



VIEWPOINTS

Discussion of topical issues
in urban morphology

Point clouds and the measurement of the physical form of cities

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Following consolidation of ‘Light Detection and Ranging’ (LiDAR) technology, 3D point clouds have become a *de facto* standard for documenting and modelling the physical form of cities. The principle of measurement is generally based on measuring the reflected signal of a pulsed laser light emitted by a laser scanner. The result consists of a set of co-ordinates indicating the location of each measured point, along with one or more attributes such as intensity of reflected light and colour associated with each point.

Scanners are now able to acquire up to a million points per second to represent the environment by very dense accurate point clouds. The integration of sensors in mobile platforms, together with the reduction of the cost of the technology, has led to a higher availability and quality of 3D geographical data especially in terms of data completeness. This is evidenced by the existence of increasingly dense aerial point clouds depicting even entire countries.

The use of point clouds to study the built environment has become increasingly common among researchers employing geomatics and remote sensing, computer vision and robotics. Exploiting such data, recent investigations address a variety of different tasks, such as the extraction of roads, kerbstones and road markings (Soilán *et al.*, 2018), visibility analysis from a driver perspective (Iglesias *et al.*, 2016), the detection of ground elements such as stairs and ramps for physical accessibility analysis for pedestrians (Balado *et al.*, 2018),

and even the creation of large-scale city models (Biljecki *et al.*, 2016).

Yet despite the potential of point clouds to measure the built environment, its use is still unexplored by the urban morphology community. How can point clouds help urban morphologists to describe and explain (or even prescribe) the physical form of different areas in a city? Are point clouds more relevant to the analysis of some elements of urban form than others? Bearing in mind the large amount of information that is produced, what is needed and what is superfluous? Are point clouds able to offer insights not only on forms but also on the process of their formation? Is this method more relevant to some morphological approaches than others?

Different morphological approaches, from the historico-geographical to space syntax, have demonstrated the importance of the ground plan and what it can offer for an understanding of the dynamics of urban form. As such, different patterns of combination of streets, street-blocks, plots and buildings have been broadly analysed in two dimensions considering an XY representation. But what would be the advantages of changing the projection map to a YZ or an XZ?

The urban landscape is three dimensional. Streets go up and down, adapting to or modifying the natural relief. Buildings have different heights and forms. Many applications, such as urban shadowing and solar exposure, flood modelling, and three-dimensional visibility, are becoming

more common. Nevertheless, the transition from two-dimensional to three-dimensional representations of the urban landscape requires careful consideration of the costs and benefits of increasing complexity.

Bearing in mind the explicit focus of the process typological approach on the three dimensional aspects of the urban landscape, notably on buildings, what can point clouds offer to this school of morphological thought? How can point clouds deal with the distinction between visual form and structural form and with the process of formation grounded on the concept of type?

In science, but more particularly in the science of urban form, the availability of data is a major concern. While the limited use of quantitative three-dimensional geographical data in urban morphology can be explained by data limitations, an eventual increase in its use has to balance the needed resources for data gathering and processing with the potential for utilization in studies of urban form.

Point clouds offer urban morphologists a new perspective on cities. They capture the three-dimensional form of the urban landscape in a rigorous way, enabling the production of three-dimensional models of streets, neighbourhoods, cities and even countries. Future research should

help understanding of the data that urban morphologists extract from these models; how these data can be incorporated in existing morphological theories, concepts and methods; and the potential for the formation of new methods, concepts and theories in urban morphology.

References

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Plots, formalism and the limits of the minimal

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Brenda Scheer's viewpoint (Scheer, 2018) raises a number of issues central to urban morphology as a discipline. It builds on her previous significant contributions over many years (see, for example, Scheer, 2001, 2016). Some of the points raised are specific to my previous paper (Kropf, 2018) while others are more general and relevant to the discipline as a whole.

The central focus of the debate is the plot or lot but extends to the way we define elements of urban form in urban morphology. More specifically, the issues appear to be: 1) whether 'form' only refers to physical objects or whether the term can be seen to encompass intangible aspects; 2) whether control (such as ownership and regulation) is an aspect of urban form; and 3) whether the term 'plot' refers

to both an element of control and an element of physical built form.

As argued previously in this journal (Kropf, 2009), I follow Kevin Lynch (1984, pp. 48, 345–58) in saying that urban form has multiple aspects, both tangible and intangible, one of which is control. I am fairly sure that Scheer and I agree on that point.

I think we also agree on the wider point that elements of one aspect should not be defined in terms of another. Most pointedly, we agree that a plot, *as an element of physical built form*, should not be defined in terms of use or in terms of control such as property ownership.

Where I become less certain is where I have ended up disagreeing and conflating the two. To