Park Syntax
- Measuring Open Space Accessibility and Smart Growth

Short paper to the 5th Space Syntax Symposium 2005
Alexander Ståhle
ISBN 90-8594-002-8
School of Architecture, Royal Institute of Technology
S-100 44 Stockholm, Sweden
alexander.stahle@arch.kth.se

1. Introduction

The two prevailing urban planning schemes dominating the 21st century have been densification and sprawl. These strategies, which have obvious consequences for green and open space, have both frequently led to deadlocks in planning, especially concerning green space exploitation. This conflict describes the well known and long debated dichotomy within urban planning and design: ‘dense’ or ‘green’. Consequently, Dolores Hayden, Peter Calthorpe, Xaveer De Geyer among other urban design theorists indicate that one of the most pressed question for future urban design is – What to do with the public open space structures of sprawl?

Since the birth of modern planning, quantitative measures and standards for open space have been developed to define density and attractiveness in urban settlements. Basically, open space standards have measured two things; attractiveness and accessibility. Attractiveness has been measured in surface area (square meters). Accessibility has been measured in metric distance (meters). My findings however show that there is a need to more thoroughly considers the concepts of attractiveness and accessibility.

2. Theoretical framework and a model for new measures

Environmental economics and Space Syntax theory (Hillier and Hanson 1984) seem to be the most fruitful to grasp the complexity of open space attractivity and accessibility.

<table>
<thead>
<tr>
<th></th>
<th>Accessibility</th>
<th>Attractivity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Old</td>
<td>Metric distance (m)</td>
<td>Surface area (m²)</td>
</tr>
<tr>
<td>New</td>
<td>Axial distance (steps)</td>
<td>Use values (number of)</td>
</tr>
</tbody>
</table>

The Place Syntax model

With the newly developed GIS-application The Place Syntax Tool (PST) it is now possible to measure “geographic accessibility with axial lines in GIS” (Ståhle et al 2005). PST also makes it possible to calculate the ‘topological’ accessibility with axial lines from every place (address or plot) in an urban area: $A_i = \sum f(W_j, d_{ij})$, where $W_j$ is a measure of the attractiveness (e.g. number of use values in open space) at the locations $j$ and $d_{ij}$ is a measure of distance from the location $i$ to the locations $j$ (e.g. axial line steps to open space). Based on this formula many types of open space accessibility measures are tested.
3. Study areas

Ten study areas of 100 hectares (+- 0.1) each have been selected for more careful analysis; three 18th century block grid areas (Östermalm, Normalm, Södermalm), three post war modernist suburbs from around 1950 (Årsta, Högdal, Rågsved), three garden suburbs (Gamla Enskede, Stureby, Örby) and one post modernist block grid area from 1980:ies (Skarpnäck). All areas are uniform as urban typo-morphologies as they are defined by the Urban Planning Administration in Stockholm (Stockholms stad 1999).

Fig. Inner city area of Östermalm – looking west towards Norrmalm [left], and 1950 century suburbia of Årsta south of the inner city – looking south towards Stureby [right].

4. Empirical data

TEMO questionnaire 2001

2001 the leading Swedish market research agency TEMO executed a questionnaire asking “Do you experience a lack of parks and nature areas in the vicinity of your home?” This results was confirmed by USK 2005. The stunning result was that many of the inner city districts, and some denser suburbs, was experiencing less lack of green areas than especially the “green” post war suburbs.

Fig. Percentage of people that do not experience a lack of parks and nature areas in the vicinity their home for the ten study areas (TEMO 2001).
USK questionnaire 2002
The USK questionnaire from 2002 was sent out to 5400 households included the question “How often do you visit your favourite park/nature area?” In this questionnaire it is just as a surprising result as for the TÉMO survey. People in the inner city, and in the garden city suburbs experience that they go much more often to public green areas than especially in the post war modern-ist areas.

On-site observations 2004
The 15th april and 30th 2004 may landscape architect Anders Sandberg executed on-site observations and visit counts in eleven parks, five in the inner city and six in modernist suburbs from the 1950ies. Visiting frequency was not always higher in the inner city, and is not dependent on size.

5. GIS-analyses
The purpose of the GIS/PST-analyses is to test conventional and new open space measures against the empirical data. At first it is just interesting to theoretically compare the different GIS-results, but in the end the real question is: How well do these measures capture people’s life world.

Conventional surface area measures
The very basic analysis of an area is how large part of it is covered by open space. The results for the study areas are not surprising from the common (planner or laymen) point of view of these city districts. The inner city areas have consequently lower green and open space ratios, and the suburb areas considerably more. When these numbers are divided with the area population the differences increased significantly.

Conventional guidelines
1999 the Swedish National board for Building, Housing and Planning (Boverket) published common guidelines on open space accessibilty, based on earlier recommendations from the Nordic Council of Ministers. 2004 Stockholm municipality published the Stockholm parkprogram, a policy for the developement and maintance of municipal green areas. All are based on minimum surface area and maximum metric distance.

Topological open space accessibility analyses
Three types of topological open space accessibility analyses were extensively tested; topological open space proximity, topological open space accessibility, and topological open space/population accessibility.
Fig. The combined measure (column 7) calculated and presented per address point within the study areas. Darker means higher green space accessibility. This measure correlated best with the TEMO 2001 questionnaire “Do you experience a lack of parks and nature areas in the vicinity of your home?”
Column 7 is a combined measure that is constructed from the theoretical model described above. This measure calculates the accessible green surface area multiplied with the number of use values (from the sociotope map) as a measure of attractiveness. Every green area is also weighted dependent on axial line distance from every address point. This means that each axial step away means half the green area. In this measure a pedestrian range has been set to 1000 meters, i.e. green areas more than 1000 meters away are not calculated. The correlation studies below show that it is 3 and 7 that is the most interesting empirically.

**Axial line integration analysis**

The axial line integration analysis says something fundamental about the spatial integration of public green and open spaces. Integrated spaces will, according to the theory of natural movement (Hillier et al 1993), play a more central role in the urbanity. These spaces will not only be more frequently visited and used, they will also probably get better known because they are located in more legible places and at the same time within the people’s daily movement patterns. In many ways the axial line integration pinpoints many of the findings and conclusions.

![Fig. Global axial line integration for two of the ten study areas, inner city area Östermalm [left] and 1950 suburb are Rågsved [right].](image-url)
6. Findings and correlations

Measured and experienced green space accessibility

The questionnaire from 2001 (TEMO) that asked “Do you experience a lack of parks and nature areas in the vicinity of your home?” was found to correlate with the combined measure presented in the former chapter, after extensive testing of many different open and green space accessibility measures. This measure calculates accessible green surface area multiplied with its number of use values, it weights green areas according to axial line distance (one axial step away means half the green space), but limits pedestrian range to 1000 meter. The correlation is to be considered as fairly high, $R^2=0.74$ ($p<0.001$). If Årsta and Gamla Enskede are sorted out the correlation goes up to $R^2=0.98$ ($p<0.001$). The correlations for any other conventional measures (open space sqm/pers) or guidelines (Boverket or Stockholm parkprogram) was only $R^2=0.02-0.22$.

The principal finding from this correlation is that there seem to be four major factors that determine green space accessibility; surface area, use values, orientation and range. If one looks at the best study area, in terms of structure efficiency (the combined measure divided with open space accessibility 1000 meter bird’s distance), Östermalm, it is systematically planned according to the Swedish late 19th century regularist Albert Lindhagen, who was inspired by Baron Haussmann in Paris among others. Östermalm is basic matrix of a continuous street grid in which a well-connected green structure of parks and esplanades is integrated. The consequence of this urban morphology is that when anyone is standing on any street that person sees a green area, and you know that this green area is part of the larger continuous green structure.

Fig. Principal schemes of the traffic integrated inner city grid with an continuous green structure [left] and of the post war suburb with a surrounding greenbelt and an interrupted street grid, with vehicular and pedestrian traffic separated [right]. Arrows principally show daily movement patterns.

In the post-war suburbs the main green structure is basically segregated around the settlement as greenbelts separating different suburbs, all according to the Stockholm generalplan 1952. Firstly, this urban design concept seem not as effective, in terms of land use, as the Haussmann-Lindhagen concepts, when looking from a life world point of view. Secondly, these modernist principles have also created un-equitable distribution of open space and open space stakeholders.

Green space proximity and experienced visit frequency

Turning to the USK questionnaire, which stated “How often do you visit your favourite park/nature area?”, correlation was found by measuring axial line proximity to nearest green area, $R^2=0.56$ ($p=0.018$), and by measuring public green space surface area within five axial lines, $R^2=0.77$ ($p=0.018$).
Fig. Correlation between how many who says that they visit their favourite park or nature area at least once a week and [left] axial line distance to the nearest public green area $R^2=-0.56$, $p=0.018$, and [right] public green space area within five axial lines, $R^2=0.77$ ($p=0.018$).

Axial line distance, i.e. orientation, seems to be the major explanation to why and how often people visit urban green areas. This conclusion is also confirmed by the Space syntax axial line integration analysis which shows that green areas in the inner city grid is much more spatially integrated than in the post war suburbs.

**Green space attraction, occupation and structural integration**

The on-site observations show that the selected inner city parks have more visitors then the selected 1950:ies parks. This is not so surprising compared to the area population densities. But, when the parks were divided into two groups; inner city parks and 1950:ies parks, correlations were found within the inner city parks between the number of use values and the number of staying visitors (not passers-through), $R^2=0.83$ ($p=0.03$). The same relation was not found to correlate at all in the 1950:ies parks, $R^2=0.05$ ($p=0.686$).

Fig. Correlation between the number of staying visitors and the number of use values in the inner city parks $R^2=0.83$, $p=0.03$ [left], and the 1950:ies parks $R^2=0.05$, $p=0.686$ [right].

My conclusion of these results is, very much similarly to the two earlier findings, that the high global spatial integration of the inner city parks means that they are appropriated more frequently. They are within the daily natural movement patterns, but they are also “marketing” themselves to the citizens because they are highly visible and legible. Hence, the post war parks are not appropriated accordingly to their attractivity because of low spatial integration and legibility.

**7. Conclusions**

There are two major conclusions to be made here. The first concerns the morphological design outcome, and the second the planning process. Firstly, it seems that there are some urban designs that work better than others. The Swedish post war modernist suburbs, as they have been fulfilled in Stockholm according to the General plan of 1952, have consequently got lower integration values, lower open space accessibility and land use efficiency. These suburbs can in my opinion to be considered as sprawl, or more bluntly as ‘un-smart growth’. In comparison the
Stockholm inner city grid, that has its park structure from 19th century regularism based on “the Lindhagen plan” from 1860, which has more spatially integrated streets and open spaces. Consequently, the structural inefficiency of sprawl opens up for qualitative in-fill and restructuring which can mean denser city but higher green space accessibility. This has been indicated by manu urbanists and researchers, and could be called the new regularism for the 21st century.

Secondly, concerning the planning process, there exists, as discussed in the introduction, a locked situation where urbanists stand against environmentalists, ‘dense’ is against ‘green’. The GIS-tools and findings presented in this paper could however, if they are considered as credible knowledge, help both parties to see that urban design can be creatively used to understand land use efficiency and open space distribution equity. The tools and findings can support sustainable and equitable urban development, and in this way help overcome deadlocks in planning. In the end, much can be gained if the common opinion of open space and “green” change from a static to a dynamic urban entity.

References

Hillier, B. & Hanson, J., 1984, ”The social logic of space”, Cambridge University Press, Cambridge
Stockholms stad, 1952, Generalplan för Stockholms stad, Stockholm
Stockholms stad, 1999, ”Stockholms byggnadsordning: utdrag ur Stockholms översiktsplan 1999”
Ståhle, A., Marcus, L., & Karlström, A., 2005, ”Place Syntax : Geographic accessibility with axial lines in GIS”, 5th Space Syntax Symposium, proceedings, Delft T E M O, 2001,