Design of hinged 3D auxetic mechanisms

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Auxetics are a type of metamaterial — a conventional material that has been patterned at an intermediate length scale to generate bulk material properties — that expand in all directions when exposed to uniaxial strain. Two dimensional auxetics have been studied for several decades in systems, from origami to 3D prints to linkages. Here, we propose two design schemes for realizable 3D printed three-dimensional auxetics based upon hinges. The first is a set of Lego-like interchangeable modules that combine counterrotating regular polygons with scissor mechanisms. This is guaranteed to have a one dimensional configuration space because it can be reduced to series of one degree of freedom Sarrus linkages. The second mechanism is based upon a branched cover over the simple two arm scissor mechanism which adds stability and enables force to be transferred around corners. Joint work with Henry Segerman.