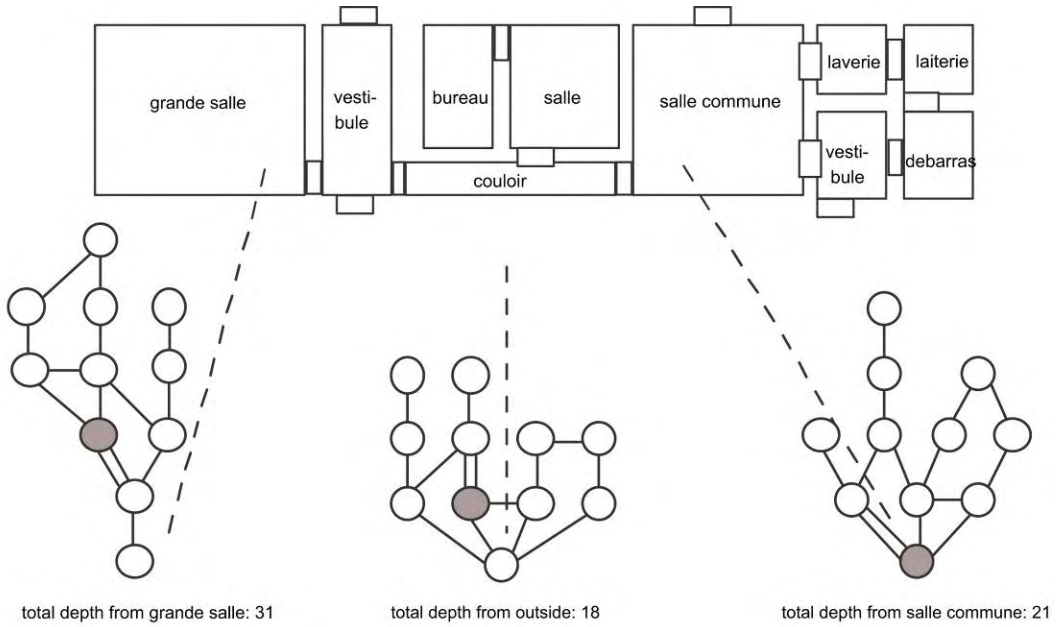

Figure 1.3 The layout of a house looks more or less integrated from different points of view

We can also use space syntax to investigate the *effect* of spatial layout on functioning. In Figure 4, we show on the left traces of 100 people entering the Tate Britain gallery in London and moving about for ten minutes. On the right is a more complex version of the analysis we saw with the house, a *visual integration* analysis of all the visual fields from every point in the Tate plan. Technically, it draws the visual field from the centre of each square of an arbitrarily fine tessellation filling the plan, overlaps these so that an overlap counts as a connection, and calculates how many visual fields you need to use to get to see the whole gallery from any point within it. Again, the darkest locations are the most visually integrated, through to lightest for the least. It is easy to see that the movement and space patterns resemble each other as patterns quite closely.

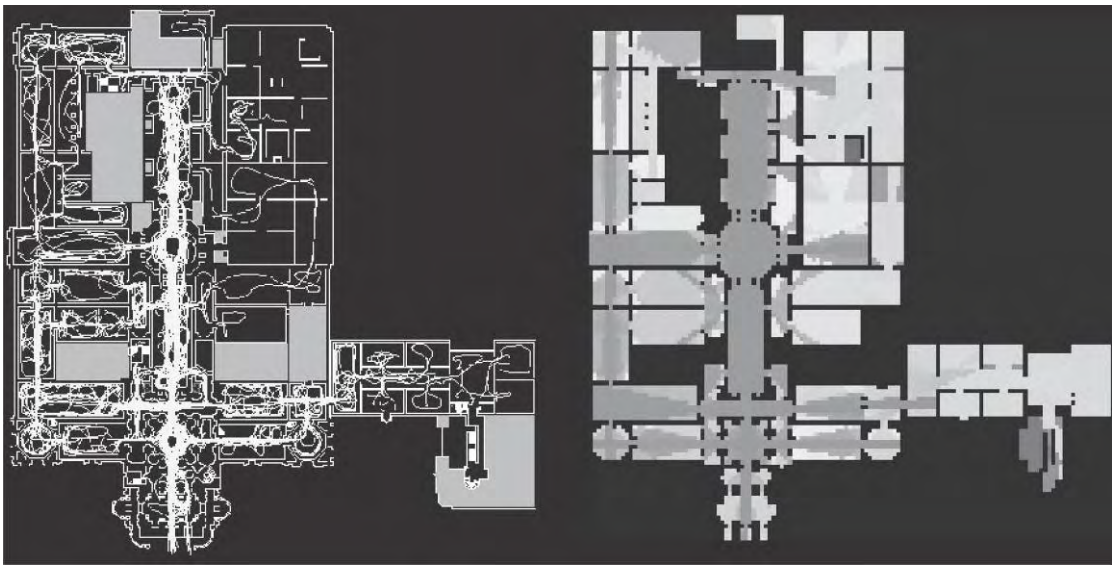

Figure 1.4 First ten minute movement traces (left) and *visual integration* analysis (right) of Tate Britain

We can check this statistically. By correlating the *visual integration* values with observed movement, it turns out that about 68% of the differences in movement rates in rooms can be accounted for by the visual field structure, implying that people are using the space structure of the Gallery, rather than, say, the attractive powers of particular exhibits, to guide them around the gallery (Hillier et al. 1996).

This then is how space syntax works. By analysing space rigorously, and observing human activity carefully, we can show that space and social activity relate in two ways: a spatial layout can reflect and embody a social pattern, as in the case of the French house, where space was laid out and categorised to give reality to a culturally given pattern of activity, and so reinforce and reproduce it; and space can also shape a potentially social pattern, as in the case of the movement study, since by shaping movement, space also creates a pattern of natural co-presence in space.

Another way of saying this is that space can be used both in a *conservative* mode to structure and reproduce existing social relations and statuses, usually by using space to segregate, and in a *generative* mode to create the potential for new relations by using space to create co-presence through integration. As we will see, the conservative mode leaves things much as they are, while the generative mode, by creating a richer field of potential encounter, can lead to the appearance of new social connections.

The basic urban relation

The distinction between the two modes of generating space on the integration-segregation dimension is critical to understanding how the social city is *either side* of the physical city, that is, how the space of the city comes to embody social ideas in its layout, and how the layout has consequences for the ways in which collections of building come to life - or fail to thrive - as living cities. First we must understand a relation we glimpsed in the Tate example, and which we have come to see as the basic urban relation: that the configuration of the urban street network, which is the largest spatial pattern in the city, is *in and of itself* a key determinant of movement flows and so co-presence in space. This may not sound very significant, but it has huge consequences for both the form and functioning of cities. We call it the theory of *natural movement* (Hillier et al. 1993). To some this will be an unexpected idea and smack of long discredited determinism. We will argue that it is nothing of the kind, and that, on the contrary, it is – with a little reflection - intuitively clear, mathematically necessary and empirically demonstrable. It is also the key to understanding cities as socially meaningful patterns of relative integration and segregation.

First, let us look at the idea intuitively. Consider the notional grid in Figure 1.5a with a main street, cross street, side streets and backstreets. Imagine that the streets are lined with houses, and people move between the houses by the more or less direct routes:

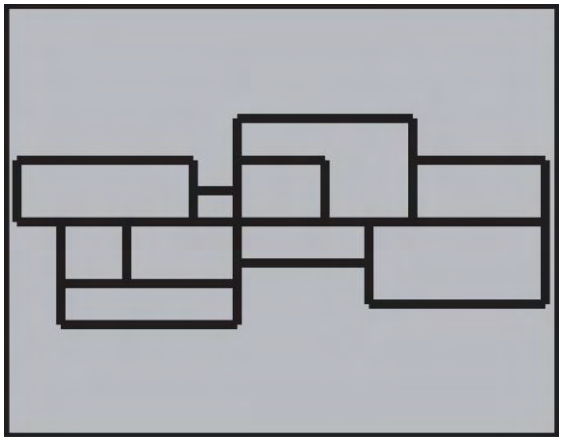

Figure 1.5a A notional grid with a horizontal main street, vertical cross street, side streets and back street

It is clear that more people will pass *through* the main street than the side streets or back streets, and more people will pass through the central sections of the main street than the peripheral ones. The main street is easier *to* get to than other streets - it is more accessible. The cross street also seems to have good potentials for both *to* and *through* movement, but we would guess it to be less than the main street. What is clear is that we intuitively expect the position of each street in the overall grid to affect emergent *to*- and *through*-

movement flows in streets and their different parts. It is not a matter of psychology, but the way the grid is put together.

Now to- and through- movement are the two principal components of human movement. For every trip, we select a destination to go to, and a series of spaces to pass through on the way. Both obviously matter to how cities work. For example, over time we are likely to go to more near than far destinations, so if some locations are in some sense 'nearer' too all locations within a certain radius than others, as in Figure 1.5a, this will give these locations greater potential as destinations than others simply by virtue of have easier accessibility. If we want to open a shop, for example, it would make more sense to put it in an accessible rather than inaccessible location. Similarly, if routes between all pairs of spaces in a layout pass through some spaces more than others, as is clearly the case, it will likewise be sensible to locate the shop in one of those spaces, though it may not always be intuitively obvious which these spaces are. The point is that these potentials are commonsense and even familiar properties of spatial layouts.

Both of these potentials can be measured. The measure of accessibility for to-movement of a space is our integration measure. The measure of through-movement potential assesses the degree to which each space lies on simplest or shortest paths between all pairs of spaces in the system. In syntax this is called the choice measure[2]. Figures 1.5b and 1.5c show the integration and choices measures applied to the axial map, and coloured up in shades of grey from dark for integrated, to light for segregated. Syntax also applies both measures at different radii, that is, it calculates integration with respect to the system up to a certain distance away, and choice for trips up to a certain length. This allows us to apply both measures on a continuum from local to global, yielding a powerful matrix of measures to investigate structural features of urban space in terms of its basic movement potentials.

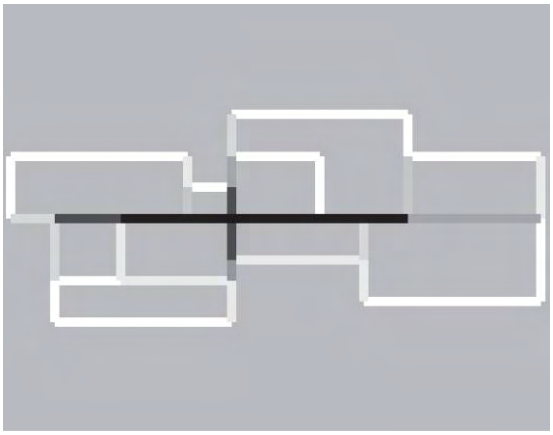

Figure 1.5b Notional grid: pattern of 'integration' values - or the closeness of each line to all others - from dark for highest through to light for least

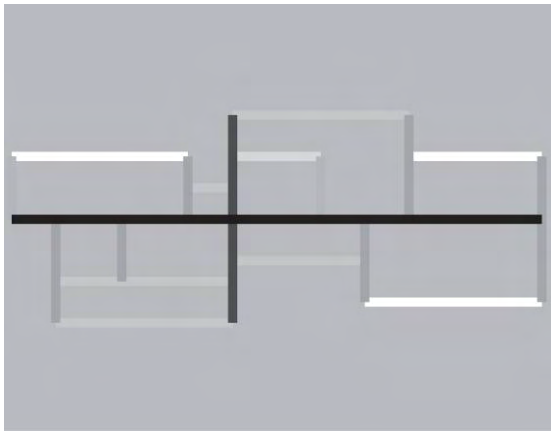

Figure 1.5c Notional grid: pattern of 'choice' values, or the degree to which each line lies on simplest paths from each line to all others, from dark for highest through to light for least

But what should we apply these measures to? Urban space is after all continuous and more often than not offers no obvious or natural division into units. The syntax approach to this question was first to take the predominantly linear nature of urban space seriously, and propose a representation of the street network based on the longest and fewest lines that could be drawn through the system (Hillier and Hanson 1984)[3]. We then treated the lines as the elements of a graph, with the junctions as links[4], and we could then calculate the measures of integration and choice at variable radii as we wanted. The decision to make the lines into elements, had the effect of internalising the line structure into the graph, and so in effect capturing key features of the geometry of the street network in the graph.

These *least line* axial maps turned out to have some remarkable properties. First they turned out to have a fractal nature (Carvalho and Penn 2004), in that all urban street networks, from Shiraz to Chicago, at whatever urban scale we consider them, are made up of a very small number of long lines and a very large number of small lines. Second by simply applying the *integration* and *choice* measures to the least line map and correlating the spatial values with observed movement rates, we commonly found that somewhere between 60% and 80% of the differences in movement flows along lines could be accounted for in terms of the configuration of the grid itself (see Hillier 1989, Hillier and Penn 1996 and etc.)

There was a second problem. In making our calculations on the basis of the axial map, we are in effect calculating distance as the number of times we have to turn (that is, to move from one line to another) go from one line to another. Is this how human beings do it? It is commonly assumed that people, insofar as they make spatial (as opposed to temporal) judgments in selecting routes, will simply minimize distance. But there is increasing evidence that our notions of distance are severely compromised by geometrical and topological factors, and even by the direction in which the estimate is made[5]. To solve this problem, and also to make the analysis more precise, a far more powerful and disaggregated version of the line analysis technique has been developed (Hillier and Iida 2005). Starting from the least line axial map, we divide each line into its segments (between intersections) and represent the segments as the nodes of the graph with the intersections as links. We then assign integration and choice measures using different definitions of distance: *shortest path (metric), least angle change (geometric), fewest turns* (*topological)* weightings to relations between each segment and all others, and we apply them at different *radii* from each segment, also defining radii for shortest, least angle change, and fewest turns paths. This yields a matrix of measures which we can use to see explore how people actually move in cities (Figure 1.6) (Hillier and Iida: 479).

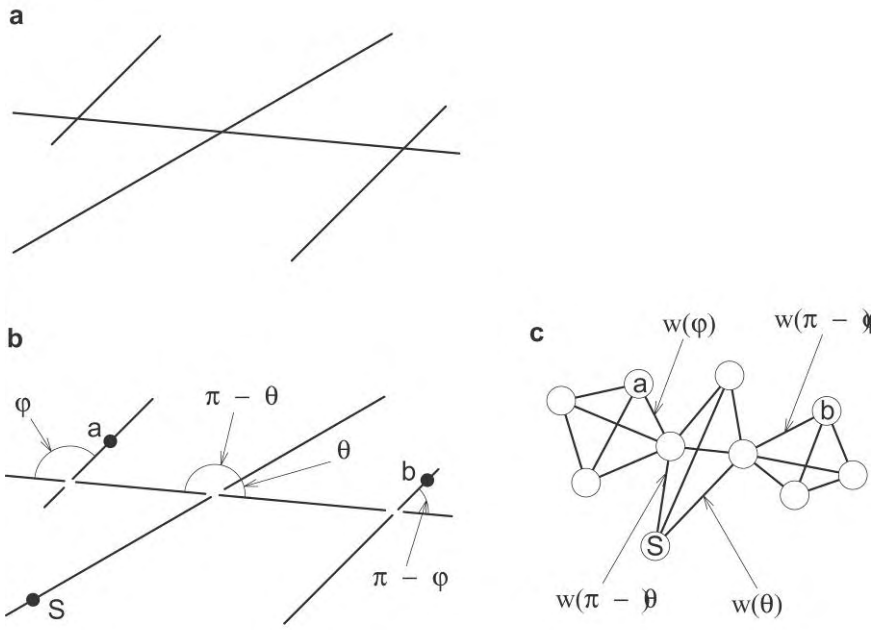

Figure 1.6 From the line model to the segment model

With these techniques, we can make different mathematical analyses of the same urban grid, and then ask which analysis agrees best with the observed pattern of movement. In a recent study of four different urban areas of London, the answer was unambiguous: *least angle* analysis is the best predictor of movement, followed closely by *fewest turns*, and with *metric shortest path analysis* well back in third place. The only plausible interpretation of this result that people do not navigate with a mental model of metric distances, but with a geometric and angular model of how the alignments of the grid are connected to each other. As cognitive scientists have long suspected, but been unable to show conclusively, we navigate with an architectural model in our heads, not a simple account of metric distances. This has major implications for how we design cities.

The bringing to light of the relation between grid structure and movement also opens up the possibility of a new way of modelling cities. Historically, mathematical approaches to modelling cities have been Newtonian. The city is conceptualised as a set of discrete zones represented as points. Exchange between zones is proportional to their combined masses inverse to some definition of distance (Wilson 2000). We can call this the *attractor* theory of cities. There are of course familiar problems with such models. They are coarse grained and neglect micro-structure, and it is not clear how there can be a theory of macro-structure without a theory of micro-structure. Zones are arbitrary constructs and do not exist in any physical sense, which makes it hard to relate reality and model in a morphologically useful way.

But if it is the case, as we believe has now been amply shown, that the fundamental determinant of movement is the configuration of the street network itself, a factor given scant attention in attraction models, then it seems that these models are not theoretically optimal either – especially if, as we will show, the pattern of attraction is itself powerfully shaped by the grid induced movement pattern and so should not be treated as primary in a model.

The structure of the urban grid

Let us then use the syntax technique to investigate the structure-function relation in cities, starting with the structure of the urban street network itself. First we can use the analysis to show how cities tend to acquire a certain generic large scale structure. For example, if we take Apt, a small town in France (Figure 1.7a) and analyse its integration pattern using the segment least angle analysis[6] (colouring up from dark grey to light grey, Figure 1.7b) as before, we find the darker lines form a striking pattern: a kind of *deformed wheel*: there is a 'hub'of integrated lines at or near the centre, integrated 'spokes' which link centre to edge, and sometime also we find integrated 'rims' or edge lines. The wheel forms the dominant pattern of public space, where most of the shops are, while the lighter areas in the interstices are predominantly residential, though of course with gradations between the two. So this means that the structure is not purely formal matter. It has to do with what is going on in the social and economic life of the town. As with the house, the analysis has detected a certain *social logic* in the plan.

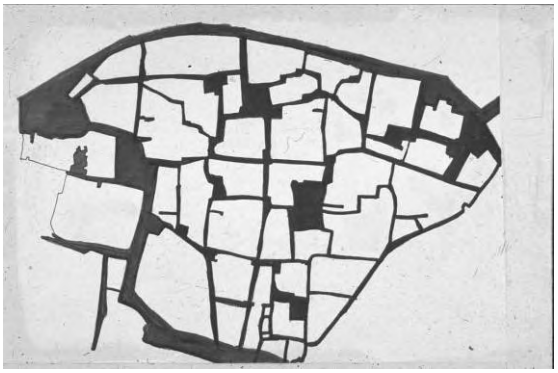

Figure 1.7a The plan of Apt, a small town in the South of France

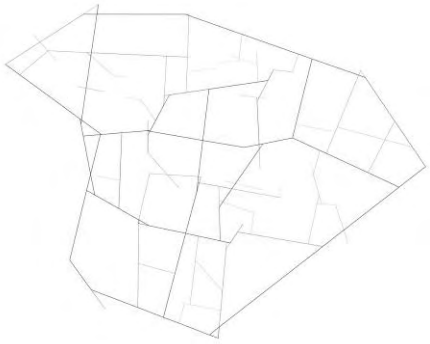

Figure 1.7b The integration map of Apt, a small town in the South of France

While not universal, the deformed wheel pattern is found again and again in the large scale structure of cities. Figure 1.8 shows it in the central areas of Atlanta.

Figure 1.8 The street plan of the central areas of Atlanta showing the deformed wheel

More remarkably, Figure 1.9 shows it in a more complex form with multiple rims in the metropolitan area of Tokyo, a very much larger system

Figure 1.9 The deformed wheel pattern in the metropolitan area of Tokyo

We find it the same underlying pattern in Venice, even without the canals, and in London we find it approximated at two levels: that of the metropolitan area as a whole, and at the level of the local area, as in Figure 1.10.

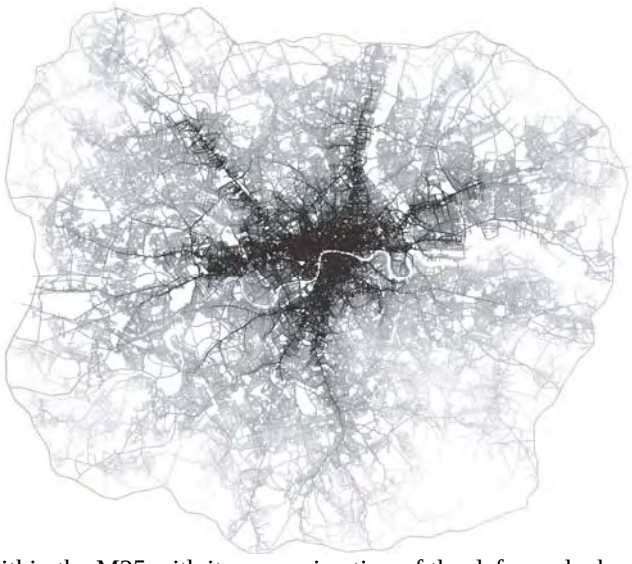

Figure 1.10 London within the M25 with its approximation of the deformed wheel

This may be why people think of London as a set of urban villages. Its ‘villages’ are usually the hubs of local deformed wheels, with the spokes acting as strong linkages to the larger scale grid, so providing locally the strong centre-to-edge links that the large scale deformed wheel provides for the city as a whole.

Why the deformed wheel? The answer is simple. It is a way of overcoming the natural tendency for centres to become segregated as the city grows around them by linking centres to edges, so accessing strangers to

the heart of the system and inhabitants to the edges. So this underlying structure of the city is a spatial phenomenon, but one which is shaped by the city as a social thing.

The integration patterns we are finding, it will be recalled, measure the accessibility of street segments as destinations, and so can be thought of as recording the to-movement structure of the city. If we look at the patterns formed by the choice measure, we are looking at the through-movement patterns, and we find these, while often overlapping with the deformed wheels, are rather different and always take the form of a network. Figure 1.11 shows on the left the structure of metropolitan Tokyo and on the right that of London revealed by the measure of choice:

Figure 1.11a The 'choice', or through movement structures of Tokyo

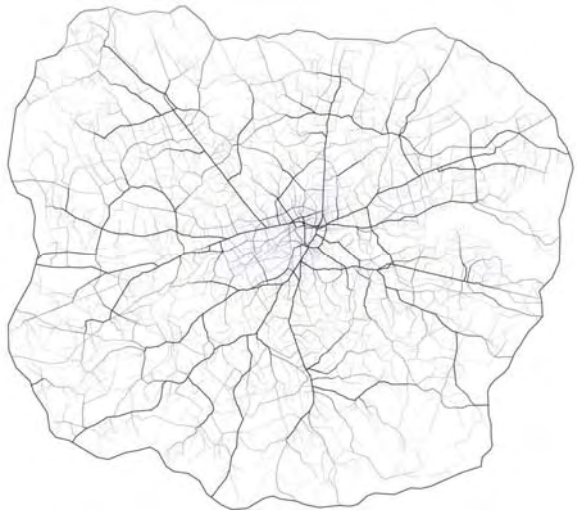

Figure 1.11b The 'choice', or through movement structures of London

The two measures can be used separately or in combination to examine the structures of different cities. Both are measures of integration-segregation, though of course in rather different senses. Most important, they can be applied at different urban scales by restricting the radius at which it is applied. For example, at the level of the whole city, choice often identifies the natural boundaries of areas (Peponis et al. 1990), but by restricting the radius, the measure often brings to light a much finer scale structure, reflecting the fact that shorter trips will tend to prioritise more local spaces. Figure 1.12 shows part of North West London analysed first (left) for trips of any length (and so for the most part for longer trips) and then (right) for trips up to 1.25 km. The right figure picks out core spaces of several 'urban villages'.

Figure 1.12a Choice analysis of part of north west London for trips of any length

Figure 1.12b Choice analysis of part of north west London for trips up to 1.25km

The dual city

But we have generated something of a puzzle. Cities are geometrically very different – a city in the Arab world for example will have little in common geometrically with a North American city – so how do they

come up with similar large scale patterns? Do cities, in spite of their differences, have certain commonalities in how they are generated? Our studies suggest that cities in general are created by a dual process, and each side of the duality exploits the relation between space and movement in a different way. On the one hand there is a public space process which is about bringing people together, and which therefore orders space in such a way as to optimise the reach of spaces and so maximise movement and co-presence. This process is largely driven my micro-economic factors, and tends to be invariant across cultures as trade and exchange always work the same way. The public space process gives rise to the global structure of the city, usually some variant on the deformed wheel.

On the other hand, there is a residential space process, which uses space to restrain and structure movement in the image of a residential culture of some kind, seeking perhaps to structure relations between inhabitants and strangers, men and women, and so on. Domestic space and its environs is usually the richest expression of culture in space, and of course it is different across regions, and even within regions. This is why we find such great differences in the fabric of the background space of the city - its geometry, its connectivity, its degree of openness - in contrast to the tendency of global structures towards universality.

So a micro-economic process generates the global similarities between cities, and a cultural process the local differences. We can illustrate this dual process with singular clarity in a city with more than one culture (now unfortunately separated): Nicosia in the island of Cyprus.

Figure 1.13a Old Nicosia within the walls

Figure 1.13b Old Nicosia integration analysis

In Figure 1.13a of Old Nicosia within the walls, top right is the Turkish quarter and bottom left the Greek quarter. Their line geometry is different. In the Turkish quarter, lines are shorter, their angles of incidence have a different range, and there is much less tendency for lines to pass through each other, and there is a much greater tendency for lines to form distinct local groups. The integration analysis (Figure 1.13b) confirms the differences. Syntactically, the Turkish area is much less integrated than the Greek area. We can also show that it is less intelligible, and has less synergy between scales (Hillier 1996), between the local and global aspects of space. Yet in spite of these strong cultural differences in the tissue of space, we still find Nicosia as a whole is held together by a clear ‘deformed wheel’ structure. The deformed wheel, as it were, overrides the cultural differences in the residential fabric of space, and creates the global system of spaces where cultures come together.

The polycentric city

We see then that society shapes the spatial form of the city by exploiting the link between grid structure and movement in different ways, on the one hand to generate interaction, on the other to restrain it in the image of a culture which is to be conserved by being built into space. The generic outcome is that all cities take the form of a network of busy and quiet zones, often in close proximity, which are essentially gradations of integration and segregation arising from our two measures. So we see the origins of the form of the city clearly in the spatialisation of society.

But what about the consequences? Are there effects back on the spatialisation of society from the spatial forms that have been created? In fact the spatial form of the city sets in motion the process by which collections of buildings become the living cities we know, with all their density and diversity of spaces and activities. It works like this. Because – at any stage of its development - the grid shapes movement flows, it means that some locations in the grid are naturally movement-rich, while others are naturally movement-poor. This effect may be found at the area level, but it will also be found at the level of this street rather than that street, and even this street segment rather than that street segment. The consequence is of course that activities and land uses that benefit from movement, such as retail, will migrate to locations which the grid has made movement rich, locally or globally, while others which prefer to avoid movement will seek out movement poor locations. In movement rich locations, the presence of movement seeking land uses will attract more movement, and set up multiplier effects which will bring more, and more diverse, land uses into that location, in proportion to the global and local properties of the grid. Where the movement-rich process becomes sufficiently intense, it will feed back on the grid to improve local inter-accessibility by reducing the scale of the grid - where the local grid does not already have that critical property (Hillier and Penn 1996).

The effect of this process is to create the city as it is: as a network of linked centres at different scales, from a couple of shops and a café to whole sub-cities (Hillier 2001) all set into a background of the residential space which continues to make up the greater part of the city. This is the fundamental form of the city – if of course it is permitted to happen. We find in effect a basic partition of the city into a dual pattern, the one created by and responding to micro-economic forces, the other, the residential part, responding to cultural forces, the one more integrated the other more segregated.

The creation of the network of centres at all scale, including the shift of centres towards edges, is the culmination of this process creating process, so we will illustrate from a place where it is not supposed to happen: the USA. Figure 1.14 shows over a century and a half how global and local factors combined, that is the intersection of two main boulevards and local grid intensification, to form this exceptional vibrant out of town centre. In general, of course, we can demonstrate these effects statistically as we did with movement, by simply correlating the scale of local centres with the spatial properties of the street network. As with movement, the relation is far from perfect, but it is pervasive.

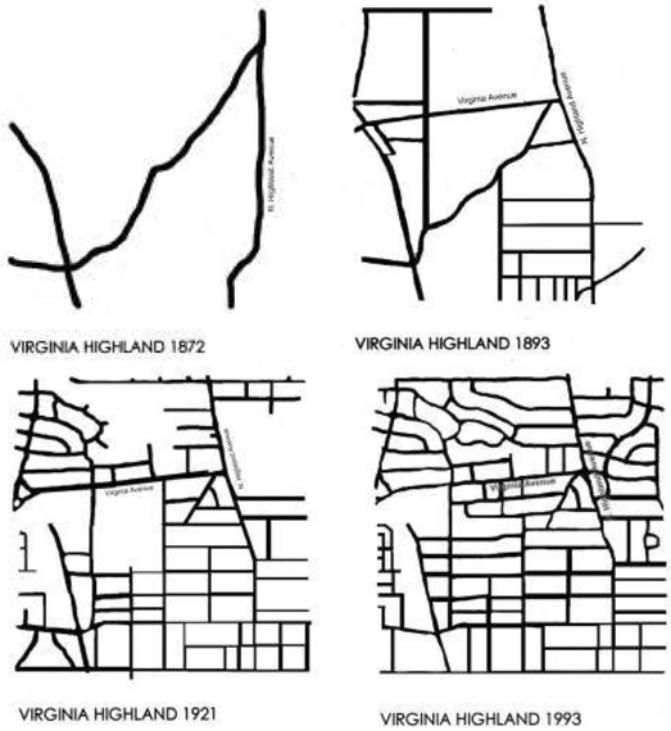

Figure 1.14 The historical evolution of a local centre, Virginia Highland in a US city, Atlanta, from 1872 to 1993, showing how global (the intersection of two main boulevards, Virginia and Highland) and local (the grid intensification around the intersection) factors combine to form the live centre. Adapted from Allen, Peponis and Conroy (2001): 7-8. Image courtesy Doug Allen

So we see that there are precise and analyzable senses in which society is *either side* of the city, both shaping its form through its spatialisation and then finding its spatialisation changed – many would say enhanced - through that form. We have shown that there is a generic relation between the city of space and the city of activity. But there is a crucial difference between this theory and what we might expect from seeing the city through the perspective of practice. In practice, a key task is to match particular activities to particular spaces, in the sense that a layout is intended to be an organization of activity. We might then expect a theory of the relations between the two cities to be in some sense a generalization of this, but it is not.

What we have shown is that the spatial form of the city arises not so much from a relation between this activity and that – though this may from time to time make its mark – but between different *kinds* of activity and the demands that they make on movement and co presence. The relation of activity to space is generic not specific: it passes through the grid configuration-movement relation. This is why we find over time that wholly new patterns of activity routinely accommodate themselves in existing cites without undue strain and with the minimum of reshaping. We may reasonably expect this to continue into the future.

Pathological Space

In interpreting cities through their spatial networks, space syntax shows that cities are constructed spatially first and foremost as patterns of gradations on the scale integration-segregation. In cities across different cultures relative segregation expresses itself primarily through local residential space. In contrast to the more global network of linked centres, which tends to maximise the integration of space, residential space expresses cultural values through its distinctive kind and degree of relative segregation.

Where then and how does spatial segregation become a social *problem*? The answer seems to be: when spatial segregation becomes extreme and loses its cultural form, as, we conjecture, happened in some of the experimental twentieth century social housing areas. When this happens, society and space are no longer interacting on the familiar terms of a spatialised culture, but in terms of a raw confrontation between new forms of space and an absent spatial culture. In investigating this, we would be moving space syntax much closer to the ground of social research. How can this be done? The key is that when seen as configuration, spatial patterns can be represented numerically, and on a space by space basis, and this allows us to give space equal status in the data table to any other variable that can be expressed numerically, including of course social and economic variables[7]. We can compare spatial and social phenomena as patterns of numbers.

A pioneering example of such a study in the 1990s, focused on a much-praised low rise high density housing estate, Maiden Lane, in Islington, London, which went from winning awards and praise from residents to being described by the police as a 'ticking time-bomb' in less than four years. Both the police and the local authority believed that the unusual experimental design had been a factor but could not say how. The space syntax research group tried through a detailed spatial and social study of the estate to formulate a precise and credible mechanism through which spatial factors might have been involved in the precipitate decline of the estate (Hillier, 1991 and revised in Hillier, 1996: 183-214).

The first thing the study showed was that the axial scale of space was dramatically reduced compared to the surrounding residential streets of Islington, London (figure 1.15). The spatial pattern was also much more complex, and there was no internal structure of the kind that is normally found in residential areas. Instead the analysis showed that the estate was structurally segregated from the surrounding streets in that its spaces were more or less uniformly segregated and had no continuity with the local area. The effect of this spatial pattern was that the estate was integrated at its edges but segregated in its interior, and this was reflected in the adult movement pattern which fell off sharply from edge to centre. The downscaling of the space and the absence of movement in the interior in fact created a situation in which even during the day you would be on your own in space for most of the time, in contrast to the surrounding residential area where the scaling and organisation of space meant that for most of the time you were co-present in space with more than one other person. In such circumstances the reports of residents of feeling fear, especially after dark, in most parts of the estate seemed to have objective correlates. Again, reasons for feeling comparatively secure in the surrounding area seemed clearly to do with the way in which space produced natural co-presence through movement.

Figure 1.15 Global integration of the Maiden Lane housing estate (in circle) within its urban context

Further striking contrasts in the 'social' nature of the space came from studying children's spatial behaviour. First, in contrast to a ten-to-one ratio of adults to children in the surrounding residential streets, the ratio on the estate was on average four children for every adult. It was clear that children were using spaces that were not being used by adults for movement. Analysis then showed that children were using the most integrated spaces that were not being used by adults, and in these spaces children formed much larger groups than on the outside. The effect was that children seemed both visually dominant on the estate, but were also removed from the kind of everyday surveillance that comes from adult movement. We showed this graphically by a useful statistical trick. Where in the surrounding area children and adults used space more or less in the same proportions, a scattergram plotting the two rates for each space would show a more or less linear relation between them: the more adults, the more children and vice versa (Figure 1.16a). Within the estate the distribution of points was L-shaped, in that the spaces prioritised by adults were not used by children and vice versa (Figure 1.16b). To a lesser degree the same was true of men and women. We called this the L-shaped problem, and showed it could be found to varying degrees in ten housing estates across London.

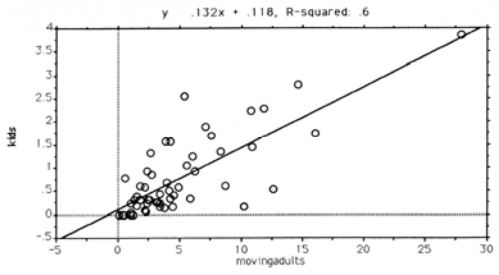

Figure 1.16a Encounter rates per axial line of moving adults to static children: surrounding street pattern

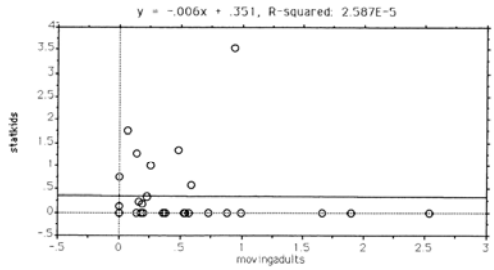

Figure 1.16b Encounter rates per axial line of moving adults to static children: housing estate

The overall effect of the spatial design of the estate was that the over-complex and structureless spatial layout of the estate had obliterated the patterns of natural movement and co-presence between different kinds of people that is the norm in urban space, and which intuition suggests is the source of our sense that urban space is secure and civilised. Unfortunately there were worse consequences in that the spaces abandoned by adults became the natural loci of vandalism and petty crime, with the effect that the estate began to appear disorderly and run down. Then as this spatial process was underway, a social variable intervened in that the local authority found it necessary to locate some problem families on the estate. How

far this was because the estate was beginning to look like a problem estate is hard to ascertain. But there is little doubt that the pathological spatial process had produced an appearance of decline and a 'bad community' perhaps before it had occurred. In this sense we might speculate that perhaps the physical symptoms had played a role in creating the disease. The key thing here is the identification of a clear spatial mechanism which can play a part in the broader social process of perceived and actual decline.

Self-Generated Settlements

Another case where a clear spatial mechanism could be shown to be involved in a social process came with a study of informal settlements in Santiago in Chile (Hillier et al. 2000 and Greene 2003). The problem was why some self-generated settlements with similar origins had consolidated into well-functioning neighbourhoods, whilst others had stagnated and others again had become centres of social pathology. By complementing space syntax measures with precise data-gathering on site (including demographic and economic data, interviews and infrastructure data as well as land use and movement data), we were able to shed light on the process of consolidation in each site. Multivariate analysis showed that the critical variable was the degree to which the layout and location of the settlement permitted the development of informal economic activity on the edges of the settlement, allowing the settlement to participate in a wider spatial economy. Those who succeeded educationally tended to leave the settlement, while those who developed successful businesses stayed on and invested in other aspects of the consolidation process. In other words, spatial integration into a more regional context of movement gave an advantage over those that were relatively segregated, and this was in fact the single most powerful variable in the consolidation process.

A third case of a spatial mechanism as part of a broader social process was found in the case of immigrant 'ghettos' studied by Vaughan (see chapter 2 for an extension of this work into a study of urban poverty). The question was: how is it that areas of concentrated immigrant settlement by choice, such as London's East End, had the ultimate successful outcome of dispersal and integration. Analysis of a range of social variables, such as household structure, occupation, poverty status – as well as communal activities such as the location of religious institutions and social organisations, found a clear spatial component in the apparent success of some immigrant groups compared to others. First, the location of naturally occurring immigrant settlements was consistently found to be at the edge of economically active areas of the city – thus enabling immigrants to participate naturally in the broader spatial economy of the region. Second, the internal organisation of the immigrant community was strongly related to the internal spatial logic of the urban area, with the main local streets hosting the communal institutions. This allowed the fluid group of migrants to benefit both from the support of a dense grouping of neighbouring co-religionists and from participation in the spatial economy (Vaughan and Penn 2006, Vaughan 2005). Clarifying such socio-spatial processes shows how facile it is to refer to immigrant concentrations as 'ghettoes'. In terms of both their spatial form and functioning, many migrant concentrations can be virtually the opposite of the traditional concept of 'ghetto'.

To some extent, the process identified in Vaughan's migrant studies also reflects a more general historical pattern in London in which different faces of the urban block were used as a way of organising the relations between different social classes, with the best off on the most integrated streets and the least well off in the most segregated. The effect was that as you moved along the street you pass the same grade of housing, but when you turned a corner it changed. The street alignment was the spatial organiser of the social pattern, not the urban block. This conserved proximity of different social classes in the same zone and permitted some economic interdependence. We call this kind of pattern *marginal separation by linear integration* (Hillier and Penn 1996). It is one of the ways in which cities have allowed people and uses to co-exist in the same area. One effect of this was that the poor became as it were 'contained' in patches and surrounded by better off people. This will be discussed in greater detail in chapter 2.

Conclusion

Space syntax then shows both how spatial patterns can be studied in their own right, and how they can then add a new dimension to social studies of the city, particularly when issues of segregation are involved. The approach is distinctive in two ways: First, space is conceptualised as an active and independent component in the analysis of social patterns. By separating the spatial from the social in the first instance, we can begin to decipher the influence of social factors on spatial form and in turn the impact of spatial form on social outcomes. Second, space syntax analysis works across scales. It is initially based on street-scale data, and this is important as it is at the level at which people experience the city, and where they meet, interact and carry out economic and social transactions. But space syntax is equally able to aggregate from this micro scale up to the most macro, without either losing sight of the other. In this way space syntax is able to

describe spatial and 'spatialised social' phenomena not from a 'bird's eye view', as is typical in studies of mapped data, but as the emergent outcome of local interactions pertaining, in a variety of ways, to the global scale.

In what follows, we extend this approach to other areas where spatial segregation seems to be part of a social problem. In chapter 2, Laura Vaughan utilises the scale and level of detail afforded by space syntax analysis for detailed studies of Charles Booth's statistics of poverty in late 19th century London. The study suggests that there is a spatial mechanism involved in the creation of poverty areas which leads on to a strong correspondence between spatial segregation and poverty.

The discussion of urban pathology, as in the case of the housing estate above, is continued in chapter 3, where Lars Marcus describes the challenge of moving from a view of segregation as a primarily social problem to a view that segregation is inherently spatial. He also illustrates how space syntax research can inform contemporary housing policy by showing the importance of understanding spatial form as a component in problems of social segregation, particularly in relation to the accessibility of public space in housing estates.

We have shown how cities are constructed as gradations of integration and segregation and have suggested that patterns of activity are shaped by the urban grid. Ruth Conroy Dalton describes in chapter 4 the unexpected outcome of designing a relatively integrated golf cart network within a labyrinthine street layout in a low density US city. The increase in available accessibility for the suburb's inhabitants, coupled with particular social and economic circumstances, has created a virtuous cycle of increased social integration and economic activity. Conroy Dalton's research provides evidence that changes to the spatial network can have a significant impact on patterns of integration and segregation in cities. As suggested at the start of this chapter: she shows that urban segregation has a physical as well as a social meaning.

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[1] There are a number of measures of the graph which can be used to describe configurational properties of the grid. Hillier et al (1993: 35) describe these in detail: stating that empirically, by far the most important measure is called 'integration radius n' or 'global integration' which measures the mean depth from each line in turn to every other space in the system, relativised with respect to how deep they could possibly be with that number of spaces, than standardised as shown in Hillier and Hanson (1984). The most integrated spaces are those from which all others are shallowest on average and the most segregated are those from which they are deepest. 'Integration radius 3' (commonly described as 'local integration'), measures the mean depth of spaces up to 3 steps away from each space in turn. Other radii are calculated in a similar fashion (radius 7 – 7 steps away and so on) in order to take account of different areal scales.

[2] In mathematics, the *integration* measure is more familiar as *closeness*, or *closeness centrality*, but syntactic *integration* has a little more mathematics to take out the effect on the measure of the number of elements in the system (Hillier & Hanson 1984: 108-114). The *choice* measure is known in mathematics as *betweenness*, or *betweenness centrality*, though again the syntactic version of the measure is calculated in a slightly different (and to our mind better) way.

[3] In *The Social Logic of Space* the relation between the linear organisation of space and the local *convex* properties, where by definition each point is visible from all others, is also dealt with at some length.

[4] This reverses the customary practice in traffic engineering, where the junctions are the nodes of the graph and the street sections the links.

[5] This work is reviewed in Hillier & Iida (2005).

[6] We find the same result with the simple axial map, but the more recent segment angular analysis is used here for consistency with other illustrated cases.

[7] We could say that just as a statistical data table takes social phenomena out of real space and into logical space, so the addition of space syntax values puts the world of real space and materiality back into the statistics.

2 The spatial form of poverty in Charles Booth's London

By Laura Vaughan

Abstract

This paper reviews recent research into poverty and spatial form and describes how the application of space syntax methods to this research area, coupled with the use of primary data from the Charles Booth maps of Poverty in 19th century London, has enabled analysis of the socio-economic and spatial structure of areas frequently perceived as 'ghettos'. Through a comparison of two distinctive areas of London – Soho in the West End and the famously poor area of London's East End, the analysis shows a consistent correspondence between poverty and spatial segregation. Booth's economically based 'line of poverty', used to distinguish between those 'in poverty' and those living 'in comfort' is supplemented in this paper by a proposed spatially defined line of poverty, distinguishing between poor, spatially segregated streets and more prosperous, spatially integrated streets. Furthermore, through the application of the latest segment angular techniques, space syntax analysis reveals a new finding relating to the formation of poverty areas, which combine low integration with large numbers of small street blocks, suggesting that this combination of spatial factors helps explain the persistence of poverty and poor quality housing, detrimental to the living standards of the poverty classes. This finding also helps explain how such areas can create a sense of entering 'another world', with the emergence of sub-cultures and new communities. The paper concludes with the proposition that when such areas are located close to economically active, well integrated streets, such spatial patterning can serve as a necessary mechanism for the social integration of minorities and is frequently part of a natural process of acculturation and integration in the urban environment.

Introduction

"Segregation is one of the key methods of accommodating difference" (Peach, 1996: abstract)

The importance of urban form in affecting social outcomes, such as poverty, is at the root of the study described here. Despite a recent growing interest in understanding the processes involved in the formation of poverty areas within cities (DTLR, 2001), this paper is different from other studies in its focus on the relationship between urban morphology and the spatialisation of poverty. It is also methodologically novel in its use of space syntax methods to arrive at quantifiable measures of local patterns of space in order to explain why poverty areas emerge. Other aspects of spatial analysis considered here include the persistence of poverty areas over time and the relationship between poverty areas and economic activity.

This paper describes spatial analysis of poverty in late 19th century London. The main source on poverty at the time is the multi-volume 'Life and Labour of the People in London' (Booth, 1891) and the maps of poverty published by Booth in 1889 and 1899. It has been said that Booth's work was the first 'empirical sociology' (Pfautz 1967: 127) of poverty and wealth and the accuracy and coverage of Booth's data made their analysis ideal for the research described here[1].

The period studied in this paper was a critical point in the social and economic history of London. Worsening poverty and unemployment during the period culminated in the publication of a searing account of the life of the poor in 'The Bitter Cry of Outcast London' by William Preston in 1883. Growing public concern with the situation of the poor as well as the potential threat to social order was raised by graphic (and in many cases exaggerated) accounts in the popular press of the time (Ginn, 2006). During the 19th century, London had a labour market based on small scale production and the finishing trades. The employment was seasonal and workers were employed on a casual basis, with employment rates fluctuating with the demands of the market. Rather than being experts in a single trade, some workers would hold several occupations during the year. Davin (1996) shows how this pattern of work made workers much more spatially dependent; work was reliant on local knowledge built up through longstanding residence in the area:

> The local network played a central part in day-to-day survival when times were difficult, you knew or would quickly hear on the grapevine where to go for cheap or free food and fuel, who would give you credit, where there might be homework given out or a child wanted for errands or child care, what firm was taking on hands, how to get a reference or charitable help... (Davin, 1996: 34)

On the other hand, the poorest classes were the most transient and thereby the poorest were the most disadvantaged by having to move:

> Variations in family income or household composition were often a reason for changing house. When income shrank through illness or unemployment, leaving even less margin for rent, somewhere cheaper had to be found. (Davin, 1996: 35)

Davin shows that this 'restlessness' was criticised by the comfortable classes and Evans (1978) shows how a misunderstanding of the nature of poverty led to the middle classes avoiding contact with the poor, except through the accounts of reformers and professionals such as clergy and public health inspectors. The poor were also viewed as being perversely immobile, concentrating in large masses of disease and immorality. The poor problem had become a spatial problem, since high concentrations of poverty were seen to be risking both moral and physical contamination by the casual poor of the respectable poor.

By the end of the 19th century the problem of the teeming masses of the poor had become so bad that it was a topic of constant concern. The Artisans and Labourers Dwelling Act (the Cross Act) of 1875 was passed in order to enable local authority clearance and rebuilding of the worst housing, although as pointed out by Fishman (1988: 8), this process took many years and ultimately led to private investment initiatives, (such as the East London Dwellings Company) to construct modern dwellings for profit. It can be said that the roots of the transformation of modern cities, are the housing changes made from the end of the 19th century onwards. This is described by Hanson (2000: 100):

> One of the earliest inward-facing morphologies in the record, and one of the most influential and best-publicised philanthropic housing schemes for the working classes, was Henry Roberts Model Housing for Families at Streatham Street, Bloomsbury (1847-50)... Nor did all the early model housing turn its back so obviously to the street: some small schemes were built as walk-up flats with an entrance from the street, others favoured outward-facing balcony access, but the majority opted for the more controllable courtyard form... by the 1860s... the Peabody Trust, was master-planning large rectangular urban sites as arrangements of `simple, clean-shaped blocks, without re-entrant angles, facing the street on the one side and a large private court on the other' (Tarn, 1969, p. 21) as the most healthy, affordable and safe way to house the urban labouring classes. The agenda for the first urban transformation had been set.

Hanson shows that the unforeseen outcome of the planning solutions to poverty was that – despite some improvements to sanitary provision, quality of construction and internal layout – the nature of the new housing form was to create deeper, more labyrinthine layouts which cut off the inhabitants from the every-day life of the streets:

> Indeed, the whole story is one of a ruptured interface between dwelling and street.... strangers passing through have been eliminated from the interior of the estate altogether by means of its intimidating, bounded and labyrinthine layout. (Hanson, 2000: 113).

The detrimental effect on social integration was to have its worst effect on the weakest and least powerful; "those who depended on their local environment the most to support them in their everyday life" (Hanson, 2000: 117-118). Hanson's proposition is that the unexpected outcome of the built solution to poverty was to exacerbate the separation between classes.

Analysis of the spatial form of immigrant quarters (Vaughan, 2005; Vaughan and Penn 2006) has concluded that immigrants tend to congregate in poverty areas, suggesting that it is the location and spatial segregation of the area itself which make it more likely to be settled by poorer immigrants. This paper takes this research further, using the latest space syntax methods of segment analysis to compare two districts of London and by considering the relationship between immigrants and living in a poverty area.

The first part of this paper gives a background to research into poverty areas, explains the nature of space syntax research into poverty and introduces the Charles Booth maps of poverty. This is followed by analysis of two poverty areas on the Booth maps, the East End and Soho and analysis which leads to the spatial definition of a 'poverty line'. After this comes analysis of the impact of the slum clearances which took place in the period between the two Booth maps (1889 and 1899) and the spatial form of immigrant settlement during this period. The paper ends with conclusions about the nature of spatial segregation and its impact on poverty.

The study of Poverty Areas

Research into poverty areas suggests that despite the many attempts to improve housing quality over the past 100 years, these interventions have "failed to substantially alter the geography of poverty", Orford et al. (2002: 34). Similarly, a recent White Paper on planning cities, DTLR (2000), indicates that "many of the areas of East London identified by Charles Booth in the late 19th century still show up today as having the worst social deprivation; in three wards in Tower Hamlets over 80% of children live in households that depend on means tested benefits" (DTLR, 2000: section 2.18).

The importance of space itself in having an impact on people's lives is rarely highlighted in contemporary studies of life in poverty, despite the fact that accessibility to the economic life of the city is clearly of as paramount importance today, as it was 100 years ago. One exception to this is Lupton (2003a: 5), who states that:

> physical characteristics, through their impact on population mix, lead neighbourhoods to 'acquire' certain other characteristics, such as services and facilities, reputation, social order and patterns of social interaction, as people and place interact. For example, disadvantaged individuals in an isolated area will form one set of social relations, while disadvantaged individuals in a well-connected area may form another.

Another growing focus of interest is neighbourhood design and well-being in poverty areas. Ellaway et al. (2005) show that area of residence is increasingly recognised as being associated with levels of obesity and physical activity. Barton (2005), in an unpublished paper - 'Healthy Urban Planning and Transport', states that "the segregation of land uses is undermining the potential for integrated neighbourhoods and local social capital." Whilst Bonnefoy et al. (2003) have highlighted a new distribution of housing conditions, with pockets of poverty alongside wealth. As noted by Glennerster et al. (1999: 8): "in the past decade or more we have begun to find increasing evidence first that inequality has grown sharply and secondly that it is more geographically concentrated." This ties in with findings in an early report on this author's Booth study (Vaughan et al, 2005a), which has shown that fine-scale spatial variations can give rise to conditions of spatial and social segregation.

This paper maintains that it is vital to consider the physical dimension of poverty, since living in a poverty area can exacerbate the disadvantages of poor individuals. Moreover, the establishment of an area as 'poor' is the result of a series of processes which have an impact on the area's deprivation. These can be concentrations of inadequate housing, bad health and other cycles of areal (area based) economic deprivation (Lawrence, 2005). Studies in the 1980s and 1990s by the Space Syntax Laboratory have found that living in poverty areas makes you more vulnerable to crime (Hillier, 2004). Lastly, poverty can also lead to unequal access to jobs and thus high rates of unemployment in a particular area (Spicker, 2003; Green and Owen, 2006).

Typical geographical research into social data involves the use of mapped data to identify visually apparent patterns. The drawback is that these tend to highlight problematic clusters (e.g. robberies in town centres) and ignore problematic distributions (e.g. burglaries in cul-de-sacs). Unlike other studies of this type, space syntax studies do not seek to aggregate data, instead they analyse statistical relationships between properties of spatial layouts and the occurrence of particular social phenomena (cf. Hillier, 2004 on crime).

Space syntax methods are particularly useful in addressing the questions raised in this paper, since they enable an understanding of the impact of small-scale variations in the urban fabric. The accuracy of spatial data is also vital to this type of study, as is the ability to relate spatial and social data at the street block scale. Previous research by the author (cf. Vaughan and Penn 2001) has developed such techniques for modelling the growth of immigrant quarters over time, using census records of entire population cohorts matched to spatial location and mapped over time. This methodological approach allows for small differences between neighbouring streets and their degree of inter-accessibility to be quantified precisely, whilst the importance of this scale is that it is at the level at which people experience the city – the scale in which they meet, interact and carry out economic transactions. With the ability to represent and quantify the relational properties of the space structure of street networks and open spaces, coupled with spatially precise social data, spatial measures are independent of variables such as class, land values and land-use, so the relationship between urban form and social structure can be studied statistically, with each variable considered in turn.

Booth's 'Life and Labour of the People in London' is, as the title suggests, a study of the local economy of each part of London. The colouration of the maps published with the books is based on a clear-cut differentiation of poverty counts from street to street (and in many cases, variations between street sections), accompanied by his own assessments about each district of the city, which were based on classifications collected by Booth and his team of researchers. These included School Board Visitors, who had a detailed knowledge of families with children. There has been criticism of the maps being impressionistic. For example, Topalov (1993) maintains that there is a certain interpretive quality to the Booth maps, firstly in the actual definition of class division, secondly in the possible subjective assigning of families to class categories. In addition to which, some of the data were extrapolated from the individual (school records) to the family level. However, the Visitors information was "cross-checked against those of philanthropists, social workers, policemen and others" (Englander and O'Day, 1998: 124). Bearing in mind that Booth gathered copious evidence on income and patterns of employment and unemployment, it can be argued that Booth's classifications were as precise and as scientific as could be achieved at the time. Both the 1889 and 1899 maps show a delineation of poverty situation based on employment patterns and forms of labour, with the result that what might have been regarded as classification according to degrees of poverty came also to be thought of as classification according to different kinds of work (Hennock, 1976). For the revised 1899 map, members of the Booth Inquiry went on 'Walks' around the area, - usually an investigator and a policeman – recording their impressions of change of colour since 1889. These are vivid in language and opinion and frequently show a great detail of change from the survey a decade earlier[2]. Underlying the classification is an emphasis that some of the poor are there for no fault of their own and perhaps a reorganisation of space will eliminate the worse street culture (Booth, 1891). As stated by Fishman (1988: 11),"the poor were not a homogeneous class", but varied in their situation according to their work status.

In both the 1889 and 1899 maps, the classification used a colour code that can be seen in table 2.1 – the classes shown in parentheses refer to the more detailed classifications used in the published books:

"Black. The lowest grade (corresponding to Class A), inhabited principally by occasional labourers, loafers and semi-criminals - the elements of disorder.
Dark Blue. Very poor (corresponding to Class B), inhabited principally by casual labourers and other living from hand to mouth.
Light Blue. Standard poverty (corresponding to Classes C and D) inhabited principally by those whose earnings are small... whether they are so because of irregularity of work (C) or because of a low rate of pay (D).
Purple. Mixed with poverty (usually C and D with E and F, but including Class B in many cases).
Pink. Working class comfort. Corresponding to Class E and F, but containing also a large proportion of the lower middle class of small tradesman and Class G.) These people keep no servants.
Red. Well-to-do; inhabited by middle-class families who keep one or two servants.
Yellow. Wealthy; hardly found in East London and little found in South London; inhabited by families who keep three or more servants, and whose houses are rated at £100 or more."
Table 1: Booth classification of poverty classes. Source: Bonnefoy et al., 2003: 53

For the purposes of this study, one of the most important aspects of the Booth maps was the presentation of spatially accurate data at the level of the street block and the large area of coverage of the data. Having two maps set 10 years apart, showing data collected by the same methods, meant that the author's research team had at their disposal an invaluable source of data showing spatial and social change over time. The use of temporal analysis provides an understanding of past processes; historical and contemporary analysis of poverty and space and can provide insight into the future impact of planning decisions.

The spatial form of poverty

Figure 2.1 is an extract from Booth's 1889 map of poverty. It shows that the main streets of the East End, Whitechapel Road and Commercial Road East are classified as red (middle class – dark grey on the main streets in this greyscale image), whilst the remainder of the district is classified in the classes below,

ranging from pink ('working class comfort') through purple to the poverty classes of light blue, dark blue and black[3].

Figure 2.1 Booth map of poverty in London, 1889, showing the East End, © Sabiha Ahmad July 1999.

A comparatively poor area in the West End of London was chosen as a second case study, due to its striking social and economic differences from its immediate surroundings. The area, broadly the geographical district of 'Soho', was defined as the streets south of Oxford Street, east of Regent Street, north of Coventry Street and west of Charing Cross Road. See illustration here (Figure 2.2), which shows that the Soho area had a large number of streets in the poverty tones of black, dark blue and light blue, framed by streets with red ('middle class') classifications. As shown by Breward (2006: 30) – in a section entitled 'Carnaby Street schmutter': "The stark difference between Marylebone, to the north of Oxford Street and Soho, to the south, was marked along architectural, ethnic, social and professional lines."

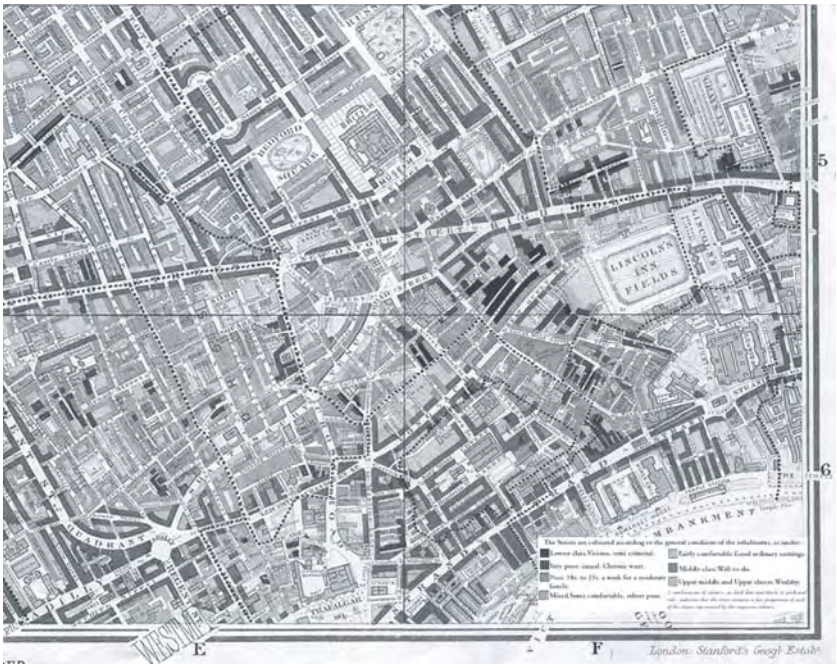


Figure 2.2 Booth map of poverty in London, 1889, showing the West End and Soho, © Sabiha Ahmad July 1999

This marked difference between the main streets and the interstices of the East End area corresponds to spatial analysis of the area. The graph (Figure 2.3) is coloured up according to the spatial accessibility at street segment scale (a street segment is the section between junctions, similar to a face of a US street block): based on a measure of the extent of street length reached at a set number of turnings away, considering the angle of incidence of the street junction. The segments are coloured in a colour range from dark to light – from integrated to segregated. In this case the computation stops at radius 4^4. The analysis also suggests an explanation for the apparent segmentation of the district from its surroundings, with a highly dominant set of streets running east-west through the district, but few highly accessible north-south streets. The interstices have pockets of more segregated streets. In other words, the main streets within the area are not well connected to many of the main streets around the area; this might be an explanation for why the East End has consistently been thought of as a poverty area. Similarly, the Soho area (Figure 2.4), south of the very dominant east-west alignment of Oxford Street, is also poorly connected outwards.


Figure 2.3 East End 1889, Total segment length radius 4.


Figure 2.4 West End 1889, Total segment length radius 4.

The Spatial Distribution of Poverty

Stedman Jones (1971) shows in 'Outcast London' that the label of the area of London which became known as the 'East End', conjured up in people's minds a...

> Nursery of destitute poverty and thriftless, demoralised pauperism, in a community cast adrift from the salutary presence and leadership of men of wealth and culture, and... a political threat to the riches and civilisation of London and the Empire (Stedman Jones, 1971: 15-16 in Fishman, 1988).

Although the East End had become a notoriously poverty area by the late 19th century, it is important to note that although Booth's statistics confirmed that over 30% of the East End population was poor, there were also more prosperous streets surrounding pockets of severe poverty. Fishman (1988) suggests that a 'major cause' of these perceptions was the 'accident of location "...one great effect of railway, canals and docks in cutting into human communities [is] a psychological one... East Londoners showed a tendency to become decivilised when their back streets were cut off from main roads by railway embankments" (Fishman, 1988: 2, quoting from The Nineteenth Century XX1V, 1888: 262).

Booth himself highlighted the importance of physical boundaries in isolating 'poverty areas' and their inhabitants from the mainstream of urban life: "Another dark spot of long-standing poverty and extremely low life... is wedged in between the Regent's Canal and the gas works" (Pfautz, 1967: 113, quoting Booth)[5]. The reasoning behind this relationship might be lack of accessibility to place of work having an impact on poverty situation – not so much as where you live, but how where you live is connected to places of work in the area[6]. The following analysis considers the measure of local accessibility known as Radius 3 (local) integration[7] which previous space syntax research has shown corresponds reliably to the distribution of pedestrian movement flows (Hillier and Penn, 1996).

Spatial analysis of the 1889 map was made in relation to the Booth classifications, considering each segment in turn (cf. Vaughan et al, 2005b). Figure 2.5 indicates that there was a distinctive difference between average spatial accessibility for segments classified in the poverty range (the black, dark blue and light blue segments) and the remainder of the streets. In general, there was a relationship between greater accessibility and greater prosperity, with a large drop in integration between the streets defined as middle class and all others. What is also striking is that the most segregated poverty class is the light blue class of standard poverty, which Booth used to classify streets which are "inhabited principally by those whose earnings are small... whether they are so because of irregularity of work or because of a low rate of pay". The question arises why the poorest classes, were not quite as spatially segregated as the light blue class. There are two possible explanations for this: first, that the bottom two classes were the underclass of the time and therefore did not follow a spatial logic of the Movement Economy[8]. The second possible explanation is that the streets inhabited by the lower two classes were divided into two main types: the rookeries, in highly segregated locations and tenement houses that, had started off more prosperous (and in more accessible locations), but had fallen on hard times. Indeed, this is supported by statistical calculations of Entropy (as defined by Hillier et al 1987 and more recently Turner, 2001 as a measure of how ordered the system is from a location), which indicate that some poor streets were in small clusters isolated from higher-class streets, while other poor streets were adjacent, set behind or perpendicular to them.

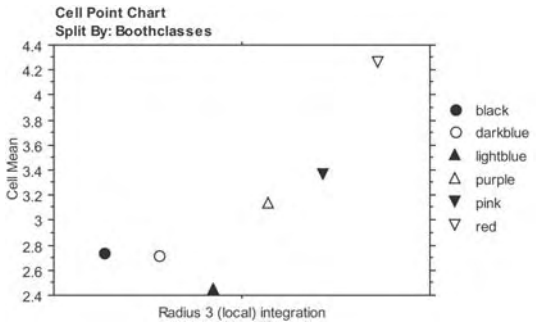


Figure 2.5 East End 1889: average axial integration per class (at street segment scale) – x axis shows classes from 1 to 6

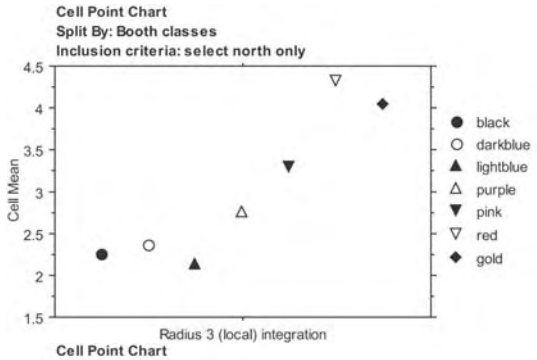
This pattern of correspondence between poverty and spatial segregation was found to continue at all the spatial scales, from local integration (each street in relation to those up to 3 turnings away), 5, 7, 9, 11, to global integration (all streets in the model). Statistical analysis of the numerical values of axial analysis values averaged by segment is displayed in Table 2.2, which shows the average values for radius 3 (local) integration and radius 7 (radius-radius)[9] integration for each class in the East End area as well as the average for all streets calculated at segment scale.[10] It is evident that all the poverty streets are less integrated then the average, whilst the more prosperous pink and red streets are more integrated than average. The differences are highly significant ($p<.0001$) for the Black, Dark Blue and Light Blue streets. It is possible to conclude from this that there is a spatial definition of poverty which matches Booth's socio-

economic definition, with a poverty line[11] of spatial segregation that lies between the three bottom classes and the remaining streets.

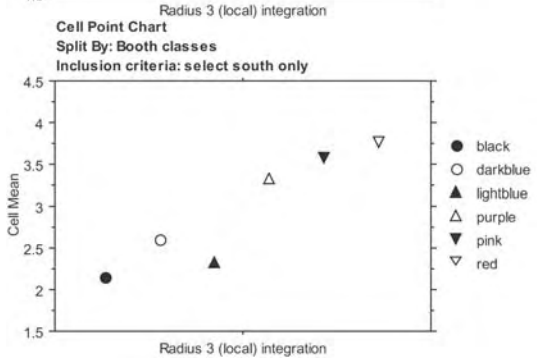
Class	No.	Local	Significance (p)	Radius 7	Significance (p)	Axial Length
Red	6	4.251	<.0001	2.000	<.0001	527.782
Pink	5	3.353	<.0001	1.771	<.0001	330.966
All streets	-	3.205	-	1.740	-	293.244
Purple	4	3.126	.0070	1.714	<.0001	256.775
Light Blue	3	2.444	<.0001	1.568	<.0001	176.869
Dark Blue	2	2.709	<.0001	1.640	<.0001	182.809
Black	1	2.732	.0001	1.656	.0017	189.715

Table 2 Average axial integration per class (at street segment scale)

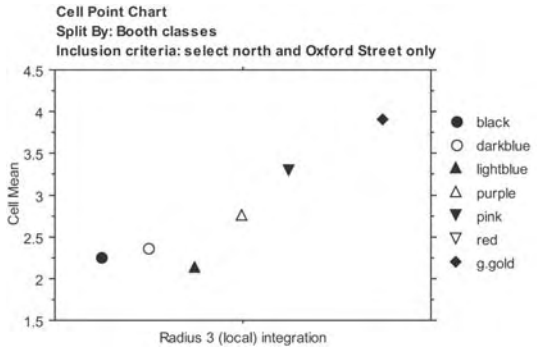
The following analysis of the West End district was made in order to see if there were clear distinctions between the Soho district and the more prosperous area to the north of Oxford Street. Figures 2.6a and 2.6b compare the 1889 map averages of axial integration per class (at street segment scale) north and south of Oxford Street (excluding Oxford Street itself, which is highly integrated and pulls up the mean values for red, middle class streets, as shown in Figure 2.6c). (The scale of the graph has been locked to ease comparison.) In both cases there is a general trend of a rise in integration alongside a rise in prosperity similar to the pattern shown for the East End, above. It is notable that the integration values for the red ('middle class') streets are much higher in the area north of Oxford Street, whilst gold ('upper middle and upper' class) streets have an average value which is below the average red values in the north and very close to the average red values in the south (when Oxford Street is included, see Figure 2.6c, the values for streets classified as red are only marginally different from the north overall). The 'stepping back' of the gold streets, many of which formed part of squares, helps support a theory proposed by Bill Hillier[12], that the tendency of the most prosperous squares in London is to remove themselves slightly from the main streets of the city, by having only one flank on the main spatial structure.



2.6a. All streets north of Oxford Street, excluding Oxford Street.



2.6b. All streets south of Oxford Street, excluding Oxford Street.



2.6c. All streets north of Oxford Street, including Oxford Street.

Figure 2.6 West End 1889: average axial integration per class (at street segment scale) – x axis shows classes from 1 to 6

Analysis of the morphological properties of the Soho area, such as block size, showed significant ($p<.0001$) differences between Soho and surrounding areas – on average the length of street segments was 47.32 metres in Soho and 67.81 in Marylebone, not counting Oxford Street itself (which has very long segments). The affect of smaller block size is an intensification of the grid, with the ability to make more small-scale journeys. In cases where this is coupled with high levels of integration, this has been found to correspond to areas of intensified commercial activity (Hillier, 2001). This is explained by Penn (2003), who shows that "one of the primary effects of the built morphology and its use by people" is to enable movement, smaller blocks enable speedier journeys across the grid. Penn's second effect is that the "morphology of the environment defines a local visual field and so defines the area from which one can derive visual information and within which one can potentially be considered visually co-present with others" (Penn, 2003: 62.12). In the cases here, smaller blocks are not coupled with large visual fields and high integration, so, the consequence effect is likely to be localised patterns of movement and social interaction, which do not engage as well with the larger scale built environment (and the larger patterns of socialisation). The critical difference from Hillier's (2001) argument is that in those cases, city centres have grid intensification coupled with high integration. These findings help explain how both Soho and the East End emerged over time as poverty areas. It also helps explain how these areas have acquired a history of being the place of sub-cultures, whether of specific economic activities, specific markets or specific social groups.

Immigrants and Poverty areas

The 10 years between Charles Booth's two 'Descriptive Maps', were a period of great upheaval, particularly in the East End study area. This was due to a significant influx of (mainly Jewish) refugees from Eastern Europe, who arrived at the East End docks and rapidly found their way to the eastern edge of the East End, where an existing Jewish community and a burgeoning tailoring industry provided the necessary social and economic support required by this refugee group. Historical evidence suggests that the outcome of this influx was rental inflation, due to the willingness of the immigrants to live in extremely overcrowded conditions (Booth, 1902, Vol. IV, p. 59.)[13] The increase in rents also led to the displacement of some of the existing impoverished inhabitants of the area, who moved down river (eastwards) to seek cheaper accommodation, as Newman (1980) has shown. Not only was there significant social change at this time, but a large amount of slum clearance was taking place during this period, as described by Yelling (1986) and Gaskell (1990).

Due to the clear variations between the two maps, two separate spatial models matched with the corresponding Booth data were constructed. Initial analysis (see Vaughan et al, 2005a) of the changes to the East End area over time indicated that the slum clearances on the western edge of the East End had the effect of improving the overall economic situation of that area – but that this was an improvement which the incomers (rather than existing residents) were in a better position to take advantage of. There was a ripple-like effect of displacement of populations eastwards, with the outcome of shifting the worse off to the more inaccessible back streets and their replacement by a population that could afford the more expensive rent and in some cases strict housing regulations: "redevelopment had turned the social composition of the Flower and Dean Street area upside down, replacing unskilled with skilled labour" (White, 2003: 91).

Data on the spatial distribution of Jewish settlement in the East End was taken from a map published in a book written as a response to concerns about the influx of large numbers of refugee Jews in the 1880s and 1890s: 'The Jew in London' (Russell and Lewis, 1900). The map covers the entire Jewish population of the East End, but excludes minor settlement clusters outside the area, (such as in Dalston or Hackney). The

information included in the map (drawn by George Arkell, who also worked on Booth's maps of poverty) was based on information supplied by the London School Board and from the School Visitors of the Tower Hamlets and Hackney areas. As these are the same sources quoted by Booth in his writing about the East End, it is safe to assume that Arkell was drawing on the contacts and information he had acquired though his work for Booth. The information used to identify the location of Jews was based on forenames and surnames, names of schools attended, observance of holidays, etc. Similar to the Booth enquiry, information on homes containing children was extrapolated to include homes without children. Thus, the proportion of Jews in the homes without children was deemed to be the same as that in homes containing children, in the same street. The basic unit was a street, or street segment, in the case of longer streets. The map uses the following categories of Jewish density (proportion of the Jewish population to other residents of East London, street by street): 0-5%, 5-25%, 25-50%, 50-75%, 75-95%, 95-100%. The bands for the lower densities 0-50%, where Jews were a minority, were coloured in reds ranging from deep red, to light pink for the highest density. The bands for the upper densities 50-100%, where Jews were a majority, were coloured in blues from light blue, to deep blue for the highest density.

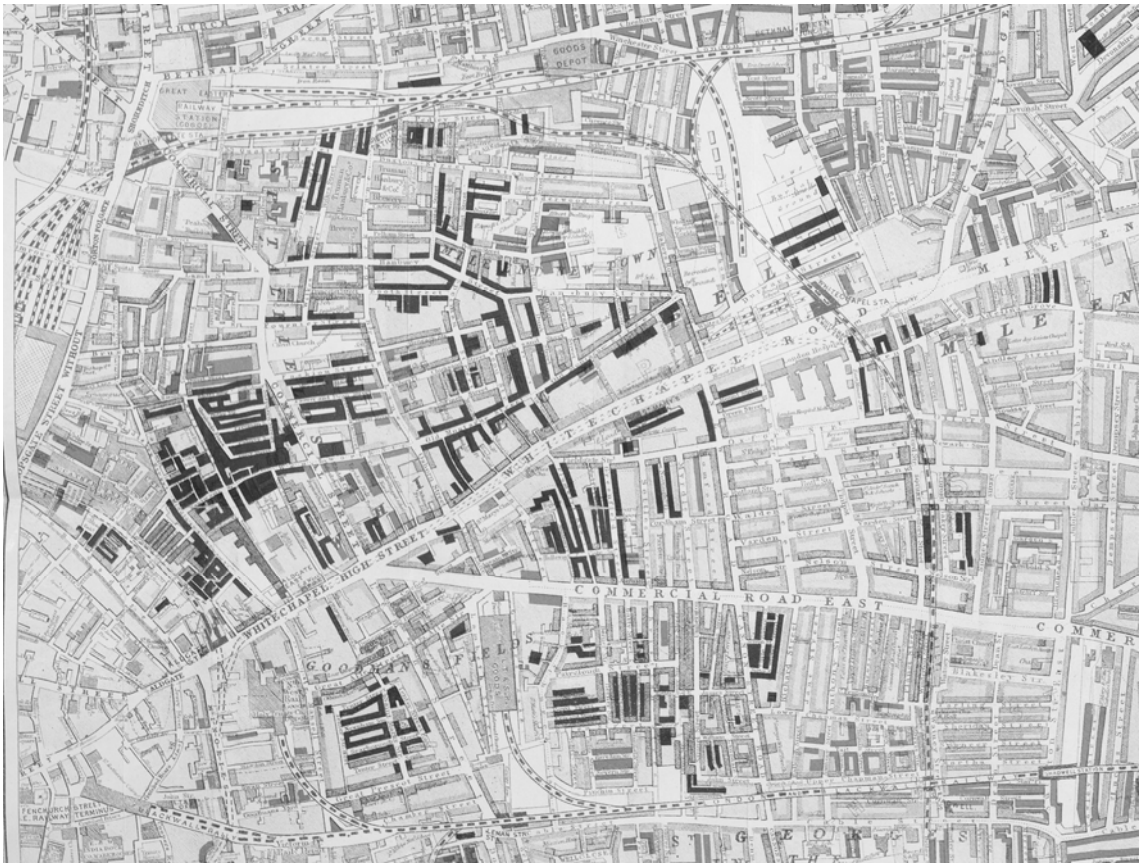


Figure 2.7: Section from 'The Jew in London' map 1899, courtesy Museum of London

The question addressed by this research is whether there is something particular about the nature of the life in poverty in a mixed, immigrant district. An examination of the Russell and Lewis data, which are the results of digitising the map classifications using the spatial database created for the Booth study, shows that there is a consistent pattern in the spatial location of immigrant settlement according to their proportion in the street ('density'). It is evident from studying the results of correlating immigrant density bands against local and global integration in Figure 2.8a and b respectively, that there is an increase in integration values to above the average for the area as density increases to the 50% mark, however integration values (and thus the potential for accessibility), decrease as density rises to the 100% mark. This is particularly the case for radius n (global) integration.

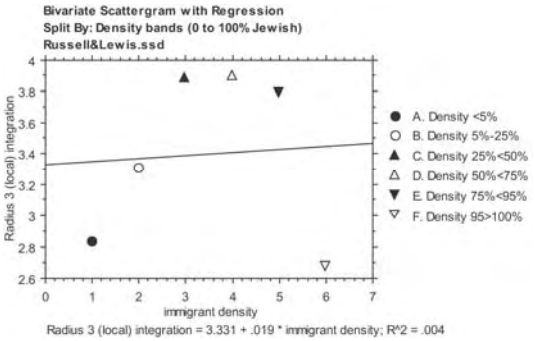


Figure 2.8a: Immigrant density correlated with Local integration

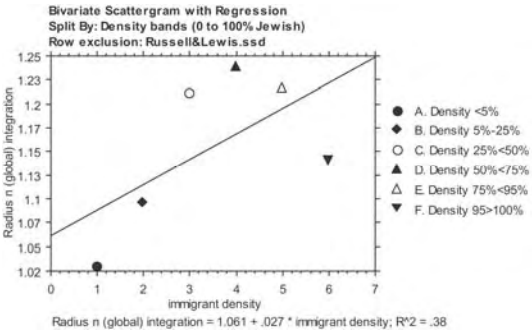


Figure 2.8b: Immigrant density correlated with Global integration

Bearing in mind that the streets most highly populated by immigrants were the back streets of the area, it follows that the distribution of poverty amongst densely populated immigrant streets should be analysed. An almost identical pattern to the distribution of integration is found when density is correlated with poverty (not surprisingly, as poverty has previously been shown to be closely related to spatial segregation). And in the univariate scattergram shown in Figure 2.9, we see that as density increases above the 50% mark, there is a marked decrease in Booth values of poverty, with the 95-100% immigrant streets having a Booth value ranging from 3.2 to 3.5 – namely falling at the high end of the poverty classes (where 1 and 2 denotes the very poor classes coloured black and dark blue and 3 is for the light blue classes).

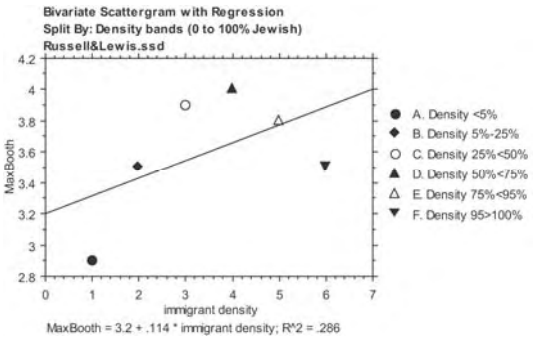


Figure 2.9: Univariate scattergram showing six density bands on the x axis, plotted against Booth classifications

In fact, this indicates that the immigrants were not located in the poorest streets, although some of the immigrant Jews lived in proximity to some of the poorest (gentile) streets of the area. Historical evidence suggests that the indigenous poor population benefited from living alongside the relatively more prosperous immigrant population. For example Davin (1996: 159), suggests that the mix of populations provided jobs which would otherwise not be available (she suggests there was less discrimination amongst Jewish immigrants, who were more likely to employ East End or Irish girls than other residents of the area).

Conclusions

This paper has found a strong relationship between poverty and spatial segregation and contrariwise, between prosperity and spatial integration in 19th century London. There is evidence that the spatial segmentation of areas of the city can have detrimental effects on the most vulnerable populations, particularly those who are dependent on local movement and local networks of support and exchange. A statistical definition of a spatial 'poverty line' was proposed by the findings that showed the Booth poverty classes being situated in the most spatially segregated streets of the area.

Previous research by the author into patterns of immigrant settlement has suggested that the formation of immigrant quarters at the edge of urban business districts is a critical stage in the integration of immigrants into society (Vaughan, 2006). In fact, Carter (1983: 188) proposes that "ethnic areas, where immigrant populations adapted to a new culture and way of life, [become] distinctive sections of the industrial city." Previous research has also shown that the location of immigrant quarters has historically been in the poorest districts of cities (Vaughan, 1999). The poverty situation of immigrants is not only relevant to factors such as the availability of cheap housing and casual labour (both of which are important to enable first footings

in a new area), but also because poor districts have an additional characteristic, that they are typically spatially and socially areas of transition, where newcomers, aliens and the 'other' can exist on the edge of the heart of the city whilst they find their feet in a new culture. As pointed out by Kershen (2004: 262), this is the case of the London immigrant quarter, the East End, which has been home to refugees for over 200 years. It is…: "a location…adjacent to the City of London, yet free from its restrictions, with a reputation for hosting nonconformity… a magnet for refugees and immigrants seeking economic opportunity and religious freedom." It seems likely therefore that the location of immigrant settlement close to the economic centres of a city is vital for their successful economic integration into the host society. Indeed, studies of historically successful immigrant groups show that the ability to connect with the economic centre through spatial proximity, coupled with support networks, helps create the foundations for economic activity and ultimately, economic mobility of people living in 'ghetto' areas. Recent research by Nasser (2004) sustains this contention, showing the successful transformation of Southall to support a "complex web of social relations and cultural affinities which manifest themselves in Southall's urban fabric". On the other hand, a pronounced separation from the economic centre can break this virtuous circle. The implication of these findings for planners and urban designers is that the dispersal of immigrants away from urban conurbations should be avoided. Moreover, the continuation of second generation immigrant clustering should not be viewed as a problem of 'ghettoisation', so long as other indicators of integration, such as education attainment and economic activity of the immigrant group are manifest.

The analysis here produced some new findings regarding the spatial form of cities. In particular, it was shown that Hillier's (2001) 'Centrality as a Process' theory can be supplemented by an understanding of how sub-areas of cities function in relation to their surroundings. The theory proposed here is that the spatial location on the edge of cities creates a springboard towards economic integration and ultimately, acculturation or social integration. The role of commerce and the markets as the first point of exchange between immigrant and host society was of vital importance. But of equal importance is the internal organisation of the spatial concentration, which can enable internal intensification of communal activity, socialisation, networking and self-support. The argument is that clustering - in particular strategic locations economically - is a necessary step in immigrant settlement. The analysis has shown that the perception that 'community' has only one dimension – complete intermixing of different cultural and ethnic groups can be replaced by a more subtle definition of simultaneous membership of a variety of 'communities' (see also Vaughan, 2006).

The analysis of change over the 10 year period showed a general improvement of poverty situation in areas which had slum clearances. By studying data for the same area in the form of a snapshot taken twice, ten years apart, the research has shown the impact of small-scale changes in the urban fabric. Indeed, a more complex situation emerges from a detailed study of the history of the area and its social transformation over time. The improvement of spatial accessibility did not necessarily improve the situation of the inhabitants of the area. In fact, the outcome was for the poorest of the population to move onto worse areas more distant from the economic centre. It is evident from studies such as those by Lupton (2003b) that only when spatial improvements are coupled with targeted social improvements, can genuine positive outcomes emerge from redesigning poverty areas.

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[1] The immigrant settlement research by the author was funded by a UK Engineering and Physical Sciences Research Council (EPSRC) PhD studentship (1995-1998) and the poverty research was funded by a two-year EPSRC First Grant (GR/S26163/01: 'Space and Exclusion: the relationship between physical segregation and economic marginalisation in the urban environment' 2003-2005).

[2] The notebooks are available on the Booth website provided by the London School of Economics (http://booth.lse.ac.uk/).

[3] See colour reproductions of the Booth maps at http://www.umich.edu/~risotto/imagemap.html for the 1889 map and http://booth.lse.ac.uk/ for the 1899 map.

[4] In space syntax analysis, as well as measuring accessibility between each street (or in segment analysis, street segment) to all other streets, known as 'radius n', analysis can be applied at different urban scales by restricting the radius at which it is applied. The radius refers to the number of steps in the mathematical graph, or in spatial terms, the number of turnings away from each point of origin.

[5] A close reading of Booth's extensive writings reveals that one important aspect of his work was his finding that urban morphology can have an impact on people's lives. Scattered through his writing are comments such as "Thus... the 'poverty areas' tended to be literally walled off from the rest of the city by barrier-like boundaries that isolated their inhabitants, minimizing their normal participation in the life of the city about them... (in Pfautz, 1967: 120).

[6] Pfautz (1967, 116) points out that for Booth, the factor "… especially decisive in determining the class of residents... might be situation, in contrast to site".
[7] See above note 4 on the definition of radius in space syntax analysis.
[8] The movement economy theory (Hillier and Penn, 1996), stems from the natural movement theory (Hillier et al, 1993) and postulates that the spatial distribution of movement is part of a powerful mechanism by which cities organise their movement-seeking land uses such as shops in relatively integrated locations and uses which have lower requirements for movement, such as housing, in relatively segregated locations.
[9] Radius-radius integration is used here to approximate global integration without 'edge effect'. 'Edge effect' describes the fact that the edge of axial models tends to seem segregated due to the fact that streets on the edge of the map are not connected onwards. It is calculated by measuring integration up to x changes of direction away, when x is the mean depth from the most integrated line in the system.
[10] 'Segment scale' refers to the fact that mean axial spatial values were calculated for all street segments broken down by Booth class.
[11] Gillie (1996) shows that Booth described a line of poverty between those who were 'in poverty' and those 'in comfort'. In fact, there is no mention in his writings of an actual 'poverty line', a concept which came about in later days by Joseph Rowntree, starting with his classic study of York.
[12] Personal communication with the author, August 2005.
[13] White (2003: 61) also states that "In the ten years after Rothschild Buildings were first occupied, it was said that rents in the Jewish quarter had nearly doubled - at a time when wage rates were rising only slowly... Such an increase in the cost of living space reflected the growth of demand for a static or declining amount of housing accommodation. "See also Russell and Lewis (1900), Newman (1980) and Vaughan (1994) for more on the history of Jewish settlement in the East End. The spatial form of the map in relation to Jewish immigrant settlement patterns was analysed in detail in Vaughan, 1994.

3 Social housing and segregation in Sweden – from residential segregation to social integration in public space

By Lars Marcus

Abstract

Segregation in the larger cities clearly appears as one of the major social problems of contemporary Swedish society. According to public research it is a problem that concerns its very foundations. Still, many of the actions taken in recent years are criticised for being ineffective. There is reason to believe that a fundamental reason for this is due to problems in translating policy to action. A dimension of the issue that is especially problematic in this regard is the spatial dimension of social segregation. Segregation is obviously an inherently spatial concept. Even so, the issue is often analysed and discussed using quite simple spatial models and weak theories on the relation between spatial and social phenomena. In this paper the aim is therefore to discuss some of the common spatial assumptions that from the point of view of spatial analysis can be challenging. Partly it concerns the concept of "areas", which within urban geography is recognised as a profoundly problematic form of representation. Partly it concerns the assumption that social segregation should be defined from the point of view of "residential constitution" of such areas, where there is reason to ask whether segregation in public space is a far more urgent issue. Some preliminary analyses will be presented that suggest that such a point of departure can prove fruitful.

Introduction – contemporary debate on segregation in Sweden

The debate on social segregation is more acute in Sweden at the moment than it has ever been. Obviously it does not only, and maybe not even primarily, concern issues of urban design and town planning, which will be the focal points in this paper. Rather the three major political areas where the issue is debated are labour market policy, especially the uneven distribution of unemployment among different social groups; school policy, where the issue of private schools, a new but growing phenomena in Sweden, is central; and finally housing policy, where the legal forms, that is to what degree new housing should be owned or let, rather than the built form, is the matter of debate. Social segregation debate also stretches into other areas, proving a ubiquity to the issue in Swedish society of today, that calls for some general background to the subjects addressed in this paper.

The background to this research is that in recent years a strong cultural identity has developed in many of the criticised housing estates from the sixties and seventies, where segregation is usually located. This type of housing has a particular and common history in that it is the result of a political decision on the national level in the early 1960s, to build one million new housing units in the time frame of ten years: *The Million Homes Programme*, in the hope to once and for all solve the housing shortage that for years had been plaguing the larger cities (Hall & Vidén, 2005). Realising that Sweden at the time had only 8 million inhabitants, it must be regarded as an astonishing undertaking, mirroring the self confidence of the Swedish welfare state of the post war era that in many other areas had proved so successful. Nevertheless, by 1974 the feat was completed and since then the criticism and debate on these particular housing estates has never ceased, a critique that in a sense also symbolises the end of the heroic era of Swedish post-war society.

In recent years, for the first time, one can speak of a cultural resurrection in these areas. Not least important has been the influence of American 'ghetto-culture' in the form of hip-hop music, graffiti and street fashion. Even though this presented a new image of these areas to the general public, discussion of these areas had a strong sense of an outsider's perspective, where one still was left with little insight of every-day life in these areas. A more interesting step in this resurrection was the start of a new magazine called *Gringo* in 2004, with the aim to undertake journalistic reporting from the inside of the supposedly problematic areas by the people actually living there. The magazine described its aim as "presenting Sweden of today without all the exoticism and out-there perspectives". The magazine was critically acclaimed and its publisher Zanyar Adami won the 'Best Journalist Prize' in 2005. But the magazine has also been criticised, for example for dealing with deeply problematic issues, such as honour killing, in a shallow manner and present a glitzy and untrue party vision of these suburban areas (Demirbag-Sten, 2006). Its status as either a critical commentator on contemporary Swedish society or a lifestyle magazine for *The Million Homes Programme* areas' elite, therefore still remains undecided.

It is important to stress that the identity of *Gringo*, and other expressions of this resurrection, to a tremendous degree is built around the *One Million Homes Programme* areas, which are constantly referred to, albeit often as 'the hoods', and by using the words *miljon* (Swedish for million) or *betong* (Swedish for concrete, the primary or at least most characteristic building material in these areas) in ironic or positive contexts. For example, *Gringo* proudly announces that one writes *Miljon*-Swedish, that is, Swedish as it is spoken in the *miljon*-areas, where it is mixed with words from the many languages spoken there, as well as some American English. *Miljon*-Swedish is furthermore also often spoken by young people with Swedish origin in these areas, once again stressing the importance of the areas in themselves and not the origin of its inhabitants.

The aim of this background has been to show, on the one hand, how today Swedish society is imbued by the issue of segregation, and on the other hand, how central urban design and town planning are to this issue. Even though one more often debates other aspects of the issue than the built environment, it is ever-present and somehow necessary to define the debate itself.

All in all, the situation bears witness to the fact that social and spatial phenomena are tightly knit together. When one addresses the issue of segregation, a rapid and often confusing oscillation between the spatial and the social dimension of the topic starts that often create fundamental problems for its proper analysis. Given that the general approach within space syntax research is to develop theories and methods for understanding this fundamental relation, its relevance to the study of segregation is very clear. The need to understand the 'social logic of space' (Hillier and Hanson, 1984) is becoming more apparent by the day.

This paper identifies two main questions. First, what to do about the ever increasing social segregation, particularly of the large social housing estates from the 1960s and 70s? Second, to what extent is social segregation a construction that risks fulfilling its own prophecy? This paper will concern itself with the first question but in the end also try to contribute to the second one.

The Swedish case – integration as a housing policy

The urgency of the issue of segregation has given rise to several public enquiries and investigations where the most important is *Storstadskommittén* (*The Large City Committee*). The conclusions drawn by this committee in its different reports from 1997 and 1998, which have also been confirmed by many later reports, say that: "the regions of the larger cities in Sweden continue to be economically, socially, demographically and ethnically segregated". This situation has led to a new and frequently used term: *utanförskap* ('outsiderness') that is to say that there is a growing portion of the population that are considered, by themselves and/or others, to be situated more or less outside of society. *Storstadskommittén* further draws the conclusion that this is a critical situation: "it concerns the foundations of our society. The society simply needs common values to stick together and be able to function".

At the same time there is a critique of the kind of descriptions that *Storstads-kommittén* represent, arguing that they can be misleading and possibly make the situation worse (e.g. Lilja, 1999). One can argue that this kind of description represents an outside-perspective that not give full account of the often rich and new forms of social life that are developing in the addressed 'problematic' areas. Repeated negative reports, that furthermore are not recognised by the inhabitants themselves, can, according to the critique, become a hindrance and make it difficult for the developments in knowledge that are taking place to take effect.

In response to these reports, the segregation issue has led to many political actions in Sweden, both on the national and the regional level. The most well-known and debated is a large comprehensive project that was initiated by the national government in 1999 under the name "Storstadsatsningen" (*The Large City Programme*), which came to encompass a multitude of small projects and actions in the least advantaged city-districts in the outer-city of the largest cities in Sweden. Like so many other programmes of this type it has been heavily criticised and several critical evaluations have been undertaken and have been shown to be meagre (e.g. The Swedish Integration Board, 2003; Törnquist, 2005; Vedung, 2005).

In general, what seems to be missing from these programmes is knowledge that is able to link aims to action. Obviously such action encompasses many other political fields than housing and urban design, such as the aforementioned labour market policies and school policies, but the spatial dimension of the issue, inherent in the very concept of segregation, somehow make housing and urban design generic to it. This is

also proven by the fact that the very definition of the issue has its foundation in geographic analyses of urban areas, especially the contested housing estates of the *Million Homes Programme*.

More specifically then, what seems to be missing is a better understanding of social segregation as a spatial phenomenon. The very concept *segregation* has essential spatial implications, it is simply impossible to conceptualise segregation without such a dimension. This implies that the issue of social segregation can never be fully understood or successfully managed without a powerful theory of space as a social entity. At the moment such a theory has been more or less absent from discourse on segregation in Sweden and instead there is a rather naïve and uncritical conceptualisation of the spatial dimension of segregation[1].

There are two key problems with the conceptualisation of segregation in Sweden. First, social segregation is usually defined in relation to a comparison between different urban *areas*, such as different city-districts. This is an example of the MAUP, the "Modified Area Unit Problem" (Openshaw, 1984), which relates to the fact that comparison of social statistics by area is highly problematic, both because how one defines the limit of an area is in most cases arbitrary, but heavily influences the results of its analysis and because area comparisons result in averaged statistics that hide the variation of data within an area. Second, what is compared between areas is usually their *residential* composition, that is, the degree to which people living within an area are homogenous in respect of social criteria, such as income, education or ethnicity. Such analysis does not then take into account people working in the area, or people simply visiting it for shorter or longer times, for example for shopping.

Now, there is reason to ask whether a certain social homogeneity, defined as the composition of its residents, within different urban areas is not to be found in any urban area. As a matter of fact, such homogeneity is something that is ubiquitous to more or less all descriptions of cities through history and over the world and one can then ask whether this really is the problem. Clearly, it could be considered a problem, but is it really the reason it has become such an urgent topic in Sweden of today? After all, this is what our cities have always looked like. There seems to be a possibility that the problem has been set up the wrong way round. The suggestion in this paper is that rather than *residential homogeneity*, what is conspicuous to many of the areas addressed in studies on the topic is the extreme *segregation in public space*, which is something that completely contradicts the rule for cities in general.

This misconception of the nature of segregation also leads to the possibility that it has - in part - misinformed political action on the subject. For example, when it comes to social segregation and the built environment, focus has for a long time been on housing policies, where great effort has been made in many places towards more diverse forms of letting, by introducing, for example, tenant-ownership in the hope that more affluent and socially integrated groups outside these areas will move in, or more prosperous segments living in the areas will not move out, all according to the normal definition of social segregation as homogenous residential composition. But if social segregation has more to do with segregation in public space than segregated housing, we actually need policies relating to town planning and urban design rather than housing policies.

A closer look on methodology

Most research on social segregation has it roots in sociology, where there is a large amount of studies on issues like ethnic segregation and gentrification. These issues have also traditionally been approached using classic descriptive statistics. The main approach is to describe the social constitution of different urban areas using average-values and percentages for different social parameters like income, education and ethnic origin. From such descriptions different urban areas have been given social characteristics, where some have proved to be very homogenous in important respects and therefore categorised as segregated. The work of the aforementioned *Storstadskommittén* for example, relies heavily on such material (The Swedish Ministry of Health and Social affairs, 1997, 1998).

For these reasons it seems most important also to turn to research that explicitly has its point of departure in space itself. The interest in the topic of space has grown vastly in recent years. Geographers such as Harvey (1996) and Soja (1989, 1996 & 2000) for example, have been most influential in the debate on social issues in recent years, introducing and stressing the importance of their spatial dimension to a wider audience. It has also become most influential within cultural theory (Crang & Thrift, 2000). Strong philosophical fundaments for many of these are the writings on space by Lefebvre (1974). Spatial analysis has also undergone a fast development when it comes to its more analytical side where the development of GIS has

been instrumental. Geographical data is now capable of being analysed in amounts and at a speed that was incomprehensible only a decade ago (e.g. Longley and Batty, 2003).

Still, on the micro-scale of human behaviour in urban space, there are descriptive problems that impede successful application of the powerful tools presented by GIS (Talen 2003, Kwan 2003). On that scale the traditional geographical units, such as areas or gravity points, often turn out to be too crude. It is exactly here that space syntax research, with its roots in architectural and urban morphology, has proved so successful, both when it comes to the development of new descriptive means, such as the axial map, capturing the micro-scale of human behaviour, and when it comes to the development of theories on the relation between man made spatial systems, such as buildings and cities, and social life (Hillier and Hanson (1984) Hiller (1996) and chapter 1 of this issue).

In the particular case of segregation in Sweden, where we can see that the very definition of the issue is to such a degree directed by the descriptive means of traditional urban geography, space syntax presents an opportunity to define the issue on a more detailed level and possibly thereby also present more efficient actions to its remedy. In short it presents the possibility to analyse segregation dynamically, as how people are connected, mediated and integrated through public space, rather than statistically, averaged across large urban areas.

New approach: integration as an urban design policy

In a research project that started in September 2006 on the relation between the spatial structure of urban areas and social segregation, the proposition is to analyse the degree of segregation in and of public space in 'segregated areas'[2]. The general idea is to try to see if such a description can be more apposite when it comes to understanding and analysing social segregation in these areas. In the following section three preliminary analyses are presented that hint at the possibility that this can be the case. The argument will be taken in three steps, starting with a principal analysis that show how public space in itself can be regarded as more or less segregated and how this in turn can influence the degree of segregation among people using public space. Next, an example will be shown of how public space as a mediator puts residents in varying relations to each other, which further can support segregated situations. Finally, it will be shown how public space puts residents in varying relations to attractions, such as public and private services, also an aspect of social segregation. Still, it needs to be stressed that these are preliminary and principal analyses and not finished studies.

The suburban landscape of Stockholm is programmatically divided into enclaves following the directions and planning ideals of the post-war era. In Stockholm the Comprehensive Plan of 1952 (*Generalplan för Stockholm 1952*) has been immensely influential even though actually never adopted as a legal document. As a matter of fact, in this plan the idea of social segregation was part of the programme. The general idea at the time was that people with similar socio-economic situation would also more easily create bonds and get along in the same neighbourhoods. As put by Göran Sidenbladh, one of the leading architects of the built expansion of Stockholm after World War II: "An important prerequisite for a feeling of true community is that the groups members belong to the same social class or group […] today one needs to respect that social bonds more easily develop in units that are homogenous from a social point of view" (Sidenbladh, 1948: 115)

The concept of *grannskapsenheten* (the neighbourhood unit), with its implicit ideas of a socially well-functioning community of a controlled size, fit these social ideas well and became the building stone of urban expansion in Sweden in the post war years, especially in the larger cities[3]. In *Generalplan för Stockholm 1952* one can find a template for such units consisting of 16,500 inhabitants having a radius of 900 meters, comprising both multi family-houses and single family-houses, but also schools, services, sports-fields as well as industry, all serviced by commuter trains (*Figure 3.1*). As a template this general layout directed the planning of the expansion of Stockholm well into the 1970s, and in some examples even longer. Clearly there are variations to the theme mirroring general changes in Swedish society. For example, while the neighbourhood unit in the 1940s and 1950s primarily was a social idea of community, it changed with growing prosperity in the 1960s and 1970s towards a commercial idea of shopping (Franzén & Sandström, 1981). It was also influenced by – what were for Sweden – new planning ideas, for example that a group of neighbourhood units could be located around a larger neighbourhood unit, offering a greater range of services, thus becoming a sub-centre of the city as a whole. In this way the neighbourhood unit, generally speaking, gave the larger cities in Sweden an easily recognisable archipelagic structure, a structure that just as well could be described as a heavily segregated structure.

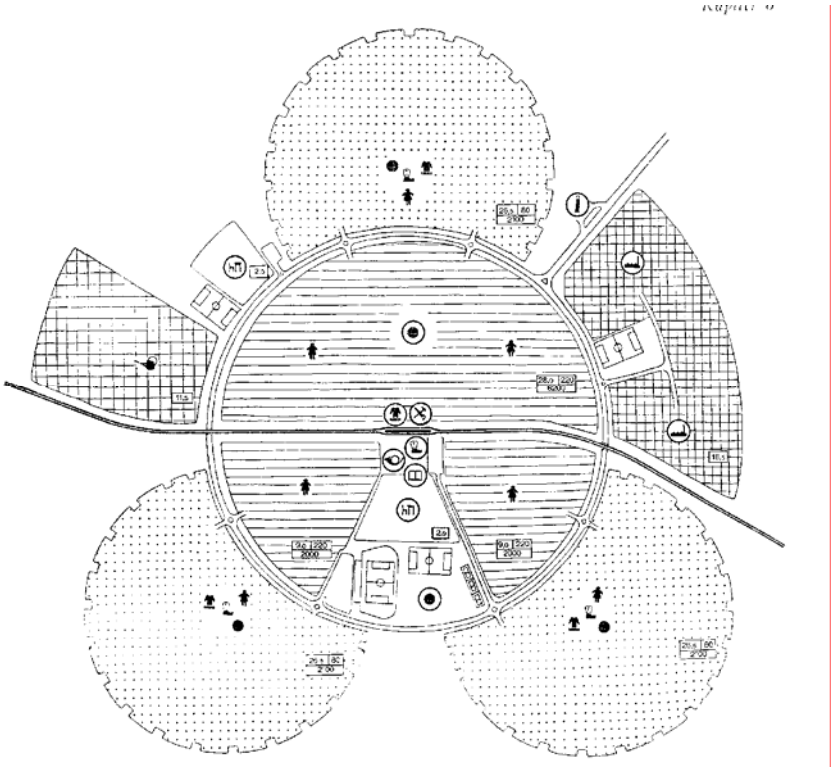

Figure 3.1. Template for neighbourhood unit supported by commuter trains, from "General plan för Stockholm 1952"

Even though this structure is easily recognised on any map, its fundamental segregating effects can be more profoundly shown by integration analysis. If we in the general manner of space syntax research, build an axial map of an area of Stockholm developed in the post-war era, and then calculate what axial lines that are most accessible within three axial steps for a pedestrian, what is called radius 3 (local) integration in space syntax research, a most telling picture appears (*Figure 3.2*). Very few of these axial lines are connected and nowhere create a continuous structure. On the contrary they show a clearly discontinuous and segregated structure where more or less all axial lines are isolated from each other. Typically we find more often than not just one axial line of high local integration in each and every neighbourhood unit[4]. Since the integration value in an extensive series of studies from cities around the world has proven to be such a strong indicator of movement (see chapter 1 of this issue), there is reason to believe that this picture mirrors movement flows in the areas, telling us that even though these can be strong within each area, there is far less movement in between areas.

Figure 3.2. The most integrated lines in an area of the southern suburbs of Stockholm. Local integration to the left and global integration to the right.

Checking this by also calculating what axial lines are most accessible from all other lines in the map, what is normally called radius n (global) integration in space syntax research, we get an almost inverted picture, a cluster in an area located in between the surrounding city-districts. One could then argue that global

integration captures movement over long distances, or in between districts; and local integration movement over shorter distances, or within districts, and draw the conclusion that these types of movement in this particular urban structure seldom or almost never overlap. If we with this as a background also argue that movement within a district is primarily conducted by residents in the same district, while movement between districts by definition implies someone visiting a district, this structure clearly speaks of segregation of public space. So, the conclusion is that whether the districts are residentially segregated or not, their public spaces already are.

The accessibility measure developed in space syntax research has been further developed into Place Syntax analysis.. Place Syntax analysis uses a GIS MapInfo software add-on tool developed by the author with others. The tool was created to measure physical accessibility to particular urban functions and attractors, such as shops or open green spaces. Using accessibility, a widely used spatial analytic measure defined as the relative 'proximity' of one place to other places, the place syntax tool uses space syntax measures of distance travelled (rather than the typical 'as the crow flies' measure) and/or amount of axial lines (which can be seen as a measure of how easy the distance is to navigate) to take account of how directly accessible the function is for the population available to use it. It is reliant on precise plot-detailed or address-point data on urban functions (See Ståhle, A., Marcus, L. & Karlström, A., 2006).

Integration analysis, as well as space syntax research in general, deals with the analysis of urban space *per se*, in that what is analysed is the accessibility to urban space in itself without any regard of the 'content' of space, such as residential population, retail or bus-stops. There is an important point to this approach, since the differentiation of space as a system in itself, apart from its 'content', is seldom done with any consistency in urban analysis. At the same time, what we often look for in urban analysis is accessibility to particular content in urban space such as the ones mentioned above. In Place Syntax analysis, the axial map is used as a distance gauge to such content, loaded with place-data on either plots or address-points. It is thereby not only possible to analyse the accessibility to other spaces, but the accessibility to specific content in space as well.

Place syntax analysis thus presents a new and in many respects more life-like mode for representing geographical data. While traditional geographic descriptions, as repeatedly pointed out in this paper, most of the time deal with representations of such data as *density within geographical units*, such as city-districts, blocks or plots; place syntax deals with representations of the *accessibility within a certain radius* to such data, for example walking distance following the actual street-grid. We can then produce maps showing '*accessibility to density*', for example (*Figure 3.3*).

There are two advantages to such a tool. First, we get rid of the area-problem, since there are no areas in such descriptions (unless one wants to calculate the average accessibility for an area). Second, we move our attention from residential location to residential relation, that is, from the question: where do people live? To the question: where do people live in relation to other people? In short, the idea is that it must be more productive to describe the mutual accessibility between residents rather than just their geographical location.

Figure 3.3. Geographical data on population represented as densities within geographical units - in this case plots - for an inner city area of Stockholm (left). Geographical data on population represented as accessible population within a radius (r=700m) from each plot, following the actual street-pattern, for the same area (right).

Apart from this there is a third benefit from this, which is intimately related to urban design. If the primary concern earlier, due to conventional descriptions, was *densities*, we can now also concern ourselves with *form*. Instead of trying to find ways that will make certain social groups move in or out of the areas to reach

a less segregated composition, one can change the accessibility between people by changing the urban form. This opens quite new possibilities for intervention in these areas, which in many evaluating reports on earlier programmes has been pointed out as necessary.

Finally, public space as a mediator can put residents in different relations to attractions, such as public and private services, which also can be seen as an aspect of social segregation.

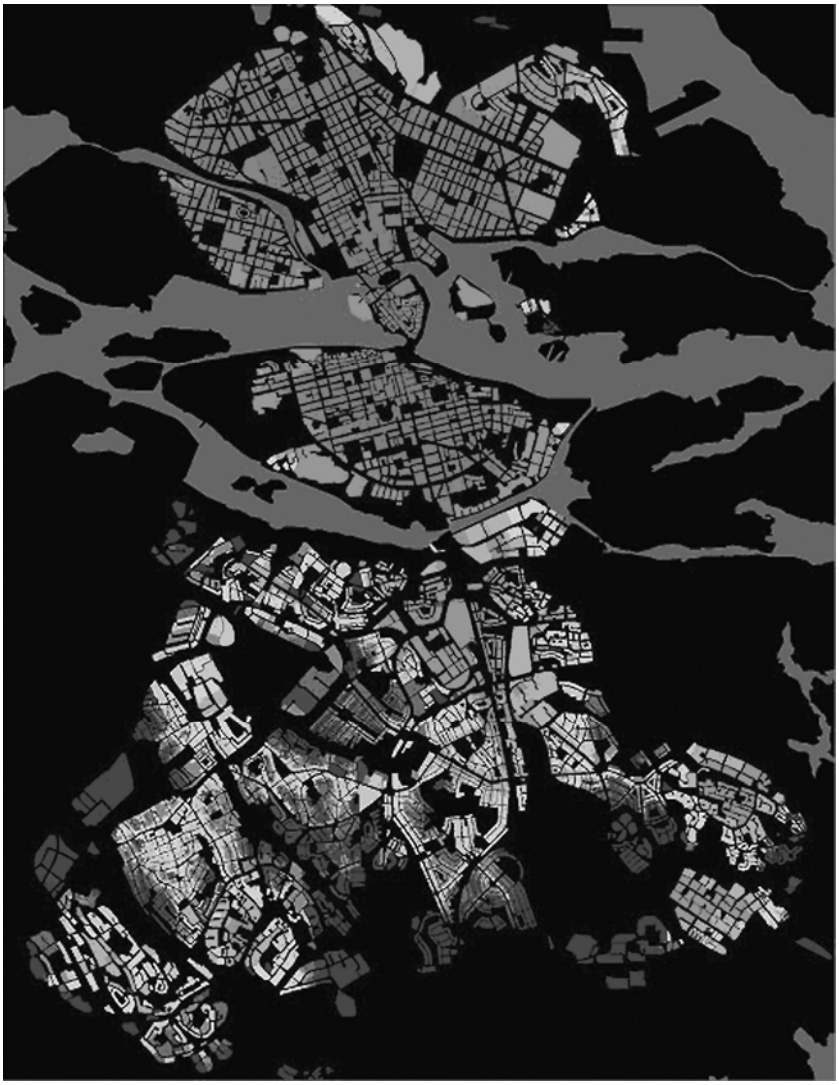

Figure 3.4. The accessibility to public and private services from each and every plot in the inner city and large parts of the southern suburbs of Stockholm. Dark grey represents high accessibility to public and private services and light grey low.

In a large survey, using Place Syntax analysis, the accessibility from each and every plot, in all of the inner city and large parts of the southern suburbs of Stockholm, to public and private services such as grocery stores and post offices, was calculated and represented on a map, making it possible to follow the variations in accessibility to such service in minute detail (Figure 3.4). Obviously the result depends on the location of such services, which are unevenly distributed, but the pattern is also influenced by the design of the structure of public space, where the grid in the inner city raises the general accessibility, while the 'meandering' structure of the outer city creates larger distances. The point here is to show how the structure of public space plays here a vital role in the creation of segregation from common attractions that often have an integrating role: once again, this stresses the possibility to develop urban design policy in the discussion of social segregation.

Conclusions

In the beginning two main questions were identified. On the one hand, what to do about the ever increasing social segregation, particularly in the large social housing estates from the 1960s and 70s, and on the other hand, a growing debate about the extent to which social segregation is a construction that risks fulfilling its own prophecy, where especially the criticism of the very same housing estates is contested.

In the discussion above some promising and at times maybe even convincing suggestions have been made concerning the first question. Firstly, that the issue of segregation has an inherently spatial dimension that needs more detailed analysis, and secondly, that the role of the structure of public space has often been underrated in earlier spatial analyses of the issue. Thus, more detailed spatial analyses can possibly lead both to refined definitions of the issue in itself, but also open the door for new kinds of actions and interventions for its remedy that earlier have been neglected. A general description of this is to say that these preliminary analyses open the possibility of urban design policies concerning social segregation, and not only concerning housing policy, which earlier has been the dominating approach.

Such an approach might have consequences also for the second question above, where earlier definitions and ways of understanding social segregation have led to perspectives where people living in the 'problematic areas' have not always recognised the descriptions of their areas. By moving from general statistical descriptions of areas to descriptions of public space as a mediator in the actual use of space, it can be argued that the analyses actually change from outside descriptions to inside descriptions. Certainly not in the way that such inside descriptions normally are defined, that is, as verbally expressed descriptions such as interviews with people living in these areas. Rather we are dealing with descriptions that mirror the actual use of space by anybody entering these areas. In principle, this could have a greater potential to be recognised by people living in the areas, than traditional geographic descriptions.

Thus, it could be argued that the methods of spatial description presented here, to a much higher degree, are representations of an inside-perspective, whereas traditional geographic descriptions to a higher degree are representations of an outside-perspective. Whereas in general debate on this conflict, most quantitative methods on the analysis of space have been criticised for their crudeness, the descriptions presented here seem to carry the potential to capture the built environment as it is actually lived and used, thus also potentially bridging the often unproductive conflict between quantitative and qualitative descriptions that at times runs the risk of becoming an ideology. Rather it could be argued that the quantitative methods presented here could help describe the situation and formulate the problems there with greater precision, and potentially find support both on 'the inside' and 'the outside'. Obviously this is only a possibility hinted at in these preliminary studies, but it is certainly one of the central questions that will be investigated by the author in a Swedish government funded research project entitled 'Urban form and social segregation - from residential segregation to social integration in public space' that started in September 2006.

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[1] The Swedish Integration Board (2003) is rich in studies and data founded on such a definition.

[2] The research project led by the author ('Urban form and social segregation - from residential segregation to social integration in public space') is funded by the Swedish research council *Formas* (The Swedish Research Council for Environment, Agricultural Sciences and Spatial Planning).

[3] The best analysis of the idea of the 'neighbourhood unit' in Sweden is Franzén & Sandström (1981).

[4] In this particular case not every city district within the area would fit the definition of a neighbourhood unit, still every district has its own most integrated street clearly separated from the others.

4 Social Exclusion and Transportation in Peachtree City, Georgia

By Ruth Conroy Dalton

Abstract

This paper will discuss how, in a small American city close to Atlanta, the flexibility and relative affordability of electric golf carts, as a viable alternative to the automobile, means that the level at which families and individuals are disadvantaged through their lack of access to public/private transport is effectively lowered. Economic access to golf carts, in of itself, would not be sufficient if it were not for the extensive, highly penetrative and 'ringy' spatial structure of the cart path system, a mostly-segregated, 150 kilometre network. A spatial analysis of this dual transportation system is presented and its implications discussed. The conclusion of this paper is that the duality of the effective spatial structure of the cart path network and the relative low cost and inherent flexibility of the golf carts combine to reduce transportation-linked social exclusion in Peachtree City. This argument is substantiated, in the final section of the paper, through the evidence of a questionnaire distributed to a random sampling of 1,038 property owners and renters in the city.

Keywords: social exclusion, transportation equality, transit equity, space syntax, axial analysis, secondary transportation system, leisure trail, planned community

Introduction: social exclusion and transportation in the UK and the USA from a UK perspective

Social exclusion is defined by the UK government as being "a shorthand term for what can happen when people or areas suffer from a combination of linked problems such as unemployment, poor skills, low incomes, poor housing, high crime, bad health and family breakdown". The fundamental idea underpinning all research into the links between social exclusion and transportation is that some groups of society, the young, elderly, less physically able, ethnic minorities and lower income groups (and often these groups are not clearly distinct but frequently overlap) become increasingly excluded from mainstream society through accessibility barriers to everyday, vital services, such as locations of employment, healthcare and shops (Social Exclusion Unit, 2003). This has come about through significant rises in car-ownership and the related trend towards more centralised services, such as out-of-town shopping centres, and the emergence of sparser urban (suburban and exurban) spatial patterns. As a consequence the difficulties faced by those without cars have increased proportionally. "Those without cars usually need more time, greater effort, and pay a higher marginal cost to reach the same destinations as people with cars." (UK Department of Transport) These trends are mirrored in both the UK and the USA. Other historical reasons for the rise of the inaccessibility of essential services in the UK include the deregulation of bus services in 1985, the rise of bus fares in real terms, growing congestion leading to the greater unreliability of bus services and a drop in local authority spending on public transport (ibid).

The causal relationship between factors of social exclusion and transport is becoming an increasingly important issue in the UK and the USA. However, the approach that both countries take is slightly different. This difference is initially highlighted by the words and descriptive phrases used. In the UK, we refer to 'transport and social exclusion', the emphasis being upon the effects of exclusion or segregation on specific sectors of society, this is in contrast to the USA where the same issues are discussed under the umbrella-title of 'transport' or 'transit equity'[1], with the emphasis being upon the core American value of equality. Along with the right to free speech, the issue of equality is central to the American national identity. Perhaps as a result of this, research and policy in the USA seems to be skewed towards how to achieve this idealised goal, for example, Grengs asks, "Should public transit serve an even higher purpose, as an instrument for advancing social justice?" (Grengs, 2005: 52), Although he later suggests that the idealism of social equity through transport is now beginning to fade, "This shift away from meeting social goals toward the more narrow purpose of relieving traffic congestion, from achieving equity toward merely efficiency, is now influenced by a neoliberal political agenda that separates the social from the economic, causing planners to lose sight of the public purpose of mass transit."

In contrast to this, the UK approach to transport and social exclusion seems to take a more pragmatic approach. In a recent report (Social Exclusion Unit, 2003) to the Office of the Deputy Prime Minister, the

Social Exclusion Unit outlines five measures that contribute to social exclusion and hence should be tackled as part of any policy, these being: the existence of a transportation infrastructure (is it actually possible to get from A to B?), the availability of information needed to understand transportation choices (do the public know how to get from A to B?), the financial cost of travel (is the journey from A to B affordable?), the creation of safe travelling environments (does an individual feel safe making the journey from A to B?) and the intelligent siting of vital services within communities (is the journey from A to B even necessary if services can be provided locally?). This practical approach, which lends itself towards policy formation and tangible solutions, appears, however, to be motivated by less lofty ideals than its counterpart in the USA. If the types of destinations that should be rendered accessible are brought into question, high on the list are places of work and learning (ibid), the other destinations being healthcare, food shopping and social activities. It does appear that, in the UK, a significant impetus to solving the problems of social exclusion and transport is strongly motivated by getting people to work and so, presumably, reducing their dependency on the state. This is not to say that such considerations are not part of US policy, for example through their 'welfare-to-work' programs (U.S. Department of Transportation, 1998), it is simply that the importance placed upon the goals and motivations driving the policies in both countries appears to differ slightly: the core elements are the same, it is the relative ranking of importance that shifts.

Finally, another key difference between the USA and UK is suggested by Sanchez and Wolf (Sanchez and Wolf, 2005) who propose that, "In the United Kingdom, policymakers and advocates often take a broader view of social inequity. The British effort to combat 'social exclusion' is a more wide-ranging approach than the U.S. focus on employment and housing mismatches. Efforts to eradicate social exclusion address communities that are isolated from or marginalized by general society." Their argument states that in the USA the definition of transportation equity appears to have a far narrower focus, essentially concerning itself solely with issues of race and class, whereas in the UK, the concern about links between transport and social exclusion covers other potentially disadvantaged groups such as the young, elderly and less physically able.

The focus of research (in both the UK and USA) into social exclusion and transport focuses almost exclusively on issues of *public* transportation. One of the problems with public transport solutions is that they frequently become stigmatised as being associated with low-income users. Where issues of transportation touch upon possible solutions to provide access to affordable modes of *private* transportation for groups hitherto excluded from, for example, private car ownership, there has been far less written and far fewer solutions implemented.

In the UK, some examples of 'quasi-private' transportation solutions include an increasing number of 'pay-as-you-drive' car clubs and lift-sharing initiatives. In addition to this, are demand-responsive, door-to-door services such as the shared taxi service in South Shields detailed in the Good Practice Guide published by the Passenger Transport Executive Group (UK) (Passenger Transport Executive Group, 2006).

If *private* rather than *quasi-private* solutions are considered, under the banner of 'subsidised personal transport', initiatives such as the provision of repair grants for otherwise un-roadworthy cars, subsidised driving lessons and the subsidised lease of cars, mopeds and bicycles (Social Exclusion Unit, 2003) can be found. One clear example of this is the 'Wheels to Work' project in Warwickshire, which offers the loan of a moped for up to twelve months to young people starting work/further education (ibid). As Roche commented in her speech to the Community Transport Association, "The mopeds have helped get young people get to both jobs and places of training and education. It's opened dramatic new horizons for many of them." (Roche, 2003).

In contrast to these British initiatives, this paper looks to the USA for one example of a sustainable, affordable *private* transportation solution that appears to be successfully, if perhaps unintentionally, aiding hitherto disadvantaged social groups. In terms of the five areas of accessibility, outlined by the Social Exclusion Unit, and described above, the cart-path network in Peachtree City serves to fulfil two of the five criteria: it is improving physical accessibility (through the provision of the network) and is making travel more affordable (through the relative cost of the golf carts). In terms of the social groups benefiting from the network, they include the older, younger, those with physical mobility problems as well as the economically disadvantaged.

The aim of this paper is to further understand the relationship between the spatial structure of the city, the success of the Peachtree City's cart part network and the extent to which this benefits its citizens, with particular focus on those sectors of society frequently disadvantaged by 'car culture'. In this respect, this

paper echoes the viewpoint of chapter 1 of this issue by considering the physical city and the social city to be a duality that must be examined together. The second aim of the paper is to question what lessons can be learnt from Peachtree City and to what extent some of these findings may be reproducible elsewhere.

Peachtree City, Georgia

Peachtree City[2] is a commuter satellite-city (or perhaps what Soja refers to as an *exopolis*, the city without, Soja, 1992: 95), 43km south to the South East of Atlanta, Georgia, USA. It is accessed via Interstate 85[3], a major travel corridor through the Deep South connecting Petersburg, Virginia in the North with Montgomery, Alabama to the South and passing through key Southern cities such as Charlotte and Atlanta en route. See Figure 4.1, for a location map of Peachtree City. The city is accessed directly from Highways 74 and 54 which intersect approximately 1km to the west of Lake Peachtree, an artificial lake created by damming Flat Creek (Satterthwaite, 2005) and which now forms the heart of the city. See Figure 4.2 for an aerial photograph and city plan indicating the highways, the two main lakes (Lake Kedron to the north and Lake Peachtree to the south) and the city boundaries.

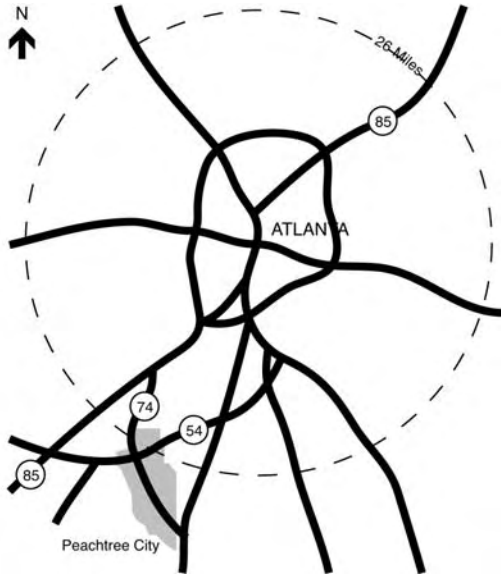

Figure 4.1. Location of Peachtree City

The city was a planned community built entirely by private developers; it was chartered on March 9, 1959. Its area covers approximately 15,637 acres with a current population of 37,868 (2005 census, an increase of 19.91% since 2000). Estimates for 2010 indicate a population of 44,156 but, for planning purposes, the city is working to a build-out target population of 38,500 residents (CPCPD, 2006a). The population density is currently 598.4 people/km² (1,550.3 people per square mile or 2.4 people per acre) (ibid) and was originally hailed as being "Suburban living at its best", whilst offering "All the advantages of a 'small town', informal and charming." (Peachtree City Corporation of Georgia, 1957).

One key aspect of Peachtree City's history was the passing of legislation in 1974 permitting the use of electric golf carts on city streets (Satterthwaite, 2005). This legislation, coupled with the creation of the first asphalt leisure trails, initially as a means of negotiation of land-easements by a utility company wishing to lay sewerage-pipes (Glanton, 2002) meant that by the early seventies the kernel of the present cart path system was already in place. The, almost accidental, pairing of utility pipes and the paths are of morphological importance, a fact which will be discussed later in the paper. Added to this nascent infrastructure, the fact that Peachtree City also boasted three golf courses meant that the means to turn a system of leisure trails into cart trails, namely the golf carts, were already owned and used by a minority of the population. Today, the extensive system of cart paths has become part of Peachtree City's unique identity and a major contributor to its success. There are now an estimated 9,000 golf carts used in the city (Kaspriske, 2003) that means that almost every household owns a golf cart and only a small proportion of these carts of these will ever be used on the golf course.

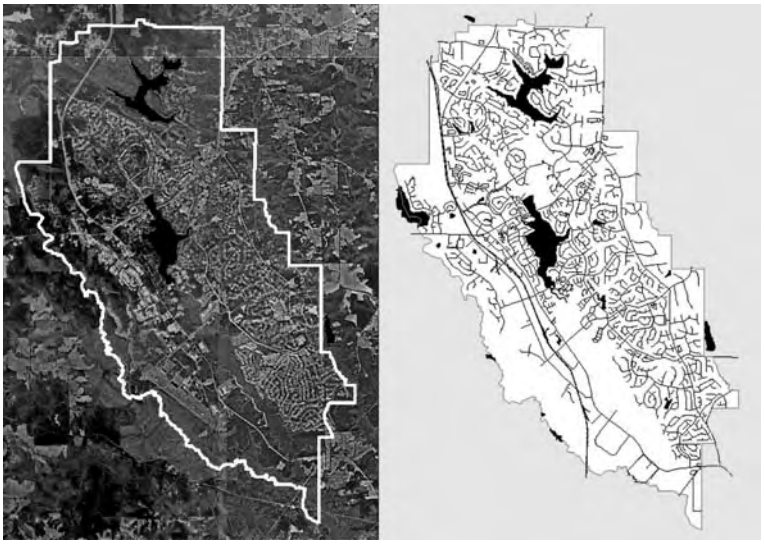
Figure 4.2. Aerial Photograph and Street Plan of Peachtree City

Methodology

The majority of the fieldwork and observations were made on two visits in May 2003; a third visit was made in July 2003 in order to conduct additional video observations. On each occasion, we hired golf carts and drove around the cart path system. On the first visit we attempted to traverse as much of the cart system as possible whilst taking photographs and noting the locations of bridges and tunnels[4] (see Figure 4.3). On the second visit we selected a continuous cart-path route extending as far south as Braelinn Road and as far north as Flat Creek Road (and passing through both integrated and segregated sections of the system as well as three local shopping centres). To make the observations we attempted to drive at a regular speed along the route noting our time at major intersections with a stopwatch and indicating encounters with other golf carts as a 'dot' on a map. On the third visit we attempted to improve upon the hand-observation method (since juggling a map, a pen and a stop-watch in a shaking cart proved extremely tricky) and decided to use a video camera to make the observations. In this way, we reasoned that we could later distinguish between encounters with pedestrians/cyclists and golf carts (or other classifications of social encounter).


Figure 4.3. View of a Typical Cart Path Tunnel and Bridge Crossing

The base data for the axial line map[5] was provided by City Hall and was extracted from their GIS dataset. We encountered some problems creating the axial map. First, the data we had was in the form of road/path centreline data with no information on road widths or building setbacks. Since the definition of axial lines is the longest and fewest lines of sight that pass through a spatial system (Hillier and Hanson, 1984), then we were very aware that our modelling would result in an approximation to *true* axial sight lines. However, during our earlier experiences of driving through the city, we had noted that the density of foliage was so great (more than thirty percent of the city is city-owned parkland, greenbelt or open space) that even had this additional information been available we doubted that the resultant axial map would have been significantly different as many potential lines of sight are impeded by the abundant foliage. Equally, in recent years, research into the use of road centre-line data (Dalton, Peponis and Conroy Dalton, 2003; Turner, 2005) combined with the use of fractional analytic techniques (Dalton, 2001; Dalton, 2005) reassured us that this approach was valid. However, because of the intricacies of the dual system we were unable to directly use the road centre-line data; instead we redrew it in the manner of a traditional axial map. The final mapping problem concerned situations where both cart paths and roads followed the same

route and yet were separate; these needed to be modelled extremely carefully. Additional care also needed to be taken to model the crossings of the path-system and the road system correctly.

In addition to the spatial analyses and observational data collected, the author was particularly fortunate to be permitted access to the complete dataset of a survey conducted in the summer of 2006 by City Hall into their citizen's usage of the cart path system. 1,038 surveys were posted to a random sampling of property owners and residents occupying rental accommodation in the city. In addition to this, the survey was made accessible at City Hall, on their website and at the city Library (which could either be filled in onsite, or faxed/posted to City Hall). Nearly 500 households responded and the results of this survey are discussed extensively towards the end of this paper.

A spatial analysis of Peachtree City's cart path system

Fractional analysis (Dalton, 2001) is a computational variant of axial analysis whereby the usual un-weighted graph representation of the axial map network is replaced by a weighed graph in which the edges are assigned values according to the angle between any two intersecting axial lines (the nodes). This method of analysis has been used in all of the Peachtree City analyses since, due to the excessively curvilinear nature of the majority of the roads in the city, fractional analysis produced consistently better results. There are four axial-break-up maps of Peachtree City (Figures 4-6):

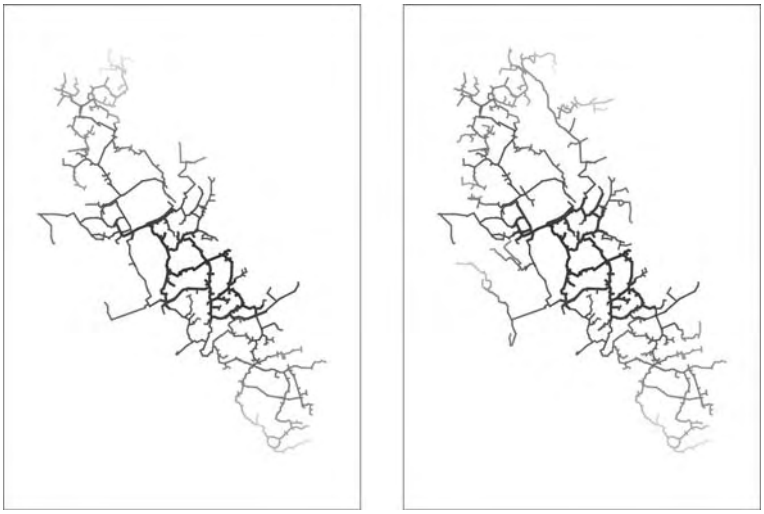

Figure 4.4. Maps A and B: Fractional Axial Analyses of the Cart Path System (Contiguous System on the Left, Entire System with Road Connections on the Right)

First, consider maps A and B of the cart path network, these have been combined into a single figure, Figure 4.4. The map on the left shows only the **contiguous** system whereas the map on the right shows the entire cart system with those link-roads necessary to permit the graph, and hence the cart system, to be fully connected. The black lines are the most integrated and the pale grey lines the most segregated. It is evident that there is little or no structure to the cart system when considered in isolation from the rest of the city. The overwhelming result of the fractional analysis is one of a pronounced 'centrality effect' which is all the more startling as fractional analysis usually reduces such effects (as compared to other configurational measures: the term configuration as described clearly in the first paper). Were the cart path to exist in isolation it would be extremely unintelligible[6]; the correlation, r2, between Radius n (global) integration and Radius 3 (local) integration is 0.03.

Figure 4.5. Map C: Fractional Axial Analysis of the Road System

Figure 4.5 (Map C) shows the fractional integration analysis of the road system, omitting the cart system. There are a number of features of this map that are noteworthy. First, the pattern of highly integrating roads forms a network, which includes a number of the primary roads in Peachtree City. Highways 74 and 54 are clearly highly integrated. Other roads that emerge as high integrators are Dividend Drive, Macintosh Trail, Crosstown Drive, the southern section of Peachtree Parkway and the northern section of Robinson Road. The presence of the lakes appears as 'holes' in the map as well as, surprisingly, the boundaries between sub-divisions (housing developments). Many of the local housing areas (or 'villages') can be identified on the plan due to their clear spatial boundaries. Another feature of this plan is the clear lack of any centre as would normally be expected in a town of this size [and as regretted by its founder, Cowan (Frankston, 2002; A.B.C., 2001)]. The closest approximation to an integration core is the intersection of Highways 74 and 54.

Figure 4.6. Map D: Fractional Axial Analysis of the Combined Cart Path and Road System

Figure 4.6 (Map D) shows the effect of connecting the carts paths to the road system. Again, the pattern of highly integrated lines includes all of the aforementioned roads which emerged as being integrated in the analysis of the road system, but includes other roads; the majority (rather than mere sections) of Peachtree Way and Robinson Road are now more integrated, pulling the pattern of integration towards the southern boundary of the city. Other roads, which become more integrated through the inclusion of the cart path network, are Flat Creek Road and Kedron Drive. Equally, as in the previous analysis, there is still no proper city centre. However, there does appear to be a *nascent integration core*[7] emerging around the Aberdeen Village Shopping Center (off Highway 54) and this core extends as far as City Hall and the Library (at the North West edge of Lake Peachtree, the other side of Highway 54 and connected via the 1972 pedestrian/cart bridge). Through the inclusion of the cart path network, this small integration core suggests that the city is beginning to function as a coherent small town and that this is due, in part, to the cart system. However, by far the most striking effect wrought by the inclusion of the cart path system is the effect on the local housing areas. Sub-divisions that were separated from their immediate neighbours have become connected. The spatial 'chasms' that were evident in Figure 4.5 are no longer present and the number of 'dead-ends' has been dramatically reduced. In Figure 4.5, 19.17% of axial lines are 'dead-ends', i.e. have a connectivity of one; in Figure 4.6, this number is almost halved, to 10.23%. In absolute numbers, the total number of 'dead-ends' is reduced by 94, (a 22% reduction), through the synthesis of the two systems. Clearly, the act of connecting the subdivisions[8] is helping to provide cohesion to the overall transportation network as well as helping to consolidate its small integration core and global, primary street circulation. However, one factor that does not emerge, which is surprising, is that the cart path network does not make the system any more intelligible (the relationship between local and global syntactic measures). The intelligibility of the system remains virtually unaltered.

The morphological importance of the origins of the cart path system (i.e. laid over waste-water/sewerage pipes) cannot be overstressed. Since the pipes would have been laid efficiently (as pipes are costly), then the pipe-network would have taken the most efficient route possible, minimizing cost. This would have resulted in the original paths following a straighter course than would normally be expected of a network of 'leisure trails'. The 'straighter' the path network, the greater the likelihood of higher mean integration values, as unnecessary spatial depth is not being added to the system. Another advantage of following utility pipes is that they will tend to be most efficient when connecting the greatest number of houses over the least distance. Practically this can be achieved by taking a route between adjacent rear-gardens, connecting proximate houses and adjacent developments (sub-divisions). This has three results; due to the nearness of the backs of houses, the cart paths are deceptively well constituted[9] (even despite the excess of foliage) meaning that they are safer than they would otherwise be. Second, the paths are straighter than they would otherwise be were they not following the line of utility pipes; this has the advantage of helping to make the paths less meandering and hence make the overall system more integrated. Lastly, the efficient positioning of the original sewerage pipeline means that the cart paths can often serve the additional purpose of connecting sub-divisions and 'dead-ends'.

Another measure of how interconnected is a settlement, is the measurement of 'ringiness' (Hillier and Hanson, 1984: 104). In graph theory, rings are known as circuits; a circuit is a path that starts and ends at the same node (and has a step depth greater than 1, otherwise it would be a loop). In order to investigate the role of 'ringiness' or circuits in axial maps, we developed a method to count the number and length (the number of axial lines forming the path along the circuit) of the circuits. The resultant software program counted only the minimum number of unique circuits in the graph. These data, along with a selection of other measures, including axial ringiness[10], are summarized in Table 4.1.

	Road System Only	**Roads and Cart Paths Combined**	**% Change**
Mean axial line connectivity	2.41	2.70	112 %
Mean axial line integration	0.43	0.48	112 %
Mean length of circuits	9.33	7.83	84 %
Axial ringiness	0.16	0.25	156 %
Number of dead ends	431	337	78 %
Number of circuits	184	410	223 %

Table 1. Values of Measures of the Road and Road/Cart Systems with their Proportional Differences

As well as the vast reduction of the number of dead ends in the system, after adding the cart paths to the analysis, the most significant change produced by combining the cart paths and the roads is the increase in the absolute number of circuits (or rings) in the dual system. By including the cart paths in the analysis it can be shown that there are more than double (223%) the number of circuits in the resultant axial map. Furthermore, it can be shown that the mean length of the paths forming the circuits falls to 84% (i.e. there are more circuits and they are shorter). If the distributions of the circuit lengths are plotted as two histograms (for roads only and the combined system), a striking pattern of differences between the road system and the integrated cart-and-road system can be discerned. Figure 4.7 shows the pair of histograms.

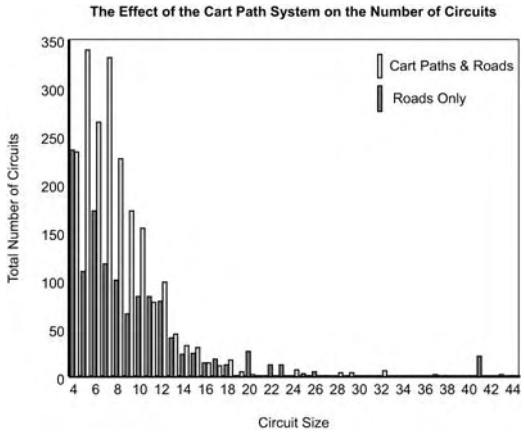

Figure 4.7. Histograms of the Distribution of Circuit Lengths for Peachtree City for Roads (dark grey) and for Roads and Cart Paths (light grey)

First, it is clear that there is an overall increase in the total number of circuits present in the system (an increase of 223%, as previously stated). However, there is also a change in the distribution of the circuit lengths. There is a greater increase in the number of shorter circuits. Prior to the inclusion of the cart path system, the axial analysis of the roads included a number of extremely long circuits (i.e. of circuit length 44). After the insertion of the cart path system, the maximum circuit depth fell to 16.

Survey Data

As mentioned in chapter 1 of this issue, space syntax analysis allows us to control for the spatial variable, in this case, in relation to issues of social exclusion and transport. However, in order to fully understand its effect, additional data becomes invaluable and, in this case, this was provided by the results of a survey, as described in the earlier methodology section. There were 489 respondents to the 2006 survey, drawn from a random sampling of 1038 property owners and renters in the city as well as several hundred additional surveys from individuals who accessed the survey at City Hall, on their website or at the Peachtree City library. (This constitutes a high response rate of approximately one third of potential respondents). The survey consisted of four primary sections divided into 36 questions and sub-questions designed to gauge the citizens' attitudes toward, and usages of, the cart path system (CPCPD, 2006b).

Citizens were asked to gauge the relative importance of planning issues facing Peachtree City, on a scale from "very important" to "not important". One of the issues they were asked to judge was the importance of future expansion of the multi-use path system. 75.66% of citizens felt that expansion of the system was either important or very important (see Figure 4.8). This matches closely with the 80.37% of people who stated that the path system was one of the things that they most liked about living in the city. 61.55% of respondents claimed that the path system constituted a very important factor in their decision to move to Peachtree City: a further 31.08% felt that it had been a factor, albeit not a major one and only 5.32% stated that it had not been an important factor at all. So clearly, although the system serves as an attraction to people relocating to the city, once they have lived in the city, a greater proportion are convinced of the path system's contribution to their way of life. A comment from one of the surveys says, "We would not live in PTC without the uniqueness of [the] golf cart paths." Later, in the questionnaire, a very high proportion - 92.02% of households - state that at least one of their members uses the path system.

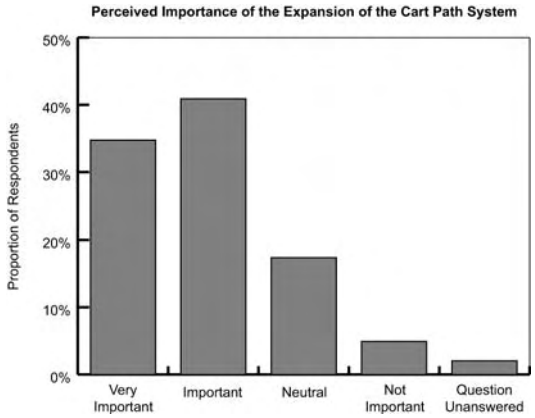

Figure 4.8. The Perceived Importance of the Expansion of the Path System

When asked about the proportion of journeys made by the cart path system versus the road system, the majority of people (55.01%) estimated that up to 20% of their household's trips were made on the path system as opposed to the road system (the average split being 25.14%/ 74.88%: paths/roads) the proportion of usage on the cart system steadily declined until only 3.48% used the path system for between 80-100% of all their household's journeys. However, were this to be representative of the city as a whole, this indicates that a significantly high proportion (382 households)[11] use the path system for almost all their trips. See Figure 4.9. One comment, in the questionnaire, stated, "I found it hard to answer your questions about the golf cart path with accuracy because I use them so often - it feels crazy to be able to explain how often we use them… many times if we can't get there by golf cart we don't go."

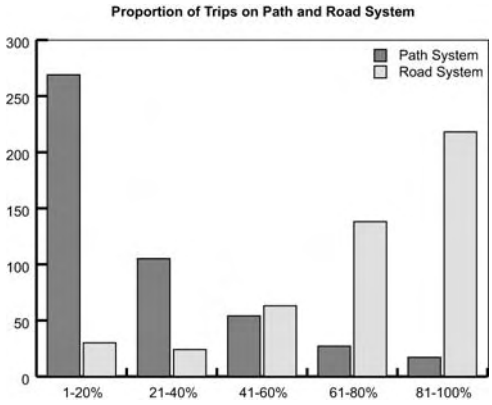

Figure 4.9. The Proportion of Household Trips made on the Path and Road Systems

In terms of the relative ownership of vehicles, 70.76% of households own at least one golf cart (3.27% own two carts), in contrast to 97.34% of households owning one or more car and 72.39% owning at least one bicycle. These relative figures are shown on Figure 4.10.

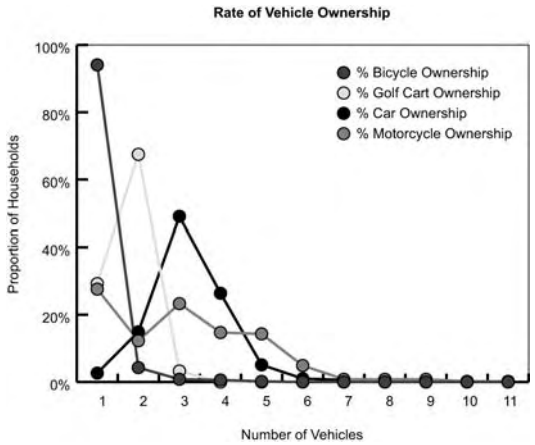

Figure 4.10. The Proportion of Households and the Numbers and Types of Vehicles Owned.

If the 70.76% of households owning golf carts is considered to be representative of the citywide population, this would amount to an estimated 8131 in private ownership within the city. This matches the estimate of 9000 golf carts (private and public) used in the city (Kaspriske, 2003). The typical Peachtree City household appears to own one golf cart and two cars (Figure 4.10).

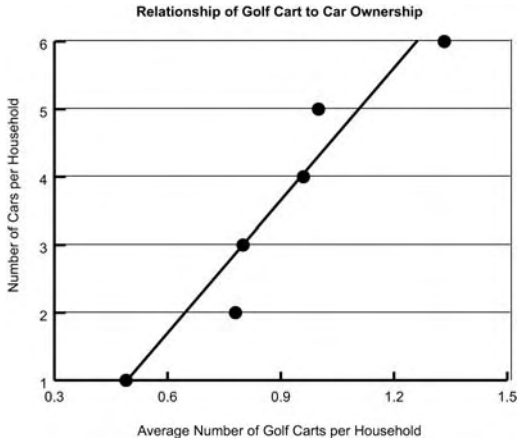

Figure 4.11. The Relationship of Car to Golf Cart Ownership

However, there is a strong correlation between the number of cars owned and the number of golf carts owned. If the average number of golf carts owned is calculated for all one-car households, two-car households etc. the average number of carts owned by one-car families is 0.49[12] and for two-car families is 0.78. This disproves the hypothesis made by the author, in earlier papers (Conroy Dalton and Dalton, 2005a; 2005b) that families might be purchasing a golf cart as a substitute or alternative to the necessity of owning a second car. Instead, it is plain that the more cars owned, the more golf carts are likely to be owned too. (For all respondents owning two golf carts, their households also owned an average of 3.1 cars.). This does, however, underline the manner in which golf carts appear to be used: namely they are being used to substitute for *trips* and not for *vehicles*. Equally, it is clear that Golf carts are not being bought as status symbols (otherwise why own more than one?); they are being purchased because they are found to be practical.

What types of trips are the ones being substituted? 78.94% go shopping by the path system, 72.60% use it to reach a recreational facility, 28.43% use the path system for the school run, 16.77% go to work and, finally, 58.90% of households use the path system for trips other than those stated above. When asked to estimate the total number of trips made to *all* of the above destinations in a typical week, the aggregate replies amount to a total of 3071 trips being made every week by the 489 households surveyed. This represents 6.3 trips made per week, per household and a total of approximately 68,973 trips being made every week, throughout the city[13].

When asked what incentives would cause a surveyed household to make more use of the path system for 'destination travel' (as opposed to, for example, exercise), the highest scoring incentive (drawn from a list) was a raise in petrol prices or the problem of growing congestion (Snow, 1999) in Peachtree City (48.47%). The next most influential incentives were, interestingly enough, both spatial. 38.24% of people said that they would use the path system more if it had more connections between their home and other destinations; 35.58% of people said that their usage of the path system would increase if routes between origins and destinations were more direct. In space syntax analytic terms, these comments equate to higher average connectivity (a greater spread/reach of the system) and the more direct routes would relate directly to a higher average integration value for the whole system. Other factors given were more time to spend travelling (24.74%), improvements in the efficiency of golf cart batteries (21.88%) and a greater choice of trip destinations in the city (10.43%).

One question, asked in the survey was particularly relevant to the issues of social exclusion and travel discussed in this paper: a list of the possible social benefits associated with the path system was provided and respondents were asked to evaluate how significant they held each benefit to be (on a scale of 1 to 5). Included in this list of benefits was the utility of the path system as a means of alternative transportation for older residents, disabled residents, those unable to afford a car, and for children (with adults) and

unaccompanied teens. What is most interesting about the replies are the relative ranking afforded to these different social groups, by the respondents (Table 4.2).

Social Benefit	"Highly Beneficial" (4 and 5)	"Of Benefit" (3, 4 and 5)	Rank of Benefits Judged to be "Of Benefit" (3, 4 and 5)
Recreation and exercise	88.34%	92.84%	1
Alternative transport	80.78%	91.62%	2
Transport for elderly	80.37%	90.39%	3
Transport for disabled	74.44%	87.53%	5
Reducing air pollution	72.39%	87.73%	4
Transport on low income	64.83%	81.19%	8
Safe trips with children	62.99%	82.00%	7
Way to meet neighbours	59.71%	82.62%	6
Teens learning to drive	45.81%	72.80%	9

Table 2 The Perceived Social Benefits of the Path System: Proportion and Relative Ranking of Importance

The most popular benefit [considering answers that rated it a '4' or a '5' (of 'significant benefit') or at least a '3' (of 'some benefit')] was actually that of recreation and exercise, namely one of the only non-transportation-linked social benefits. The next most highly rated benefit was the rather general benefit of being an alternative transportation system (felt to have at least some benefit by 91.62% of respondents). Next, in popularity, 62.99% of people felt that the fact that the path system provided a way for older citizens to travel within the city was highly beneficial (whilst 90.39% felt that it was at least of some benefit.). This fact is reflected by some of the comments provided at the end of the survey: for the most part these reflect the fact that senior citizens are an important sector using the path system and are not reticent about stating their needs, from the more general comment, "Senior citizens comprise a large part of the population and expect better facilities.", to the very specific, "I think a bridge across Highway 54 at the Public Shopping Center would be helpful as there are a lot of people of retirement age in this area.". Only one voice of dissent is heard, making the comment, "I am disappointed with the very high profile that is made out of senior citizens." However, since most of us recognise that we will be old ourselves one day, this is an easy social benefit to be in sympathy with.

As it happens, Peachtree City, like many other US towns, is facing a demographic time bomb, as it has a rapidly aging population. In the city's Comprehensive Plan (CPCPD, 2006a: 9), it is stated that, "the majority of our current population is between the ages of 40-55. In twenty years time that population is anticipated to be over the age of 65." And more specifically, "It is anticipated that, between 2005 and 2030, the number of residents over the age of 65 within the city will increase by approximately 93%." (ibid: 59). 16.36% of the respondents to the survey were of retirement age, this is somewhat higher than for the whole population; in 2005, 3089 citizens were over 65 years of age constituting 8.16% of the population.

The next most highly (fourth of nine) ranked social benefit of the path system was the benefit to disabled residents, although there were no comments made at the end of the survey suggesting that this was an issue that provoked strong feelings one way or another. In many respects, the issues underlying transport and related social exclusion problems are similar for both the old and the less physically able (two groups that frequently overlap). In terms of path usage, those who might be physically unable to drive or equally simply feel unconfident/uncomfortable about driving a car can still maintain a degree of independence. As the former mayor[14] of Peachtree City, Brown, describes, "Daily activity in suburban areas requires an automobile for transportation. By permitting electric vehicles on our multi-use paths our senior citizens and disabled persons can maintain a normal lifestyle without the use of an automobile, bus, or train. They are comfortable with the low speeds and the lack of interaction with automotive traffic. The greatest benefit is that they maintain their social independence and they are able to remain in their homes." (Brown, 2005).

The social benefit ranked fifth, was that of reducing air pollution [discussed in the author's previous paper on Peachtree City (Conroy Dalton and Dalton, 2005)] and the sixth ranked benefit was that of providing an alternative and economically affordable means of transport to low-income families. There are considerable economic benefits to owning a golf cart. According to Bullard (Bullard Johnson and Torres, 2000, p.40) the average American household spends one fifth of its income on each car owned. To be able to replace a car

(be it for a spouse, teenager or just a local 'run-about') by a golf cart represents a considerable cost saving. Not only is the initial cost of buying a golf cart cheaper than that of a car, but because the carts are electric the ongoing running and maintenance costs are lower too. However, if you are unable to afford even one car, then the golf carts become a necessity rather than a luxury. One of the functions of the cart path system in Peachtree City is to provide a private transportation alternative that is financially viable for low-income (and in the USA this is often synonymous with minority) communities. As Brown describes, "New low-income immigrant families from Mexico and South America are able to rent homes and offset the high cost associated with automotive transportation by using inexpensive, low-maintenance electric vehicles on our multi-use path system. There is no stigma attached to using electric vehicles on the multi-use path system as exists with mass transit as nearly every household within the city owns an electric vehicle." (Brown, 2005).

However, as seen from the previous section of the survey on car and golf cart ownership, this appears not to be happening. Citizens do not seem to be buying a golf cart as a substitute for a second car, but as an addition to it. Neither is there strong evidence of golf carts being owned instead of cars (a total of just five households in the survey claimed to own a golf cart yet no car; this constitutes just 1.02% of the respondents. These five had an average income which was slightly less than the average household income of Peachtree City, which is $92,695, but not of a level that could be considered 'low-income'[15].)

Equally, there does seem to be a rather ambivalent attitude towards low-income families in Peachtree City. On the one hand, it is cited by 81.19% of respondents as being an important social benefit of the path system (namely as a means for low-income families to participate fully in the life of the city) and yet, many of the comments at the end of the survey reveal a clear desire that Peachtree City remain an city whose residents are higher than average income earners. Comments such as, "Low income housing… should be limited." "Stop building apartments." And "Discontinue all subsidized apartments in PTC." Were made. One counter-plea was put forward at the end of a survey, "Some people love it here but are too poor to stay, even people who don't make much money are good people and deserve to have a place to live they can afford. PTC is sad because the cost of living is very high…" In summary, it does appear that although only a small minority of households could be considered to be low-income, the path system does ensure that they need not be socially excluded for transportation reasons.

Interestingly, the one group who are often socially excluded through transport and are clearly benefiting greatly from the path system in Peachtree City are the young adults or 'teens'. In Peachtree City a young adult may drive a golf cart from the age of fifteen or from twelve if accompanied by a parent or guardian (CPCPD, 2006c). This not only permits them a degree of independence at a younger age, but means that pressure is taken off the road system during the 'school run'; older children can drive themselves (and younger siblings) to school, as well as to extra-curricular activities (e.g. soccer practice). However, in terms of the social benefit it provides, this benefit was ranked lowest of all nine polled with only 45.81% respondents saying that it was highly beneficial (72.80% conceded that it was of some benefit). The reason for this somewhat lukewarm response was clarified by the many comments at the end of the survey, typical examples being: "Too many reckless teens on cart paths." and "Too many kids are driving golf carts with disregard to rules and people on the paths." But not all respondents view this phenomenon in such a negative light, some positive comments being: "I love the ability of teens being able to utilize golf carts." and "I think it is rather important that teens continue to be allowed use of the path system with or without a driver's license so that parents who would rather ease into their children's ability to drive [have this option] available." Despite the apparent problems of rather reckless driving behaviour by young adults, they are clearly taking full advantage of the path system in order to travel to school, work and to socialise. It would be practically impossible to imagine that a young adult of Peachtree City might suffer from transport related social exclusion problems, in the manner in which young people frequently do elsewhere. This is, perhaps, a case of one issue (social exclusion) being supplanted by another (antisocial behaviour).

Discussion and Conclusions

There are two trends that are evident from the preceding sections of this paper. The first trend is, unarguably, that the path system in Peachtree City is being heavily used and is extremely popular with the city's residents. This popularity is substantiated by the findings of the survey detailing household's everyday patterns of usage of the system. It is also evident that certain sectors of society are benefiting more from the existence of the network and, in particular, minority groups that might otherwise struggle to make essential trips. These being: the elderly, those with physical mobility problems, the young and the economically disadvantaged (although, on evidence, this group appears to be small in Peachtree City). Furthermore, these social benefits are recognised and lauded by a significantly large proportion of the

population. The only possible exception to this universal approbation could be the high usage of the path system by young adults, a phenomenon that suggests that the uptake of trips by this group has essentially become a 'victim of its own success'.

The second trend arises from the spatial nature of the path system. Because the cart path system serves to significantly reduce dead-ends and connect adjacent local areas (evidenced in the increased ringiness of the combined network) then it is inherently functional as an alternative transportation system. Add to this, the fact that the cart path system connects residential areas to useful 'destinations'[16] such as schools, shopping centres, cinemas and libraries then the network that has been created, and is still being expanded, is a parallel structure that can begin to take the pressure off the road/car system.

With respect to issues of social inclusion the benefits outlined above are clearly a result of the existence of the path system. It must, however, be noted that these benefits are not automatic; if the cart system did not function well, it would not have the high proportion of usage that it does and the associated benefits would be less easily discernable or simply absent altogether. It is not enough to have a cart path system – you have to have the right system and Peachtree City seems to have got it right.

What are the implications of this for other communities and in particular for the UK? In terms of social exclusion and transport it is clear that having an affordable, alternative transportation system, can be of benefit to those members of society most as risk of exclusion through transport related issues. However, it is highly unlikely that the success of Peachtree City could simply be transplanted in the UK. However, there is a growing trend, in the UK, towards 'greenways' and leisure trails. A distinction should be made, at this point, between 'commuter routes' or routes connecting key destinations such as places of work, shops and schools etc. and 'leisure routes' where the emphasis is on exercise in a natural environment. Of course, the two types of pathway need not be mutually exclusive, as is clearly demonstrated by the Peachtree City path system. However, with respect to combating social exclusion through access to transport, it is the first kind of path, the 'commuter routes' that are required.

In the UK, most 'commuter routes' are aimed at the cyclist and many towns already have, or have proposals for, segregated cycle paths for commuter traffic. Clearly, in terms of the above mentioned socially disadvantaged groups, cycling is an option that could appeal to the young and the economically disadvantaged but will rarely be a viable option for older or physically disabled people.

Another trend, that is receiving a lot of press in the UK at the moment, is the high rise of 'mobility scooters' that are precisely targeted at the elderly and those with mobility problems. One of the current debates is about the safety of these vehicles, particularly when occupying the same crowded pavements as pedestrians; there has been a sharp increase in the numbers of accidents involving mobility scooters. However, in one respect they are the closest UK solution to Peachtree City's golf carts. But, they do suffer from a problem that the golf carts do not have and that is stigma. What is particularly successful about the golf carts of Peachtree City, is that they are effectively a 'one size fits all solution' and as Brown says, there is no stigma attached to driving around in a golf cart, since everyone does it. Many young and disabled people in the UK are put off buying a mobility scooter due to its associations with the elderly (Adams-Spink, 2005). The other disadvantage to mobility scooters (and, to some extent, bicycles) is that they are single occupancy vehicles. If a disabled mother wants to take her child to school, she would not be able to use a mobility scooter (RoSPA, 2005). It is clear that part of the success of the golf carts in Peachtree City is also attributable to the fact that they are able to take passengers, in other words they are particularly flexible as an alternative transportation option.

Finally, even were a combination of bicycles, electric-assisted bicycles and mobility scooters available and were allowed on a path system, would this be as successful as the path system in Peachtree City? In Milton Keynes [17], there is a dedicated, alternative path network, known as The Redway (it is covered in red asphalt). They are intended for use by pedestrians, cyclists and wheelchair users. Although a grey area in British law, most mobility scooters are classified as wheelchairs (RoSPA, 2005) and are therefore permitted on The Redway. In theory, here is a system of segregated paths, permitting a wide range of alternative vehicles and yet its usage is comparatively low (Franklin, 1999). The reason for this is that the Redways of Milton Keynes are too meandering, lack a coherent spatial structure, have a low connectivity, short lines of sight and are almost completely unconstituted (in space syntax terms). This network is simply poorly designed (ibid).

The conclusion is that in order to reproduce the success of the path system of Peachtree City in the UK, two primary needs would have to be satisfied. The requirement of a spatially coherent and integrated path network and a suitable vehicle, permitted to use the path, that is sufficiently flexible to fulfil the needs of disparate users, meaning that it is truly egalitarian (and so has no stigma attached to it). Were this duality of needs met, it is clear that this would be a solution that would help to combat transport related social exclusion, as is clearly demonstrated by the case study of Peachtree City. If such a transportation solution to social exclusion could be found it would constitute a private rather than a public transport solution and hence this would be quite a different approach to the vast majority of current transport initiatives being researched or implemented in this area.

Any future research into this area should address the following questions: what would be needed to transform a spatially dysfunctional network, such as Milton Keynes' Redways, into a fully functioning, useable, parallel system? If no existing network is in place, how could such a network be integrated into an existing road system? What changes in legislation and/or technology could promote a new 'type' of flexible vehicle capable (in the mode of Peachtree City's golf carts) of utilising such a system?

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[1] In the USA, *transport/transit equity* (sometimes referred to as *transit racism*), is defined simply as *"unjust, unfair, and unequal transportation policies and practices"* (Bullard Johnson and Torres, 2000). Equally, in the USA, the phrase *transit* as opposed to *transport* frequently refers to the provision of public-transport as opposed to *transport*, which also includes modes of private transport such as cars, cycling and walking.

[2] Community website http://www.peachtreecityweb.com/

[3] Guide to Interstate 85 can be found at http://www.interstate-guide.com/i-085.html

[4] In January 2005 we were provided with a spreadsheet of all locations of path underpasses (tunnels) and bridges by City Hall for purposes of verifying our original data.

[5] An axial line is an un-occluded line of sight and line of potential uninterrupted movement. An axial map is a 'skeleton' map consisting of the fewest and longest lines of sight that pass through every convex space in a system (Hillier and Hanson, 1984).

[6] In *Space is the Machine*, Hiller defines the intelligibility of a settlement as being the relationship between local, predominantly visual, cues and the larger-scale spatial structure. Where this correlation is high (r^2>0.5), an observer's immediate, visible surroundings provide clues to the overall spatial structure: this is said to be an *intelligible* environment. An unintelligible environment is one where what can be seen bears no relation to a settlement's overall structure, hence giving rise to confusion and disorientation.

[7] In the city's current Comprehensive Plan (CPCPD, 2006a: 10), one of the issues raised is whether there is *"a need or desire to create a downtown area or "central business district" within the city? If so, where should this be and to what extent should it be developed?"* It could be argued that this 'nascent integration core' is an indicator of where such a CBD should be sited, should it be desired.

[8] Subdivision (or 'subdivided land') refers to any parcel of land that is to be used for condominiums, apartments, or any other multifamily dwelling units.

[9] The measure of *space constitution* can be found in The Social Logic of Space (Hillier and Hanson, 1984: 105) and is simply the number of building entrances opening onto a convex space (or axial line). This is an example of *permeably constituted* space, however a space can also be said to be *visually constituted* if it is 'overlooked' by windows. The implications of spaces being constituted or un-constituted are associated with personal safety and perceptions of safety. Since the presence of a door opening onto or a window overlooking a space implies the potential for the presence of a person (either emerging from the doorway or observing you through the window) then spaces that are constituted are more likely to be safer (or perceived as being safer) than spaces that are not. This is the effect of 'natural policing' through co-presence, or in the case of constituted spaces, *virtual co-presence*. During our cart-path journeys in Peachtree City we were constantly surprised at the degree to which, in spaces which initially seemed secluded, glimpses of back-doors and windows were frequent. The paths were far more *visually constituted* than first appearances would suggest.

[10] The definition and equation for *axial ringiness* is given on page 104 in the Social Logic of Space. Axial 'ringiness' is defined as being (2L-5)/I, where L is the number of axial lines and I is the number of islands or rings (or circuits in graph theoretic terms).

[11] This is based on a figure of 10,984 occupied households (US Census, 2000), taken from the city's Comprehensive Plan (2007-2027) report, Table 1 (CPCPD, 2006a: 66).
[12] These figures are based on an assumption that a *non-response* to the question of how many golf carts a household owns is equal to zero.
[13] If an average golf cart roundtrip is held to be approximately, at least, two miles in length (the author's own estimation) then, every week, 137,945 miles of trips are made on the Peachtree City path system. Using the EPA figures for fuel consumption, it could be suggested that the city is reducing its CO_2 emissions by 57,315 kilograms (126,358 pounds) per week or 2,9 million kilos per annum through their use of the path system.
[14] Brown's term of office was 2002- 2005 (elected to post November 27, 2001).
[15] According to the *Federal Register*, Vol. 71, No. 15, January 24, 2006: 3848-3849, the 2006 HHS Poverty Guidelines state that for a household with four members, the poverty income threshold is at $19,999 or below. 2.04% of the survey's respondents could be said to be in poverty. This compares to 6.8% of Peachtree City households, according to the Comprehensive Plan (CPCPD, 2006a).
[16] City Hall's own definition of the network is one that interconnects, "*neighborhoods, retail centers, churches, schools and recreation areas.*" (Peachtree City Department of Planning, 2006).
[17] Milton Keynes is the last and largest of the English 'new towns', begun in 1970, in the county of Buckinghamshire to the North West of London. Its population was 184,506 at the 2001 census.

5 Conclusions

By Laura Vaughan

This special issue of Progress in Planning has shown how space syntax–can be used as an analytic framework for studying space as a dimension of social problems such as segregation. The importance of understanding that spatial form can be an intervening factor in urban problems of this kind–has been the recurring theme in this issue. Rather than being a 'fuzzy concept', that can be categorised–only in social, economic or ethnic terms, segregation has been shown here to be a measurable function of the urban form of cities, and as such pervasively implicated in the ways in which social problems come into being.

By examining measurable spatial segregation in a variety of ways in this issue, we can suggest some general conclusions on the spatial syntax of segregation as an extension of the general interpretative socio-spatial model provided by space syntax research. In chapter 1 Bill Hillier and Laura Vaughan provided an explanatory model for how cities accommodate difference by organising patterns of accessibility according to the degree of co-presence required by the activity contained in each space, a key factor in the self-organising processes that make cities the way they are. An example of this was provided by Laura Vaughan in chapter 2, who showed that voluntary immigrant quarters can be part of a natural process of settlement that takes advantage of the range of integration and segregation available in the city. In other words, the more economically mobile members of immigrant communities are able to make preferential moves to parts of the city that allowed them to be spatially integrated whilst maintaining internal structures of self-support by being located in a tightly clustered settlement. This corresponds to the two-step logic theory of Hillier et al (1993), and is the 'means of linking the local to the global and achieving that compression of scales - the sense of being in a locally identifiable place and part of a much larger global system, at one and the same time...' (Hillier et al, 1993: 35). In chapter 3, Lars Marcus showed that when public space is designed to be segregated rather than its natural form of being part of an integrated network of streets, it can have profound effects on the ability of housing estate residents to form social ties amongst themselves and across the city. Then in chapter 4, Ruth Conroy Dalton showed that a highly labyrinthine housing area can naturally develop new patterns of movement, and potentially increased social and economic engagement, by reducing spatial segregation.

We can learn from the examples given here how design and planning decisions can have a sometimes unexpected effect on problems such as social isolation and economic segregation. Chapter 2 showed that the organisation of poorer areas with step-wise changes in land use and class between each face of the city block can help manage the mixing of the variety of cultures and classes at the fine scale so that the interdependence of the range of people which make up cities is maintained through proximity without propinquity. To a degree, current ideas such as the Mixed Use Urban Block follow such principles. Chapter 3 emphasised the importance of integrating the public realm of neighbourhoods whilst chapter 4 showed how an alternative perspective on integrated transport can lead to unusual solutions to social and economic exclusion. It is evident that transport policy should take care to consider the potential contribution of integrated pedestrian (but not necessarily pedestrianised) routes as well as small public spaces and parks (see Greenhalgh and Worpole, 2002) to urban renewal.

Recent economic and political trends have brought the subject of segregation to the foreground of policy debate. In the UK there have been a variety of responses to these trends. For example, a key component of the UK government's *Sustainable Communities* agenda points to the need to design effectively for inclusive communities of differing ethnic background or economic status (Jenks & Dempsey 2005) and the need for cohesive communities. Many government responses have been with social initiatives, such as the *New Commission on Integration and Cohesion*. Other initiatives such as *Neighbourhood Renewal*, despite addressing both physical and social dimensions, would benefit from the additional knowledge on the relationship between spatial form and society provided by the studies reported here.

This issue has highlighted the urgent need for spatially precise analytic tools in design and planning which can take account of spatial form as a separate variable from social statistics. It has also demonstrated the powerful ability of space syntax models to analyse local to global relations. The importance of taking account of the large scale impact of local design decisions should be linked with the ongoing implementation of spatial planning at the local level (see Nadin and DCLG, 2006:15, who indicate the

importance of understanding 'networks of connections and flows cutting across boundaries at different scales' in the current environment of 'high mobility coupled with low accessibility').

One of the most important lessons to be learned from space syntax research is the need for improved methods for gathering social data at the small area scale. Previous analysis of the spatial aspects of deprivation and poverty has been based on censuses of population sources (Noble et al., 2000, Ballas, 2004), which usually provide information at neighbourhood scale level. Many policy applications of detailed geography rely on the postcode unit, which match about 15 households (Lloyd et al, 2003). Yet, at the present time there are a variety of obstacles for small-scale data analysis using the space syntax approach. Spatial studies of deprivation require analysis of small-scale variations in morphology and correspondingly detailed data on poverty and other socio-economic variables. Due to the requirement for anonymising contemporary data, access to detailed socio-economic data is limited. In particular data (such as deprivation statistics) are not detailed enough for small-scale spatial analysis. Typically the smallest scale data publicly available, the Lower Level Output area, which considers, on average, 125 households) is too large, and often aggregates together very different street alignments. This makes the data unsuitable for studies which wish to understand the relationship between urban form and social outcomes. Even the smallest statistical area is problematic for researchers seeking geographical detail which relates to people's every day experience of urban life – namely, data which distinguishes between different streets, or (ideally) street sections. For space syntax, the elementary unit of urban organisation is the building opening on to a linear street. We have shown that by approaching spatial analysis in this way, links between social and spatial phenomena begin to reveal themselves. However this is the most difficult level at which to acquire the necessary social and demographic data. Our data gathering and holding habits are not, unfortunately, in a syntactic form.

To make matters worse, there is also an inconsistent approach to data gathering and processing at the local level, so that in some cases local authorities do not have access to geo-referenced data; the first step towards precise spatial/social analysis. Data are also invariably collated within statutory boundaries, so adjacent councils cannot easily share information and come up with joint strategies for spatial decision-making. Improved methods of data gathering and sharing would enable councils to take account of the impact of local decisions (such as new shopping areas) on neighbouring districts.

But even with such data difficulties, the future of space syntax seems certain to involve diversification into many problem fields. The 2006 space syntax international symposium in Istanbul includes themes ranging from 'Science and architecture', 'Society and space', through 'Domestic culture and space' and 'The dwelling and its inhabitants' to 'Computation in architecture and urban space' and 'Advanced digital technologies' – reflecting the past/present of the field alongside the present/future. Links outwards from the field are reflected in themes such as 'Urban morphology' and 'building morphology'. Whilst the growth of space syntax as a field informing public policy is reflected in themes such as 'Security, safety and crime in urban structures'. The growth of space syntax as a theory informing design is reflected in themes such as 'Evolutionary approaches in design' and 'Generative design in architecture.

This rich range of subjects is not surprising in a field which has grown exponentially over the past 30 years, yet it is also notable that space syntax continues to be driven by its original idea, as a tool to think and experiment with, not just as a tool of analysis (see Hillier and Hanson, 1987); space syntax is not just a method – it is a theory. Through the contribution of hundreds of researchers world-wide, this theory is constantly developing in response to the latest questions about the future of our cities, buildings and places. It can be posited that the future of space syntax lies with the integration of the art of place (design), with the science of space (analysis) - using evidence-based scientific models to test future ideas before they are implemented on the ground.

Further reading in the field of space syntax can be found at http://eprints.ucl.ac.uk/view/subjects/14500.html and on the websites of space syntax symposia at http://www.spacesyntax.net/symposia/index.htm. Information about the work of the space syntax research group at UCL can be found at http://www.space.bartlett.ucl.ac.uk/.

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