Strategic Planning and Design with Space Syntax

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Abstract. *In strategic planning and design, planners can benefit a great deal from planning models and simulations (2D, 3D and 4D). Carrying out strategic planning and design with the support of (spatial) models can open up a bright spectrum of opportunities and insights that were not evident before. Planning models and simulations support an awareness-raising process. In this context, space syntax also fits in. In the following we will discuss the constraints and opportunities of space syntax and show how space syntax can add value to strategic planning and design (based on the Ljubljana masterplan) for a sustainable and sustaining built environment.*
Keywords. *Urban analysis; strategic planning and design; space syntax; spatial simulation and modelling.*

INTRODUCTION

Strategic planning is a "[…] disciplined effort to produce fundamental decisions and actions shaping the nature and direction of an organization's (or other entity's) activities within legal bounds" (Olsen et al. 1982 in: Bryson 1988, 74).

In the context of the built environment, strategic planning means directly witnessing, experiencing and observing aspects of behaviours in the real world as a proven way of inspiring and informing new ideas (informed decision making). Careful observation of people's behaviour and market forces combined with the urban and regional layout can open up an insight that uncovers a bright spectrum of opportunities that were not evident before (Fulton Suri 2005). This is based on the consideration that for any planning and design strategy we need to start with an original insight about the usage of space (movement, activities, etc.) and its spatial layout. The meta-idea is to address diverse levels of the built environment such as transport, demography, businesses, production, services, tourism, health sector, living, leisure, etc. We have to acknowledge that the built environment on all scales (from local to global and vice versa) is driven by various forces – interwoven in a quite complex manner.

In the following we will explain how space syntax (taking into consideration its controversial views) can add value to the method of strategic planning and design.

A BRIEF REVIEW OF SPACE SYNTAX

Space syntax theory addresses the relationship between physical elements of a city (configuration), its social activity and the pattern of utilization. Marcus defines the space syntax theory in a very understandable way when he explains that the main variable of urban form that is analysed within space syntax is accessibility and how the accessibility between spaces varies according to the changes in the configuration of urban form (Marcus 2007).

Karimi adds that space syntax theory focuses on creating a platform for society and space, to give a spatial nature to society as well as a social dimension to space (Karimi 1997).

This methodology considers space and the spatial structure as the fundamental concept of urbanism. Each spatial manifestation unit of urban agglomerations develops an interface with itself. There is a direct link between the urban structure and the pattern of activity, as the organization of a city and its network of "open spaces" is created by the urban agglomeration of socio-spatial units. One of the major attributes is the relationship between movement – represented by connectivity and accessibility – and the spatial network, known as configuration. Figueiredo underlines that "one key characteristic of recent urban studies on urban morphology is the use of networks to describe the built environment. From this perspective, the city is not seen as a collection of building blocks that may have geometrical regularities, […] but as a network of interconnected open spaces – the urban grid" (Figueiredo 2007, 1). Thus, he points out that such studies present cities in terms of their underlying spatial organisation, tracing a connection between space and society.

As a basic tool, space syntax applies the axial line as the minimal set of longest straight lines of sight interconnecting all open spaces. Marshall says that the axial line reflects the geometry of bounded space (Marshall 2005). The axial line intersection of an axial map becomes the edge and the retrieved graph structure of the axial map is the "axial graph". An axial map is a geometric model of an urban grid that can translates into a topological graph. This topological graph has the street network structure as its "underlying" property.

As Hillier describes the city as a set of lines (Hillier 2003), he draws attention to the importance of connectivity and its topological arrangement into a network by the geometry of a system. What can be derived from this point is that the abstract connectivity (configuration) is more important than the position of space (composition) (Marshall 2005).

What space syntax represents is a topological network model to link urban structures with social activity through the idea of connectivity and accessibility. Accessibility mirrors a spatial ordering principle quantifiable as centrality and periphery (or: isolation, Rose et al. 2008).

CARLO RATTI'S SPACE SYNTAX CRITICISM VERSUS HILLIER'S & PENN'S REJOINDER

Like every theory, space syntax, too, has generated criticism and controversial views. In the following we would like to review two major topics (building heights and land use) of the famous scientific discussion between Carlo Ratti and Bill Hillier & Alan Penn (2004).

Does space syntax deal with building heights?

Carlo Ratti (2004) argues that the axial map discards all 3D information, as building height never appears in space syntax analysis. He stresses the fact that in contrast to Hillier's hypothesis of a more or less equally loaded grid with buildings (termed as natural movement) (Hillier 1993 in: Ratti 2004), an urban grid is rarely loaded in a uniform way. Building heights change within the city, modifying pedestrian movement. Ratti goes on to say that "a similar effect is produced by bus stops, underground stations, and the characteristics of streets, such as their width" (Ratti 2004, 492).

He also admits that the widths of streets are partially taken into account in the axial map. Further, Ratti states that building height would not

matter if Hillier's argument that urban attractors are a mere consequence of configuration ("tallest buildings appear in the most integrated parts of the town") applied to the built environment. He underlines that especially with planned cities, this argument may not be applicable, as planning decisions are often based on social, economic and technical reasons – in contrast to the configuration of a street network. Further, functions (i.e. car parks) can generate higher pedestrian movement rates than the original configuration of the network (integration, choice) would suggest.

Hillier and Penn respond to Ratti by explaining that space syntax has no difficulty at all in dealing with such factors as building height, pointing out that this factor is implemented in the regression model rather than in the spatial model. They emphasise their position by referring to a study done in five areas in London (Penn et al. 1998) which showed that building height was important for pedestrian movement at the level of area, though not at the level of individual road segment, but that the effect of building height was minor compared with configurational variables (Hillier, Penn, 2004, 504).

However, the trend in planning practice and research is towards a systemic planning approach combining geo-referenced data sets, topological and topographical factors with spatial 3D and 4D models (see also: planning support system – PSS). Lynch argues that "way-finding is the original function of the environmental image […]" (1960, 125); his notation of the city in the context of the visual ordering principle (imaginary trip) is based on five elements: path, edge, district, node, and landmark. Thus, the third dimension is an essential element of way-finding. If we consider Ratti's argument about the non-homogeneous distribution of building heights within a town or city, we return to Lynch's landmarks. Landmarks gives orientation within an urban system independent of their location (prominent or non-prominent location). In general, way-finding is achieved through the perception of direction, distance and vertical height. Thus, incorporating the third dimension into the spatial space syntax model would add important value in developing a holistic tool.

Does space syntax take land use into account?

In the context of land use, Ratti shares Batty's opinion (2002) when quoting him: "[Space syntax] accessibility measures, although providing indices associated with forecasting trip volumes, are not based on models which simulate processes of movement and thus do not provide methods for predicting the impact of location changes on patterns of pedestrian flow. In short although these indices can show changes in flow due to changes in geometry and location of entire streets, they are unable to account for comprehensive movement patterns which link facilities at different locations to one another." (Batty et al. 1998, 3 in: Ratti 2004, 492f). Batty argues in favour of the use of an Agent Based Model (ABM).

In contrast, Hillier (1999) offers a model in which locations are weighted in such a way that an additional local grid (i.e. shopping mall) is added to the street network (axial map). This, of course, will change the value of integration as the gravity of the street network changes due to the additional number of elements added. Ratti sees Hillier's model in a critical light, arguing that "the procedure, however, seems quite ambiguous, as it arbitrarily assimilates an indoor commercial centre to a real street network. Furthermore, it does not provide any method to quantify these fictitious additions to the urban grid, leaving the possibility of unconscious postrationalism – whereby it is the axial map analysis that mirrors movement and not vice versa." (Ratti 2004, 493).

Hillier and Penn agree with Ratti in the sense that the axial map does not technically integrate land use factors. They argue that there is a good scientific reason for it, as technically it is quite simple to calibrate lines with land use (improving r^2).

For a theoretical understanding of cities as well as practical importance (where should shops be put?), both see in the investigation of the impact of configuration and movement on land uses and,

further, the formation of centres and sub-centres, a higher value. Further, Hillier and Penn argue that in space syntax theory, land use is a dependent variable: spatial configuration influences movement and, further, can be expected to influence land use. They support this hypothesis by offering an extensive empirical investigation by Hiller (1999, 2000), (Hillier & Penn 2004, 506).

Seeing the discussion of land use in the light of a "goal following" approach (agent-based modelling) that asks the question "How does a specific location of a shop influence movement?", Batty is right in saying that agent-based modelling (ABM) can better manage to investigate and answer this question.

Raford highlights the difference between space syntax and agent-based models very clearly when he says that "as a statistical model it [space syntax] is relatively simple and robust, allowing for quick analysis of a range of cases and outcomes. But it is fundamentally static and falls short of many of the advantages that ABM provides, particularly dynamic activity over time, complex agent interaction, goal following, social learning, and emergent behaviour (Manson 2006, Miller and Page 2007, Epstein 2006, Gimblet 2002, Batty and Jiang 1999; in: Raford 2010, 243).

We agree with Raford that a research tool integrating space syntax with agent-based approaches is a promising direction for future research, as it is a more flexible way of exploring the role of space and accessibility in a variety of dynamic processes such as land use change, urban transportation, shopping, crime, and other forms of social behaviour (see also Raford 2010, 243).

HOW WE DESIGN CITIES IS HOW WE UNDERSTAND THEM

The framework strategic planning and design benefits from space syntax in terms of the opportunity of making informed decisions (awareness-raising process) in the light of their possible future consequences. As discussed above, space syntax offers a link between spatial organization and socio-economic factors. It gives rise to the effects of spatial layout design on social and economic value indicators such as movement rates, crime patterns (natural surveillance) and land uses.

For any planning and design strategy, we need to have an original insight about the usage of space (movement, activities, etc.) and the spatial layout itself. The meta-idea is to address diverse levels of the built environment such as transport, demography, businesses, production services, tourism, health sector, living, leisure, etc. Each planning and design strategy can only be vital with respect to the use of its space.

In order to achieve sensitive and appropriate handling of these above-mentioned forces for sustainable and sustaining planning interventions, planners must not only analyse the factors of transportation, market forces, land use and people's behaviours, etc. but also understand them in their singularity as well as their mutual interaction (topological and metric relationship) embedded in the built environment on both a local and global scale.

In general, the strategic design approach serves to fulfil a sustainable and sustaining planning strategy and the outcome that is globally important for metropolitan areas. Let us recall that sustainable planning addresses the development of strategies to reduce the use of resources, increase economic efficiency and improve integration of social aspects (i.e. pedestrian-friendly environments, well-balanced public and private transport modes, efficient street networks; land use; movement economy: access for all to jobs, shopping, services, health care, culture and leisure) (Czerkauer-Yamu et al. 2010).

However, we can assume the idea of strategic design as a systemic approach incorporating the elements of a multi-disciplinary and inter-disciplinary holistic strategy. The core of a structured, strategic design process can be summarised and implemented into planning processes as follows:

Finally, participation processes are important during the whole planning process. These can be

- Purpose of the effort
- Identification and clarification of musts confronting planners and the area under scrutiny (regulation rules, etc.)
- Development and clarification of mission and value (e.g. in the context of sustainability)

Planning prerequisites

- Global and local environment assessment

Baseline analysis

- Strategic issue
  - Conflict embodiment – what, how, why, where, when, who (can be used for all approaches below)
  - Goals approach
  - Scenario approach
  - Direct approach (planners and designers go directly from the view of the client)

Option testing

- Strategy development (strategies are developed based on the issues previously identified (e.g. short time strategy, long term strategy, in a spatial manner e.g. it can be phasing)
- Description of the future (planners describes what the area or region in question should look like as it successfully implements its strategies and achieves its full potential)

Expertise & recommendation

- Post-evaluation (approx. two years after the design was implemented)

Post-evaluation

carried out as: stakeholder consultations, developer consultations, public consultations, design workshops, etc.

In summary, strategic planning and design benefit from the opportunity of making informed decisions (we have to see this, of course, relatively to the built environment's nature of complexity), exercising maximum discretion, solving current problems of an area, improving performance and efficiency of an area, dealing effectively with changing circumstances and building expertise.

Based on this background and requirements, it can be seen that concepts, models and simulations (2D, 3D, 4D) are important, as all of them (bundled) contribute significantly to the formulation and exchange of spatial ideas. These visualised ideas address the users of space for a further in-depth interpretation in order to reach the next level of a more specified and realisable interpretation (awareness raising process) (Voigt 2005).

THE LJUBLJANA MASTERPLAN – A CASE STUDY

Ljubljana[1] lies strategically at the intersection of two main routes of the pan-European transportation corridors. The 230-ha area masterplan "Smartinska Partnership" is located in the north-eastern part of the city between the historic core and the ring highway. The Swiss architects Hosoya Schaefer[2] envisioned transforming the predominantly introverted, environmentally burdening urban area of former industrial manufacturing into a vital, rich urban space with its own identity and integrity. Thus, a holistic design and planning approach combining intuitive design with a strategic, programmatic planning conception supported by the space syntax method (Hillier 1996) was chosen.

The space syntax analyses for the Ljubljana masterplan focuses on the baseline study, option testing, expertise and recommendation, and long and short term strategies with regard to the accessibility of the street network. In the following, we will discuss selected space syntax analyses.

Figure 1-
(Hosoya Schaefer 2009)
Ljubljana masterplan – building mass model

City-wide accessibility – strategic model

City-wide accessibility maps visualize the connection structure of the street network, e.g. between the masterplan area and the historic core of the city. Important facilities, services and infrastructure are linked to a great degree to the foreground network (Fig. 3, marked in red). Space Syntax Ltd. states that it has been found that this measure corresponds well to vehicular volumes where specific traffic restrictions do not apply (Space Syntax Ltd. 2009, 33). Ljubljana's foreground street network shows radial and orbital roads. We can identify a "deformed wheel" structure, as in many European naturally grown cities, and a ring road carried out as highway. This analysis enables to identify efficiency lacks and potentials and the possible impact of a scenario on the whole urban system.

Point depth analysis – catchment area

This analysis visualizes, e.g., "missing links" in greater detail (zoom) on a pedestrian-friendly scale. Figure 3 identifies a "missing link" between the historic core and the masterplan area. Especially the shopping mall of the masterplan area (BTC City) is accessible only by car and best reached by means of the highway ring (see strategic model). This "ring culture" is not an integrative part of the city. A possible solution is to introduce "stepping stones" in walking distance, like Kolinska (street network intensification), to re-link the historic core with BTC. Walkability can improve the functionality, character and identity of an area.

The missing link – catchment area analysis. Point depth analysis (walking distance) on the network overlaid with crow-fly distances (circular radials).

Block sizes – permeability

Block sizes have an impact on walking times in urban areas. The bigger the blocks are within an area, the less pedestrian movement sensitive the area is. The more pedestrian movement sensitive an area is, the more likely we will find local shops there (in contrast to shopping malls developed on a car-based

Figure 2
(Space Syntax Ltd. 2009)
Image left: The analysis of the city-wide accessibility highlights the fact that the (existing) masterplan area does not function as an urban centre and is not well-connected to the historic core of the city.
Image right: The proposed masterplan has the potential to unlock spatial potentials of the wider surrounding area, based on the higher connectivity within the site and to its neighbourhood.

accessibility approach). A coarser urban grain is mostly found around residential or industrial areas, whereas a finer granularity is found around shopping streets. Hence, the block size can give an idea of existing and potential land use. Space Syntax Ltd. explains the influence of the urban grain on land use by stating that "finer grains maximize the available surface – i.e. block frontages – for display and interaction, while minimizing journey lengths. This 'grid intensification' helps to support retail, catering and leisure activities and is an important property of urban centres and sub-centres" (Space Syntax Ltd. 2009, 35). Well-balanced distribution of block sizes respond to mixed uses and therefore sustaining areas.

Phasing – successful implementation

Another important task within strategic planning and design is the successful implementation of a design (short-term and long-term strategy). This process of implementation needs a defined process allowing stable, continuous development, adaptation and achievement of the planning

Figure 3
(Space Syntax Ltd. 2009)
The missing link – catchment area analysis. Point depth analysis (walking distance) on the network overlaid with crow-fly distances (circular radials); left: existing; right: proposed..

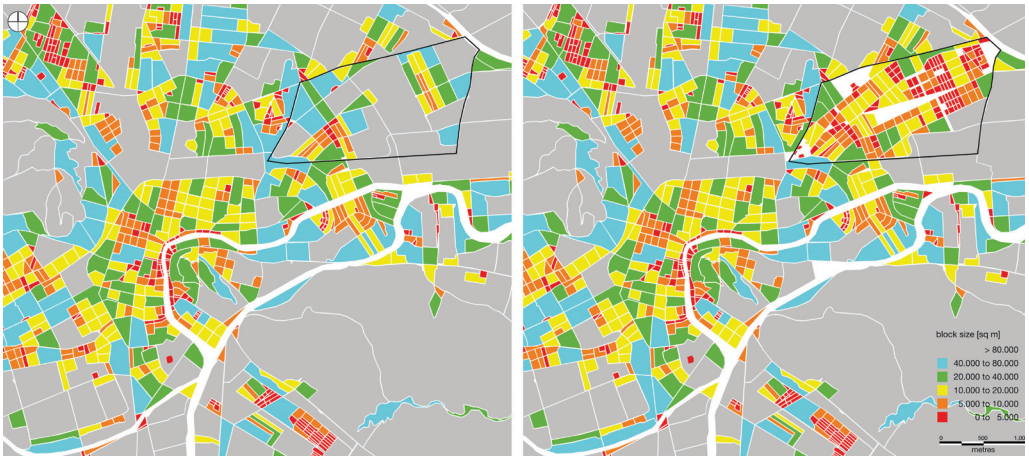

Figure 4
(Space Syntax Ltd. 2009)
Block size analysis helps us to understand the "permeability" of a city. A proposed finer grain (right) aims at achieving higher pedestrian movement scenarios through shorter trips based on smaller blocks; left: existing, right: proposed.

concept, while at the same time minimizing disruptive factors (the overall concept needs to stay intact). Hosoya Schaefer underlines that "decisions which affect the long-term feasibility and viability of the masterplan, such as process management, EU fund applications, multimodal strategy, or government city strategy, need to be taken at the right moment. Decisions that are taken too early might not be well-founded enough to provide stability in the process; decisions that are taken too late will create a lock-in situation that will negatively affect the outcome of the masterplan process. Process management is a key function […]." (Hosoya Schaefer 2009, 262). In this context, space syntax carries out a so-called phasing strategy for the street network, being very similar to option testing (scenario approach).

A closing note on space syntax

What we have seen with space syntax is that it supports, to a great degree, an awareness-raising process. Space syntax helps to give new insights on urban functionality by visualizing spatial relationships. In the light of strategic planning and design, it can help us gain an insight into specific problems of an area and their possible solutions. Further, it can be used in participation processes by planners, local authorities and the public. Space syntax is a support tool for urban analysis to enable informed decisions. It can also add value to planning support systems (PSS).

The constraints and opportunities of space syntax are as follows:

- It is a topological model having the ability to link urban structures with social activity through the idea of connectivity and accessibility.
- It is relatively simple and robust, allowing for quick analysis of a range of cases and outcomes.
- It adds value to the strategic and design process: strategic issues, goals approach, scenario approach, direct approach, strategy development, description of the future, and post-evaluation.
- The axial map does not technically integrate land use factors.
- It is a static model falling short of the advantages that ABM provides (dynamic activity over time, complex agent interaction, goal following, social learning, and emergent behaviour).
- It discards all 3D information, such as building height.

REFERENCES

Bryson, J 1988, "A Strategic Planning Process for Public and Non-profit Organizations", *Long Range Planning*, vol. 21, no.1, pp.73-81.

Czerkauer-Yamu, C and Frankhauser, P 2010," A Multi-Scale (Multi-Fractal) Approach for a Systemic Planning Strategy from a Regional to an Architectural Scale", proceedings, Real Corp 2010 – *15th International Conference on Urban Planning, Regional Development and Information Society*, pp.17-26, Vienna.

Figueiredo, L and Amorim, L 2007, "Decoding the Urban Grid: Or Why Cities are Neither Trees nor Perfect Grids", *proceedings, 6th International Space Syntax Symposium,* Istanbul, pp.006/1-006/16.

Fulton Suri, J 2005, „Thoughtless acts? Observations on Intuitive Design". Chronicle: SanFrancisco.

Hillier, B 1996, *"Space is the machine. A configurational theory of architecture"*, Cambridge University Press, Cambridge.

Hillier, B and Penn, A 2004, "Rejoinder to Carlo Ratti", Environment and Planning B: *Planning and Design*, vol. 31, pp.501-511.

Hosoya, H and Schaefer, M 2009, Šmartinska Partnership Ljubljana, *Masterplan Spring 2009*, publication date: March 26th 2009.

Karimi, K 1997, "Continuity and Change in Old Cities. An Analytical Investigation of the Spatial Structure in Iranian and English *Historic Cities before and after Modernisation"*. PhD Thesis, University College London.

Lynch, K 1960, "*The Image of the City*", Cambridge/Mass.

Marcus, L 2007, "Spatial Capital and How to Measure it: An Outline of an Analytical Theory of the Social Performativity of Urban Form", *proceedings, 6th International Space Syntax Symposium*, Istanbul, pp.005/1-005/12.

Marshall, S 2005, *"Streets and Patterns"*, Spon Press, London/New York.

Raford, N, 2010, "Social and Technical Challenges to the Adoption of Space Syntax Methodologies as a Planning Support System (PSS) in American Urban Design", *The Journal of Space Syntax*, vol.1, issue 1, pp.230-245, http://www.journalsofspacesyntax.org/

Ratti, C 2004, "Space syntax: Some inconsistencies", Environment and Planning B: *Planning and Design*, vol. 31, pp. 487- 499.

Rose, A, Czerkauer C et al. 2008, "*Space Matters*", Arch Plus – Zeitschrift für Architektur und Städtebau, no.189, 41.Jahrgang, pp. 32-37

Voigt, A 2005, "Raumbezogene Simulation und Örtliche Raumplanung. *Wege zu einem (stadt-) raumbezogenen Qualitätsmanagement*", Österreichischer Kunst- und Kulturverlag, Wien.

1. Since 1991 Ljubljana has been the capital of the independent state of Slovenia.
2. Design led by the Swiss architects Hosoya Schaefer with the assistance of Space Syntax Ltd., Arup London, Mountainworks Netherlands, Vogt Landschaftsarchitekten AG Switzerland, and IBV Hüsler AG Switzerland.