

Single-Sheet Polyhedra

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Single-Sheet Polyhedra



Origins and Antecedents

The waterbomb, boxes, ornaments, 3-D stars

The Platonic Solids

- Origami for the Connoisseur, Kasahara & Takahama

Pyramids, prisms and compound shapes

- John Montroll has a lot of books on this

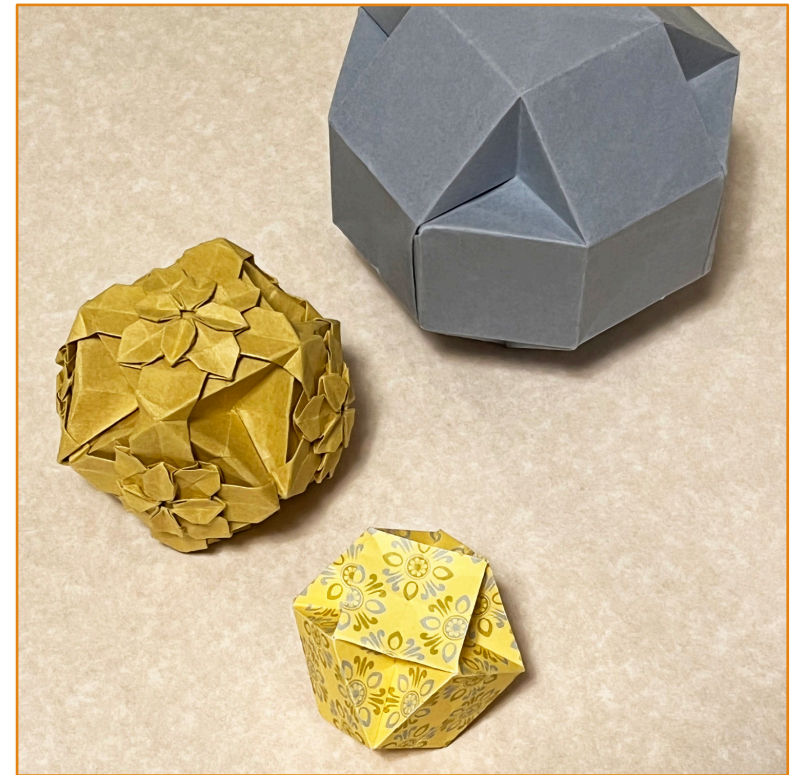


Basic Geometries – Square Grid

Most familiar, easiest to get started with

Good for models in the cube family

An excellent choice for tessellations

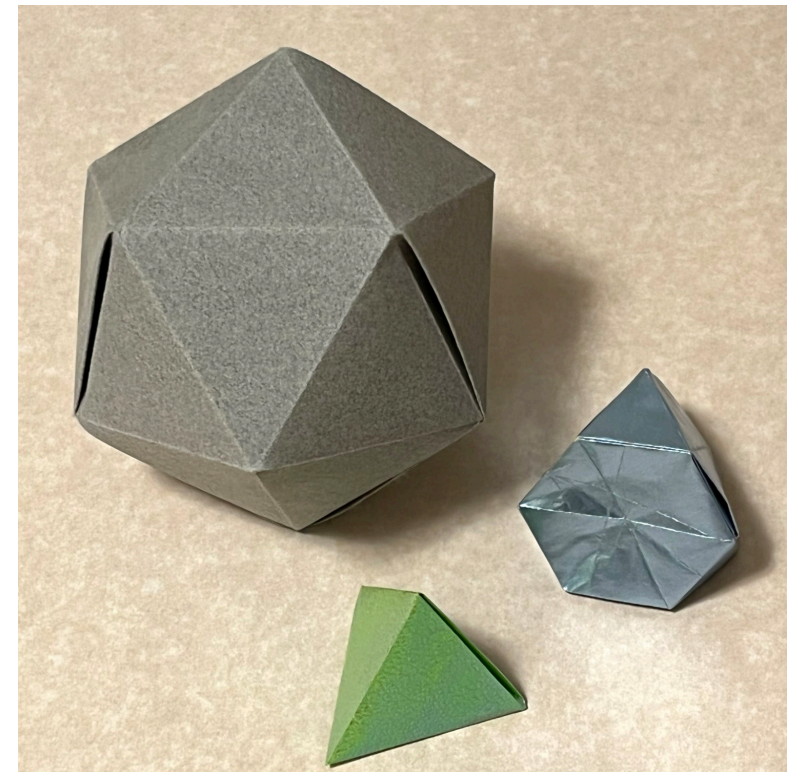


Basic Geometries – Triangle Grid

Tetrahedron, Octahedron & Icosahedron

Tetrahedron & Octahedron together can tile 3-D space

Icosahedron is different

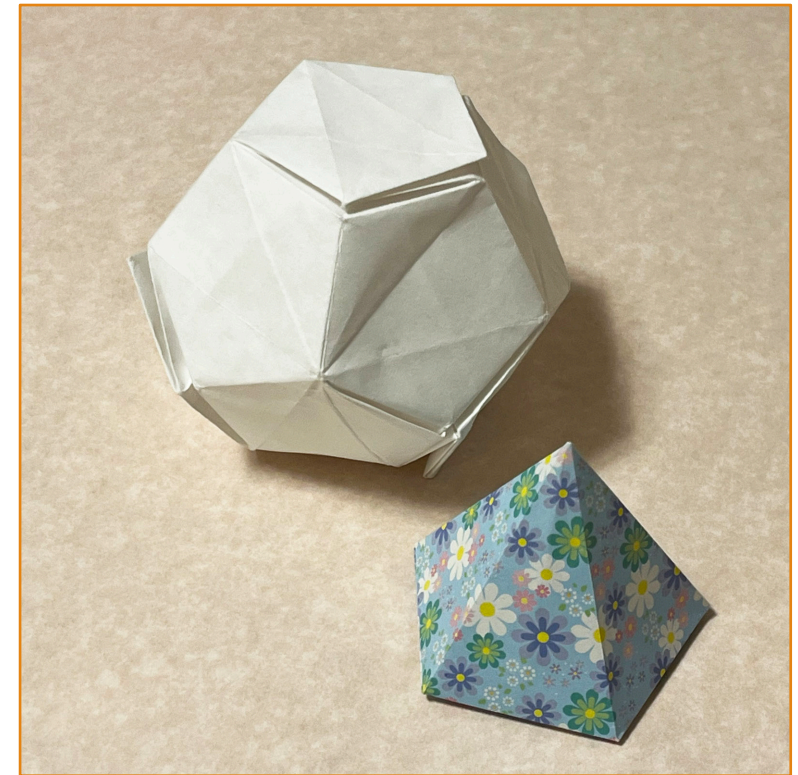


Basic Geometries - Pentagon Grid

You can't actually make a grid of pentagons

But you get some really cool triangles and rhombi

Fivefold geometry is very hard – but very fun!



Other Geometries

Mixed polygons – Archimedean, compound, etc.

- Need to decide on base geometry for overall plan

Unusual triangles and rhombi

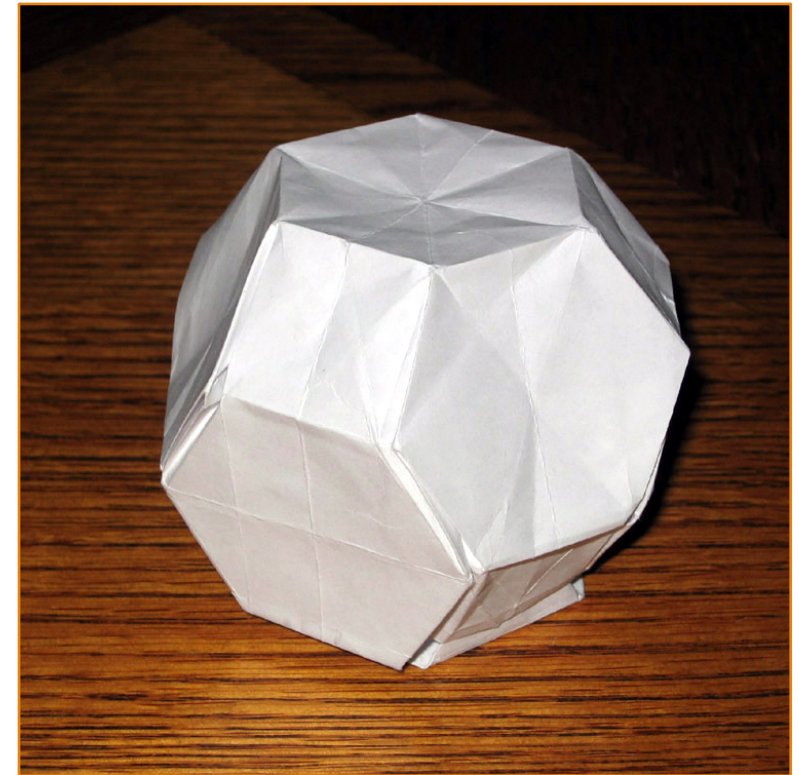
- Can be challenging to develop from a grid

Rectangles, parallelograms, trapezoids, etc.

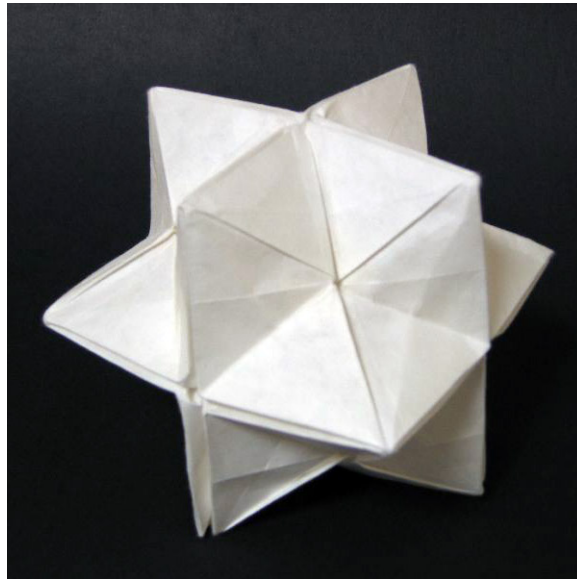
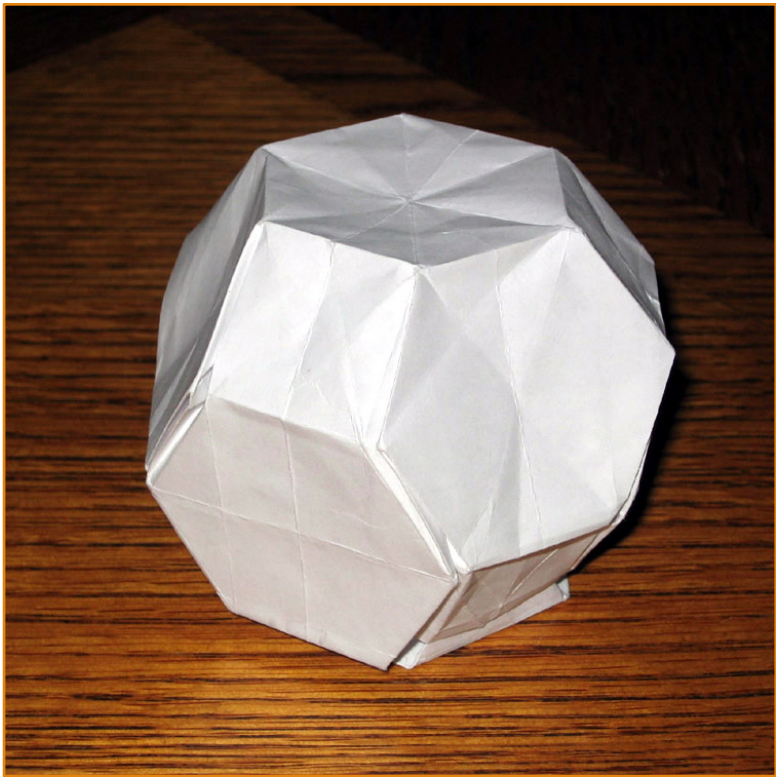
- Largely unexplored

Curved folds

- Lots of cool stuff out there, but gets away from polyhedra



Other Geometries



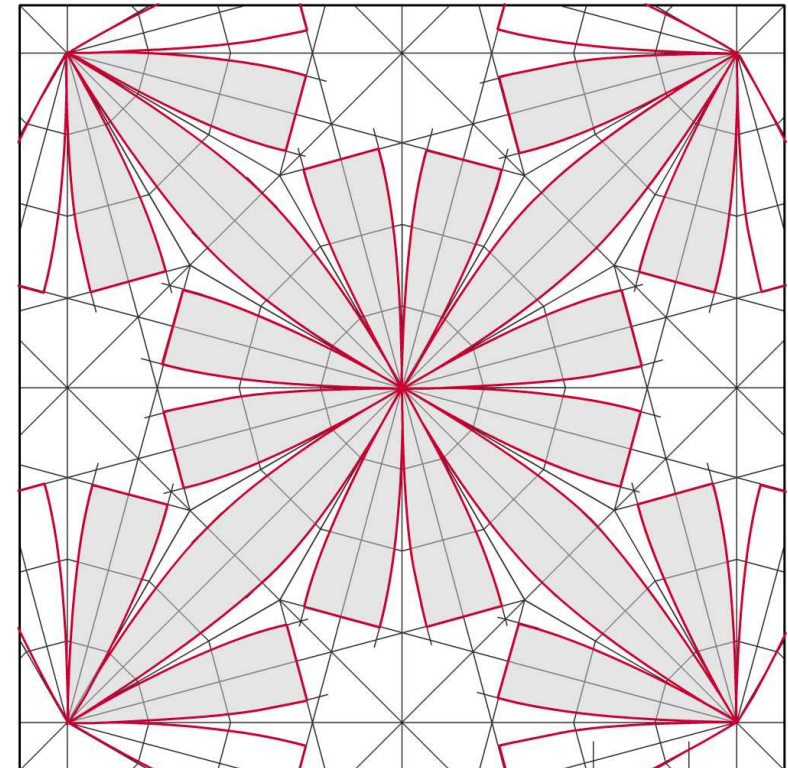
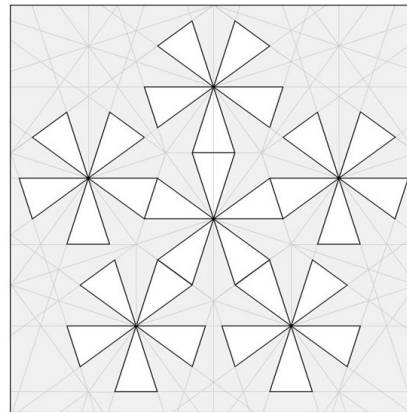
Basic CP Plans/Layouts

Polar Geometry

- Usually uses square, hexagon or pentagon paper
- The center of the paper is the “north pole”
- The edges come together at the “south pole”

Two Hemispheres

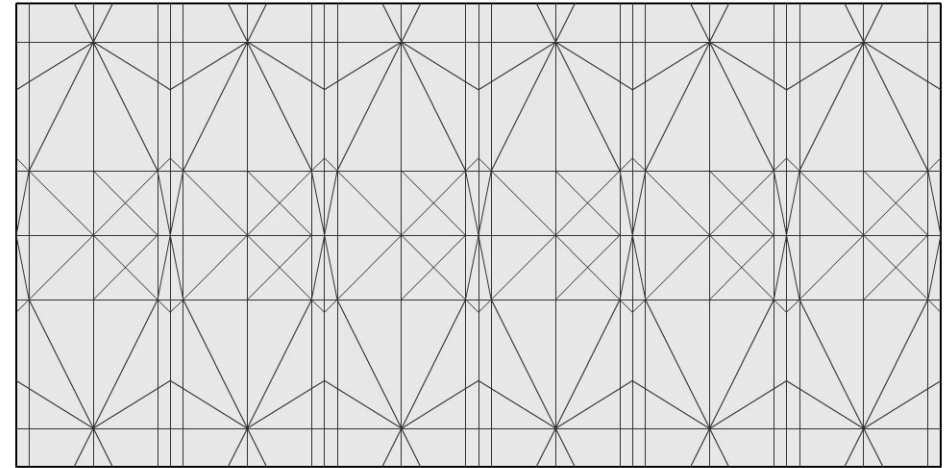
- Requires two sheets of paper
- Useful for studies and experiments
- Can be hard to lock the two halves together



Basic CP Plans/Layouts

Cylindrical

- The paper is usually a rectangle
- The center of the paper is a point on the “equator”
- The ends of the sheet come together on a meridian
- Then paper tucks in the the north and south poles



CP Layout Considerations

Symmetry – even/odd (bilateral/rotational)

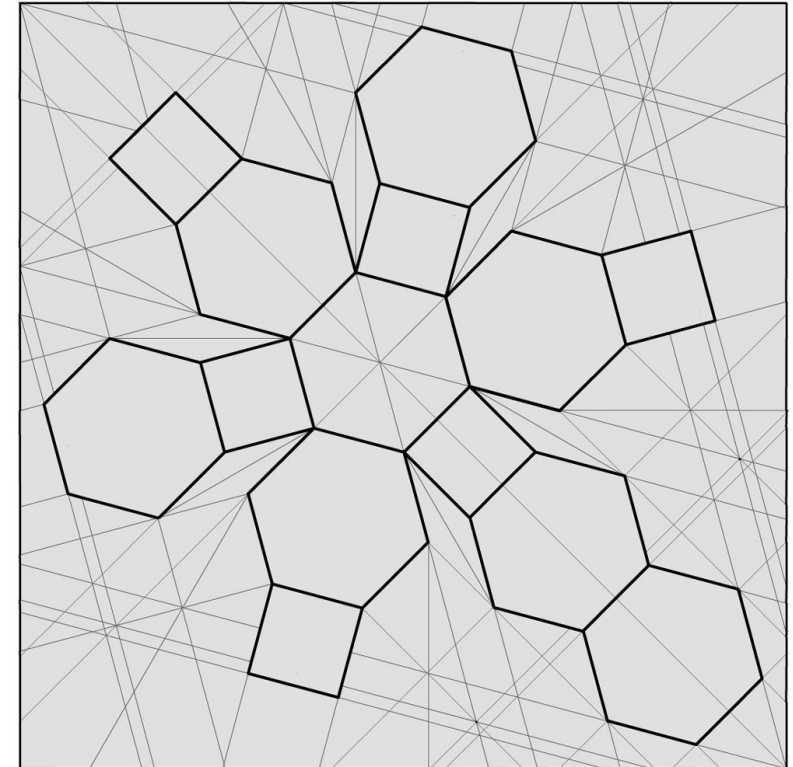
- sometimes a nice symmetry is not possible

Where is the center of the paper?

- a vertex, the middle of an edge, or the center of a face
- often need to make room for a last face opposite the center
- or, could split up the “South Pole” face

Number of divisions in the grid

- how much margin – necessary for tabs to close the model
- hard or easy number – multiple of 2, 3, or 5
- divide by the largest number first



3-D Layout Considerations

Internal layers, ridges, etc.

- Usually want to keep the paper evenly distributed inside
- The more layers, the more the model wants to spring open

Closing and locking the model

- You'll need extra paper for tabs and slots
- Usually better to make the closure symmetrical
- Sometimes it's okay to leave the bottom face open

Paper choice

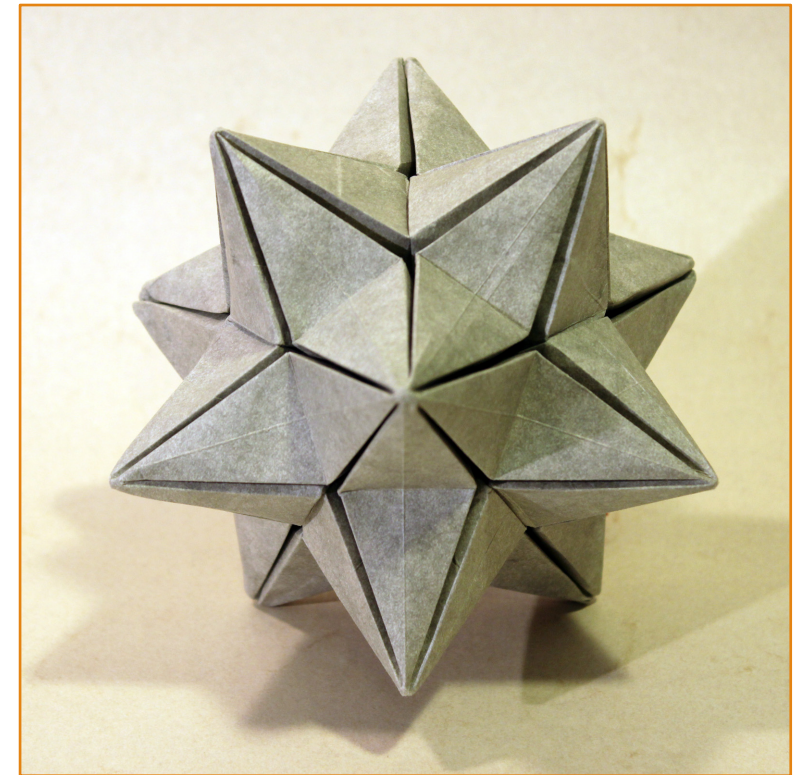
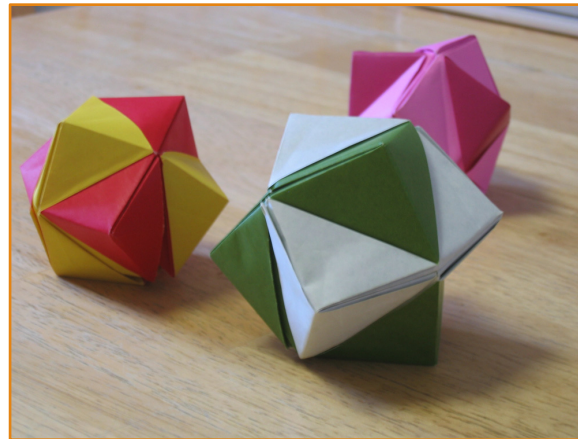
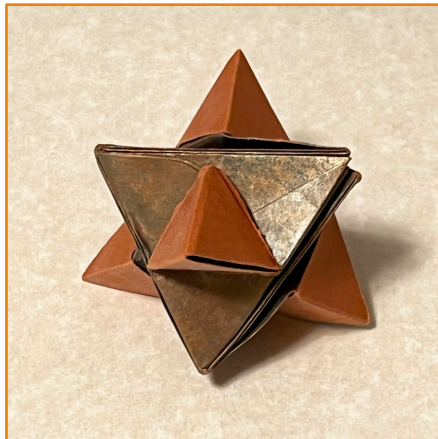
- Stiff enough that creases stay sharp and faces pop
- Not too thin – many parts of the model are one layer thick
- Not too thick – those layers add up fast!

Stellated Polyhedra

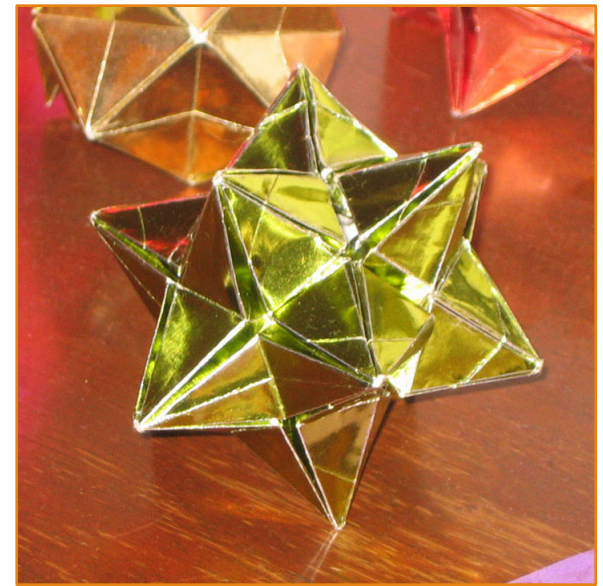
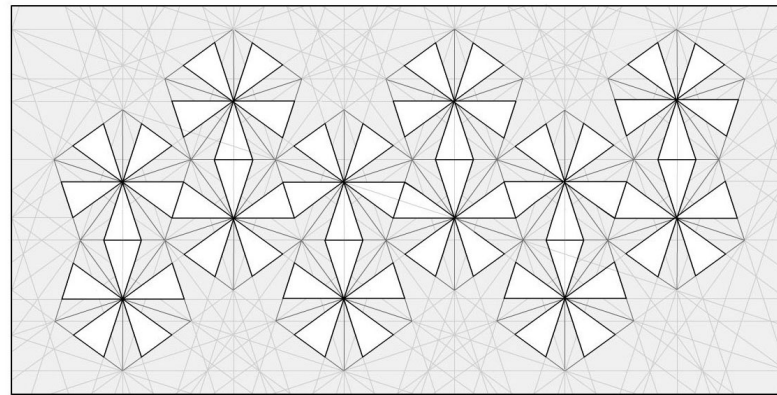
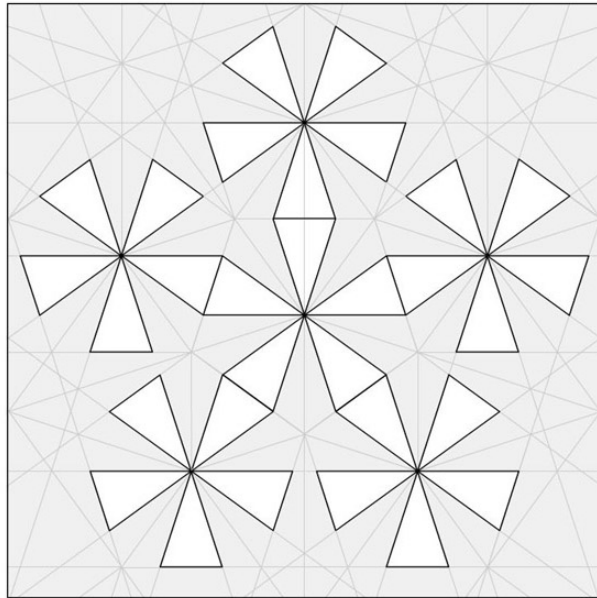
A vertex sum > 360 degrees necessitates hidden paper

- More pointer points means more hidden paper

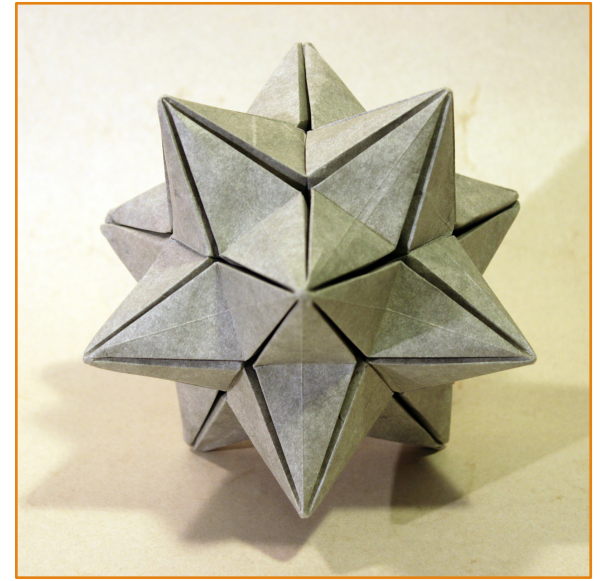
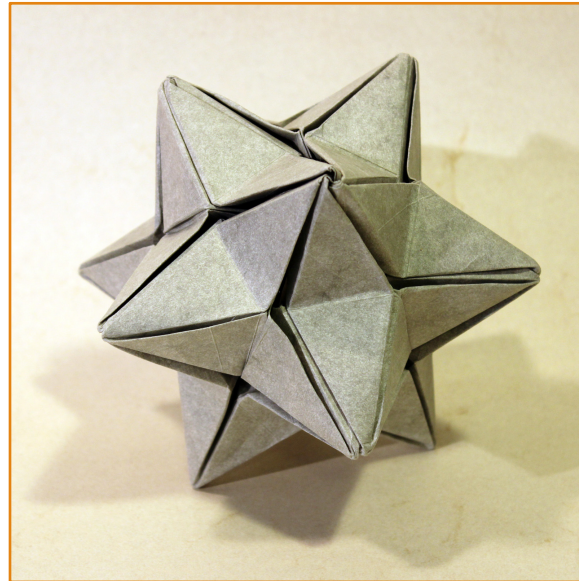
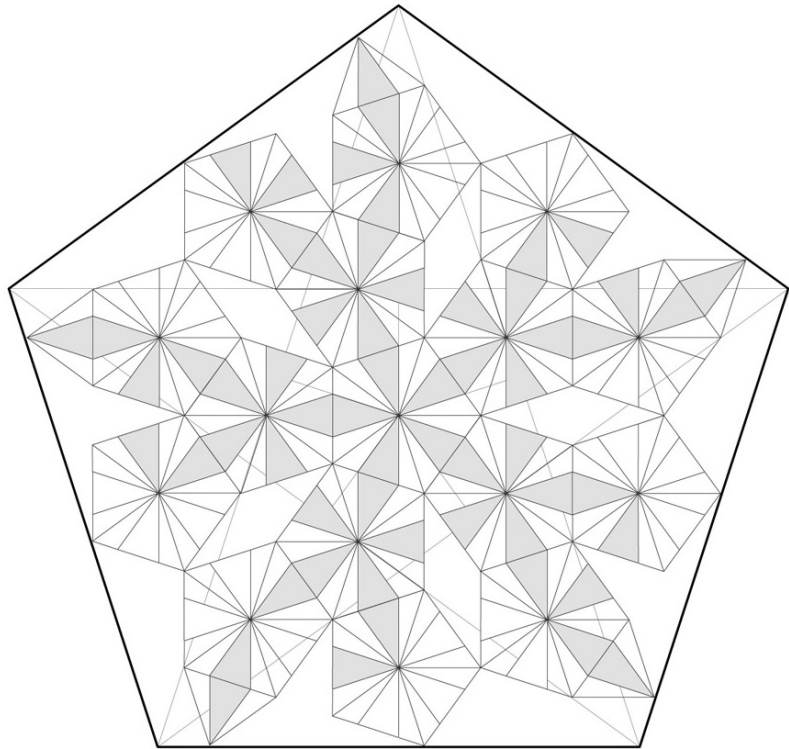
Internal layers and closing the model can be challenging



Stellated Dodecahedron - Studies



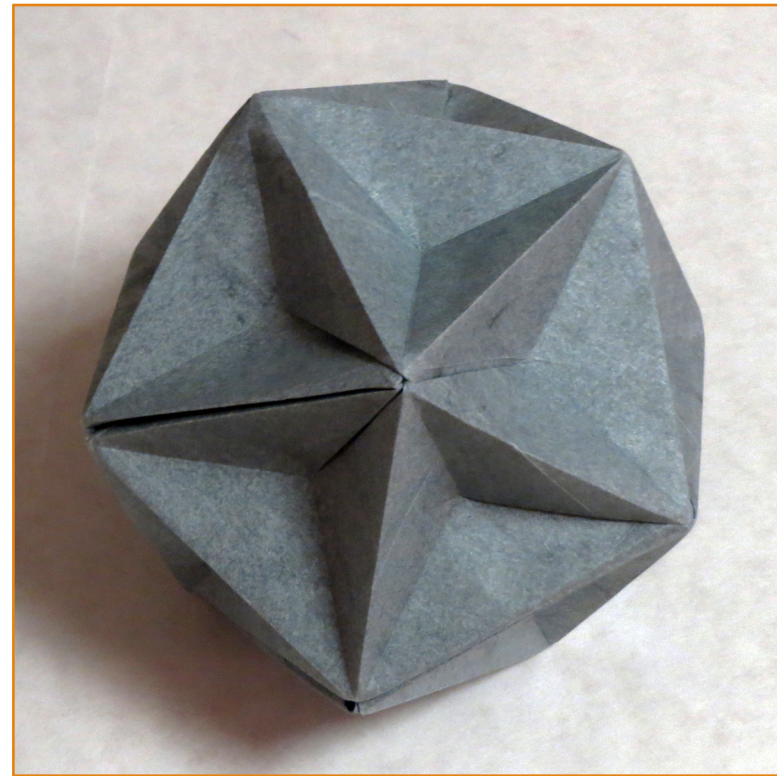
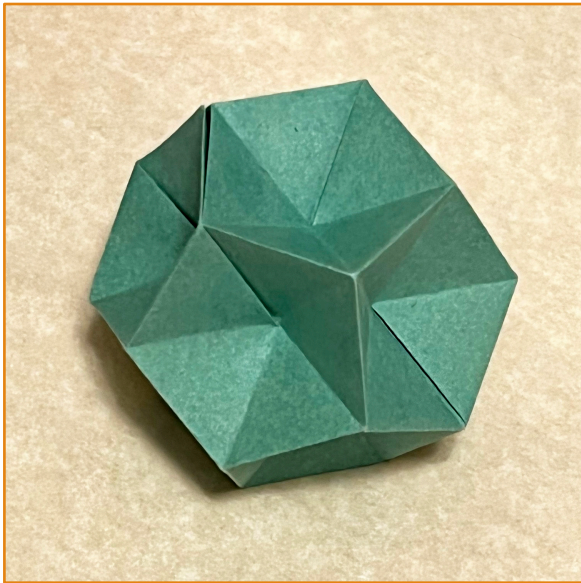
Stellated Dodecahedron



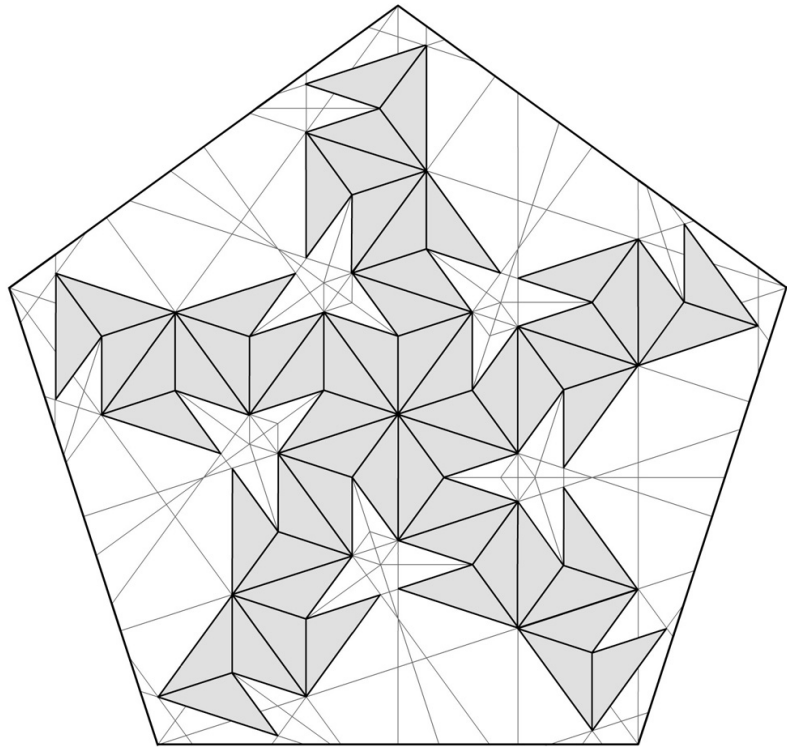
Sunken Polyhedra

Sunken is the inverse of stellated in a sense

- But less room inside for hidden paper

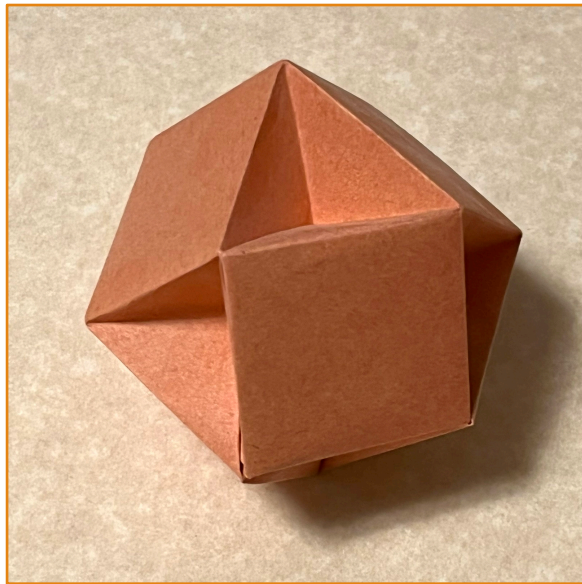


Great Dodecahedron



Dimpled Polyhedra

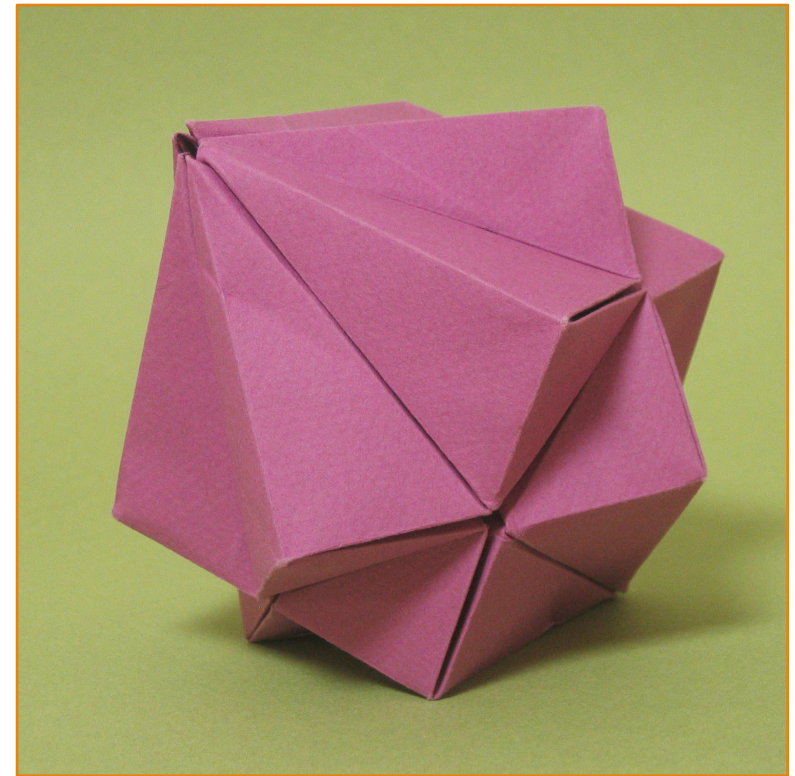
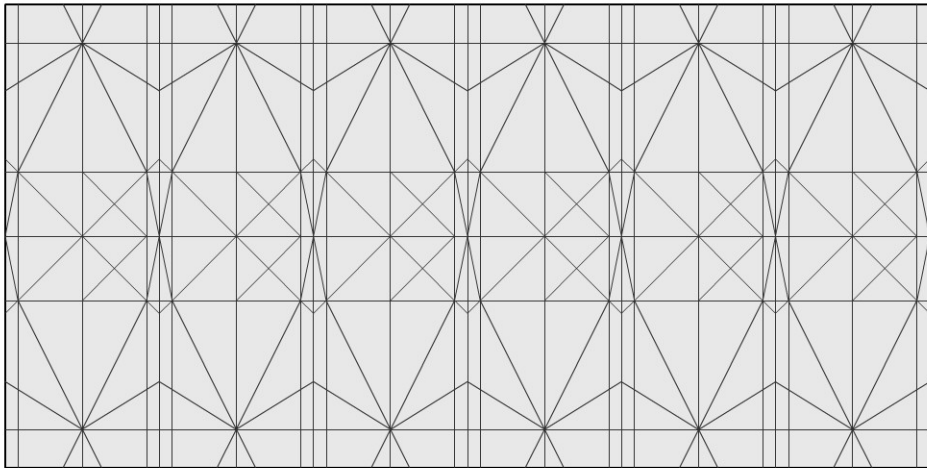
Half-sunken, can suggest complicated shapes



Compound Polyhedra

Often involve different polygons

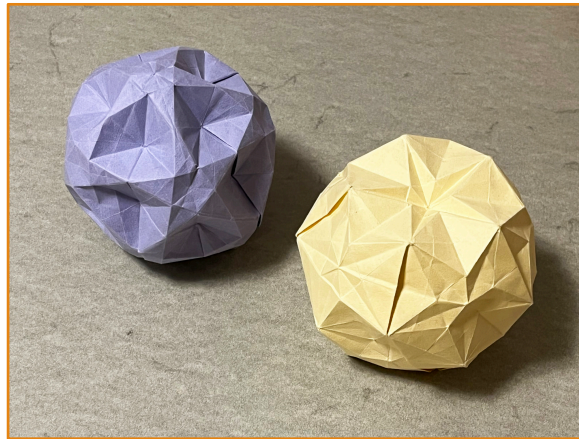
Some can be thought of as stellated forms



Starballz

Use both stellation and sunken-like folds

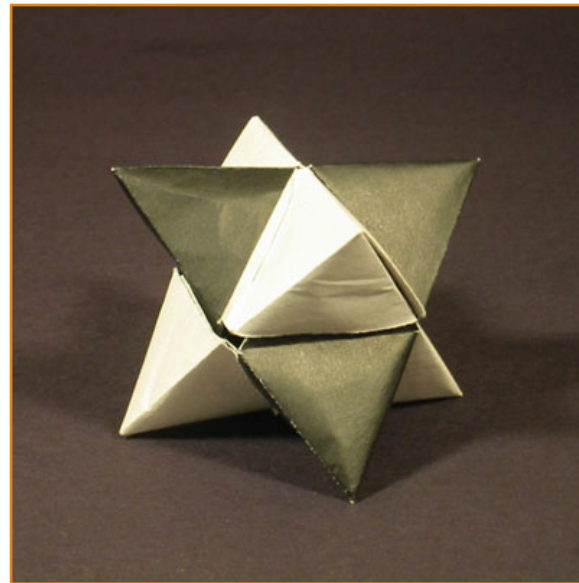
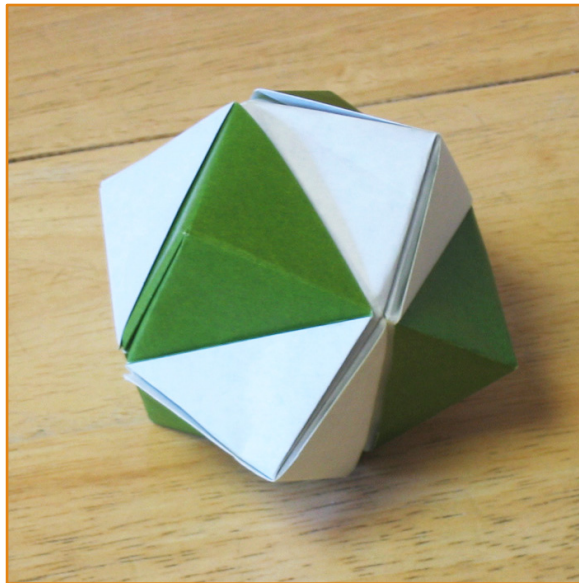
Many local vertex angles are 360 degrees



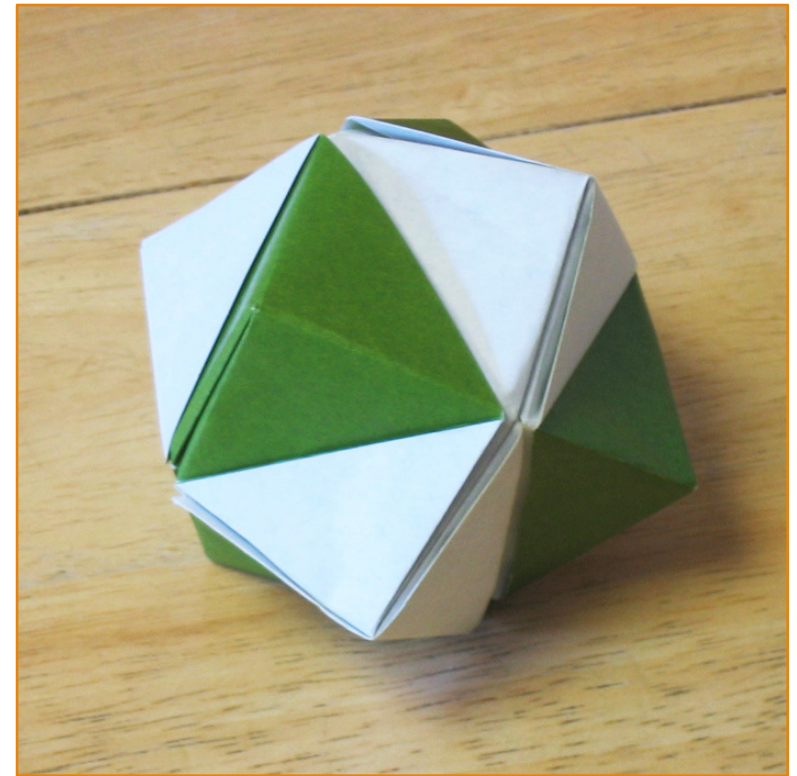
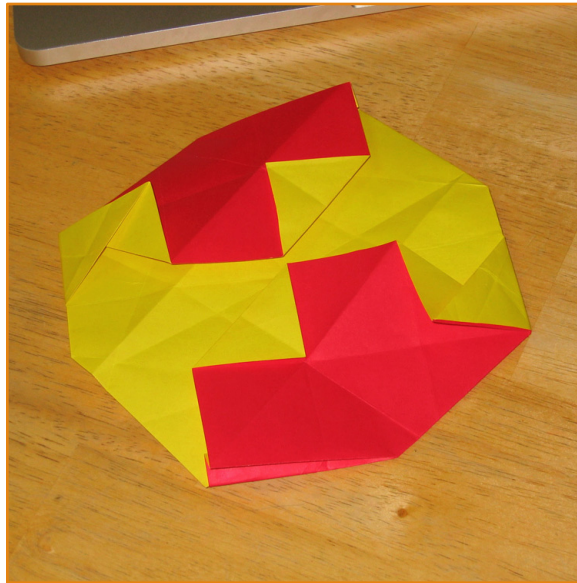
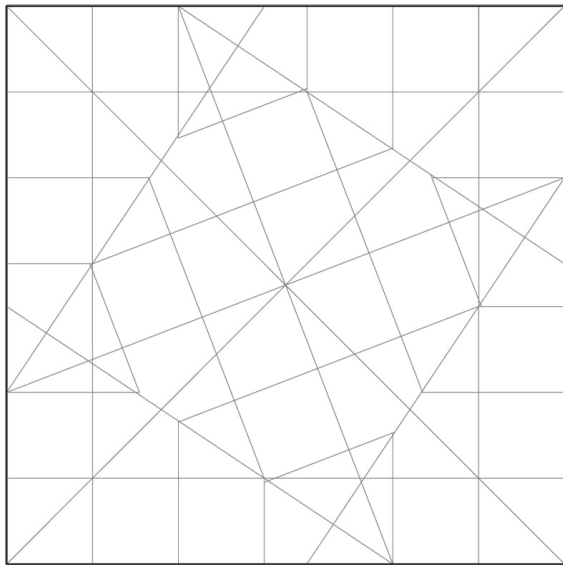
Color Change

First create color change regions on a flat pattern

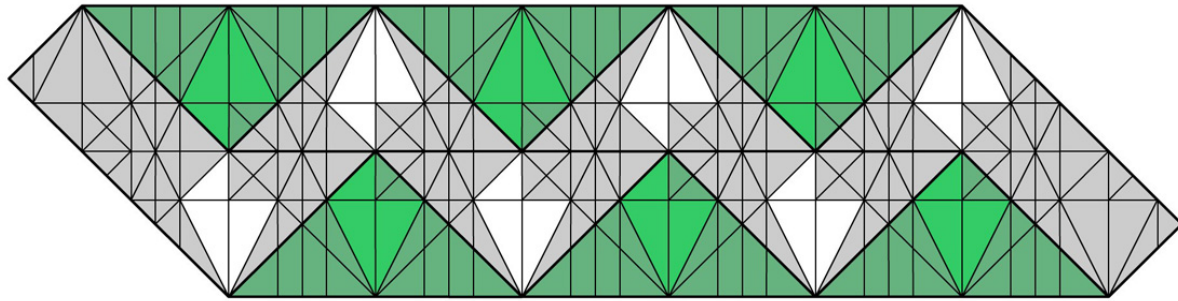
Then fold the 3-D form from that



Color Change – Stellated Octahedron



Color Change – Dual Cube

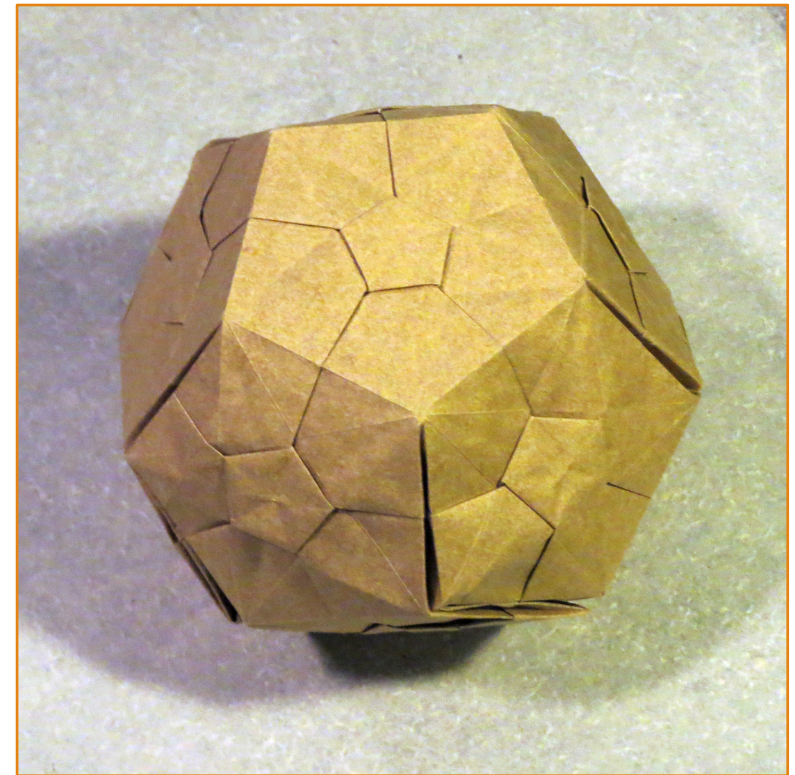


Combining Polyhedra w/ Tessellations

A fun alternative to modulars

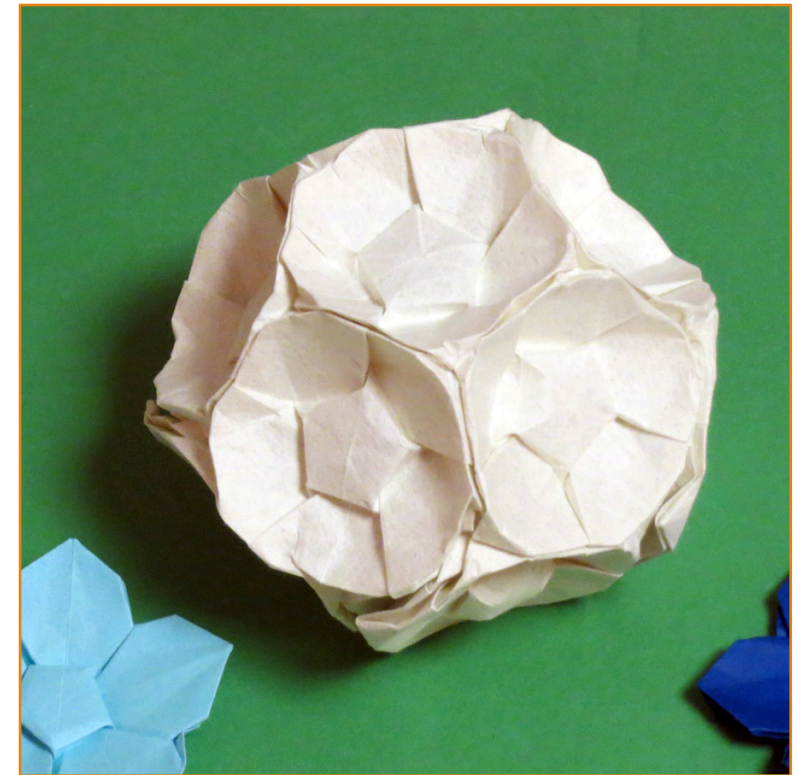
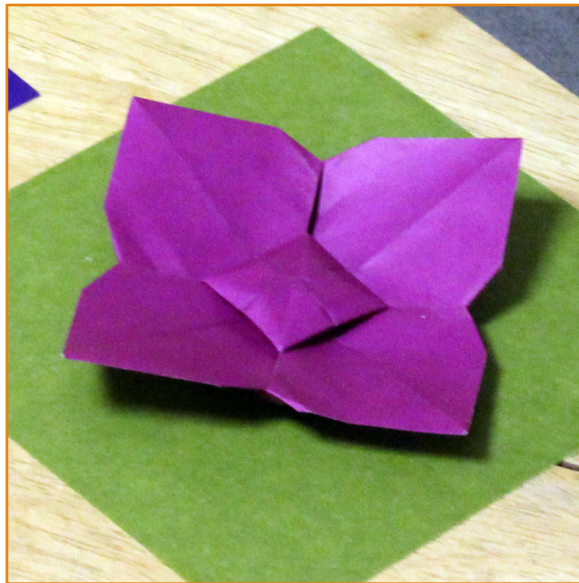
First embed the tessellation in the right places in the sheet

Then take that and create the 3-D form



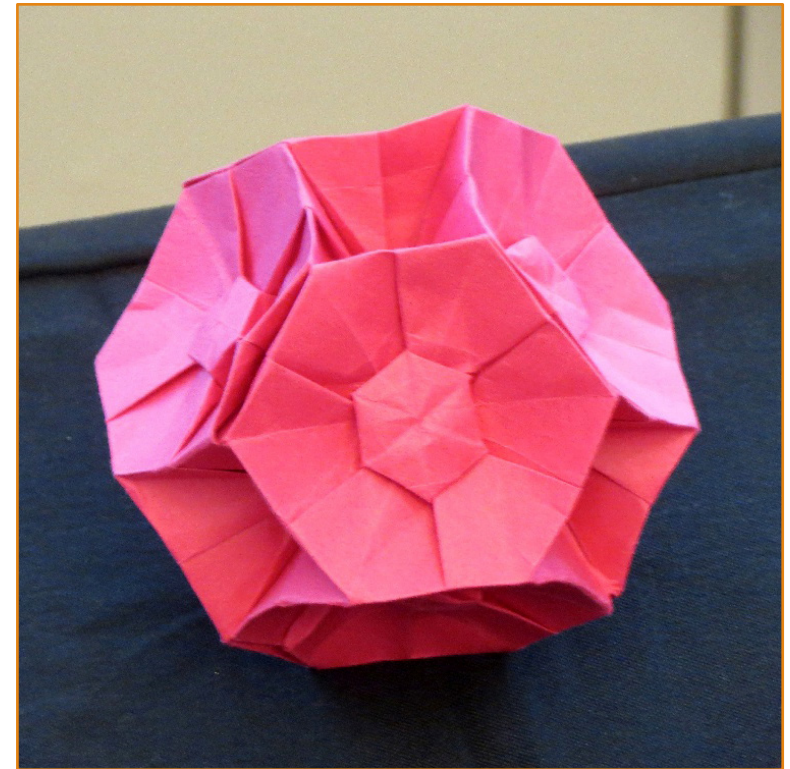
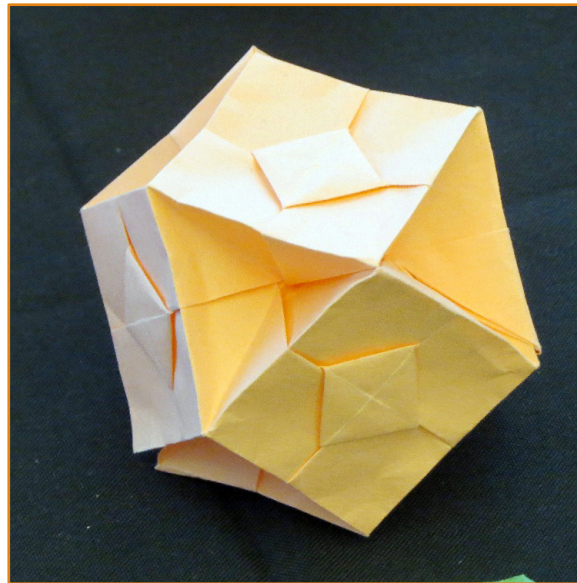
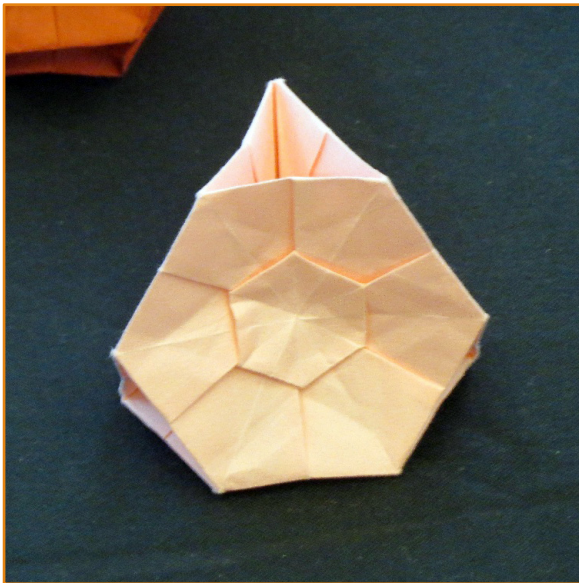
Flowerballs

Dodecahedron with square and pentagon modules

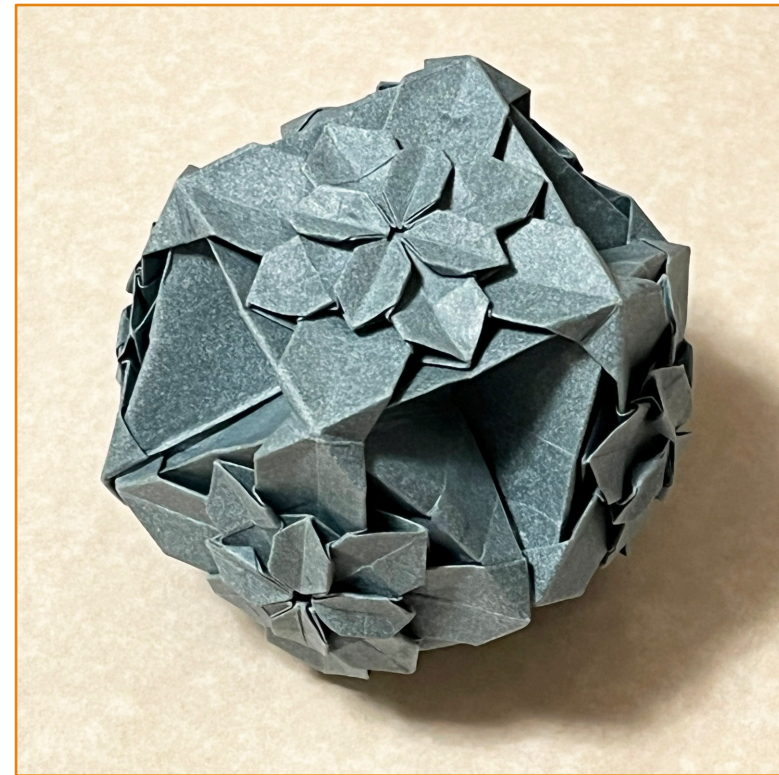


Flowerballs

Tetrahedron, Cuboctahedron, Truncated Octahedron



Hydrangea Cuboctahedron



Future Directions

Explore other geometries

Spirals, fractals, quasi crystals, hyperbolic surfaces

Combine with curved folding

Combine with representational and natural forms

Other ideas ...



Discussion

Any questions?

