ALGOGRAM: AUTOMATED DIAGRAMS
FOR AN ARCHITECTURAL DESIGN STUDIO

CHRISTIANE M HERR AND JUSTYNA KARAKIEWICZ
University of Hong Kong, Hong Kong

Abstract. Building on a previously presented theoretical model for the integration of cellular automata into the design process, this paper introduces cellular automata as architectural design process support in the form of automated conceptual diagrams. This approach is the outcome of a series of successive software implementations, which are briefly outlined in terms of key features and observations made during their applications. The main part of the paper focuses on Algogram, the latest implementation, and its application in a second year design studio. The integrated concept of abstract representations, automated design exploration and individual interpretation is introduced as automated diagram.

1. Introduction

Among generative design strategies available to architectural computing, cellular automata (CA) have been described as an approach to support design by facilitating the generation of complex patterns (Chase 2005). CA were originally invented as mathematical games by Ulam (Schrandt and Ulam 1970) during the 1940s, and subsequently applied in a variety of fields to simulate complex processes based on the parallel and local interaction of elements. Previous applications of CA in architectural design have emphasized representations of form with cells depicting building volumes in a variety of ways. In the work of Coates et al. (1996), Krawczyk (2002) and Watanabe (2002), CA are used as generative tools to produce variations of building form (see Figure 1). The CA systems employed in these examples are based on uniform Cartesian grids with cubic cells, usually with very few cell states. Binary cell states such as “zero” and “one” or “dead” and “alive” are often translated into volumetric representations of matter or voids, resulting in three-dimensional forms that are then interpreted as building mass.
In the early, conceptual design stages, architects typically use visual representations such as sketches and diagrams, which relate more to concepts rather than objects (as discussed in Section 3 below). The direct association of CA-generated shapes with building form as in the examples cited above may thus be premature and limiting. The approach taken here builds upon a previously proposed extended CA model that has been adapted for architectural design purposes (Herr and Kvan 2007). It builds on the design process model proposed by Schön (1983), which is extended to include CA-based design support as part of the design move and offers CA support in form of optional, small-scale steps to an otherwise conventional design process. To explore the implications of this approach and further develop the underlying theoretical assumptions, a series of four software implementations were developed and tested with architecture students in design studio and workshop settings. It was not the purpose of this study to optimize a specific tool. Software implementations instead served as platforms to explore an approach to CA-based design processes and provided mainly qualitative data for this study. As a result of outcomes from the software implementations, this study progressed from an initial focus on CA as generators of building form to an emphasis on rule-based support of diagrammatic representations. This paper first briefly presents the explorative research process that led to the application of CA-based design support in form of automated diagrams. The final implementation, Algogram, and its application in a second year design studio are described in more detail in the second half of the paper.

2. Exploring CA-based Modeling of Form and Relationships

The first three implementations of the initially proposed extended CA model (Herr and Kvan 2007) indicated several shortcomings of the approach. They are briefly summarized below to provide the background of the subsequent development of Algogram, which discussed in more detail in Section 4 and 5. Following a previously published initial pilot study (see Herr and Kvan 2005), the first implementation was used by 23 graduate architecture