Geometrical Transformation:
A Method for the Creation of Form in Contemporary Architecture

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Abstract

The relation between mathematics and architecture is crucial in today's architecture. Architects have referred to a large number of mathematical concepts and theories in their architectural designs and theoretical writings. In order to create a new architectural form which presents the characteristics of today's world, they focus on architectural form and the process of form-creation. It is common to refer to 'geometrical transformation' as a method for the generation of form. Thus, this paper aims to explore how the mathematical concepts are utilized in the creation of architectural form. It focuses on 'geometrical transformation' as a method for the generation of architectural form.

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In recent years, architects have inclined towards the recent developments in mathematics besides physics and biology. This is strongly related to their close interest in the problems of form. Although they possess spatial, programmatic, structural anxieties in their design processes, the main theme is architectural form. A number of references such as fractal geometry, non-linear geometry, and topological geometry are used in architecture as a tool for the creation of the new formal expression of the contemporary world. Their struggles are to present dynamic, chaotic, multiple characters of contemporary urban life. Within the direction of this aim, they have increasingly referred to new geometries which are not defined in Cartesian System and by Euclidean parameters as a source. Concepts and theories of mathematics are utilized to characterize architectural end-products. They are also used as a method in the creation of architectural form.

In order to produce such complex geometrical forms, architects mostly refer to geometrical transformation as a method. It is common to functionalize the geometrical transformation as 'Folding' in today's architecture. Although the concept of folding is referred under the effect of Deleuzian thinking by some designers, in practice, their understanding of the concept mainly emerged as a tool in the creation of form. So, this paper is also in struggle to show this main interest in contemporary architectural design processes.

Peter Eisenman's Rebstock Park project is an example to which architects, theorists, critics mostly apply to justify architects' interest in new forms based on new geometries. For example, architectural theorist Jeffrey Kipnis says that; "both the Rebstock Park and the Alteka Tower are driven more by folding as a process than by any particular fold as a diagram"[1]. Eisenman clearly confirms that the concept of fold becomes the basic logic for the projects of Rebstock Master Plan, Alteka Office Building, and Center for The Arts.[2] He shortly defines the notion of fold in terms of geometry as 'the crossing or an extension

from a point'[3]. He asserts that the points that are fixed by X, Y and Z coordinates at the beginning condition have not same connections with each other at the end of the folding. Eisenman uses two orthogonal / Cartesian grids. He connects each orthogonal grid by folding. It is a process defined as the geometrical transformation of the orthogonal grids.

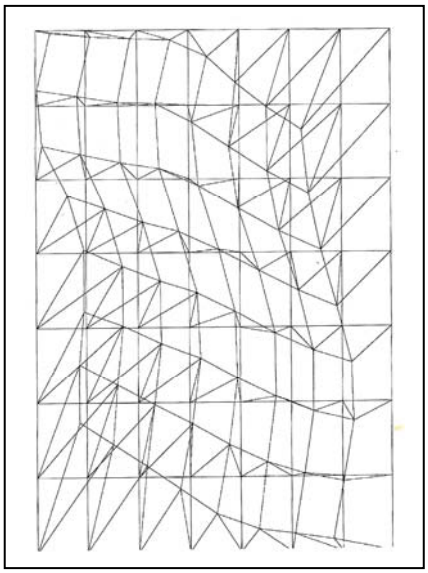

Figure 1. The geometrical transformation diagram of Peter Eisenman's Rebstock Project
(Source: A.Picon & A.Ponte (eds.), *Architecture and The Sciences: Exchanging Metaphors*, p: 339

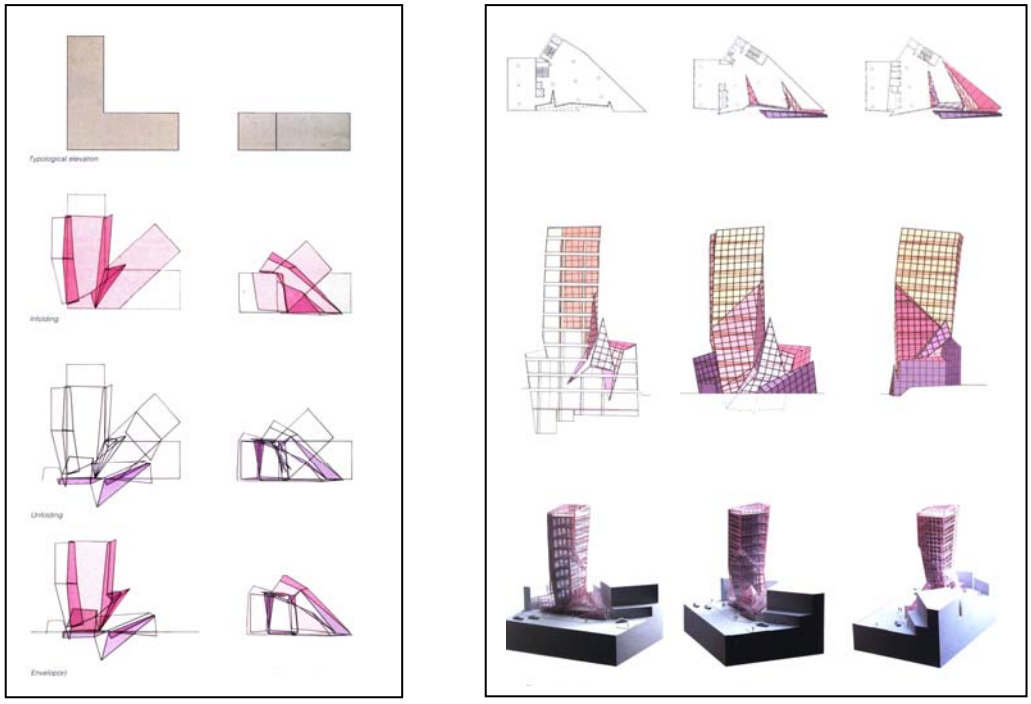

Figure 2. The geometrical transformation diagram of Peter Eisenman's Alteka Office Building
(Source: G. Lynn (ed), Architectural Design, no:102, (London: Academy Group Ltd, 1993), pp: 28-29

Architect Patrik Schumacher emphasizes the definitive role of the method of geometrical transformation in the form-creating process of the redesign of Heathrow Terminal project. The form-creating process is explained by folding and the end-form characterized by the 3d lattice;

> "In terms of geometry and material the research started with simple folded surfaces and evolved into a highly complex 3d lattice…For our studies we began by simply constructing a model of the molecular structure of these materials at an observable scale. These models were build up from simple base modules that captured the capacity of bi-axial expansion. Each module can expand to 1.5 the normal scale. Those modules were then arrayed into lattices."[4]

This attitude is clearly seen in other projects of Zaha Hadid Architects. For example, Centre for Contemporary Art project was initially composed of 2D splines and lifted into 3D.[5] Geometries derived from distorted symmetry, rhythm of folds, folded planes are crucially determinant in the form-creating process of Zaha Hadid Architects' works including Art Centre in Graz, Ice-storm installation for the Museum of Applied Arts in Vienna, The Temporary Guggenheim in Tokyo.

Alejandro Zaera-Polo explains the production of the overall form and of the construction of Yokohama International Port Terminal project through the method of folding. He writes that; "when faced with the construction of the building… we decided to use the same system that generated overall form, this time using the folds in the surface as a structural device. Subsequently the surface was folded at a different scale."[6]

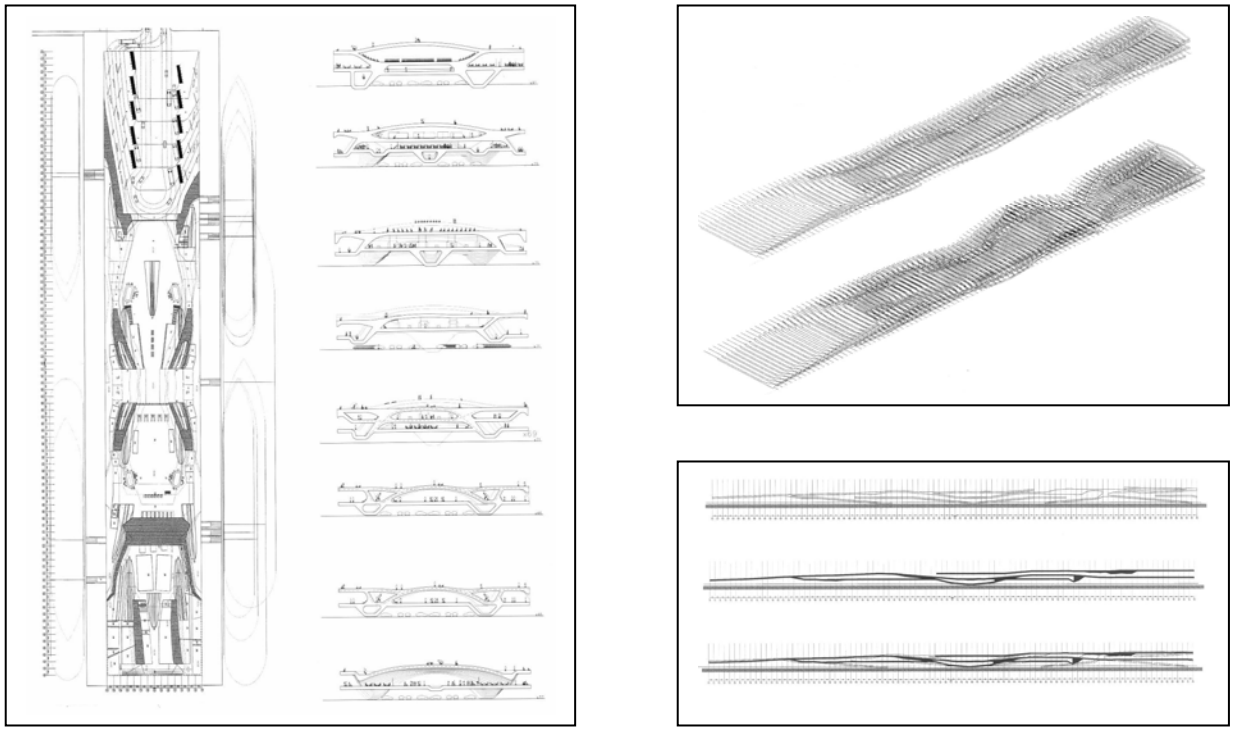

Figure 3. Yokohama International Port Terminal (Source: Architectural Design, vol.67., no. 5/6, May-June 1997), pp: 72-73

Architect Greg Lynn's definition of 'animate form' is also related to form-creating process. Architectural form is produced at the result of a continuous process of geometric transformation. [7]

The geometry of the fold is employed in the Nara Convention Hall project by Bahram Shirdel. The whole spatial and formal organization of the building is based on the continuous geometrical fold.[8]

The extension for the Victoria and Albert Museum in London designed by Daniel Libeskind is one of the architectural works that are mostly discussed about the relation between mathematics and the architectural form. The geometry of form of the building is spiral created by folding. The structure and cladding of the building designed by Cecil Balmond, is formed by the 'fractile'.[9] Architect and artist Alicia Imperilae explains the system of the cladding: "Balmond uses the tile as a surface strategy and conceives of the tiling as a 'shimmer' that runs up the spiral form. The tiling is based upon the fractal, in that the new 'fractiles' are self-similar at differing scales and combine in different scalar combinations in non-repeating patterns."[10]

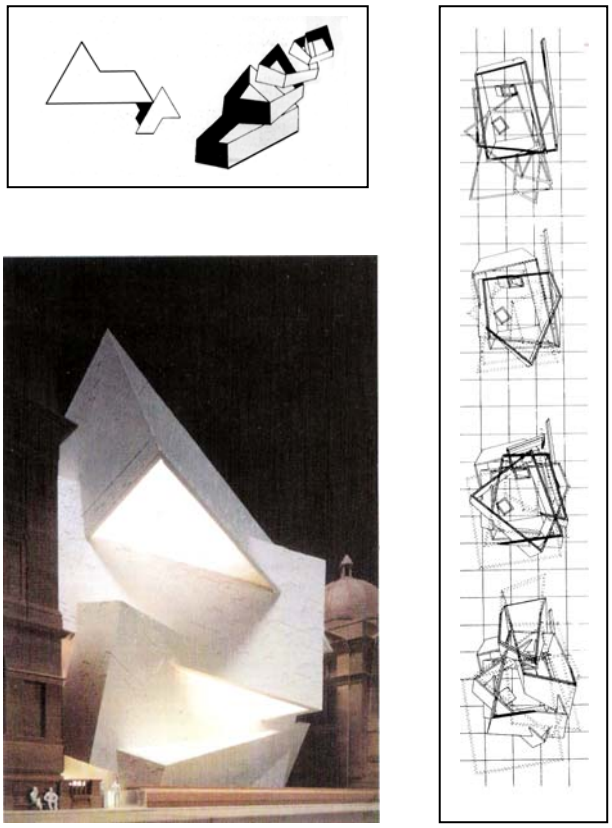

Figure 3. The geometrical transformation process of Daniel Libeskind's Victoria Albert Museum (Source: A. Imperiale, *New Flatness: Surface Tension in Digital Architecture*, pp: 28-29

Geometrical transformation has become the basic method for managing the process of form-creating in last ten years that is period in which architects basically focus on the problem of form. They have struggled to create new architectural forms. With this aim, they have been interested in the developments of mathematics. Architects are attracted by the new geometrical concepts and theories such as fractals,

folding, nonlinearity, complexity etc. In order to produce complex, dynamic, an exact formal orders, they utilized geometrical transformation as a method by computer technology.

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[3] P. Eisenman, *Folding in Time: The Singularity of Rebstock*, in G. Lynn (ed), ibid, p: 25.

[4] Patrik Schumacher, Responsive Environments – From Drawing to Scripting, (2004) http://www.patrikschumacher.com/AADRLDrawingScripting.html

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[9] D. Libeskind, The Victoria & Albert Museum Boilerhouse Extension, Architectural Design, vol: 67, no: 9/10, 1997, p:66.

[10] A. Imperiale, *New Flatness: Surface Tension in Digital Architecture*, Basel: Birkhäuser, 2000, p: 28

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