SPACE SYNTAX AND THE DUTCH CITY

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0 Abstract

Space syntax, as developed at the Unit for Architectural Studies, University College London, proposes a fundamental relationship between the configuration of space in a city and the way that it functions. The analysis of space in terms of its configurational properties - or syntax - may, according to the theory, allow us to determine some aspects of the functioning of cities.

It has been the aim of the work described in this paper to test this proposition in five Dutch cities, and to try to explore the nature of any fundamental space/function relation in the Dutch city reflected by space syntax.

The results include a basic confirmation of the ability of the space syntax instrument to post-dict the intensity of the occupation of public space by people in the cities studied at two levels - at the level of the individual space embedded in the local area, and at the level of the local area embedded in the whole city. This last level may be something particular to the Dutch city and it is argued that it may arise - in spite of variation in conditions such as population and housing density - because of certain homogeneities in the spatial and functional structure of the Dutch city and out of certain historical and practical conditions affecting the expansion and development of the Dutch city.

1 Introduction

This paper begins by accepting the basic concepts and methods of the descriptive theory of space, known as space syntax, developed at the Unit for Architectural Studies, University College London (Hillier & Hanson, 1984). It takes the position that the key to urban function, at the level of the movement of people through the city and the distribution of people within the spaces of the city, is the way in which each space is accessible from every other space in the city, not in terms of metric distance, but rather in terms of topological distance, or the number of changes of direction needed to move from one space to another. It aims to contribute towards an understanding of the functioning of cities as spatial configurations by testing principle assertions of space syntax against a number of cities in the Netherlands. It presents some of the findings of a research programme begun at the Delft University of Technology and continued at the Unit for Architectural Studies (1). It is intended to stand alongside similar studies conducted in other cities in other parts of the world, and to take account of some of the particularities of the Dutch city and of Dutch planning.

The justification for the use of space syntax as an aid in urban design is to a large degree based on correlations found between the space syntax measures generated by the model, and numbers of people surveyed in real urban space. Space syntax proposes a fundamental relationship between the configuration of space in cities and the way that it functions, and correlations between space syntax integration measures and the numbers of people in public urban space have been measured in a number of cities. Published examples include; Barnsbury, Kings Cross and Golders Green in London (Hillier et al., 1987) (Hillier et al., 1993) and six cities in Greece (Peponis et al., 1989).

This paper describes first the testing of space syntax measures as predictors of the rates of occupation of public urban space by people in 36 areas in five Dutch cities and then goes further by attempting to test and extend the instrumentality of space syntax from the level of the individual space embedded in the urban area to the level of the area embedded in the city as a whole.

2 The Dutch City

It is has often been remarked that the Dutch landscape is best viewed from the air, laid out as a thing of near perfect rationality by a hand guided by the instruments of surveying and of the drawing board. The Dutch city often seems to be a logical part of this pattern - not so much an interruption, as an intensification of the pattern. The pattern is a thing of necessity - of water engineering in the main in this land dominated by water - and it moderates everything it touches, cuts all norms, all paradigms of planning and spatial layout to its own scale and its own geometry. The way that Dutch cities have grown over time and the way that they appear today in the disposition of their parts and the edges and clarities of the whole, has been critically influenced by water engineering and the practicalities of gaining buildable land from the landscape.

Some of the very first permanent settlements in this part of the world were built on raised artificial hillocks or terpen, rising sometimes only a matter of centimetres above the surrounding marshes (Beenakker, 1992). Since then, land has been won from the marshes and protected against flooding by a combination of drainage and pumping, dyking and the raising of ground levels, all of which means high preparation costs for buildable land and the need for planning, preparation and investment before the establishment of any new urban area. These conditions have meant that the historical process of urban growth has not in general been anything as 'organic' as the incremental infilling of areas on the margins of towns, structured by linear movement routes. Instead, what has tended to happen has been that whole parcels of land have been surveyed, drained and prepared, then subdivided and developed very quickly as a project or a series of projects to their intended density. For example, the expansion of Amsterdam in the 17th century took place on two or three clearly delimited parcels of land (Bureau Publiciteit, Dienst R.O., 1983). Dutch cities tend as a result to reveal clear boundaries between their parts as well as very clear edges to the city as a whole.

One immediately obvious consequence of this general pattern of development is the clear divisions apparent in the spatial network of the city. Neighbourhood configurations tend to be physically and spatially separated from adjoining neighbourhoods, the separation being reinforced by the fact that drainage canals or ditches usually encircle neighbourhood areas, and these canals or ditches are crossed at a relatively limited number of points, bridges being expensive.

Figure 1. Typical figure/ground map, 2.5 km square; Amsterdam.

Figure 2. Typical figure/ground map, 2.5 km square; London.

A less obvious, but perhaps still more significant consequence of these conditions of development is that, because existing movement routes in and around the city are less influential in determining the axes and directions of development of the city as a whole, expansion taking place instead in relatively self-contained pockets, there tend to be fewer long highly integrating spaces - those spaces like Oxford Street in London and the major boulevards of Paris that provide a global scale reference and orientating function, often connecting and integrating and making coherent, in terms of the global whole, quite widely separated parts of those cities. When one looks at the basic space syntax model (the axial map - or the set of longest and fewest straight lines that completely and continuously cover the public open space) of various cities, one can begin to quantify this factor. Amsterdam, for example, has an axial map comprising 8 591 lines, each of which connect with on average 4.5 other lines. Although it has a high concentration of long lines in two or three new areas on the edge of the city, in the central areas, where the areas which were tested are located, it has only 7 lines which directly connect with 25 or more other lines and 29 which connect with 20 or more other lines. In contrast, London within the north and south circular roads comprises 17 321 lines, and although each of them connect with on average only 4.2 other lines, 54 of them connect with 25 or more other lines, and 113 connect with 20 or more other lines. What is probably significant is the fact that the long lines in London are much more evenly distributed throughout the whole configuration than in Amsterdam which has concentrations of long lines in certain areas, due to the particular geometries of certain planned area layouts.

A further consequence of the particular circumstances constraining the development of the Dutch city is that building densities tend to be much more even from centre to edge than in most other European cities. This particular factor is also a result of the fact that the residential 'function' is dominant in almost all areas of the Dutch city; and a concern with access to the ground for urban residents throughout this century has meant that in most areas there are few buildings above four or five floors in height. All these factors contrast in particular with the situation in London where many of the fundamental concepts of space syntax have been formulated and where the utility of the space syntax model has in the main been tested.

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Figure 3. Axial map of Amsterdam

All of the cities used in the sample consist of areas from a number of distinct historical periods broadly corresponding to times of economic prosperity and expansion in Holland. Early growth occurred within protective walls in towns of any size and in fact this accounted in most towns for development until the late nineteenth or early twentieth centuries. Some larger towns, notably Amsterdam, expanded out of their original fortifications as early as the 17th century and new areas were laid out on fairly rational planned grid patterns at the edges of the mediaeval town. The next phase of expansion came in the late 19th and early 20th centuries, again on the edges of the town as it existed and usually on a very simple gridded pattern, influenced initially by the convenience of the grid as a means for the parcelling out of land for speculation and the laying of streets and other infrastructure, and later by 19th century developments in urban layout in France and the New World. In most towns this phase of development has formed a circular or part-circular belt around the historical core. Urban expansions after 1945 were of two types, both frankly anti-urban, and took most towns and cities to a scale which has far outstripped their original turn of the century sizes. The first type was modernist with its typically amorphous spatial characteristics but reasonably high densities - modified in its Dutch manifestation by strong constraints on height and footprint. The second was more suburban and influenced by ideas of territoriality and 'defensible space' and was characterised by an extreme local view of public space. In addition numerous instances of urban renewal have been carried out within existing urban fabric, usually that of the 19th/early 20th century belt, and usually committed to maintaining most of the density and the urban character of the area.

3 The Sample

Five Dutch cities ranging in size from the largest in the Netherlands (Amsterdam) to a small provincial centre (Alkmaar) and a semi-autonomous peripheral district of Amsterdam (Zaanstad) and 36 areas within them were investigated. Amsterdam is the capital of the Netherlands and its largest urban conglomeration. It is in spite of this small by the standards of most other major European cities with a population of about 725 000. Den Haag with a population of 445 000 is the administrative capital of the Netherlands and while, in common with other Dutch cities, still being strongly residential, it houses also, mainly in its central and north central areas, a major part of the huge Dutch central bureaucracy and the business and services that append to it. Den Haag is manifestly different to Amsterdam in feeling. While Amsterdam is dense, close, bustling, with a tight 'urban village' feel in many of its parts, Den Haag is more open and sedate, the parts being less strongly differentiated, and the whole being more easily perceived. Haarlem, only 20km from the centre of Amsterdam has about 150 000 inhabitants and obviously feels the influence of its larger neighbour very strongly. It is in many ways however a significant centre in its own right for services, tourism and industry. It is a part of the so-called Randstad, a highly connected ring of towns and cities interspersed with farmland stretching from Utrecht in the east, westwards through Amsterdam and Haarlem, south through Leiden and Den Haag and then east through Delft and Rotterdam. Alkmaar is a small regional centre of about 92 000 inhabitants about 40km north of Amsterdam. It is strongly differentiated in that it has a strongly urban - though small scale - centre within the mediaeval city walls and extensive suburbia in relation to its total area. Zaanstad is an industrial/residential conurbation that has grown this century around a string of villages along the Zaan river just north of Amsterdam. It does not have a strong historical centre like those of the other four cities. Although most cities in the Netherlands - especially those of the Randstad - are strongly connected, and the Randstad can be seen functionally as one interconnected complex of centres and peripheries, Zaanstad clearly feels like a periphery to Amsterdam and is difficult to separate from the capital in any significant terms.

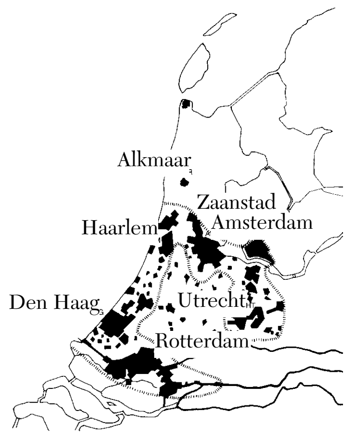

Figure 4. Map of the Netherlands.

Areas were chosen in these five cities on a number of bases. Firstly, they were required to form a reasonably representative cross-section of the neighbourhood areas within each city; secondly, they each showed some internal consistency to visual analysis in the geometrical properties or texture of their grids; thirdly, they had to constitute commonly understood local areas or neighbourhoods with fairly clearly demarcated and commonly understood edges. Nine areas were chosen in Amsterdam, eight in Den Haag, six in Haarlem, seven in Alkmaar and six in Zaanstad. Samples of the spaces in these areas were surveyed for the density of their occupation by adults on foot and bicycle. 180 spaces in the nine areas of Amsterdam were surveyed, 144 spaces in the eight areas of Den Haag, 133 spaces in the six areas of Haarlem, 131 spaces in the seven areas of Alkmaar and 119 spaces in the six areas of Zaanstad.

The areas surveyed in Amsterdam were the Jordaan (17th century), the southern part of the Grachten or the lower Grachten (17th century), the Nieuwmarkt (17th century), the Dapperbuurt (1910s), the old part of the Indischebuurt (1910s), the new part of the Indischebuurt (1980s comprehensive urban renewal), the old part of Watergraafsmeer (1920s), the new part of Watergraafsmeer (1940s) and Diemen Zuid

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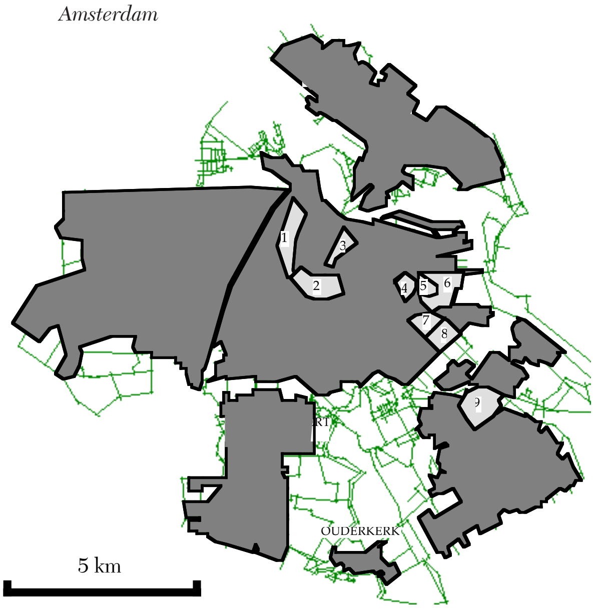

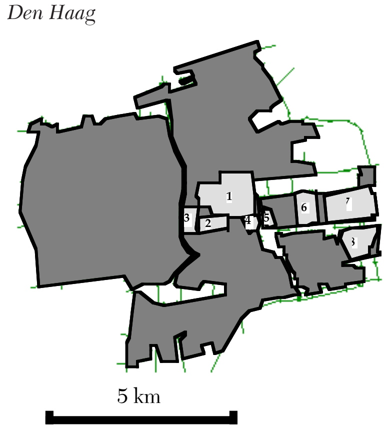

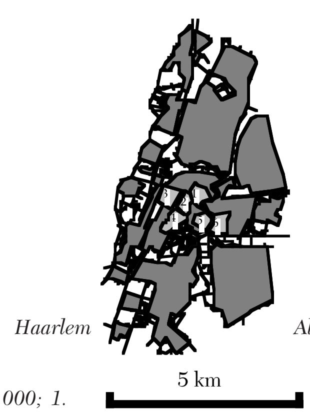

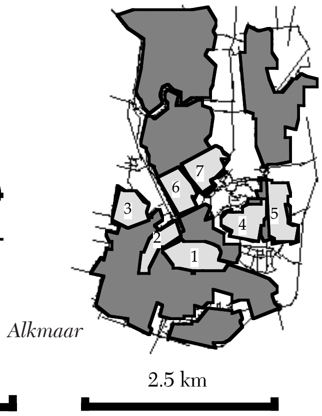

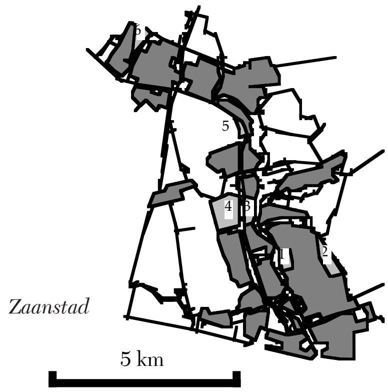

Figure 5. Amsterdam, 1:100 000; 1. Jordaan, 2. lower Grachten, 3. Nieuwmarkt, 4. Dapperbuurt, 5. old Indischebuurt, 6. new Indischebuurt, 7. old Watergraafsmeer, 8. new Watergraafsmeer, and 9. Diemen Zuid.

Figure 6. Den Haag, 1:100 000; 1. Centrum, 2. Schilderswijk 1, 3. Schilderswijk 2, 4. Rivierenbuurt, 5. Bezuidenhout West, 6. Bezuidenhout, 7. Mariahoeve, and 8. Essesteijn.

Figure 7. Haarlem, 1:100 000; 1. Centrum, 2. Botermarkt, 3. Leidsebuurt, 4. Florapark, 5. Rozenprieel, 6. Slachthuisbuurt.

Figure 8. Alkmaar, 1:50 000; 1. the mediaeval centre, (Centrum), 2. Stationbuurt, 3. Bergermeer, 4. Oudorperpolder, 5. Oudorp, 6. Huiswaard 1, and 7. Huiswaard 2.

Figure 9. Zaanstad, 1:100 000; 1. Zaandam, 2. Peldersveld, 3. Bloemwijk, 4. Westerkoog, 5. Wormerveer, 6. Rosarium.

(1980s). In Den Haag they were the mediaeval centre or Centrum, the part of Schilderswijk west of Vaillantlaan (1910s, 1990s urban renewal), the part of Schilderswijk east of Vaillantlaan (1910s, 1980s urban renewal), Rivierenbuurt (1900s), Bezuidenhout West (1970s), Bezuidenhout (1940s), Mariahoeve (1960s) and Essesteijn (1980s). In Haarlem they were the mediaeval centre or Centrum, the Botermarkt area (17th century), Leidsebuurt (1910s), the Florapark area (1910s), Rozenprieel (1910s) and the Slachthuisbuurt (1920s). In Alkmaar they were the mediaeval centre or Centrum, Stationbuurt (1900s), Oudorperpolder (1980s), Oudorp (mediaeval, 1980s), Bergermeer (1980s), Huiswaard 1, and Huiswaard 2 (1980s) and in Zaanstad they were a part of Zaandam just to the east of the Zaan (1900s), Peldersveld (1980s), Bloemwijk (1920s), Westerkoog (1970s), a part of Wormerveer (1910s) and Rosarium (1970s).

4 The Test

The objectives of the work were twofold. In the first place, it was intended to test the ability of the space syntax measures of integration (the property of the mean topological distance - or number of steps - of a space from the rest of the spaces of the system being considered) to post-dict the occupation of public space by people. In the second place, it was intended to try to determine whether similar properties relating to grids of whole areas might determine or tend to determine the general background occupation of the public space of whole areas by people.

4.1 Testing Space Syntax at the level of the individual space embedded in the area
There were two important issues that the first part of this process intended to address. The first was the simple ability of space syntax integration measures to postdict the rates of occupancy of individual spaces within areas, and the second was to try to analyse the distribution of the density of occupation in the area so as to infer how much of the surrounding spatial network is significant in determining the particular space occupancy pattern in that area. Optimising the correlation between integration and occupancy measures, by changing the size of the surrounding spatial network to be included when calculating integration measures, may help to make clear the spatial structures in the city that are significant as far as people on the street are concerned. This larger area that the area under study 'refers' to when integration values are calculated, I will call the area of reference.

If integration measures are calculated for the axes in the area under study on the basis of their relationships to the axes in the configuration of the whole city, then the area of reference of the area at its most global is being tested. If integration measures are calculated for the axes in the area under study on the basis of their relationships to the rest of the axes in the configuration of the area alone, then the area of reference of the area at its most local is being tested. Areas of reference in between these two extremes may be considered by including more or less of the surroundings when calculating integration measures for the axes in the area under study. Areas that seem on the face of it to naturally group together have been considered together as well as apart. If there seem to be good reasons, areas have also been split up and investigated in parts. Integration measures for the areas are considered at the following levels of engagement with their surroundings; 1. embedded, or considering the area embedded in the whole urban configuration, 2. embedded in natural quarters, considering the area embedded in the large scale configurational 'lump' of which it is a part (these 'lumps' are shown in Figures 5 to 9), 3. embedded in group of areas, considering the area embedded in any smaller scale configurational 'lumps' of which it may be a part, and 4. disembedded, considering the area on its own.

Twenty to thirty spaces in each area were surveyed for rates of occupation by people walking or on cycle. The areas were surveyed by walking at a constant normal walking speed along a predetermined route through the spaces in series counting the people passed and ignoring those who were moving across the space being surveyed (those on a crossing axis). Each route was walked twenty times at different times of the day and for different days of the week. Values were then allocated to each space for each of the classes of people counted standardised to number of people per 100 metres walked. Only one class of people - walking and cycling adults - was considered in making up the occupation rates for this study.

The axial diagrams prepared for the five cities included all public space accessible to walking and cycling adults and excluded all spaces (like freeways, motorways, etc.) which were inaccessible to them.

Sets of correlation coefficients were computed between densities of occupation of public spaces as surveyed in real space, and their syntactic properties. These syntactic properties were measured both for different areas of reference and for three dif-

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ferent radii. That is three different maximum topological distances (numbers of steps) were considered when computing integration measures. In the first place, topological distances to their maximum within the system being considered were used in computing integration measures. In the second and third places topological distances up to a maximum of three and one were used in computing integration measures. The first of these measures is known as global integration and it measures the integration of a space (or the line in the model) with respect to the whole system of spaces (or lines) being considered. The second of these measures is known as local integration and it measures the integration of a space with respect to that set of spaces within three steps of the space concerned. The last measure is simply the number of spaces that the space in question connects with - or the connectivity of that space. The logarithms of rates of occupation of urban space were plotted against connectivity and integration measures for the area computed against areas of reference,

4.1.1 The predictability of rates of occupation of urban space

The results of this exercise are summarised in Table 1, which shows how well rates of occupancy correlate with integration at three different radii when the area of reference is the whole city, and also shows best correlations when optimised against other areas of reference.

It is immediately clear that the area of reference chosen is highly significant as regards the power of integration values to predict rates of occupancy in public space in the examples tested. In only 6 cases out of 36 is the area of reference the whole city for the optimised correlation between rates of occupation and integration measures. In all other cases it is some smaller area surrounding the area being tested.

Eight out of the nine areas tested in Amsterdam showed an optimised correlation coefficient of over 0.7. Six out of eight of the areas tested in Den Haag, five out of six of the areas tested in Haarlem, six out of seven of the areas tested in Alkmaar, and two out of six of the areas tested in Zaandam scored the same level of correlation. Overall, 27 of the 36 areas scored a best correlation coefficient over 0.7. Of the nine areas which failed to achieve a correlation coefficient of 0.7, six are post world war two neighbourhoods and the remaining three are the Leidsebuurt in Haarlem (0.665), the Centrum of Alkmaar (0.609), and Bloemwijk in Zaanstad (0.688). While there seems to be a tendency for very recently built neighbourhoods to show lower correlation coefficients, this is by no means a rule; the new Watergraafsmeer in Amsterdam, Essesteijn in Den Haag, and Bergermeer, Oudorperpolder and both parts of Huiswaard in Alkmaar all show good correlation coefficients. It is clear that there is no very reliable pattern as regards the 'type' or the historical origin of the area grid and the correlation between rates of occupation and integration values or the best radius of integration or best area of reference.

It seems most likely on the basis of these results that best areas of reference are related to very specific functional attractors and the functional make-up of the areas. The example of Oudorp in Alkmaar - best area of reference, the Oudorp/Oudorperpolder group of areas - is interesting where it is quite clear that a lot of the movement in the area is by people on their way to or returning from the modern and

Table 1	Correlations of public space occupancy with;				
	Conn	*Int r3*	*Int rn*	*best post-dictability*	*(area of reference)*
AMSTERDAM					
Jordaan	0.764	0.779	0.288	0.779	Int. rad. 3 (embedded)
lower Grachten	0.796	0.777	0.528	0.796	Connectivity
Nieuwmarkt	0.608	0.645	0.791	0.806	Int. rad. n (quarter)
Dapperbuurt	0.697	0.774	0.604	0.917	Int. rad. 3 (group of areas)
old Indischebuurt	0.759	0.825	0.831	0.880	Int. rad. n (group of areas)
new Indischebuurt	0.749	0.749	0.587	0.749	Conn./Int. rad. 3 (emb)
old Watergraafsmeer	0.903	0.917	0.820	0.917	Int. rad. 3 (embedded)
new Watergraafsmeer	0.729	0.724	0.848	0.853	Int. rad. n (quarter)
Diemen Zuid	0.436	0.531	0.386	0.531	Int. rad. 3 (embedded)
Mean	**0.716**	**0.747**	**0.631**	**0.803**	
DEN HAAG					
Centrum	0.713	0.546	0.428	0.847	Int. rad. 3 (area alone)
Schilderswijk 1	0.709	0.765	0.758	0.775	Int. rad. n (quarter)
Schilderswijk 2	0.642	0.696	0.564	0.778	Int. rad. 3 (group of areas)
Rivierenbuurt	0.754	0.807	0.626	0.829	Int. rad. 3 (area alone)
Bezuidenhout West	0.430	0.582	0.386	0.763	Int. rad. n (area alone)
Bezuidenhout	0.607	0.548	0.498	0.612	Int. rad. 3 (area alone)
Mariahoeve	0.164	0.170	0.449	0.449	Int. rad. n (whole city)
Essesteijn	0.509	0.692	0.702	0.716	Int. rad. n (area alone)
Mean	**0.566**	**0.601**	**0.551**	**0.721**	
HAARLEM					
Centrum	0.597	0.764	0.652	0.785	Int. rad. 3 (group of areas)
Botermarkt	0.555	0.701	0.672	0.701	Int. rad. 3 (embedded)
Leidsebuurt	0.607	0.665	0.588	0.665	Int. rad. 3 (embedded)
Florapark	0.738	0.822	0.669	0.822	Int. rad. 3 (embedded)
Rozenprieel	0.654	0.830	0.825	0.830	Int. rad. 3 (embedded)
Slachthuisbuurt	0.511	0.628	0.752	0.752	Int. rad. n (whole city)
Mean	**0.610**	**0.735**	**0.693**	**0.759**	
ALKMAAR					
Centrum	0.326	0.354	0.509	0.609	Int. rad. n (quarter)
Stationbuurt	0.620	0.655	0.724	0.724	Int. rad. n (whole city)
Bergermeer	0.481	0.693	0.738	0.738	Int. rad. n (whole city)
Oudorperpolder	0.499	0.561	0.514	0.760	Int. rad. n (area alone)
Oudorp	0.415	0.455	0.501	0.737	Int. rad. n (group of areas)
Huiswaard 1	0.529	0.712	0.513	0.712	Int. rad. 3 (embedded)
Huiswaard 2	0.526	0.650	0.746	0.770	Int. rad. n (group of areas)
Mean	**0.485**	**0.583**	**0.606**	**0.721**	
ZAANSTAD					
Zaandam	0.732	0.763	0.138	0.766	Int. rad. 3 (embedded)
Peldersveld	0.089	0.019	0.063	0.145	Int. rad. n (quarter)
Westerkoog	0.446	0.477	0.190	0.604	Int. rad. n (area alone)
Bloemwijk	0.634	0.614	0.366	0.688	Int. rad. n (area alone)
Wormerveer	0.615	0.632	0.758	0.758	Int. rad. n (whole city)
Rosarium	0.473	0.422	0.300	0.473	Connectivity
Mean	**0.498**	**0.488**	**0.303**	**0.572**	

Table 1. Correlations of rates of occupancy with integration at three different radii (connectivity, local integration and global integration) when the area of reference is the whole city. Best correlations when optimised against all areas of reference.

obviously attractive shopping centre in neighbouring Oudorperpolder. It appears also that a lot of primary school children from Oudorp go to school in Oudorperpolder and parents are also part of this occupancy pattern. In another interesting case, that of the Centrum of Alkmaar, the area itself seems to act as an attractor. Functionally Alkmaar is highly centralised with most of its shopping and other high movement and space occupation density producing functions concentrated in the old centre, with the rest of the city overwhelmingly residential with very small local shopping areas and community services.

It is interesting to note that the fact of an area being a commercial and retail centre does not guarantee that the area will be orientated towards the global configuration in terms of its area of reference. The Centrum of Den Haag is orientated towards a very local area of reference, reinforcing the perception of it being an island of highly priced and glossy shopping and hotels surrounded by some worthy but often rather down at heel social housing areas. In fact the possibility of Den Haag becoming a two centre city - one orientated inwards and fed by public transport and the parking garages, and the other orientated towards the rest of the city - seems to become more and more real as the large urban renewal projects around Schilderswijk reach completion. This possibility - that strong retail areas may be orientated inwards to stations, bus stops and parking garages, as well as outwards to what is more commonly assumed to be the area's hinterland - may help to explain the relatively poor correlations between public space occupancy and integration measures in Alkmaar's Centrum. It is possible that two (or more) separate orientations overlap and tend to partially cancel each other out in this case.

4.1.2 The question of predictability and 'intelliggibility'.

The worst results by far for the values of best correlations were obtained in Zaanstad whose spaces taken as a whole also have the lowest mean connectivity. Mean connectivity values are 4.545 for Amsterdam, 4.731 for Den Haag, 4.173 for Haarlem, 3.615 for Alkmaar, and 3.415 for Zaanstad. While it appears that the mean connectivity for Alkmaar is not very different to that of Zaanstad, if one excludes the northern part of the city which contains none of the areas tested in Alkmaar, the mean connectivity for the remainder is 3.896. Both Alkmaar and Zaanstad have very few long lines; Zaanstad has just 3 lines which connect with 20 or more other lines out of a total of 2 840 lines, while Alkmaar has 2 out of a total of 2 428 lines.

Hillier has proposed that the predictability of public space occupancy rates (represented by the correlation coefficients in Table 1) is a function of the correlation between local and global measures of integration (this factor being known as intelligibility) and has obtained good correlations between these two factors in studies done in London (Hillier et al., 1987). My results only partly bear this out, showing correlations between predictability and intelligibility in Amsterdam (0.880) and Den Haag (0.769), and none at all in Haarlem, Alkmaar and Zaanstad.

These results suggest at the very least that the relationship between the predictability of public space occupation rates and the space syntax measure of intelligibility breaks down in conditions where mean connectivity becomes low. But they could equally suggest rather more than this. It is not inconceivable that local integration and global integration will tend to become more alike in conditions where mean connectivity is rather high - thus automatically tending to produce high intelligibility measures where mean connectivity is high, and especially where there is an evenly distributed network of long lines. As far as the intelligibility (in its more general sense) of the layout is concerned, it is also far from inconceivable that layouts with high mean connectivities, and a high incidence of long lines, will be more intelligible because they present more information (simply in terms of visible connections) to people moving through them. In fact, in the 36 cases investigated, the relationship between mean connectivities (and for that matter, mean local and global integrations) of areas, and the predictability of public space occupation rates is not much better than that between intelligibility and the predictability of occupation rates, and the question must remain, in those relatively few cases that perform badly with regard to predictability, whether this may not be due to some other non-configurational factor or factors.

But there is another factor - over and above that of the predictability of occupancy rates in individual spaces in area layouts - that is important with regard to the social working of area layouts, and that is simply the general overall density of occupation of the spaces of the area taken as a whole.

4.2 Testing Space Syntax at the level of the area embedded in the whole city

The design of urban extensions in the Netherlands most often involves the complete making of a living environment on what was previously agricultural or waste or disused industrial land. This will often involve the layout from scratch of a spatial pattern rather than the infilling of a pattern within some preexisting urban or ex-urban spatial pattern. While most Dutch urban extension and urban renewal areas are highly finished and thought through on every level, from the architectural to the social, the 'urban desert syndrome' is far from unknown and the social dangers implicit in empty and poorly supervised public open space are well recognised. It is also clear that the effects of these dangers tend to be felt in the least used spaces in areas with low general rates of public space occupancy, rather than in those spaces which are better used.

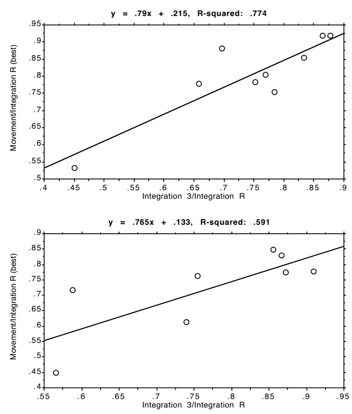
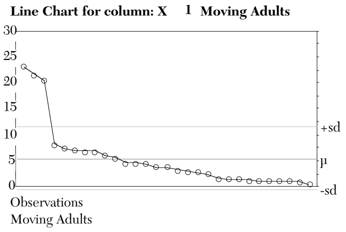


Figure 10. Best correlations between occupancy and integration measures (Predictability) plotted against Intelligibility for Amsterdam (left) and Den Haag.

If one looks at profiles of the occupancy of public space within areas a typical pattern emerges. One finds in most cases that there are a relatively low number of spaces in relation to all the spaces in the area which carry a quite disproportionate amount of the occupancy in the area as a whole and that these spaces seem typically to link the global and the local scales within the overall space pattern of the city. In fact the rate of occupancy of these spaces may often have as much or more to do with the space's global function than with its local function. Of course, the rates of occupancy of the lesser used spaces may have more to do with the relationship of the area with the global city than they have to do with purely local spatial considerations, but this would seem unlikely given the results I will present here.

In fact it would seem likely that the values represented by the gentle slope rising from the right in these two examples, along with some proportion of the higher values on the left, approximate to what Hillier calls natural movement, that part of the occupancy of urban space determined by the grid configuration itself (Hillier et al., 1993). The remainder of the higher values on the left would then approximate to the effect of 'multipliers', mainly due to shops and other functions and possibly also to a 'supergrid effect' - an effect due to a city scale movement pattern through that set of lines that are most globally integrated through the whole city. I have proposed a notional way of separating out the element of movement which approximates to



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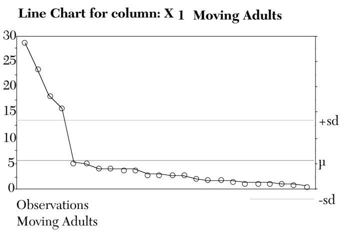

Figure 11. Observations of moving adults/100m for Amsterdam Jordaan and Amsterdam Southern Grachten.

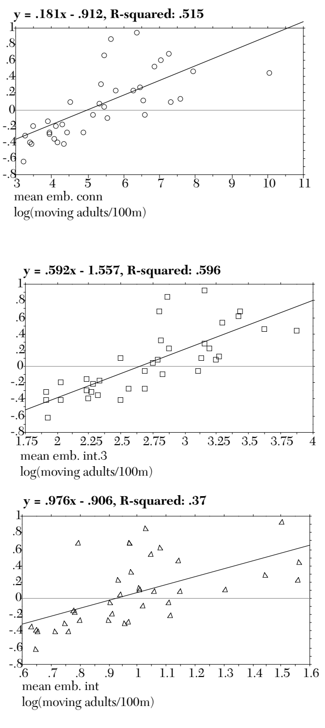

Figure 12. Natural movement means of whole areas plotted against means of connectivity, local integration and global integration.

natural movement in these samples. This involves simply excluding the 25% of highest values and the 25% of lowest values and taking a mean of the remaining mid-range 50%.

I have then compared these notional natural movement means of whole areas with the means of connectivity and local and global integration for the whole sample of 36 areas. These results are shown in Figure 12.

Three results stand out as being obvious outliers in this set of results, especially in the mean connectivity and mean local integration against mean natural movement scattergrams. These points represent the Centrum of Alkmaar, the Centrum of Haarlem and the Centrum of Den Haag. These three areas were the only areas tested where the dominant function was not residential, but retail and commercial, although they each also had a high residential component. Excluding these clearly special cases gives the results shown in Figure 13.

It is immediately obvious that there is a clear tendency for neighbourhood areas with higher mean connectivities to have higher natural movement means. The correlation coefficient for this relationship is 0.829. What is even more obvious is the strong correlation between a neighbourhood's mean local integration and its natural movement mean with a correlation coefficient of 0.872. The relationship between mean global integration and mean natural movement is much weaker with a correlation coefficient of 0.667.

This result must be seen as being extraordinary in the light of some conventional assumptions about the city. No account has been taken of factors such as density or population in results taken from five clearly if not widely separated cities. In fact the Dutch city presents certain homogeneities in terms of density, function, and global shape and structure, as was pointed out earlier - there are nevertheless clear differences in densities in the sample of 36 areas. It has been impossible to get data on densities in similar enough forms for all these areas, but data on both population densities and housing densities (Amsterdamse Bureau voor Onderzoek en Statistiek, 1994) for the areas tested in Amsterdam shows no correlation whatsoever with the public space occupancy data used here.

It was suggested earlier that it is plausible that people may tend to receive more information from their environment if they happen to have more connections with other spaces within their direct field of vision. The view of the connections themselves may be only a part of the story - densities of movement on crossing axes and other visual clues may also come into it - as might mental maps of the environment that take a grasp of the environment beyond what is immediately visible to a range limited by the complexity or simplicity of the surrounding spatial network. What is strictly visible may be extended to what is just around the corner - or what is just around the corner from what is just around the corner! It is possible that this extended notion of connectivity - to two or three times around the corner, or to something that is plausibly modelled by local integration - captures something essential about the way people grasp and effectively use these environments. Environments which cannot easily be grasped to any useful range will be left by all but those seeking a quiet place for a spot of burglary or graffiti artistry.

5. Extending the concept of the virtual community

Hillier has proposed that the virtual community is a "potential field of probabilistic co-presence and encounter … (which) … has a definite and describable structure," (Hillier et al, 1987) this structure being compellingly represented by the coloured maps produced by the Axman computer programme. The virtual community is not one pattern however but is a layering of many patterns defined and determined by radii of integration considered and by areas of reference. The exact patterns of public space occupancy in the real world appear to slip into one or other or perhaps even a number of these patterns, so that they seem not to be determined in a hard sense, but make use of the opportunities for differentiation and range of involvement with the surroundings that the configuration of space offers. However, as these results show, this is not where the effect of space configuration ends - at least not in Dutch cities. There appears on the basis of these results to be another level of the virtual community which is if anything more strongly determining and which is the basis for the 'engineering' of areas into well populated and therefore vital and safe urban environments - or their opposites, urban deserts. The pattern of differentiation of mean local integration of areas over the city as a whole appears to determine to a remarkable degree the background density of occupation of the public space of areas within the city. It seems to be at this scale in the Dutch city, at the scale of the local area - that same scale at which the Dutch city expands and develops - that space is most determining and where the underlying impetus for urban vitality, in the large majority of urban spaces, appears to originate.

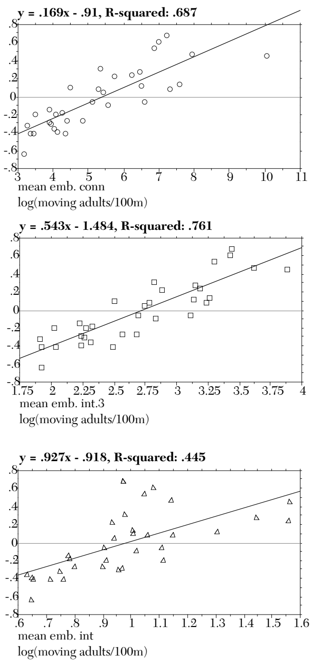

Figure 13. Natural movement means of whole areas plotted against means of connectivity, local integration and global integration.

Notes.

1. The first part of this research was carried out within the Department of Urban Renewal and Social Housing at the Faculty of Architecture, Delft University of Technology and was published as a doctoral dissertation (Read, 1996). The research is being continued at the Unit for Architectural Studies, University College London, under a Human Capital Mobility Fellowship funded by the European Union.

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