

# Optimization of settlement layout based on parametric generation

Song Jinghua<sup>a</sup>, Xie Xinqin<sup>\*</sup> and Yu Yang<sup>b</sup>

*School of Urban Design, Wuhan University, China*

*(Received November 17, 2017, Revised January 12, 2018, Accepted January 19, 2018)*

**Abstract.** Design of settlement space is a complicated process while reasonable spatial layout bears great significance on the development and resource allocation of a settlement. The study proposes a weighted L-system generation algorithm based on CA (Cellular Automaton) model which tags the spatial attributes of cells through changes in their state during the evolution of CA and thus identifies the spatial growth mode of a settlement. The entrance area of the Caidian Botanical and Animal Garden is used as a case study for the model. A design method is proposed which starts from the internal logics of spatial generation, explores possibility of spatial rules and realizes the quantitative analysis and dynamic control of the design process. Taking a top-down approach, the design method takes into account the site information, studies the spatial generation mechanism of settlements and further presents an engine for the generation of multiple layout proposals based on different rules. An optimal solution is acquired using GA (Genetic Algorithm) which generates a settlement spatial layout carrying site information and dynamically linked to the surrounding environment. The study aims to propose a design method to optimize the spatial layout of the complex settlement system based on parametric generation.

**Keywords:** parametric design; Cellular Automaton; L-system; genetic algorithm; layout optimization

---

## 1. Introduction

Since the middle of the 20th century, the development of complicated science theories has set humanity free of the constraints of classic science and we have started to transcend the boundary of natural geometry from design to manufacturing. Jencks (2007) has studied “When sciences based on non-linear mathematical relations begin to replace classic Newton mechanics and become the fundamentals for people’s understanding of nature or the cosmos; and when theories such as chaos and self-organizing are used to explain the contradiction between cosmic expansion and species evolution, some basic concepts of people’s thinking on form design were shaken, therefore, the emergence of architectural form full of complexity becomes inevitable”, French philosopher Gilles Louis René Deleuze also argues, described by Yu (2011) and Leng (2011), that the fundamental attribute of event is generation which is a dynamic movement; the concepts from different fields maintain differences and communications which give birth to another field, i.e.,

---

\*Corresponding author, Master student, E-mail: 380550442@qq.com

<sup>a</sup> Ph.D., E-mail: 113318088@qq.com

<sup>b</sup> Ph.D., E-mail: yang.yu@me.com

























- Charles Jencks (2007), *Critical Modernism: Where is Post-Modernism Going What is Post-Modernism*, Academy Press.
- Leng, T. (2011), *Digital architectural design guide by complexity theory*, South China University of Technology, 140-142.
- Li, X. (2009), *Research and application of particle swarm optimization based on simulated annealing method in the urban layout of the land space*, Shandong Normal University, 11-13.
- Li, X. and Xu, W. (2015), "The application of algorithm and digital modeling techniques in architectural design", *New Architecture*, (5), 10-14.
- Lin, Q. (2013), "Architectural fractal generating based on 3D IFS methodology", *World Architecture*, (9), 106-109.
- Lin, Q. (2015), "Particle system and fractal movement", *Urbanism and Architecture*, 1-3.
- Luo, Y. (2015), *Optimization research of the parametric architecture based on optimizing method*, Southwest Jiaotong University, 55-68.
- Neil, L. (2009), "Swarm Urbanism", *World Architecture*, 1-2.
- Shen, J. (2012), *Research on methods of using technical analysis in grasshopper for green building design*, South China University of Technology, 41-49.
- Song, J., Zhao, B., Xiong, Y. and Guo, X. (2009), "Quantitative analysis of contributing factors in settlement generation", *J. Civil. Architect. Environ. Eng.*, **31**(2), 110-115.
- Xu, W. (2012), "Parametric design and generating by algorithm", *Urban Environ. Des.*, (1), 250-253.
- Yu, H. (2011), *Parametric Urban Design Based on Rhinoceros: A Case Study of Jixian Urban Center*.

TK