World Academy of Science, Engineering and Technology
International Journal of Architectural and Environmental Engineering
Vol:16, No:10, 2022

Snake Locomotion: From Sinusoidal Curves and Periodic Spiral Formations to the Design of a Polymorphic Surface

Authors : Ennios Eros Giogos, Nefeli Katsarou, Giota Mantziorou, Elena Panou, Nikolaos Kourniatis, Socratis Giannoudis

Abstract : In the context of the postgraduate course Productive Design, Department of Interior Architecture of the University of West Attica in Athens, under the guidance of Professors Nikolaos Koyrniatis and Socratis Giannoudis, kinetic mechanisms with parametric models were examined for their further application in the design of objects. In the first phase, the students studied a motion mechanism that they chose from daily experience and then analyzed its geometric structure in relation to the geometric transformations that exist. In the second phase, the students tried to design it through a parametric model in Grasshopper3d for Rhino algorithmic processor and plan the design of its application in an everyday object. For the project presented, our team began by studying the movement of living beings, specifically the snake. By studying the snake and the role that the environment has in its movement, four basic typologies were recognized: serpentine, concertina, sidewinding and rectilinear locomotion, as well as its ability to perform spiral formations. Most typologies are characterized by ripples, a series of sinusoidal curves. For the application of the snake movement in a polymorphic space divider, the use of a coil-type joint was studied. In the Grasshopper program, the simulation of the desired motion for the polymorphic surface was tested by applying a coil on a sinusoidal curve and a spiral curve. It was important throughout the process that the points corresponding to the nodes of the real object remain constant in number, as well as the distances between them and the elasticity of the construction had to be achieved through a modular movement of the coil and not some elastic element (material) at the nodes. Using mesh (repeating coil), the whole construction is transformed into a supporting body and combines functionality with aesthetics. The set of elements functions as a vertical spatial network, where each element participates in its coherence and stability. Depending on the positions of the elements in terms of the level of support, different perspectives are created in terms of the visual perception of the adjacent space. For the implementation of the model on the scale (1:3), (0.50m.x2.00m.), the load-bearing structure that was studied has aluminum rods for the basic pillars Φ6mm and Φ 2.50 mm, for the secondary columns. Filling elements and nodes are of similar material and were made of MDF surfaces. During the design process, four trapezoidal patterns were picketed, which function as filling elements, while in order to support their assembly, a different engraving facet was done. The nodes have holes that can be pierced by the rods, while their connection point with the patterns has a half-carved recess. The patterns have a corresponding recess. The nodes are of two different types depending on the column that passes through them. The patterns and knots were designed to be cut and engraved using a Laser Cutter and attached to the knots using glue. The parameters participate in the design as mechanisms that generate complex forms and structures through the repetition of constantly changing versions of the parts that compose the object.

Keywords : polymorphic, locomotion, sinusoidal curves, parametric
Conference Title : ICPDMS 2022 : International Conference on Parametric Design Modeling Strategies
Conference Location : Athens, Greece
Conference Dates : October 13-14, 2022