Chapter 3

Drawing Tensegrity, Discover Trans-Polyhedra:
From Polyhedra and Tessellation to Find New Architectural Forms

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ABSTRACT

This chapter brings attention to the concept of tensegrity and its applications, situating the design of these structures in the era of parametric architecture. The tensegrity structures present interesting peculiarities, for example, extreme lightness accompanied by surprising structural rigidity. The representation of the algorithm for the tensegrity structures comes both from the polyhedra and from the plane tessellations. Each tessellation or polyhedric form has its specific representation but through a single representative algorithm, it is possible to generate a tensegrity structure. This structure is composed of poles and cables; which are the corners of another polyhedron. The new solid perfectly reflects the description of a trans-polyhedra, that is a solid of transition between the initial solid and its dual. In this way, it is possible to affirm that trans-polyhedra represents the tensegrity, and even in the field of plane tessellation there is the same correspondence between the trans-tessellations and plain tensegrity.

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INTRODUCTION

In 387 BCE Plato founded an Academy in Athens, a gathering spot just outside the walls of Athens, where, over the doors to his academy, were the words “MEDEIS AGEOMETRETOS EISITO”, meaning, “Let no one destitute of geometry enter my doors”. Geometry, and his ideal representation, is at center of interests, because “[Geometry is] pursued for the sake of the knowledge of what eternally exists, and not of what comes for a moment into existence, and then perishes, must draw the soul towards truth and give the finishing touch to the philosophic spirit…” (Plato, Republic, Book VII).

Geometry is a path of abstraction and interpretation of the reality. And Plato, around ca. 350 BC, in his Timaeus, described the Platonic solids, equating the tetrahedron with the “element” fire, the cube with earth, the icosahedron with water, the octahedron with air, and the dodecahedron with the stuff of which the constellations and heavens were made (Cromwell, 1997, pp. 51-57, 66-70, 77-78). It is a stream that involve also architecture and any manmade fabrication, providing artists, architects and designers with sources of inspiration, representational means and structural verification (Bertol, 2015, pp. 39-45). And in these coordinates, Galileo Galilei’s poetic definition of the universe “written in the language of mathematics, and its characters are triangles, circles, and other geometrical figures” (Galilei, 1979).

Polyhedra represent an abstraction reference for ideal representation of the form, also because their symmetry and their properties guarantee the structural equilibrium. Both characters paradigmatic and exemplifying of the form are still fascinating today, moreover they still are an operative instrument for the construction of models. While the scientific method works first on the construction of the model, in the definition of the same concept it is ascribed the need of simplify and abstract, which is a condition that connotes the same form of polyhedrons. Polyhedra then represent exemplified forms though which it is possible to identify all characteristics and connotations. In this prospective the present research analyses a logic transformation of geometrical forms, just as the tensegrity representation is.

Defining Tensegrity structure without visual support is particularly difficult. The most suitable, and relatively recent definition, is the one attributed to Prof. Motro R. of Montpellier University “It’s called Tensegral a system in a stable self-equilibrated state comprising a discontinuous set of compressed components inside a continuum of tensioned components” (Motro, 2003).

Analyzing the definition, we can identify the “compressed components” as the poles present inside the system, while, the “tensioned components” are composed by the net of tie-rods that connect every tensioned element creating exactly the “continuum” (Leonardo).

It is possible to create tensegrity structures starting from the polyhedra and from the plane tessellations. This path represents a paradigmatical strategy able to show heuristic potentiality in cinematical morphogenesis. As Gombrich says, “while the problem of space and its representation in art has occupied the attention of art historians to an almost exaggerated degree, the corresponding problem of time and the representation of movement has been strangely neglected” (Gombrich, 1982). Workable solutions are almost certainly case specific and subject to continual evolution through exploration by the creators of these images.

The representation then showed both its autopsic potential as an analytic device that can evaluate movement and its value as a heuristic medium for the modeling of complex surfaces, because descriptive geometry, according to Gaspar Monge, has two unique fields of application: “the first is the exact representation of drawings of only two dimensions and those objects which have three and that are open to rigorous definition; the second is to deduce from that exact description of the bodies everything that