Chapter 16
Algorithms-Aided Sustainable Urban Design:
Geometric and Parametric Tools for Transit-Oriented Development

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ABSTRACT

This chapter is part of a research on algorithmic approaches to sustainable urban design. It focuses on the use of computational tools to provide quick and dynamic assessment while planning and discussing interventions in urban areas. The objective is to address the use of algorithmic systems to formulate effective strategies for sustainable urban projects, guided by Transit Oriented Development (TOD) principles. TOD is an urban development model that considers geometric principles and measurable parameters for designing sustainable cities. It advocates the creation of mixed-use neighborhoods within walking distance to a variety of transportation options and amenities, so that basic urban needs are easily accessible. In addition to establish a theoretical framework connecting algorithmic-parametric concepts and geometrical features of TOD, this chapter describes an experimental employment of algorithmic models working on TOD principles, in order to enhance a systematic and dynamic testing and subsequent argumentation for sustainable urban projects.

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INTRODUCTION

The application of mathematical models as a mechanism for optimization of urban development has long since been studied and proposed by experts. Dantzig and Saaty (1973) advocated the use of mathematical models to evaluate improvements in urban development by optimizing infrastructure in high-density neighborhoods. Salingaros (2010), in turn, demonstrates possibilities of generating urban morphologies from the application of planning legislation as generative code.

On the other hand, Mitchell (1991) understands that the contribution of computational revolution to the design process lies on the replacement of the human intellectual skill by machines that processes information. However, Oxman (2006) considers digital design the one in which the process of shaping the object is highly mediated by digital technology and, yet, the role of the designer remains central. Thus, it is important to consider the process, as it is to highlight it in the designer's leading role for decision-making.

To Menges (2006) design as subject is a manner of abstracting and assessing possible alternatives of settings, scenarios and concretions without necessarily achieving each possible solution physically. In this sense, relating parametric and algorithmic resources, and their capability to dynamically manage data, can support an interactive design approach. These tools have the necessary flexibility to explore numerous possibilities, allowing the comparison of different options and the choice of the most suitable solutions, according to the adopted performance parameters and criteria.

Computational design has become widely accepted in architecture. However, few approaches use computational resources supporting urban design, in order to develop adaptable masterplans. The algorithmic thinking applied to urban design has it fundamentals on the argument that parametric systems enable the prompt generation of different alternatives of composition from the simple alteration of values of one or more specific parameters, allowing obtaining different scenarios that can be assessed in a way to steer the decision-making. It is a panorama open to interdisciplinarity, to collaborative work, due to the fact that modifications can be easily made and so can evaluations, all this leading to better performance.

The parametric paradigm applied to urban design constitutes a new possibility that is based upon the utilization of patterns and design rules. The aim of this approach is to facilitate the dialogue between different participants of design process, allowing the elaboration of flexible proposals. Parametric systems introduce the possibility of constantly altering models during the whole design process, allowing the generation and testing of several versions within a controlled design environment, just by changing values of a specific parameter. For that, parametric software have become a vital tool since they make possible the visualization of either the ensemble of a project or the intervention and updating of the parts. Computational design and algorithmic-parametric procedures are contributing to change design methods, as they provide ways of exploring multiple solutions – including optimization tools to indicate solutions with better performance.

In the meanwhile, the matter of sustainability currently assumes a central role in the observation of contemporary urban centers and in the dimensions of its development. The socio-environmental picture that characterizes contemporary societies illustrates that the impact of humankind on the environment is becoming more complex, both quantitatively and qualitatively.

It is a fact that cities no longer encompass the current development model. It is vital to think about self-sustainable cities development by means of integrating urban planning, urban design and architecture. In this context, it becomes highly recommended, apart from a new culture of cities, the existence