Design and Prototyping of a 3D Shape Changing Mechanism
Design and Prototyping of a Planar Shape Changing Mechanism with Layering Issues
Joshua Nieman
Advisors: Dr. Andrew Murray & Dr. David Myszka

**Background**

**Shape Change**
Shape-changing mechanisms are composed of a set of rigid links and revolute joints and have the capacity to morph between shapes when actuated.

**Layering Issues**
Layering is the ordering of links based on the planes they reside in.
- With little study to how to layer, there are too many possibly outcomes to study.
- This is a major problem in shape change mechanisms since they are designed as 2D systems and converting to 3D mechanisms is complex.

**Prototype Challenges**
- Low profile connections necessary to reduce total weight: Retaining rings implemented.
- Rigid material required to distribute forces between layers: Acrylic was chosen since rigid and visually appealing.
- High precision hole location and link sizes are required: All links were laser cut.

**Mechanism Complexity Increases with Number of Segments**

<table>
<thead>
<tr>
<th>4 Segment</th>
<th>5 Segment</th>
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<tbody>
<tr>
<td>More segments make a closer profile match but creates more links and makes mechanism more complex and much harder to layer</td>
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**Prototypes**

- Material was not rigid enough which caused twisting in multi-plane connections during actuation.

**Link Layering Heuristics Created**

- Prioritized layering:
  - Important links were prioritized to be in top, since they were required to be seen.
  - Other links were then layered based on their connection to important links.

- Layering focus centered on region and phase:
  - Layering is simplest to overcome when in 1 stationary position.
  - The most complex region during the entire cycle was layered first.
  - Then studying the movement of the mechanism, the collisions altered the layering.

- Multi-plane connections:
  - Connections allowing connected links to not be required to reside on adjacent planes.

Final fully layered mechanism side view.