

Modelling of Public Spaces

In the quest for methodology for material culture research

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Abstract. *The relationship between the material settings and situational belonging to a more general notion of the culture of a given community remains the subject of inquiry of at least two scientific disciplines: anthropology and urban morphology studies. In this study an assessment of the various modelling platforms is performed with the objective of finding the most efficient method which allows the description of the semiotic features of urbanscapes. The ideal system should link the parametric definition of urban geometry with the high flexibility of data input and easy manipulation. In order to enable culture related analyses of urbanscapes, analyses should be performed which refers to the semiotics of morphological structures in the detailed scale of urban enclosure, which are streets or squares. Some elements of the proposed method of index key analyses are explained as one possible solution for the problems posed.*

Keywords. *Urban design; urban morphology; anthropology; parametric modelling; outdoor space.*

INTRODUCTION

The analyses of urbanscapes provided by anthropologists, refer both to the public realm and the indoors, mostly domestic spaces. The situation, defined in anthropology as a theatre of human activities (Perinbanayagam, 1974), describes settings suitable for humans. Goffman (1959, p.18) defines a situation as “*the full spatial environment anywhere, within which an entering person becomes a member of the gathering that is (or does then become) present*”. Thomas, who introduced the concept of situation in the 1920s, defined it as a “*constellation of the factors determining behaviour*” (1937, p.8), cited in (Schumacher 2011, p.420). Any of the numerous definitions of situation assumes the presence of void surrounded, to various extents, by volumes. Space,

defined in such a way, becomes a place following the rationale of Yi Fu Tuan (1977). When using the terminology of positive versus negative spaces, as introduced by Ashihara (1981), the proportions of height and plan dimensions influence the potential of voids to be ‘transformed into figures’, following the Gestalt theory (Ashihara 1981, p. 142). This indicates the importance of profile in the analysis of outdoor spaces.

The void, constituting a physical representation of a public realm, is an element enabling the commensurability of the theoretical framework of anthropological studies and the epistemological approach of urban morphology. The classification of research in urban morphology (Gauthier, Gilli-

land, 2006), places the oeuvre of morphologists who incline towards the anthropological method (Rapoport 1999, 2003; Rykwert 1989; Lynch 1960, 1994) on the border between the cognitive and normative approach.

This current paper undertakes a trial to identify those features of 3D urban models which refer directly to the description of urban settings that may be characterised as culture related. It proposes a methodology of assessment which incorporates culture-related, technical and practical issues into our rationale. In this way it identifies possible pathways to answering this multi-dimensional question. The paper is organised as follows: after this introduction, the explanation of classification methodology is presented with regard to culture based issues. Further on, the evaluation of models prepared with various software is performed, the results being presented in tabular form. The last section discusses the assessment results and potential future research avenues. It also summarises conclusions from the paper.

URBAN SPACE AS A SUBJECT OF ANTHROPOLOGICAL ELABORATION

The anthropological concept of walking, elaborated by Certeau (1988, p.98) where any place is perceived as a space of enunciation and his comparison of the usage of space and urban structures to speaking in a given language, provides a valuable asset for analysis of the way urban spaces are created. A desirable harmony of urbanscapes requires congruency of the form of structures and of human behaviour. Certeau (1988, ix) discusses a concept of singularity – the scientific study of relationship - that links everyday pursuits to particular circumstances. The necessity of congruence of human activities and the form of urban structures was discussed abundantly by Lynch (1960, p. 132 and further). Rapoport (1990, p.38) distinguishes pragmatics as one of the three major components of the semiotics of urban space, along with syntactics and semantics. He defines pragmatics as an examination of the ways different elements function in defined situations, the emotions they evoke, the attitudes and preferences associated with

them and the kind of behaviour required. He relates this aspect of urbanscapes directly to the culture of space usage. Panerai et al (2009) propose the concept of *habitus*, which assumes that urban structure, as reflecting the social practices of everyday life, becomes the form of record of these practices.

The set of identifiable cues, which may be qualified as culture-specific (Rapoport 1990, pp.106-107), and referring to spaces, includes features like: “*quality, size, shape, enclosing elements, paving, barriers, and links, etc.*”, requires examination with regard to the distribution of human flows and concentrations and their intensities, and, consequently, opportunities for contact. Both Gehl (2010) and Whyte (2009) point at similar rules of the use of outside spaces. The territorial distribution and exchange of non-verbal cues serves the communication purpose and usually certain semantics may be attributed to it (Goffman, 1959). The behaviour of a given human group in concentrations reflects its culture while the movement component tends to be more universal and less culture dependent, as Hillier and Hanson (1984) claim. The claim is also made that the rules which govern the non-verbal communication component of the human group’s behaviour are the same ones behind the distribution of clues in the urban settings. They both represent the same culture of space usage. Hall suggests that human relationship to all the art forms is “*more intimate than is commonly supposed (...)*” as it is based on synchrony in which the “*(...) audience and artist are part of the same process.*” (1989, p.80)

Another claim made is that the rules which govern the nonverbal communication component of human group behaviour are the same which serve the distribution of cues affecting the communicative features of public spaces, as discussed by Rapoport (1990). Hillier and Hanson argue that societies vary “*in the type of physical configuration [and] in the degree in which the ordering of space appears as a conspicuous dimension of culture*” (1984, p.4). They (1984, p.224) discuss the method of investigation of encounters as morphic languages, which have different manifestations in space.

CASE STUDY

The current paper presents the results of the ongoing research, aiming to describe the unique character of the urban structures of central Poland, which are commonly attributed to their former Jewish citizens. A few samples referring to the variety of examples coming from cities and towns of different size and periods are intended to show the diachronic aspects of the presence of this cultural group. Changes in lifestyle and thus in the culture of usage of space, which had been taking place since the 18th, during the 19th and in the beginning of the 20th century, is connected with, amongst others, the processes of the assimilation of this group, were reflected by the alteration of the space order.

In metropolitan cities, like Lodz and Warsaw of the beginning of the 20th century, the richness of the variety of everyday practices along with the transformations of the industrial era and the influences of the four main cultural traditions in this area: Polish, Russian, German and Jewish, led towards the palimpsest of spatial threads. At the same time, in the close vicinity, traditional religious communities (including changing religious trends, i.e. Hasidim, as described by Wodziński, 2005) conducted their strict, religion-based lives of the former “*shtetl*”-like culture.

METHODOLOGY OF ASSESSMENT

The paper's objective is to examine the capacities of various software in the quest for the best possible way to answer the question of relations between physical space and human activities which take place there. A few sample models of various historical spaces, done with the use of different tools have been done. The observations of the results, in the form of tabular matrix, allows identification and comparison of modelling methodology. The requirement to describe the various cultural conditions was a key criterion for evaluation. The use of subsequent modelling approaches is envisaged:

1. simplified and textured models in Google SketchUp including urban furniture, streets equipment, etc.

2. parametric models in CityEngine
3. parametric models in Rhino/ parametric model in Rhino extended with Grasshopper
4. the database of resources in ArcGIS, including archive photographs, maps and films/ model in ArcScene
5. index key analysis.

Index key method

Apart from the predefined commercial modelling methods, the 2D profile based analysis may be applied, as explained in Hanzl (2013), of which a basic shortcut is provided below. The index key method assumes examination of urban enclosure profiles and urban silhouettes. Quantitative parameters describing the form of space are introduced, including: central angle, corrugation and regularity. Analysis is based on the notion of convex defined by Hillier and Hanson (1984, p. 91) “*a part of a space, which represents the maximum extension of the point in the second dimension given the first dimension*”. The way in which an observer perceives space in the urban interior depends on the parameters of cross-section. The basic features important for describing convex spaces are profiles and walls silhouettes (Wejchert 1984). The analysis of a wall silhouette allows identification of the required index points, which further serve for definition of cross-sections. Each index point refers to one profile. The starting point for each cross-section is located on the line, which is parallel to the wall and goes through the geometrical centre of the given convex (Figure 1). Profiles are perpendicular to the convex wall. Each profile is described by its central angle, which is an angle between the horizontal plane parallel to the floor at the height of 1,5m (the medium level of sight for humans) and a line going through the highest point of the building defining the closure in a given index point. The point belongs both to the silhouette line and to the cross-section. Central angle analysis is made for each of the cross-sections created at each of the index-points of the distinguished walls, and then combined for the walls forming the convexes, using the following formula (1), where $\alpha_1, \alpha_2, \alpha_3, \alpha_n$ are values of central angles

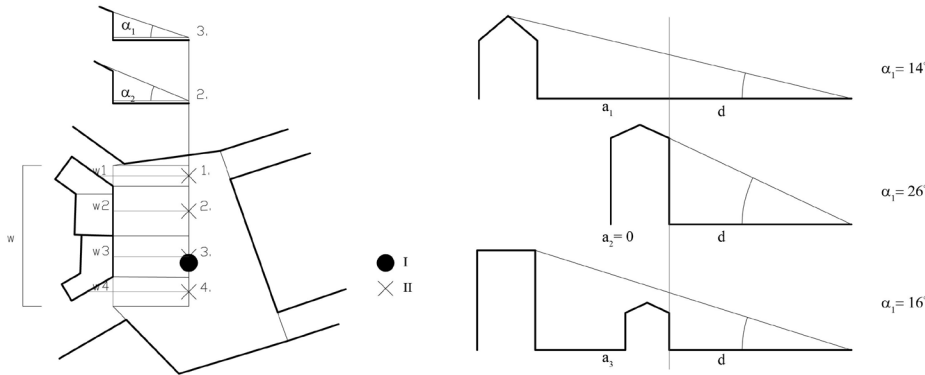


Figure 1
Index points and cross-section definition. I – geometrical central point, II – index key points, an central angles for each cross-section, w_n – widths of each unique part of wall. Corrugation of the wall, an - offset of a part of a wall, d – distance of the wall from the central point of the cross-section.

of each of the defined cross-sections, n is the number of index points for each wall, w_n is the width of a piece of a wall represented by a given index point and w is the length of the whole wall.

$$\alpha = \alpha_1 \times \frac{w_1}{w} + \alpha_2 \times \frac{w_2}{w} + \alpha_n \times \frac{w_n}{w} = \sum \left(\alpha_n \times \frac{w_n}{w} \right) \quad (1)$$

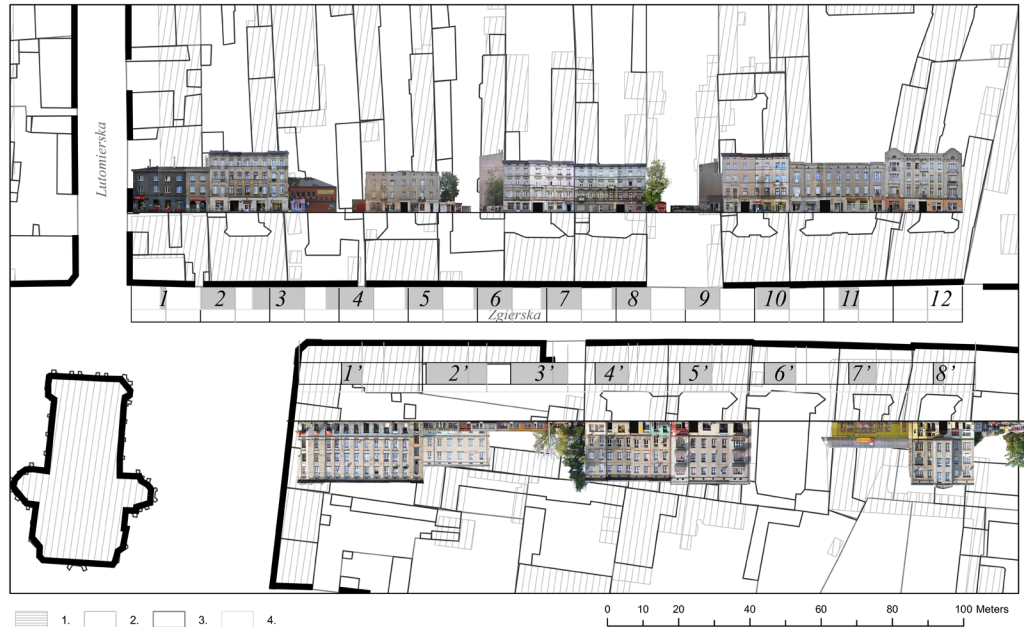
The definition of space may be either precise or hazy. In the first case, the walls form clearly cut edges, in the second one, buildings and other objects are scattered, forming a kind of fuzzy boundary. In a situation where buildings are set back from the line of frontages, the method allows for the description of an angle in a way similar to the other cases. Variations of a buildings' offset are another parameter important for the definition of the space's character. The line of frontages may be located on the edge of a given convex or set back, the offset may be regular or irregular, any of these attributes influence the perception of the space (Figure 1). Corrugation may be defined using the formula (2), where φ symbolises the corrugation value of the wall and a - the offset of a single part of the wall. The possibilities of comparison of different situations are enabled thanks to the normalisation of offset values as in formula (3), where a represents the offset in metric units and d - the distance of the wall from the central point of the cross-section. In the case of some elements, offset of the lines of frontages should be provided as positive numbers.

$$\varphi = \frac{\sum \gamma_n}{n} \quad (2)$$

$$\gamma_n = \frac{a_n}{d} \quad (3)$$

Further analyses include the distribution of index points which reflect the distribution of buildings and which may be described by a parameter of regularity. Such an analysis allows for easy detection of rhythms, repetitions, symmetries, axial layouts, etc. Distribution of index points may be described as clustered, spaced or scattered. The parameter of regularity may be defined referring to an ideal pattern, which means equal distribution of the number of points defined for a given wall. Any shift from the point resulting from an equal division should be measured and normalised by the width of the wall represented by each index point. The sum of all shifts divided by the number of index points describes the value of regularity for each wall. The regularity of the whole closure is described by the average value. The regularity may be described with the use of the formula (4), where τ is the regularity parameter, r represents a single shift, ω - width of an average part of a wall, w - width of a single wall and n is the number of index points for a given wall (5). The example of the regularity analysis is presented in Figure 2, results are included in Table 1.

Figure 2
 The analysis of regularity: current buildings (1) and parcels (2), historic buildings (3) and parcels (4). Values of shifts (r) for each key point shown in grey. Zgierska Street, Lodz, drawing uses results of inventory by students of Institute of Architecture and Town Planning of Lodz University of Technology, 4th sem. tutor M. Hanzl.



$$\tau = \frac{\sum r_n}{\varpi} \quad (4)$$

$$\varpi_n = \frac{\sum w_n}{n} \quad (5)$$

RESULTS AND DISCUSSION

The starting evaluation refers to the most basic features of a model, including criteria referring to presentation, efficiency of modelling and purpose (Table 2). Efficiency in modelling is understood as the relation between workload and modelling results. Some of the assessment criteria defined by Thompson (2012) were considered, though the specific purpose of the model required in this case resulted in an alteration of the list. The historic character of the modelled structures allows one to renounce evaluation of some features, e.g., 'up-to-date ones'. The analytical purpose and research performed by the limited number of users, when comparing to other

uses of 3D models, allows us to omit some features. Though, by turn, as some of the analyses should be performed by specialists coming from various domains, ease of operation of the model as opposed to the high proficiency and specialisation of an operator may be welcome. Assessment of model samples is done in the scale 0 to 1, where 0 represents the absence of a feature or a situation when a given criteria doesn't apply, 1 is accorded in cases when a range of features is available, e.g., the model may be well detailed or generalised in a given software, 1/2 when the modelling process imposes only one possibility.

In the case of the analyses which deal with: (1) external appearance of walls of enclosures both of streets and squares, with (2) form of floor, and with (3) form of ceiling we may assume that they may be incorporated into anthropological analyses as the appearance of these elements present some semiotics.

When analysed from the point of view of meaning of urban structure appearance may be ap-

n	r [m]	w [m]	τ	n	r [m]	w [m]	τ
1	1.59	16.37		1'	5.81	35.71	
2	9.80	6.73		2'	17.15	34.49	
3	14.72	22.03		3'	16.15	11.26	
4	13.55	19.48		4'	9.41	23.04	
5	10.77	20.47		5'	9.10	23.74	
6	10.93	19.31		6'	8.92	24.43	
7	11.48	19.71		7'	7.78	19.88	
8	11.05	20.26		8'	2.96	18.24	
9	9.68	21.59					
10	9.30	18.72					
11	5.56	26.64					
12	0.05	21.97					
rn	9.04	19.44	0.46		9.66	23.85	0.41
σ	4.46	4.70			4.82	8.11	

Table 1

The analysis of regularity:
τ - the regularity parameter,
r - a single shift, w - width of a
single wall, n - the number of
index points for a given wall.

proached through various properties which may be classified into a few groups, following various layers of the notion of meaning, which may be recorded in urban structure notation. The presented approach assumes various analyses of culture related features, which means that models should be assessed with regard to the possibility of examining these features.

In order to perform these analyses, the classification of various layers of meaning provided by urban settings was used as defined in Hanzl (2013a). It assumes the following categories of characteristics:

- description of flows and traffic which is reflected by street/ road profiles
- semiotic parameters of urban structures which

Assessment factors	City Engine	Sketch-up*	Arc Scene	Arc GIS	Rhino	Rhino+ Grass-hopper	Index key
<i>Generalisation</i>							
Scalability	1	1/2	1	1	1	1	0
Level of Details	1	1/2	1/2	0	1	1	0
Realism of presentation/ fidelity	1/2	1	1/2	0	1	1	0
<i>Possible way of utilisation</i>							
Presentation	1	1	1	1/2	1	1	0
Analyses	1	0	1/2	1	0	1	1
<i>Presentation</i>							
Legibility	1	1	1	1	1	1	1
Precision	1	1/2	1	1	1	1	1
Efficiency of modelling	1	1	1/2	1	1/2	1	1
Possibility of usage of external data sources (cloud point)	1	0	1	1	1	1	0
Editability	1	1	1/2	1	1/2	1	1
Proficiency	1/2	1	1/2	1	1	1	0

Table 2

Assessment of model samples following a basic set of criteria referring to presentation and modelling efficiency. *In the case of SketchUp a simplified model with textures and visualisation of some elements of urban furniture/ street scape is discussed.

are explicit and reflected in cultural practices as in the notion of situation defined in the beginning of the paper

- indirect semiotics of urban structure resulting as has been assumed from kinetics patterns of movement of humans in a given culture.

The very basic layer of information inscribed in urban settings is related to the functioning of a given place. Requirements of outdoor commerce, for instance, impose the necessity of large open spaces, occupied by stalls and stands, usually ordered but still competing for the attention of a passerby. In cases when commerce is also located around tenements they adopt similar features as well. Usually the floor of such enclosures is a sort of impervious surface, to avoid mud. There is no greenery: trees, lawns or bushes cannot survive in such conditions. Usually stands are roofed, which is often also the case of passages. The regularity of enclosure walls is not necessary for commerce purposes. In ground floor shops especially, exhibitions compete for attention similarly to free standing kiosks in the open space of a market. Another example which may be discussed is landmark buildings which may be situated both as freestanding ones or constitute a part of the street facade. Decisions upon the location of such buildings are usually influenced by a number of factors, both internal, resulting from cultural preconditions of a given group and external - derived from legal regulations of a country, natural conditions, etc.

A comprehensive explanation of the various attributes of physical structure related to semiotics was provided by Rapoport (1990, 2003). In order to examine the above characteristics the following features should be analysed as also discussed in more detail in Hanzl (2013a, after Andersen 2012): (1) contour, (2) shift (like shift of cornice providing dynamic transition between neighbouring facades), (3) colour palette, (4) profile, (5) relief, (6) plasticity - twists of line of construction, corrugation, (7) rhythm - of facades, windows, etc, (8) framing - as emphasis of architectural elements, (9) pattern - touchable, increasing tactile qualities. Another feature crucial for

the gestalt perception of urban spaces is profile. In order to become a true form, a street, as well as any other outdoor space, must possess a 'figural character' (Norberg-Schulz, 1963, p.83; after Ashihara, 1981, p.142).

In this case the assessment of model samples is done in the scale 0 to 1, where 0 represents the absence of a feature, 1 is accorded in cases when a feature is easily available, 1/2 when special competence is required to operate the system to achieve the desired results (Table 3).

The classification points at the suitability of parametric versions of modelling software to render character of development in a very efficient way. This kind of software uses, in practice, rules which are behind those qualities of the environment which are responsible for its character, and using them makes them explicit rather than implicit. At the same time detailed presentation of all features of urban spaces in models is useful for presentation purposes but may constrain analytical applications. When analysing meaning, some functional schemes inscribed into urban structure, applications such as City Engine or Rhino or Rhino + Grasshopper, may be especially successful. They use quantitative values describing flows (e.g. people). Similar methodology is used in the case of GIS software which allows the modelling of flows and nodes following their quantitative description. For some analytical purposes predefined forms of physical objects may constrain flexibility of the analytical approach. This is to some extent the case with CityEngine.

CONCLUSIONS

The evaluation of examined methods of modelling of urban spaces allows one to conclude that the best results should be achieved in cases of usage of parametric software which is altogether flexible, easy to operate and introduces new definitions. In addition, a database of knowledge prepared with GIS is a useful complement together with additional tools resulting from the application of the index key method defined for this research. The research is an ongoing one, thus the final list of assessment criteria

Assessment factors	City Engine	Sketch-up*	Arc Scene	Arc GIS	Rhino	Rhino+ Grass-hopper	Index key
Parametric approach	1	0	1/2	1/2	1/2	1	1/2
Flexibility in parametric design	1/2	0	1/2	0	1/2	1	1/2
Predefined solutions in parametric approach	1	0	0	0	0	1/2	0
<i>Ability to perform various analyses</i>							
Analysis of rhythms	1/2	0	0	0	1/2	1	1
Analysis of street profile	1	0	0	1/2	1/2	1	1
Analysis of urban silhouette	1	0	0	0	1/2	1	1
Analysis of urban details	1/2	1	1/2	1/2	1/2	1	0
Analyses of functional schemes	1	0	1/2	1	1/2	1	0
Analysis of flows	1	0	1/2	1	0	1	0

Table 3
Assessment of models samples
emphasising possibilities to
perform various analyses and
parametric approaches.

may be enlarged, following the acquired experience and expansion of acquired data. So far, the application of the index key method was a graphical one. Preliminary research shows that it could be incorporated into the Rhino+ Grasshopper parametric platform, which indicates possible pathways of further methodology development. Current research tries to look for analytical methodology, which may serve to relate the culture of usage of space with the semantics of material urban structures. Similar research is conducted in the field of archaeology (e.g., Hodder, 2012) though there space is commonly approached as a geometrical abstraction, which may be described through the language of mathematics. Tilley (1994, p.11), discussing phenomenological experience of space, speaks about “*the irrational abstracted idealism of a geometrical universal space*” which is grounded into “*the differential structuring of human experience and action in the world*”. It seems that urban morphology while dealing with elements which define character of public spaces should be able to find those features of urban structures which represent some semantic values. To some extent, this definition is present both in formal planning practice of the urban plans of local development and in the definition provided by parametric descriptions offered by some software.

The definition of an atmosphere, which refers to a general character of some physical settings as Andersen (2012) puts it, requires the development of phenomenological research based on the former descriptive studies of authors like Rykwert (1989) or Rapoport (1990). The ability to perform such studies with the assistance of computer technology could enlarge the scope of analyses significantly. It seems the only way to import these threads into the more general ontology for urban design, thus enlarging, e.g., studies conducted by Portuguese researchers, represented by, e.g., Beirão et al, (2012), etc. In the contemporary “*era of parametricism*”, as Schumacher (2011) proves, may be the only efficient way to take the issues of local culture into account. It is necessary to define an ontology for the description of outdoor spaces which could encompass these issues. This current paper is a step on the way towards this definition.

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