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Shapes that Click:

Bistability in Quad Combinatorics

Four-bar linkages – loops of four rigid bars joined by revolute hinges – are typically rigid in three dimensions, but in special cases they move. Between these extremes lie “shaky” linkages (infinitesimally flexible) and “snapping” linkages, which are the focus of this talk.

A snapping four-bar is bistable: it can be assembled in two distinct configurations and, when these are close enough, an external push forces a rapid snap from one to the other. The geometry of such mechanisms was laid out by W. Wunderlich in the 1970s, with important recent contributions by G. Nawratil, H. Stachel, and D. Huczala.

We show how to build arbitrarily large assemblies of snapping four-bars arranged with the combinatorics of a quad-net. Our approach blends classical constructions with tools from several areas: higher geometry (Study’s quadric model for rigid-body motions) and kinematics (discrete rolling motions) guarantee the existence of these structures.

Turning existence into practical designs requires careful control of hinge axes in space. To achieve feasible realizations, we draw on discrete differential geometry and the inverse of Whiteley averaging, producing surface-like bistable structures that snap around minimal surfaces. We will present 3D-printed models that exhibit the predicted behavior, including a snapping object with the combinatorics of a cube that extends an early example by Wunderlich.