Chapter 34

Morphogenetic Paths between Geometrical Traces and Fabrication Issues: Geometrical Analysis and Digital Form Studies

Domenico D’Uva
Politecnico di Milano, Italy

ABSTRACT

The growing population of buildings in contemporary cities has pushed the search for innovative and recognizable architectures to unpredictable peaks, where the sole aim is to emerge from the skylines. The first and most intuitive way to reach this aspiration is an increase in complexity of shapes. Understanding how the complexity is reached is an aim worth to be explored, through the analysis of the geometry. The complexity of geometry is such to require specific tools to be properly studied and used. The aim of this work is the understanding of the parametric morphogenesis, meant as the process of form creation, of the 30 St. Mary Axe in London, by Norman Foster. In this sample, the shape characterization is analyzed, not as a complexity showing off in itself, but as a perceived result of a synergy between environmental, structural and functional issues through its geometrical analysis.

INTRODUCTION

The approach of designers with the relation between buildings and urban environment has always been a complex process, that implies a large number of factors. The growing population of buildings in contemporary metropolis has pushed the search for innovative and recognizable architectures to unpredictable peaks, where the sole aim is to emerge from the skylines (Rolando, 2013). The first and most intuitive way to reach this aspiration is an increase in complexity of shapes, (Migayrou & Mennan, 2003) but it seems of great interest to search for more methods. A way to understand how the complexity is reached is the analysis of the geometry (Forster, 2004). The complexity of this issue is such to require specific tools to be properly studied and managed. The tools used for this work are both analogical and digital.

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The geometry is the basic tool to comprehend form, while the generative design software are the tools to manage the complexity (J. Burry; M. Burry, 2012). The architectural morphogenesis coordinates both aspects, starting from conceptual schemes, which evolve into design drawings that undergo feasibility constraints driven by geometry. This work analyzes the workflow for the morphogenesis of the building, through a detailed geometrical comprehension of the steps that bring the architectural form from concept to the final built architecture. The morphogenesis is actuated through the shape drivers (Rolando, 2008), special elements that are essential to characterize the form of architecture.

The case study for the shape analysis is an iconic building as the 30 Swiss Re skyscraper designed by Norman Foster. In this sample, the shape characterization is analyzed, not as a complexity showing off in itself, but as a perceived result of a synergy between environmental, structural and functional issues through its geometrical analysis.

The shape driver in this building is circular arc, which is present both in plan, both in section. The geometrical process has been worked out through the location and definition of the arcs that make the complete profile of the building; then the analysis is focused on the plan definition. The problem of arcs definition viewed in section was converted into a logical combination of triangles of different sizes that represents radii. The revolving of final profile around an axis generates the envelope of the building, where circular based floors are represented. The specific angle of rotation of each floor generates a series of variations, by creating triangular shafts in plan, and, by producing an harmonic pattern in elevation. Then the geometric definitions of the building have been investigated with a selection of widely spread digital parametric tools. The draft algorithm starts from the planar definition of the skin section, which is eventually revolved around a central axis. This procedure generates an infinite series of continuous curves, parametrically controlled within a certain extent of degeneration. A more complex algorithm has been laid out with additional correction factors, giving a wider range of non-degenerate curves and a more precise control over shape definition. The corrections concern proportional ratios variations in the triangles that defines the main profile, and the insertion of an additional circle to the peak of the building. The result of this work is an algorithm which can precisely generate the curve that define the real building skin, together with infinite different solutions which can undergo more feasibility constraints and achieve a better efficiency.

**METHODOLOGY**

The exploration of the reasons and the ways to express complexity is a theme of interest that architects face continuously when they relate with built environment. The starting sense of amazement produced by the perception of the esthetic features of interesting buildings is something all designers feel and want to reproduce in their work. This effect is mainly produced by exterior components of the architecture, but it is important to go beyond external appearances to really comprehend the mechanism that rule the form of the building. This method has the aim of spoil and understand the complexity in architecture. It has been analyzed and developed by professor Rolando, who applied it through the years within the courses of representation in the faculty of Architecture in Politecnico di Milano.

The analysis of the building starts from small geometrical elements that make up architecture, fully understandable bits that build the shape of the whole edifice. This starting step is important to identify the composing elements and its binding rules. The different elements can be divided into supporting and supported. The most important are the supporting ones, endowed with a double function; support