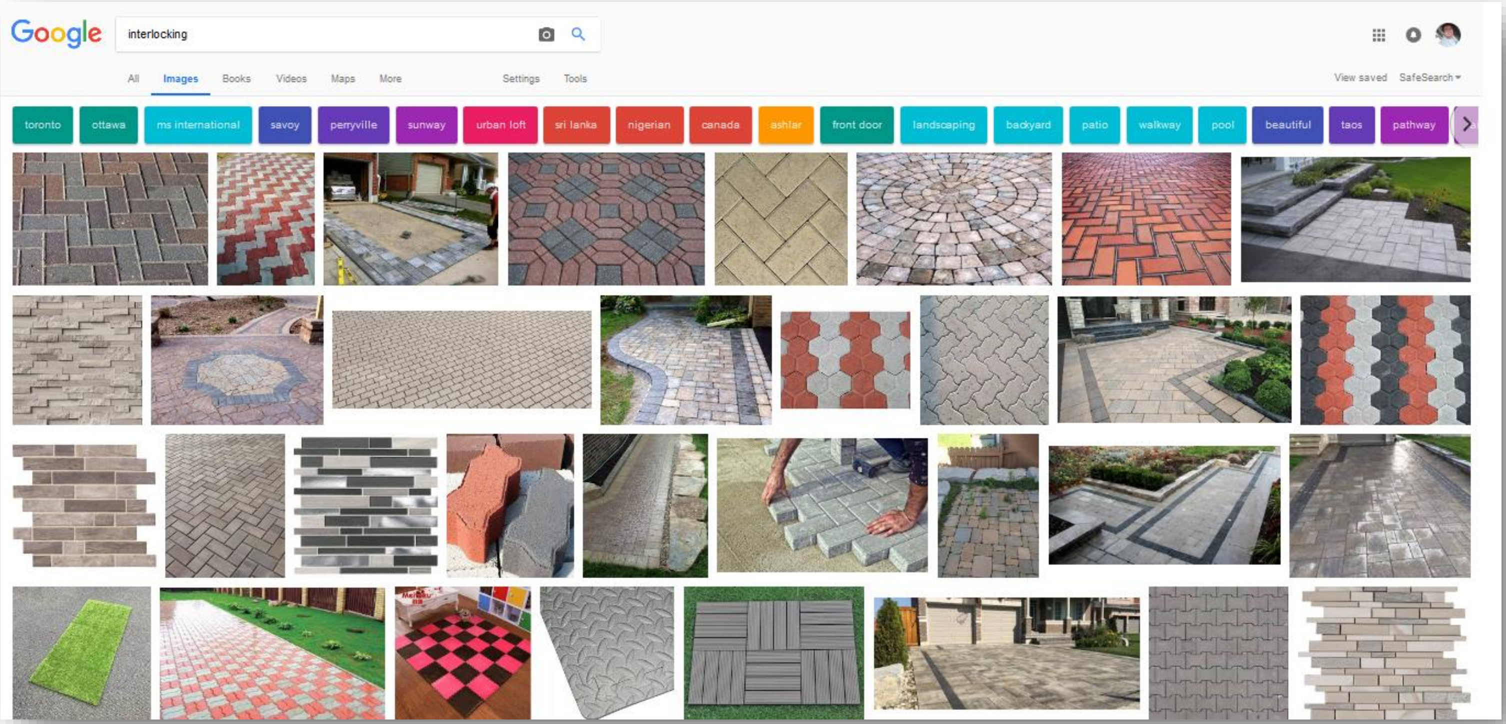
Convex Interlocking Generation Based on Polyhedron Midsection Evolution

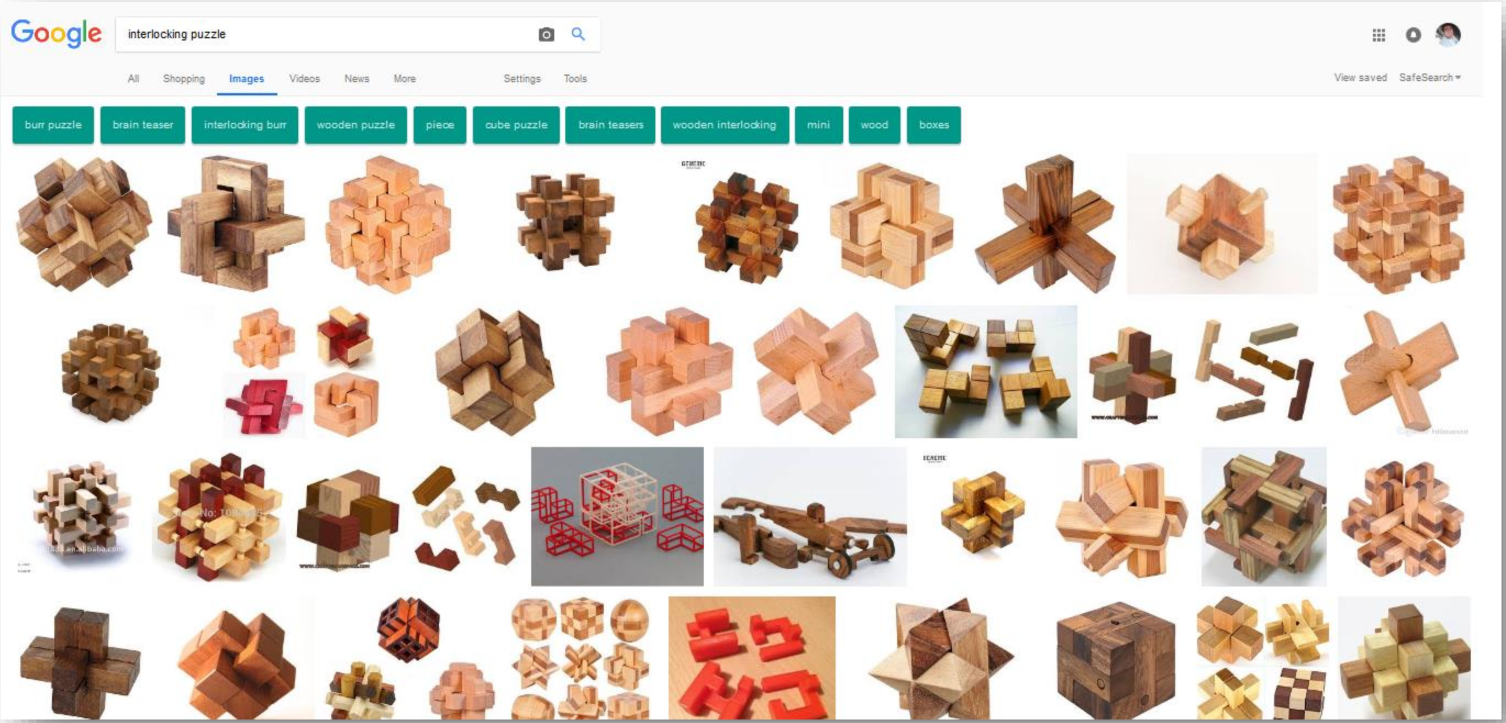
By: Andres Bejarano

Advisor: Christoph Hoffmann

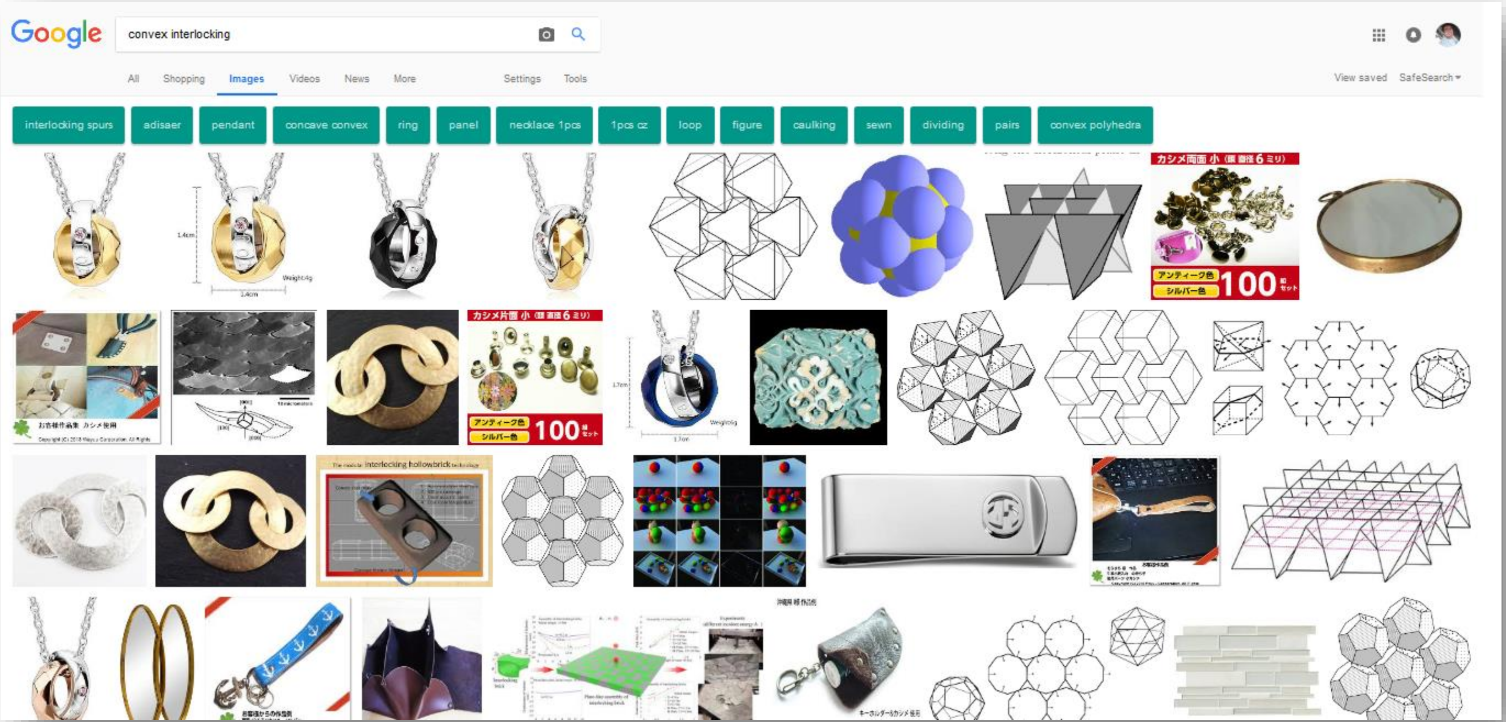
Outline



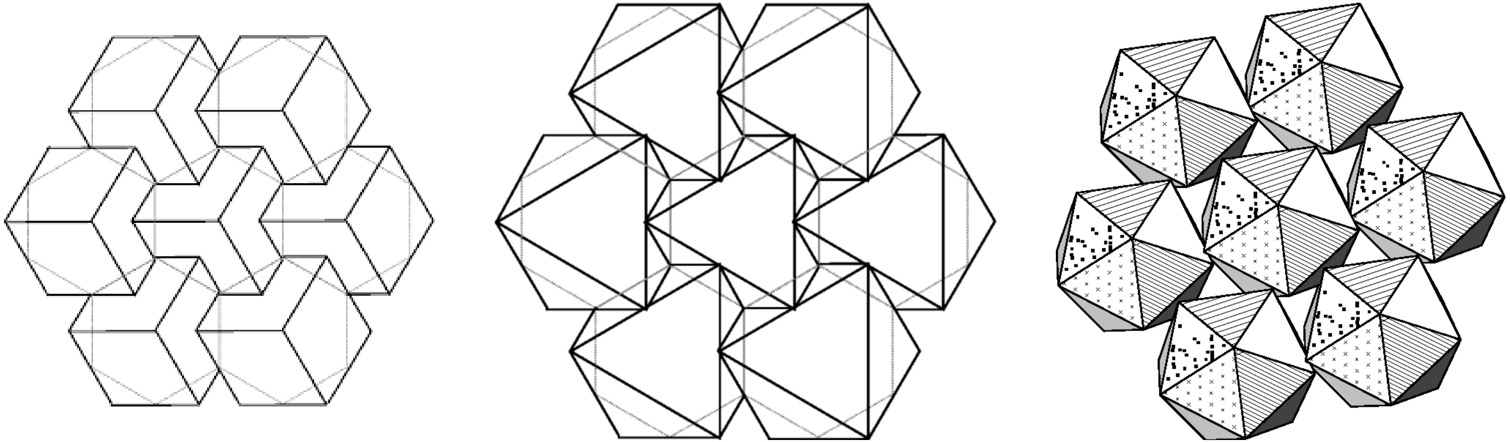
Interlocking according to Google Images



Interlocking puzzles according to Google Images



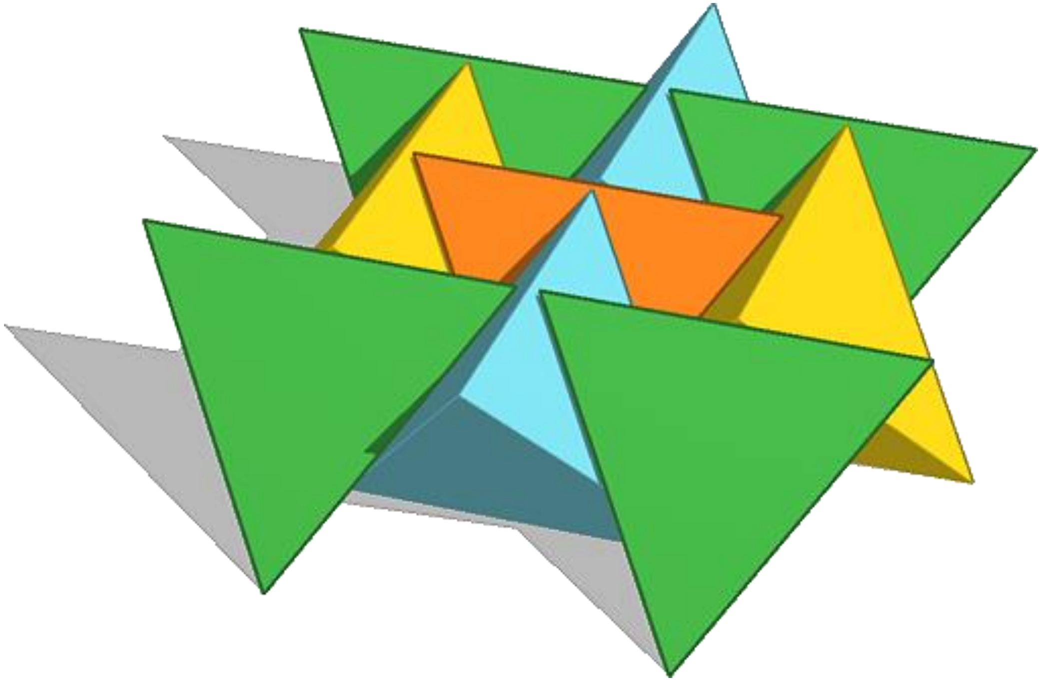
Convex Interlocking according to Google Images



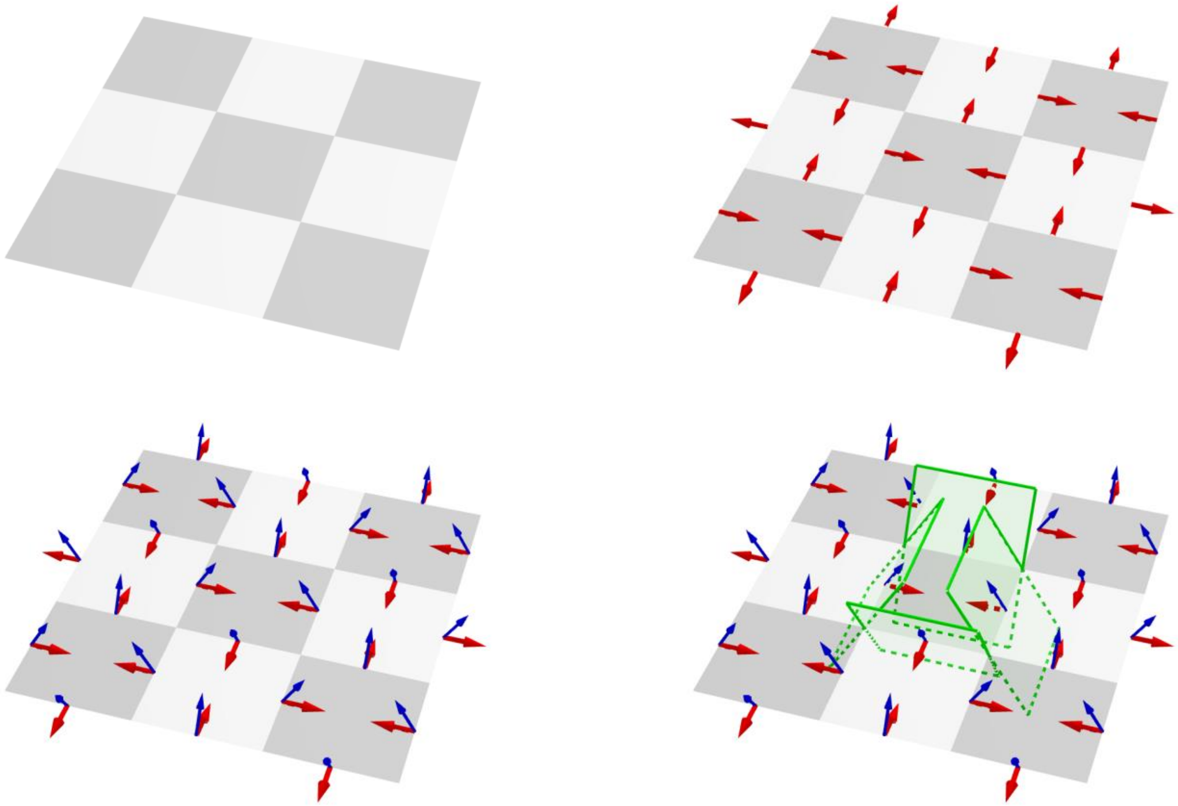
Let’s focus on this convex interlocking!

"*Interlocking is achieved if in every row of elements one can identify two sections normal to the assembly plane such that while one section ensures **kinematic constraint in one direction** (normal to the assembly plane), the other section provides the same elements with **constraint in the opposite direction**.*

(Kanel-Belov et al., 2008)



Convex Interlocking: A primer



Convex Interlocking: Generation

Why it matters?

Angles

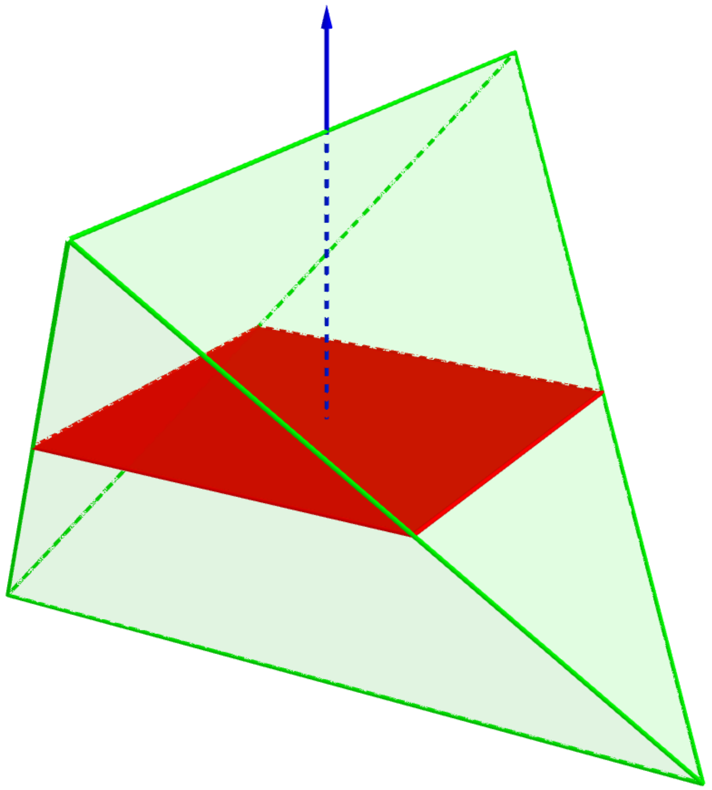
Set the directions and angles on the edges. Define the tilting planes and intersect them for the piece vertices. Then define the piece. If pieces overlap then repeat with different angles and repeat.

Flatland

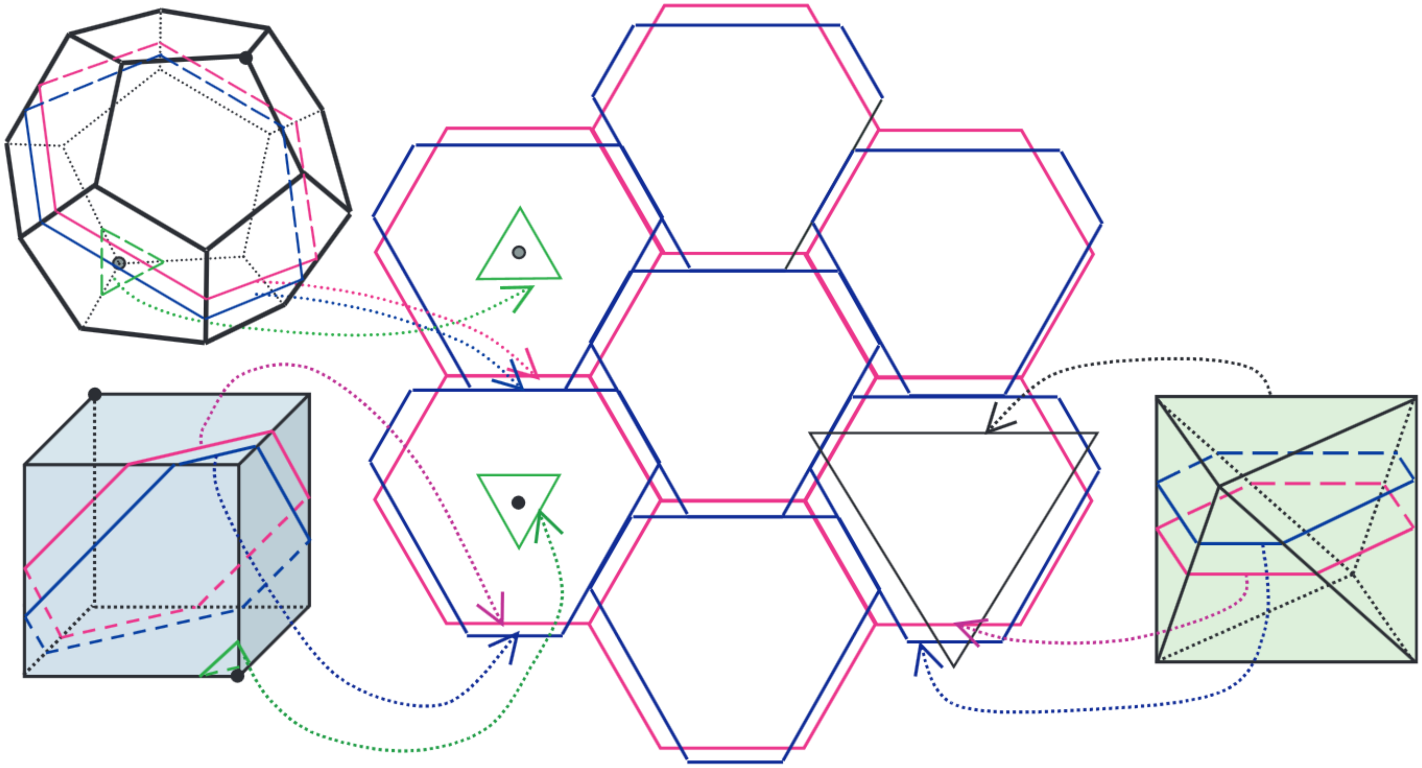
Research on mechanical properties of convex configurations are on the rise. However, al of them are based on planar surfaces.

Unknown

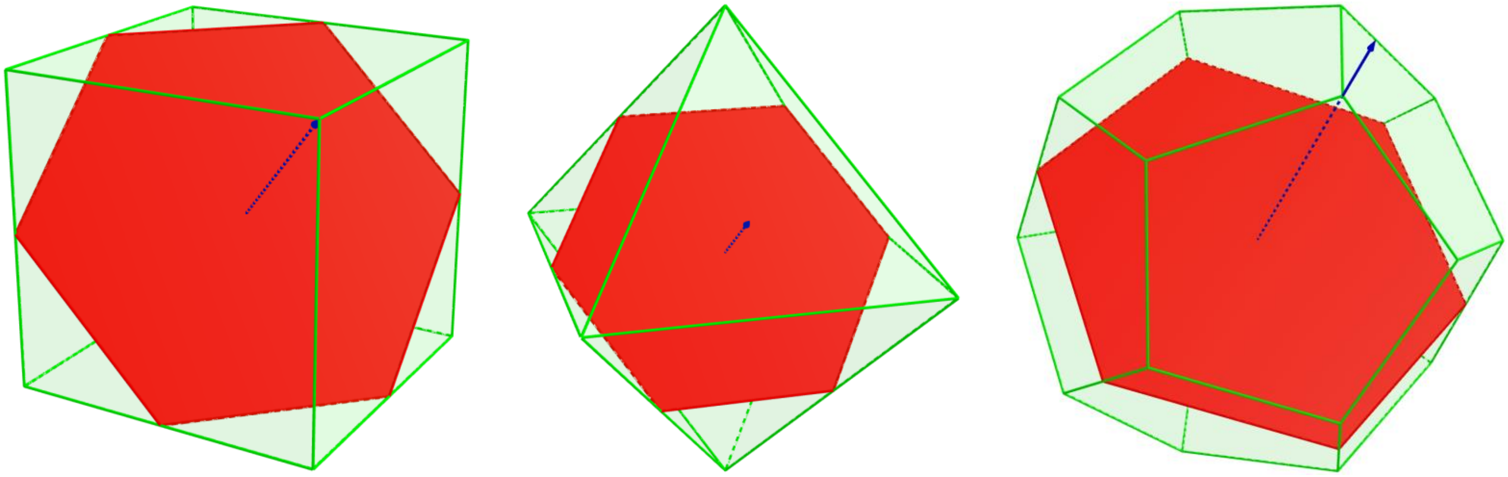
A few people have tried a generalization of the concept into 3D geometric domains. Mechanical properties of configuration based on other geometric shapes are unknown.



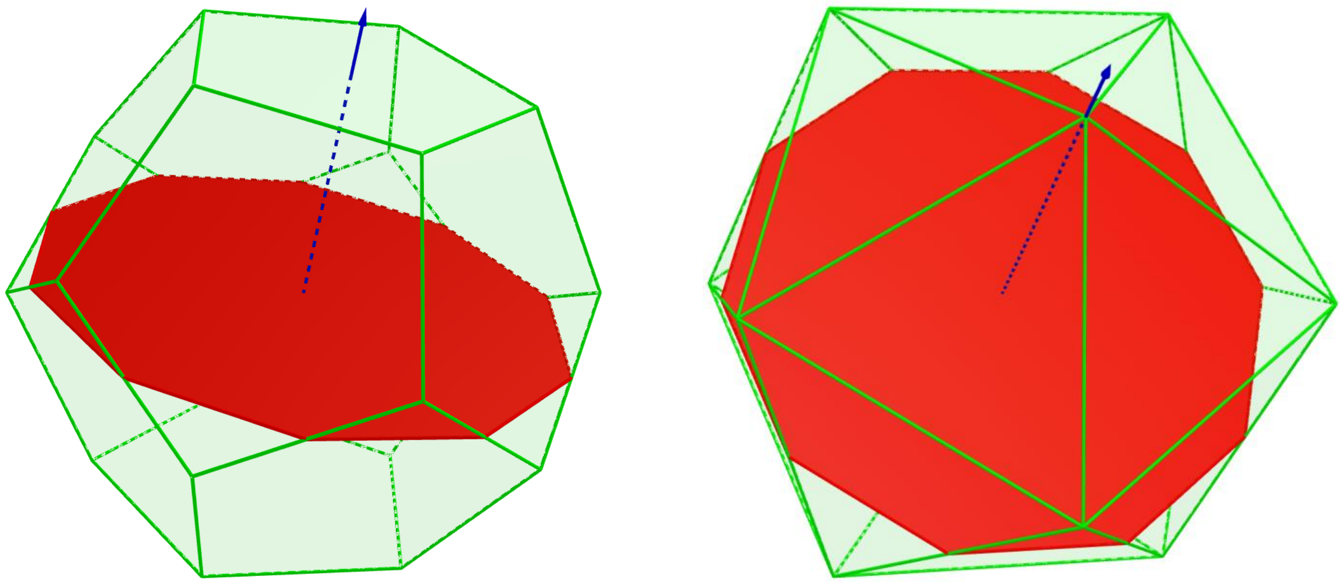
It works thanks to evolution: Starting with a square



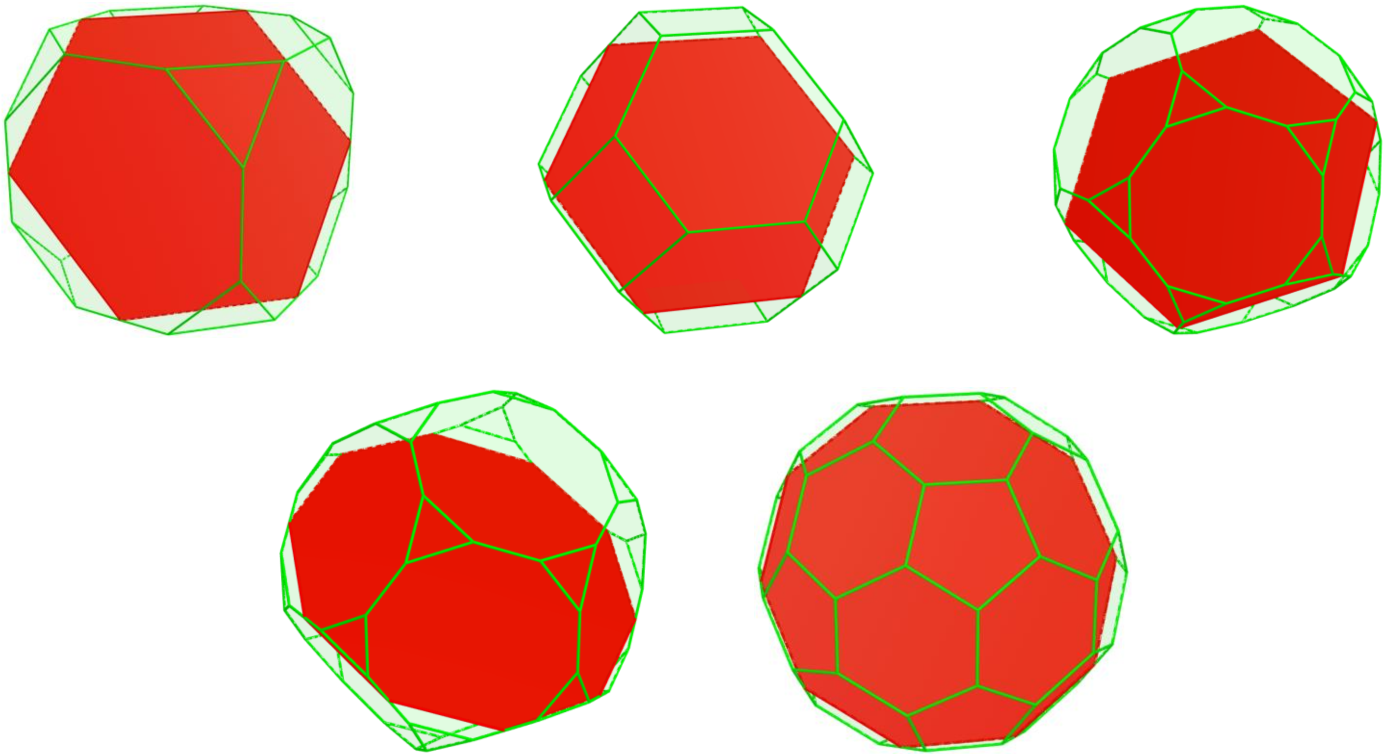
It works thanks to evolution: Starting with a hexagon



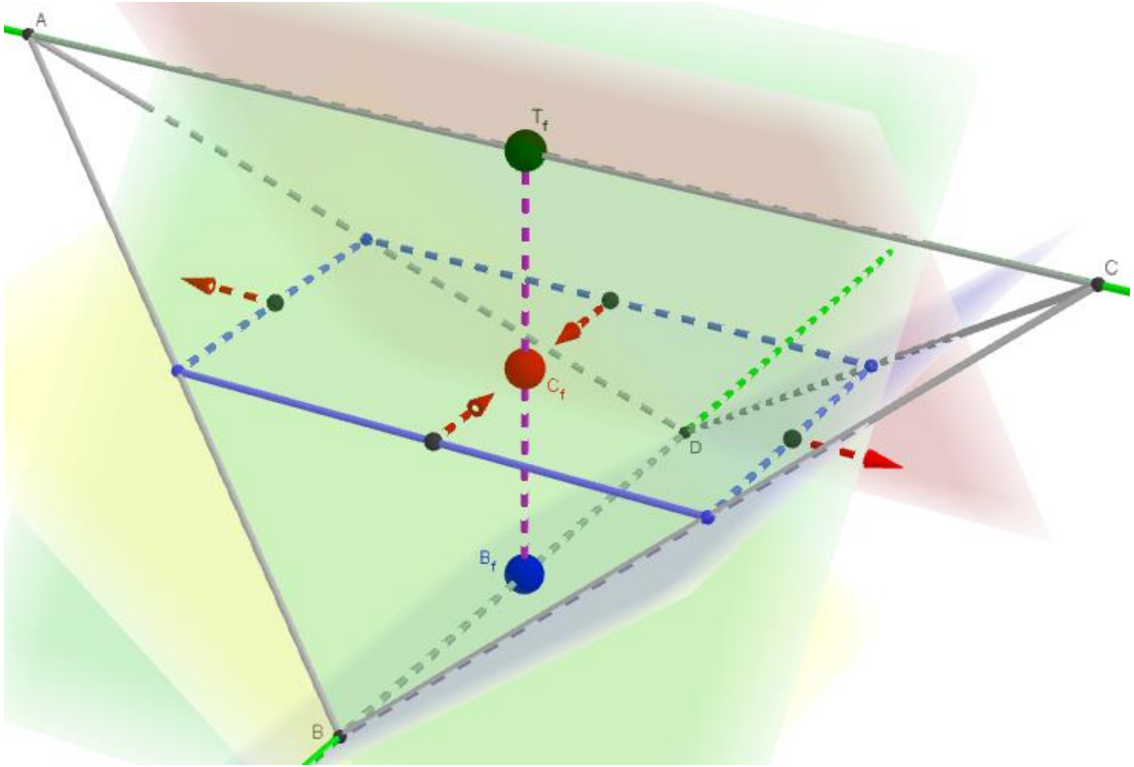
It works thanks to evolution: Starting with a hexagon



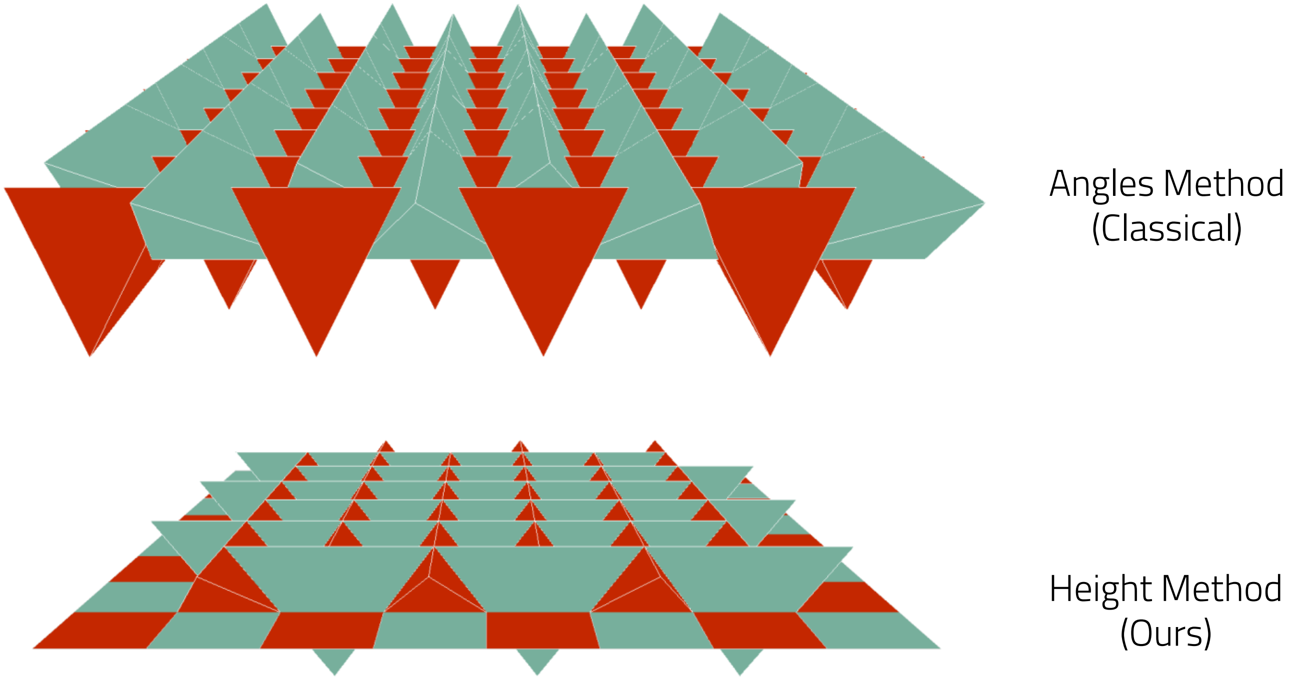
It works thanks to evolution: Starting with a decagon



It works thanks to evolution: Works with some Archimedean solids



Our approach: Use a height parameter and reach the evolution



Angles are not calculated, still valid configurations are obtained

Before the demo...

Missing content

Formal description and technicalities have been avoided due to time constraint.

Applications

Automobile industry and US army are experimenting with the concept. Architects work on aesthetics, Engineers focus on mechanical properties.

Now to the demo

Current work

- Working on the formal explanation of the convex interlocking behavior.
- A third generation method based on top/bottom section grids. Generated pieces could be quasiconvex.
- A fourth generation method based on multi-stepped polygon evolution.
- The reason for multiple generation methods is the mechanical properties displayed by different piece shapes.
- Applications (architecture, arts, engineering)

Thanks!