

A syntactical analysis of settlement form – an investigation of Socio-spatial characteristics in low-income housing settlements in Port Elizabeth, South Africa.

Andrew Palframan
School of Architecture
Nelson Mandela Metropolitan University,
P O Box 1600, Port Elizabeth, 6000, South Africa
e-mail: andrew.palframan@nmmu.ac.za

Key words: Settlement form, space syntax, configuration, integration, functional performance

When conventionally produced low-cost housing settlement types are investigated as part of a process aimed at producing new (better) typologies, as for example in housing competitions, the central focus of design tends to be the dwelling units themselves. The spaces that define the relationship between the units (as described generally by the settlement layout) are most often a secondary consideration. This focus on the dwelling unit as primary issue, with a consequent lesser concern for the nature of the linking spaces, is evident in most existing low-cost housing settlements in Port Elizabeth.

Space Syntax theory suggests that the factor which influences the functional performance of any particular space in a spatial system is the relationship of that space to all other spaces in the system and not the physical characteristics of that space itself. Following from this, it is proposed that the functional success of housing settlements rests neither with the design of housing units themselves, nor with the physical character of any spaces in particular. Rather, functional success rests with the way in which all spaces are integrated within the spatial layout of the settlement as a whole, and how the settlement's spatial structure is integrated within the spatial structure of the surrounding (urban) fabric.

The paper presents the findings of research carried out to investigate the nature of spatial configurations of housing settlements in Port Elizabeth South Africa. The aim ultimately is to speculate whether current configuration typologies used in the design of housing settlements are functionally relevant, appropriate, and generally achieve the spatial qualities aimed for in their designs. The research uses Space Syntax approaches and methods.

1 Introduction

While much of architectural theory that is concerned with the issues pertaining to the relationship between form, function and meaning focuses on the physical attributes of built artifacts, Space Syntax theory suggests that a primary influence on the perception and use of city space is not the physical (mass) elements of built environments, but the space between those masses. The reason for this focus on space is because the space between the mass is the “stuff” we move through. Movement of people is influenced by the way that spaces are related to one another in an urban system, and this influences the way that various spaces are used because the way that movement takes place influences the degree and manner to which contact between people is generated or inhibited. This potential for a spatial system to generate or inhibit contact between people is what ultimately influences the functioning of space. Or put in Space Syntax terms, the disposition of a space as a function of the *configuration* of the spatial system of which it is a part is what influences its *functional potential*. This way of conceptualizing space suggests that there is an inherent social logic to every spatial system and that this social logic is a function of the way that spaces are related to one another in a spatial layout (1+2). On these terms the city and the spatial systems within it are in essence mechanisms for generating contact, their natures and characters determined by the configuration of their spatial layouts – their *space syntax*. Within Space Syntax discourse, tools have been developed for the quantitative measurement and description of these configurative properties of space which enable their analysis.

This paper presents the results of syntactical analyses of the spatial layouts of four low-income housing settlements in Port Elizabeth South Africa. The settlements studied were all within the Nelson Mandela Metropolitan region, the study comprised an analysis of one sub-area in each of the settlements Walmer Township, Bloemendal, Motherwell and Missionvale. The settlements are similar in that they are all low-income “township” areas, and the particular zones studied were all of similar size. Although similar in these respects the cases were selected more particularly for some fundamental differences in nature: The selected area of Walmer Township was informally settled and the layout of the settlement was not formally planned. Hence the layout of the settlement was arrived at by the people themselves. The Bloemendal and Motherwell cases were selected because they represent two examples settlements of formally planned and conventionally provided by the municipality, (a single storey freestanding 40m² unit per 200m² plot organized in layouts that were determined by planners at the Nelson Mandela Metropolitan Municipality); and the Missionvale case was selected because it set out to challenge the design of the municipally provided models (aimed at providing greater choice to occupants, aesthetic variety and a better quality of public space through higher density, semi-detached two-storey units where plot/unit size relationships were played against each other to achieve a variety of choices (the layout was determined by independent planners)). These three models, differentiated by the ideology that generated the design, might therefore be referred to as *informal*; *planned conventionally provided*; and *planned alternative*. A comparison of the spatial characteristics of the cases corresponding to these models forms the basis of the discussion presented.

Owing to the size of the sample, the research is speculative rather than conclusive in nature, and while providing principle conclusions that are deemed pertinent by the author, the sample group was too small for the findings to be considered universally proven. The work while speculative in nature is deemed relevant by the author, since the method and approach used to analyze spatial layouts has not previously been applied to the analysis of these types of settlements in South Africa. The perspectives offered through the use of this approach and these methods differ markedly from conventional readings of space

and the space-function relationship. It is thought that this perspective might offer insights which might prove to be of general value to the (re-)thinking of spatial relationships in these settlements and its effect on social functioning.

The paper is written in four parts. The first part comprises the introduction; Part two discusses Space Syntax theory and the methods and approaches used; Part three presents and discusses the research and findings as evidenced in the series of processed axial maps and graphs presented; And part three presents conclusions on the findings.

2 Theory and Methods

Space Syntax theory puts forward the notion that spatial systems have an inherent social logic to them, in that social interaction in a system is determined by the way that it is configured (2). This because the functioning of any particular space; its *functional performance*, is a function not of its physical attributes, but that space's relationship to all other spaces in the spatial system in which it is embedded. The reason for this, as touched on in the introduction earlier, is the spatial systems' action as a *generator of contact between people* - Since space is the medium through which people move, the configuration of space influences the movement of people through it, in so doing influencing the degree (number and amount) and type (whether between *inhabitants* and *inhabitants*, *inhabitants* and *strangers* and or *strangers* and *strangers* to an area) of contact between people in any particular space. So ultimately, it is the nature and degree of contact between people as a by-product effect of movement that influences the functioning of public space. This natural co-presence of people as a function of the *configuration* of space Hillier terms the *virtual community*. The virtual community he says is "No more or no less than the pattern of natural co-presence of individuals brought about through the influence of spatial design on movement and other related aspects of space use." (3). The co-presence of people in a *virtual community* may be described as the "raw material" for the emergence of an actual community, and the nature of the virtual community is in this way seen to influence the nature of the actual community. Following this line of thought then, it can be argued that it is vital to establish a good virtual community through the organization of space if a healthy "actual" community is to emerge in an urban environment. What then is good and bad urban space and what are the syntactical characteristics of spatial systems which are seen to have the requisite qualities for the development of either healthy (virtuous), or unhealthy (pathological) virtual communities?

Before putting forward suggestions on what might in line with Space Syntax theory be considered healthy and unhealthy urban spaces, some discussion on the methods used in Space Syntax analysis and the means of describing urban space is deemed necessary. The methods have been developed to provide a description of the *configuration* of spatial layouts since, as has been suggested above, it is the *configuration* of an urban spatial system, as determined by the layout of the movement spaces, which influences the nature of the virtual community that will emerge in a settlement. In order to clarify the methods used, attention turns to the maps presented in Fig.1. The maps in fig. 1 are the *processed axial maps* for the four settlements. An *axial map* is a map drawn to describe the continuous space of a settlement in a usable way. This is done by drawing the fewest and longest possible lines of sight and access through the spaces of a layout.

This procedure results in an unprocessed axial map which is then processed using the *Axeman* or *Webmap* computer programmes. This processing brings to light the configurative relationships between the spaces. It does this by working out quantitative values for the topological relationship of each space to all the other spaces in the system. These relationships are illustrated in the processed axial maps through gradations of colour - the most integrated spaces (spaces most closely related to all other spaces) represented in bright red, to the least integrated (or most segregated) shown in dark blue. The processed axial maps can then be said to represent the *configurations* of the spatial systems determined by the layouts, in this case those of the housing units presented in Fig.1. Since the calculation of spatial values is quantitative in nature, the relationships between the spaces can also be represented on graphs. The scatterpatterns formed by the points (representing the integration values of the lines/spaces) on these graphs highlight the particular characteristics of the configurations' nature. Graphs showing the integration values of the spaces for each of the four spatial systems are shown in Fig.2. Here the scattergrams show the correlations between global integration and local integration in each case. Global integration is the value which represents the relative integration of a particular space to all other spaces in the system. The local integration value (also called radius 3 integration) represents the relative integration of a space to all spaces three steps away from that space. This research concerns itself essentially with the analysis and comparison of the cases presented based on their configurative characteristics - characteristics brought to light by the quantitative definition of the relationships between each of the spaces in their spatial systems.

Having discussed the tools and methods employed in syntactical analysis, the question posed earlier as to the nature of good and bad urban space can be returned to and discussed in terms of their syntactical attributes. In *Space is the Machine*, in an investigation of urban space in general, the characteristics of good (traditional) urban space are qualified and the syntactical characteristics of good urban space identified by Hillier (4). In short good urban space is produced by spatial systems in which the by-product effect of movement is fostered, thus engendering a productive and healthy virtual community; while bad, or what is termed *disurban* space, tends to be produced by urban systems where natural movement and its by-products are hindered, in so doing generating reproductive environments. These syntactical qualities are reflected in the scatter patterns produced by representing certain attributes of their configurations in relation to others in graph format.

A key typical characteristic of good, well-structured, urban space is a good relation between the two scales of movement known as the *local* scale and the *global* scale. This relation is evidenced graphically through the correlation between *global integration* and *local integration* measures for each space. In the case of good urban space the scattergram pattern for this correlation is one where the points of the scatter form an evenly distributed series of points moving up from left to right in an elongated form which tightly hugs the regression line. Furthermore, in cases where sub-areas are presented as highlighted points within the overall scatter of a larger settlement, the smaller scatter of the sub-area should exhibit these same characteristics as the larger with the scatter of the sub-area crossing the main regression line of the whole (indicating a well-structured local intensification of the whole grid). Developing the discussions on good and bad urban space further, Hillier goes on to highlight the characteristics of settlements that appear to flout all these principles and moves on to discuss *structure* and *order* (5).

In introducing the difference between structure and order Hillier suggests that spatial complexes are intelligible to us in two ways: "as artifacts we move about in and learn to understand by living in them; and as overall rational *concepts* that can be grasped all at once and which often have geometrical or

simple relational natures” (5). The first may be called *structure*; the second *order*. Configurations which are ordered are made up of similar parts in similar relations and as formal compositions they immediately reveal their nature because the mind easily grasps the repetitiveness of the elements and the relations that make up the form. There is a tendency for greater geometry in plan and this geometry to be associated with less integration of space and a greater tendency towards a symbolization of the axis. Moreover in reading such a layout there is the implication that the form has been conceived “all at once” and can be grasped as a single concept. Spatial complexes possessed of structure on the other hand, might, as a form on plan, appear irregular and almost disordered, though they do not appear so when they are lived in and move around in. This characteristic is inherent to the majority of traditional towns and cities Hillier says, since: “For the most part, towns arise for essentially functional reasons, and, naturally enough, evolve according to a functional logic” (6).

Scattergrams for the correlation between global integration and local integration that suggest a high level of order, and the application of a single concept for organizing space “all at once” in a way which does not produce well-structured space, typically appear as a pattern – the pattern shows with the points forming a series of vertical or horizontal lines with gaps between them. In these situations numerous spaces that have almost the same measure of global integration but a variety of local integration measures (vertical lines) or a range of global measures for fixed levels of local integration (horizontal lines). That this is part of a fixed ordering process in design is obvious – a particular stepwise fixing of hierarchies as trees or rings, producing these layers at fixed global or local measures.

The research conducted seeks to expose the syntactical properties of the layouts in the four cases presented through space syntax methods, thereby facilitating speculation on the nature of the spatial environments that have been produced. This speculation arises from the results of configurative processing, and focuses on what can be read in terms of two fundamental qualities, noted above: firstly, the characteristic interfaces between scales of movement inherent in their configurations’; and secondly, their natures in terms of characteristic qualities of *structure* or *order*. To examine these, one turns to the graphs showing the correlation between global integration and local integration for each of the configurations (figure 2.).

3 Research results

With reference to the results as represented by the graphs in Fig. 2: In the case of Walmer township (Fig. 2a) the points representing the integration measures for each of the spaces in the configuration form an even scatter, moving evenly up from left to right with the points of the scatter ‘hugging’ the regression line. The closeness of all points to the regression line suggests a very strong correlation between global and local integration measures, in fact the actual figure for the measure of correlation is 0.802 (a figure of 1.0 being perfect correlation). This high correlation suggests a strong interface between global and local scales of movement. Moreover, the even distribution of the scatter throughout its linear progression upwards from left to right suggests that the configuration is possessed of a high degree of *structure* and does not appear to be necessarily highly *ordered*. In all then, the form of the scatter suggests that the spatial layout in this case is possessed of characteristics attributed to more successful (virtuous) spatial systems; systems which are linearly organized with strong edge to center connections and integration characteristics that establish a healthy co-presence of inhabitants and strangers throughout the

configuration. The analysis suggests a spatial environment that is productive in nature with a high potential for a 'healthy' virtual community.



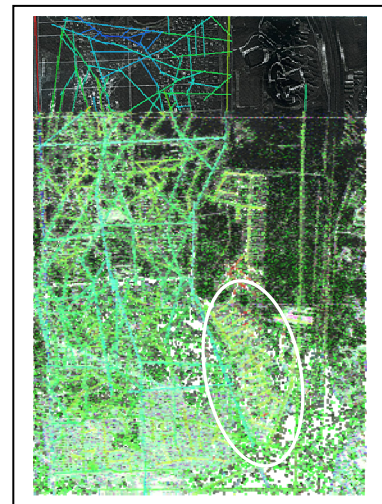
a. Walmer



b. Bloemendal,



c. Motherwell



d. Missionvale

Figure 1: Processed axial maps.
Each case is shown with the study areas (sub-areas of the settlements ringed).

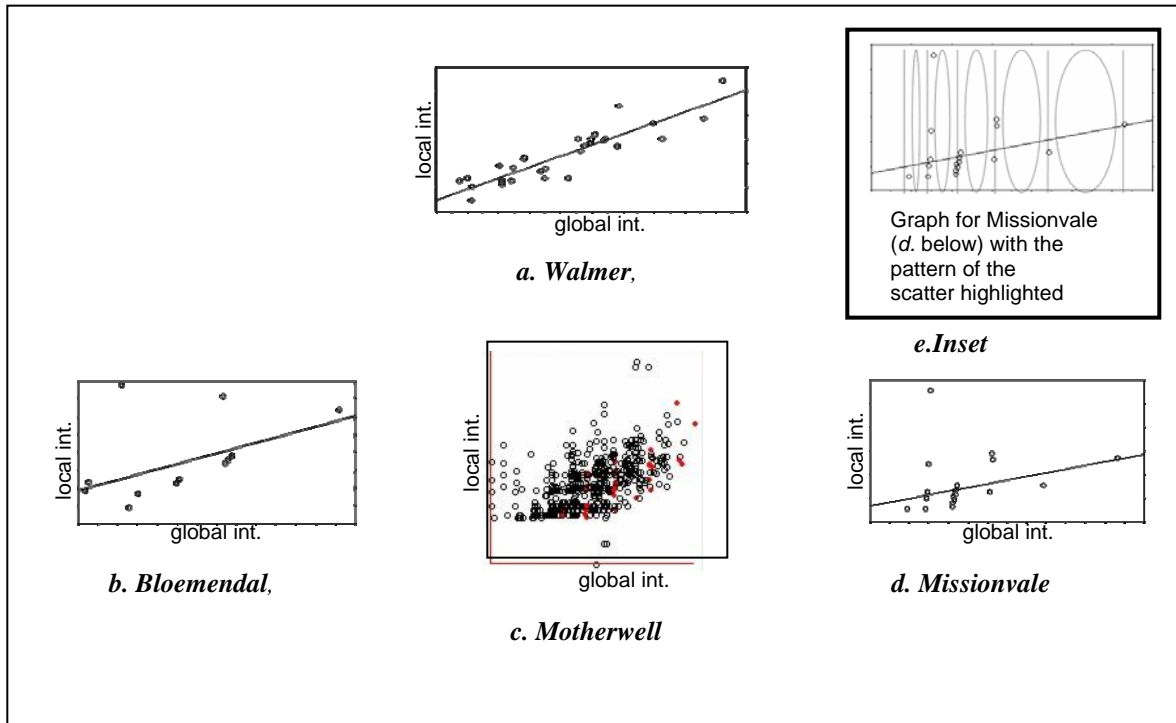


Figure 2: Graphs showing correlation between measures.

The graphs show the correlation between *global integration* (x-axis), and *local integration* (y-axis) for each of the four areas. The Motherwell correlation was processed using *Webmap* while the other three were processed using *Axman* (hence the difference in appearance). Furthermore, all spaces in the Motherwell system in its entirety are shown, with the spaces of the study area represented in red; while in the other cases, only the spaces of the study area are shown (although their relative values were of course arrived at as a function of their larger spatial systems as a whole).

The other three cases do not evidence the above characteristics. In all three, the scatterpattern for the correlation between global integration and local integration does not form an even scatter moving linearly upwards from left to right, tightly grouped around the regression line. The correlation value for the Bloemendal case is only 0.264 and for the Missionvale case only 0.106; very low when compared to the Walmer measure of 0.802. Motherwell was processed using *Webmap* so the actual value could not be read numerically but from the scattergram, pattern it can be deduced that this value would also be very low. The erratic scatters for these cases show spatial systems where the interfaces between scales of movement are disjunctive – suggesting that natural movement is distorted in terms of the potential for the establishment of a healthy virtual community, and that the systems tend towards being *reproductive* rather than *productive* in nature.

The scatterpatterns, while not evenly distributed and conforming to the characteristics of a well correlated local to global relationship could not really be described as totally erratic however– there is in fact a distinct pattern to all three scattergrams; a pattern that is particularly pronounced in the Missionvale and

Motherwell cases. The pattern shows as a series of vertically aligned linear grouping of points with obvious gaps between these linear groupings (Highlighted in Fig.2e). These gaps are evidence of particularly distinct disruptions in the interface between scales of movement in the system, indicating an uneven flow of spatial relationships where spaces are formed which are lacuna's in terms of the distribution of natural movement. What this patterning furthermore suggests, with its range of local integration measures at fixed levels of global integration, is that the systems exhibiting the pattern are organized by the imposition of a high level of *order*. They show that they are likely to have been systems that were conceived of "all at once"- conceived with a particular fixed perspective on the ordering of spatial hierarchies based on particular (theoretical) notions of socio-spatial functioning and using conventional geometric means of organization. In all, the scattergrams suggest that these might be spatial systems laid out using conventional generalized conceptions of hierarchy and spatial *order*, rather than organizations based on more complex understandings of the *structure* of traditional urban settlement patterns.

4 Conclusion

The Walmer Township case, a spatial layout that was not formally planned but was informally developed by the inhabitants of the system themselves, exhibits the same syntactical qualities as the 'well functioning' traditional urban environments described by Hillier. The three other cases, all developed using conventional planning conceptual biases do not show strong evidence of these qualities (Missionvale is spatially conventional even though the case challenges low-income housing environments on density and other formal issues) – in general these show evidence of the rejection of the simple continuous deformed grid for layouts which seek to make a series of "neighborhood enclaves" presenting spatial systems which are arrived at through an urban design policy of replacing *continuous urban structure* with *destinations* which are not available for natural movement.

Exactly what the "ideal" syntactic structure of spatial layouts in South African low-income housing settlements would be has not been established. It was of interest to note however that the Walmer Township case, a spatial layout that was not formally planned but was informally developed by the inhabitants of the system themselves, when subjected to space syntax analysis, exhibits similar syntactical characteristics to what have been described as well functioning environments all over the world. The formally planned settlements in both the conventional and alternative cases do not exhibit these syntactical characteristics however. Could it be that there is a functional structure to settlements that have evolved (unplanned) according to a natural functional logic that is not generally captured in the theoretical formulations that constitute the conceptual premises on which most conventionally planned low-income housing settlements are based?

As has been said, given the very small sample, the result of this research at this stage has not proved a general pervasiveness of the stated conditions in low-income housing environments in general. Speculations regarding the universality of the conditions are at best tentative, but, in that they call in to question the conventional conceptual bases on which spaces are so often produced, the results are nevertheless thought by the author to be significant and interesting. The making of good housing environments so often rests with functional, aesthetic and spatial concerns of the units themselves; or, when the realm of public space is considered, involves the enhancement of public space through 'urban

design' by, for example, the demarcation of specific communal public spaces and the provision of street furniture and planting. All this, it might be argued, if applied to syntactically dysfunctional environments might still not make well-functioning environments, since their *spatial* layouts may be *socially* flawed to begin with. Perhaps there is something to be said for attempting to make better environments by simply organizing the layout of the spaces through which people move differently - in a way more attuned to the characteristics of well-functioning traditional urban space. Cognisance of this issue should perhaps be taken most particularly in low-income environments, where every gesture, material or spatial, costs and therefore counts. In doing this, designers would need to make use of different theoretical rationales in the design process than those conventionally used. Rationales not originating in generalized, geometric notions of spatial organization and its relationship to human use, but are developed by the reading and understanding of spatial systems in terms of their specific configurative properties and the consequent social implications – Designs developed, in other words, with an understanding of *structure* rather than by the simplistic imposition of *order*.

References

- [1] Hillier, B., Hanson, J. *The Social Logic of Space*, Cambridge, 1984.
- [2] Hillier, B. *Space is the Machine*, Cambridge University Press, Great Britain, 1996.
- [3] Ibid. pp.189
- [4] Ibid. The syntactical characteristics are elaborated on in *Part 2 of Space is the Machine*. More general characteristics for good urban space are defined as “variations on certain themes”. These include: Buildings arranged in outward facing blocks so that building entrances continuously open to the space of public access. The space of public access is arranged in a series of intersecting rings which are regularized by a greater or lesser degree of linearization of space to form the - more or less deformed –grid of the town. Through this linearization the larger scale structure of the town is made intelligible both to the peripatetic individual moving about within the town and to the stranger arriving at its edges. The linear structure links the building entrances directly to a pattern of space which also links closely to the edges of the town. The effect of this linear organization of space is to create a structure in the ‘axial map’ of the town, that is a distribution of local and global integration, which becomes the most powerful functional mechanism driving first the pattern of movement and, through this, the distribution of land uses, building densities and larger scale spatial and physical elements such as open spaces and landmarks. The essence of urban form is that it is spatially structured and functionally driven (pp.214).
- [5] Ibid. pp. 232 -238
- [6] Ibid pp.236