# Single-Sheet Polyhedra

JOHN SZINGER

# 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

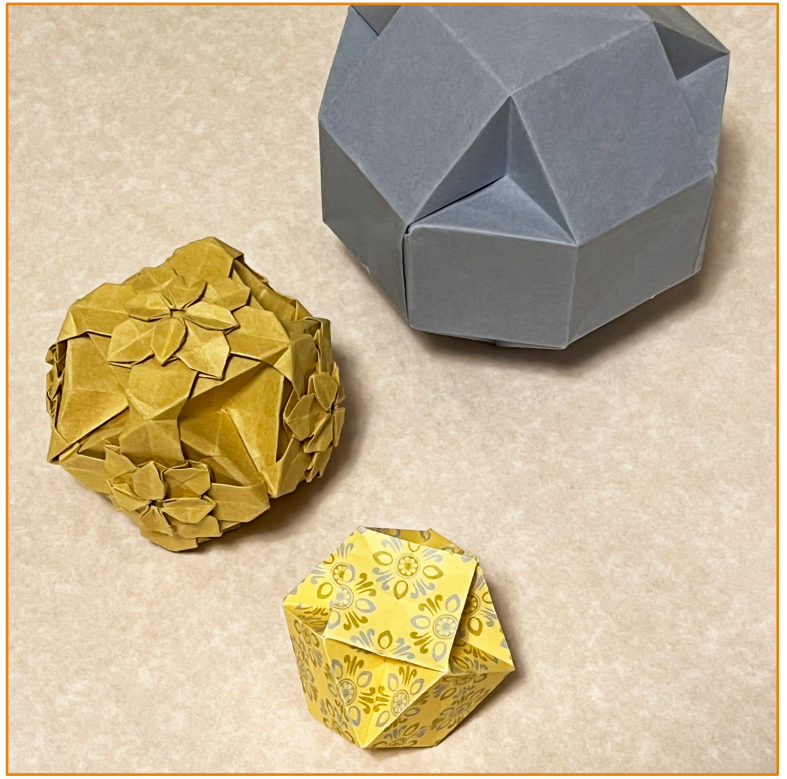
- John Montroll has a alot of books on this

# Basic Geometries – Square Grid

Most familiar, easiest to get started with

Good for models in the cube family

An excellent choice for tessellations

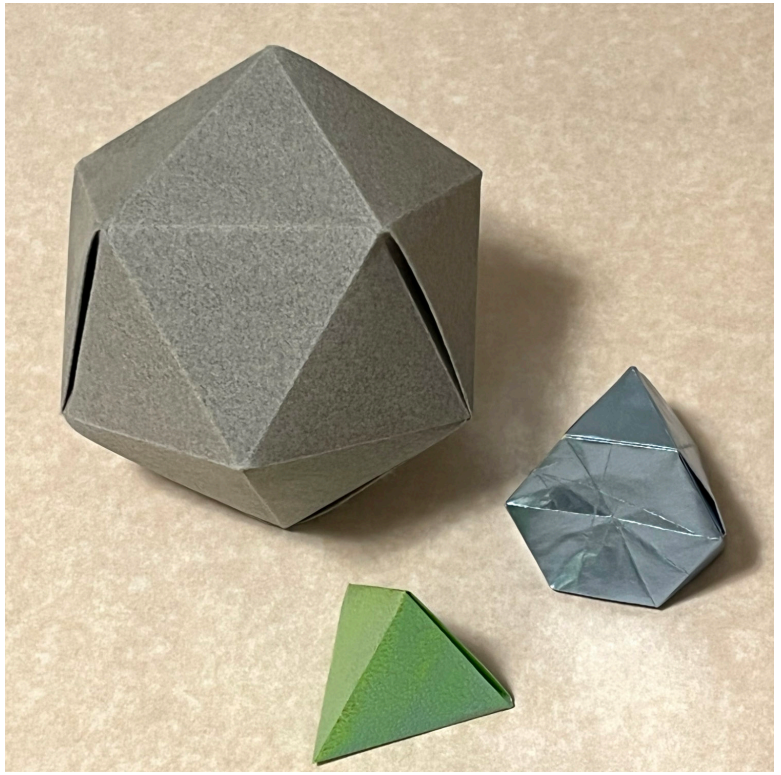


# Basic Geometries – Triangle Grid

Tetrahedron, Octahedron & Icosahedron

Tetrahedron & Octahedron together can tile 3-D space

Icosahedron is different

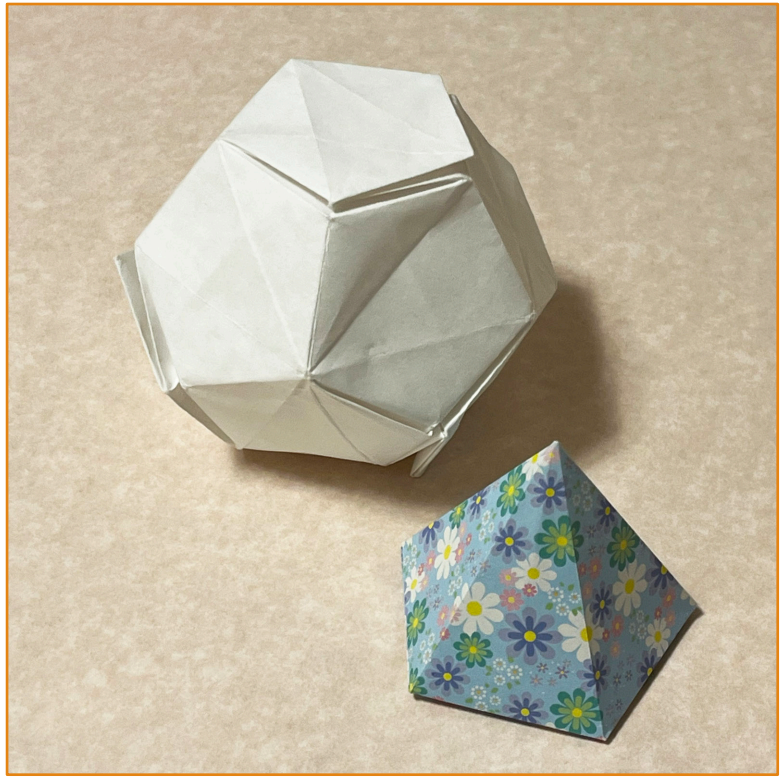


# Basic Geometries - Pentagon Grid

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!



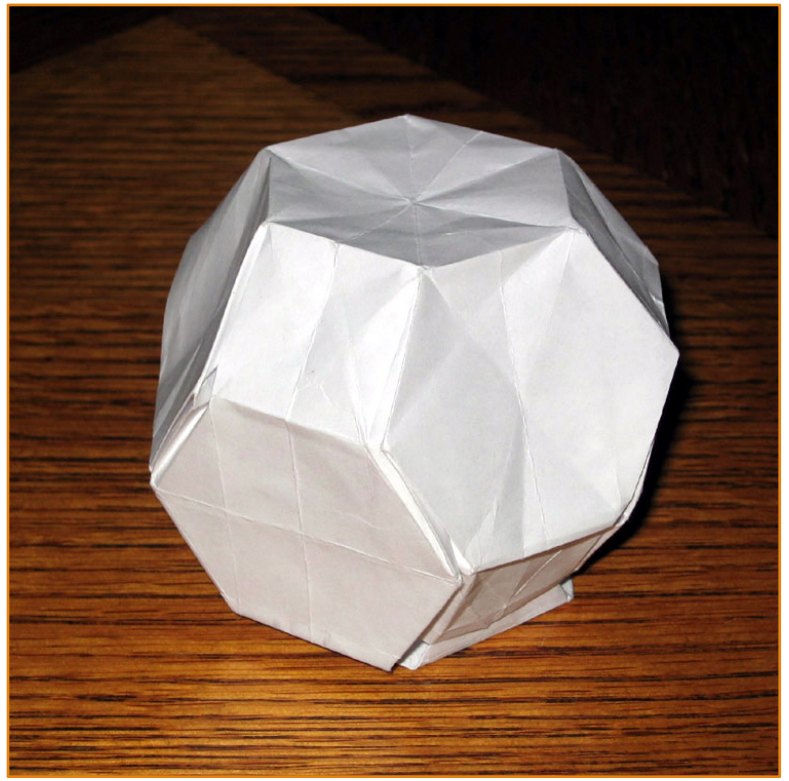
# Other Geometries

Mixed polygons – Archimedean, compound, etc.
- Need to decide on base geometry for overall plan

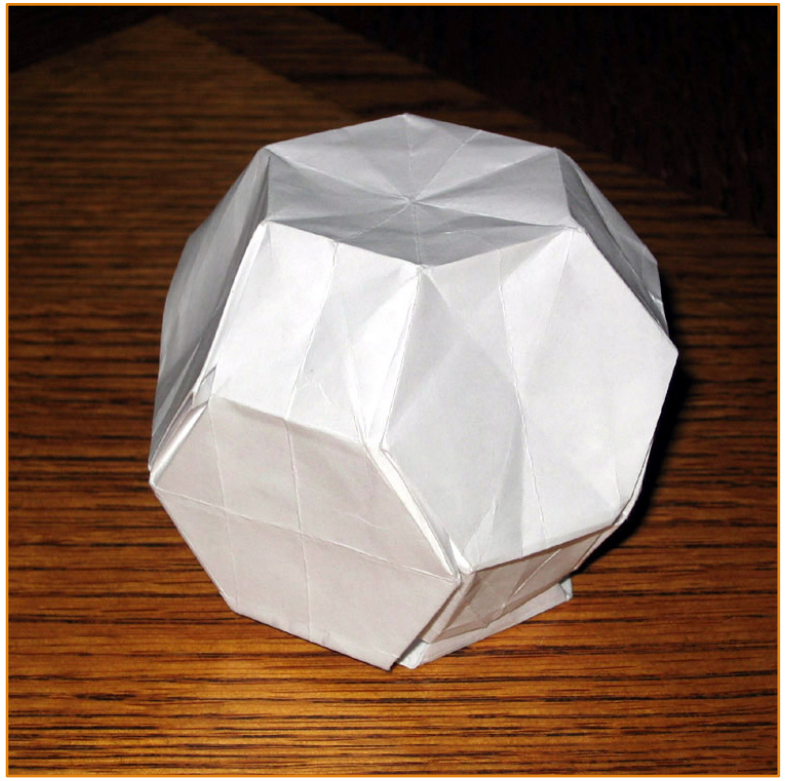
Unusual triangles and rhombi
- Can be challenging to develop from a grid

Rectangles, parallelograms, trapezoids, etc.
- Largely unexplored

Curved folds
- Lots of cools stuff out there, but gets away from polyhedra



# Other Geometries



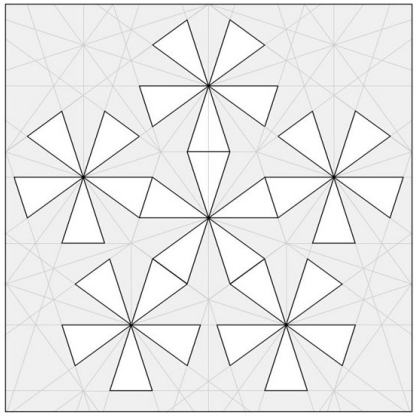
# Basic CP Plans/Layouts

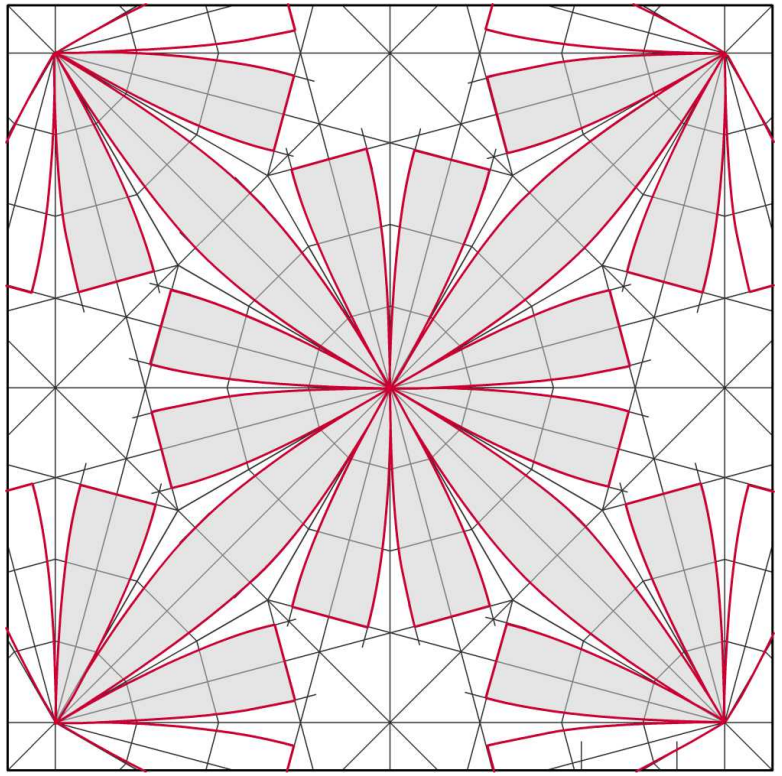
Polar Geometry

- 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

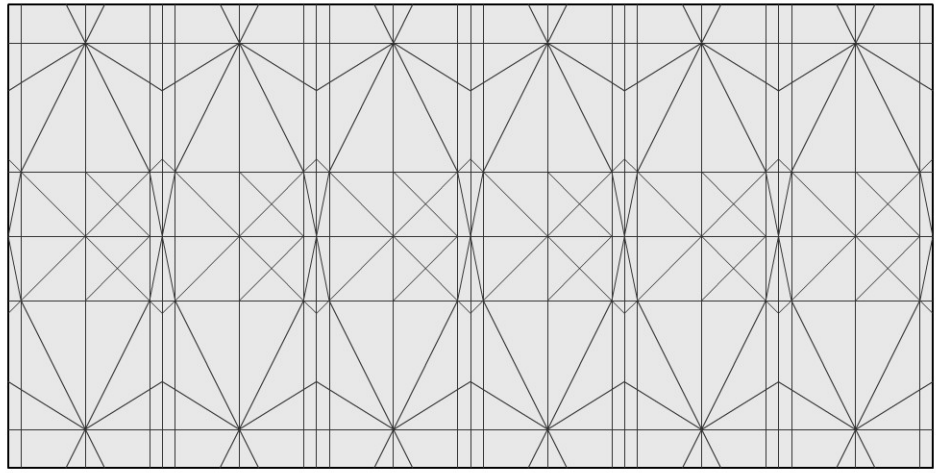




# Basic CP Plans/Layouts

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)

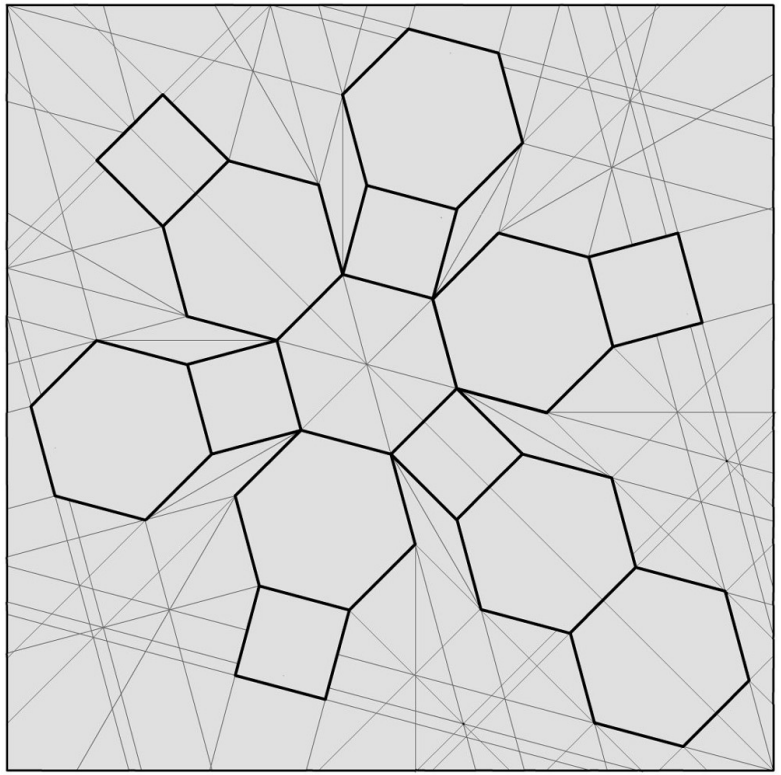
- sometimes a nice symmetry is not possible

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 larges 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

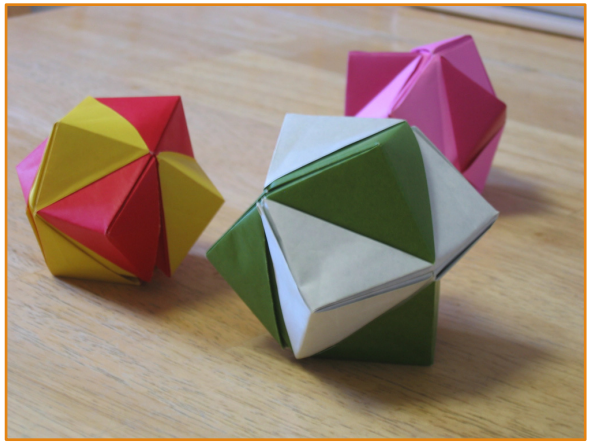
- Stiff enough that creases stay sharp and faces pop
- Not to thin – many parts of the model are one layer thick
- Not thick – those layers add up fast!

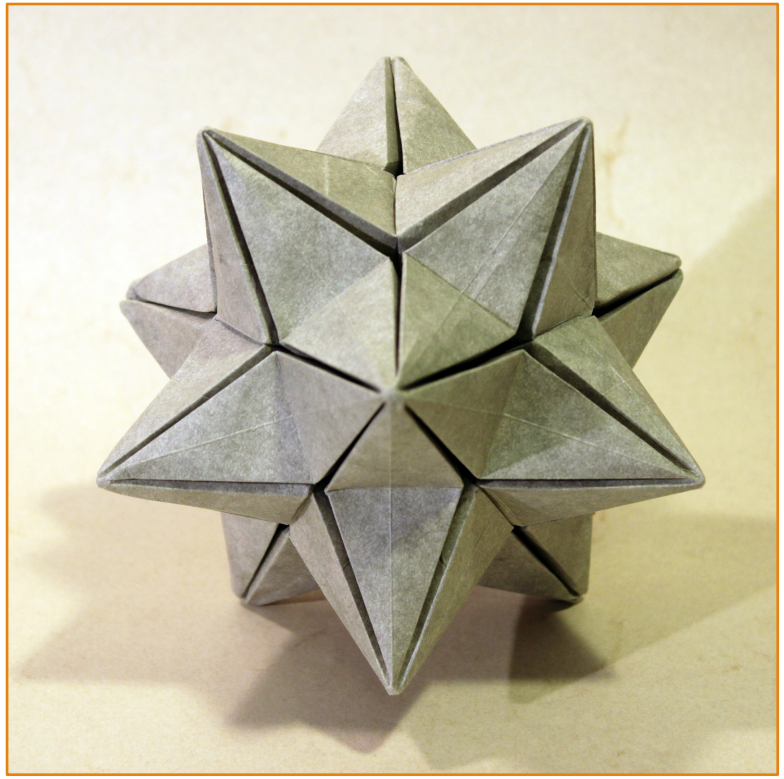
# Stellated Polyhedra

A vertex sum > 360 degrees necessitates hidden paper

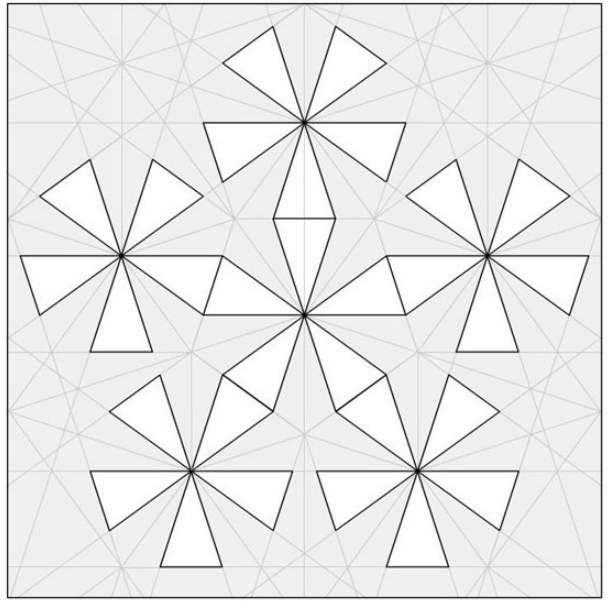
- More pointer points means more hidden paper

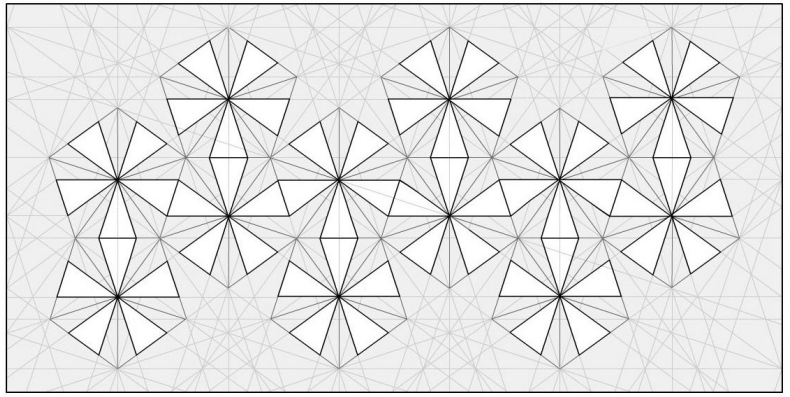
Internal layers and closing the model can be challenging

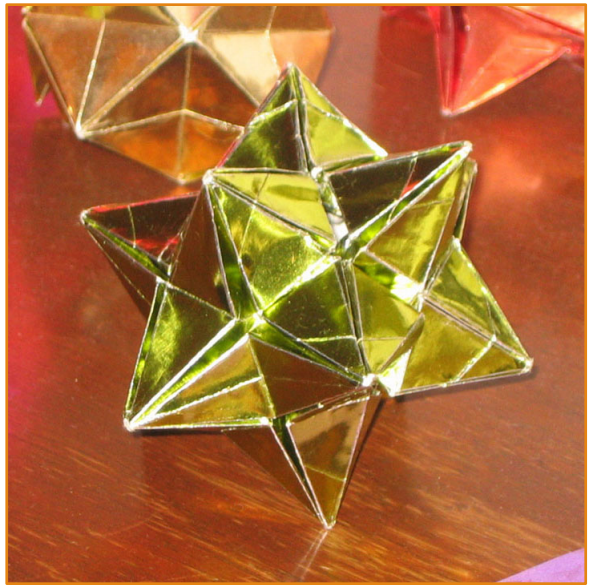




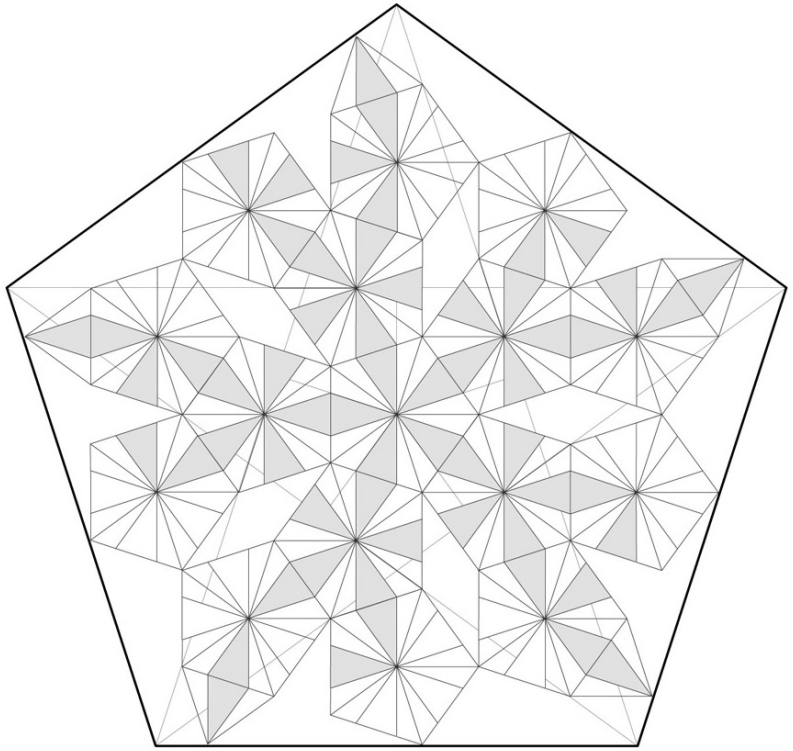
# Stellated Dodecahedron - Studies

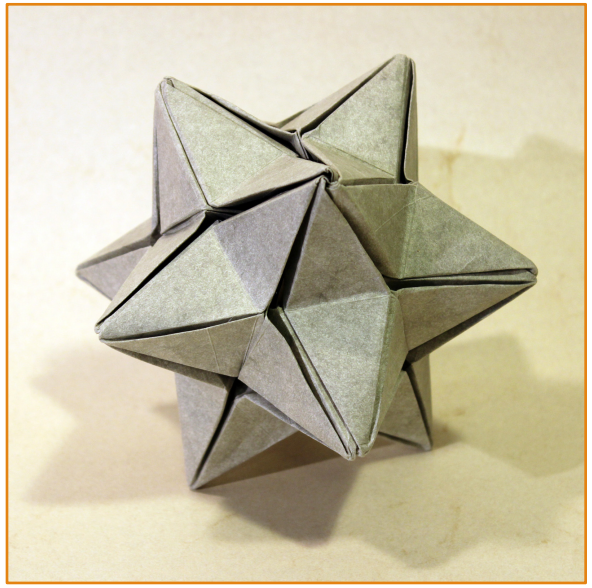


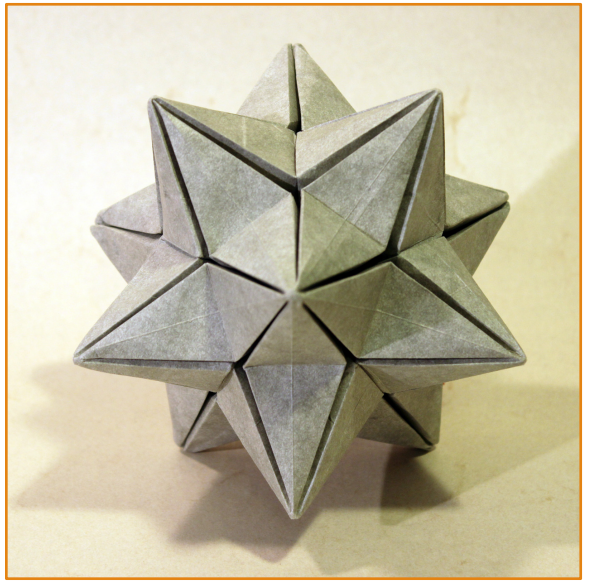




# Stellated Dodecahedron



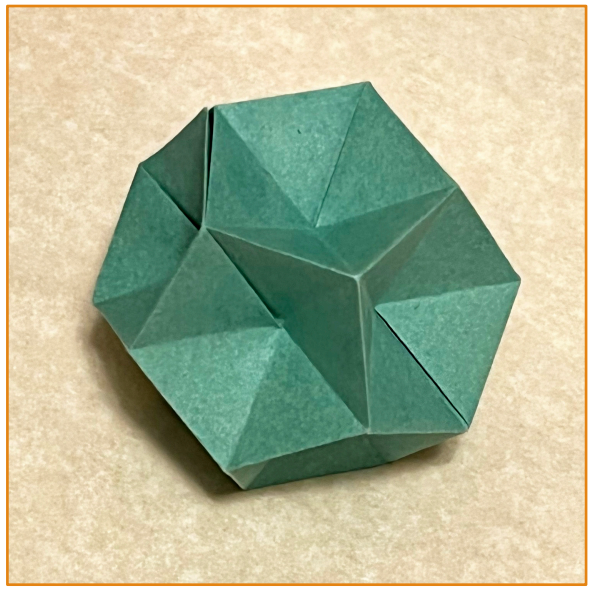




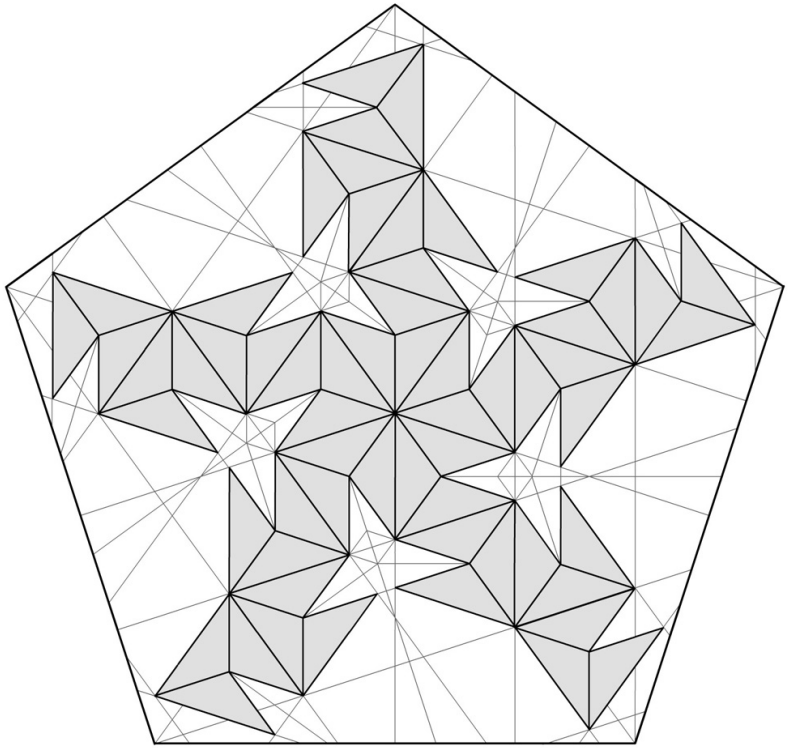
# Sunken Polyhedra

Sunken is the inverse of stellated in a sense

- But less room inside for hidden paper

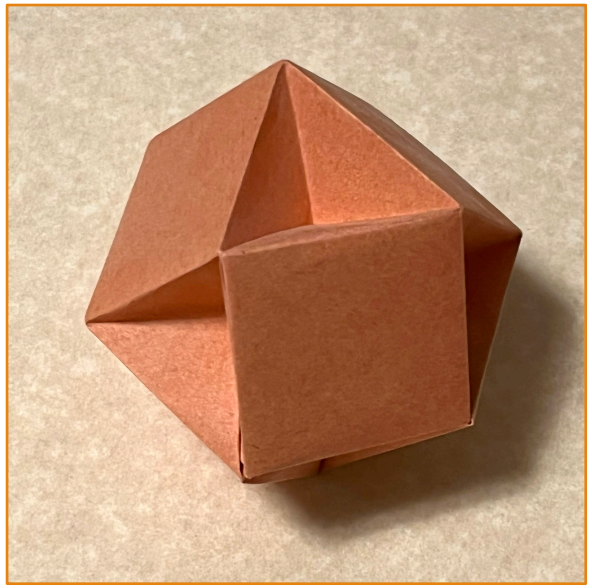


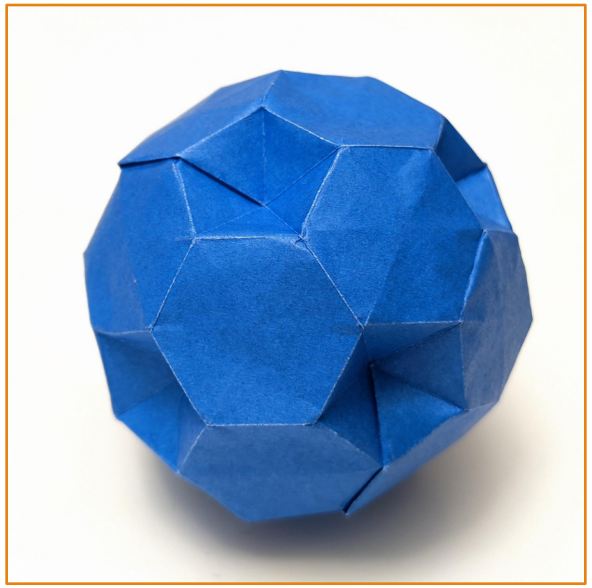
# Great Dodecahedron



# Dimpled Polyhedra

Half-sunken, can suggest complicated shapes

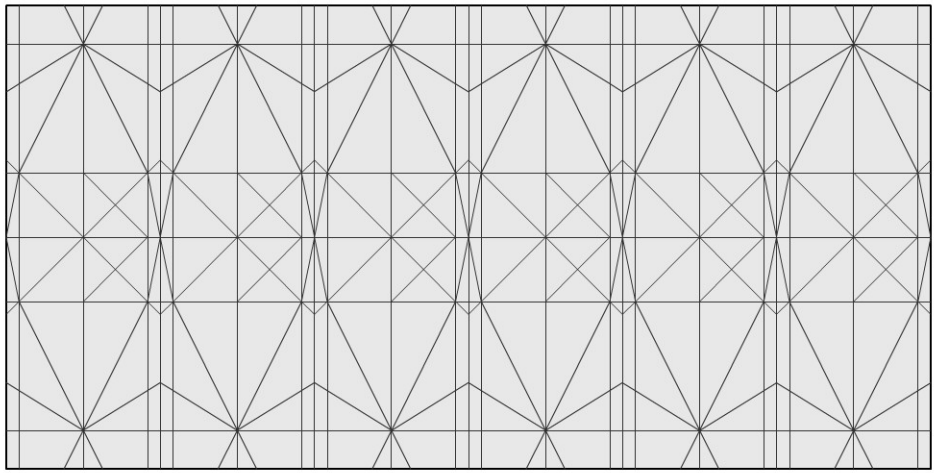


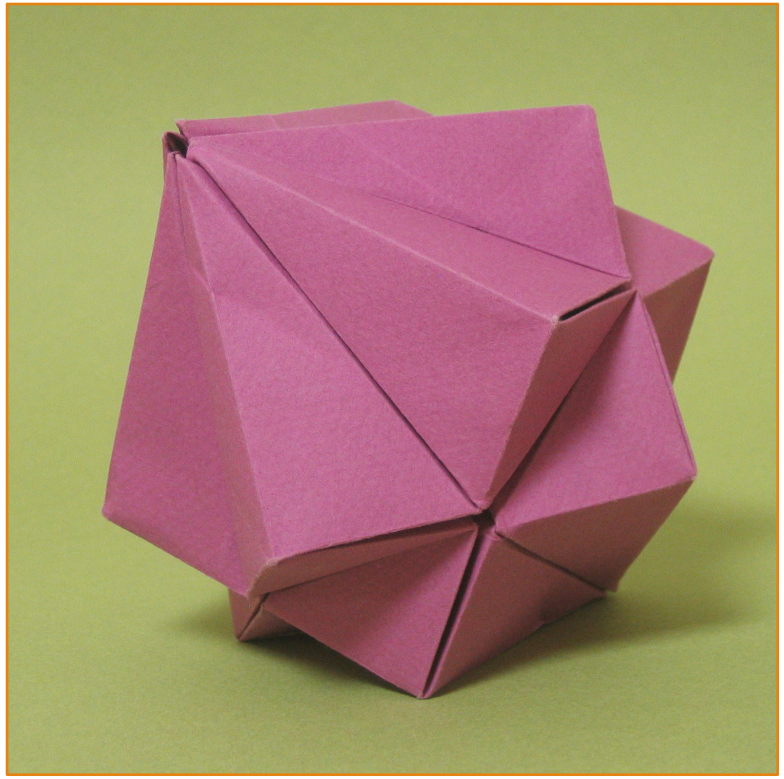


# Compound Polyhedra

Often involve different polygons

Some can be thought of as stellated forms

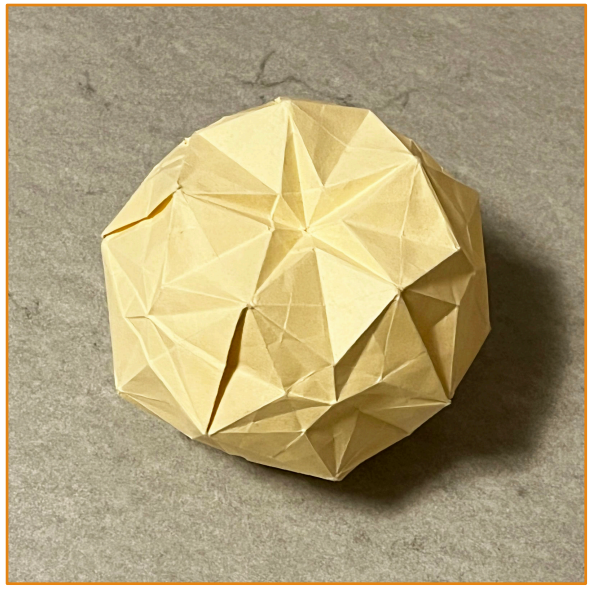


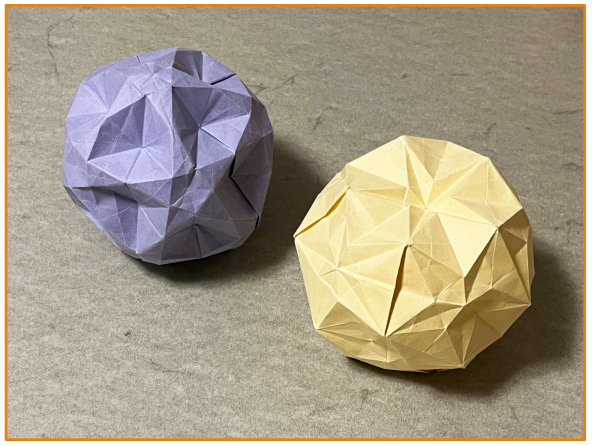


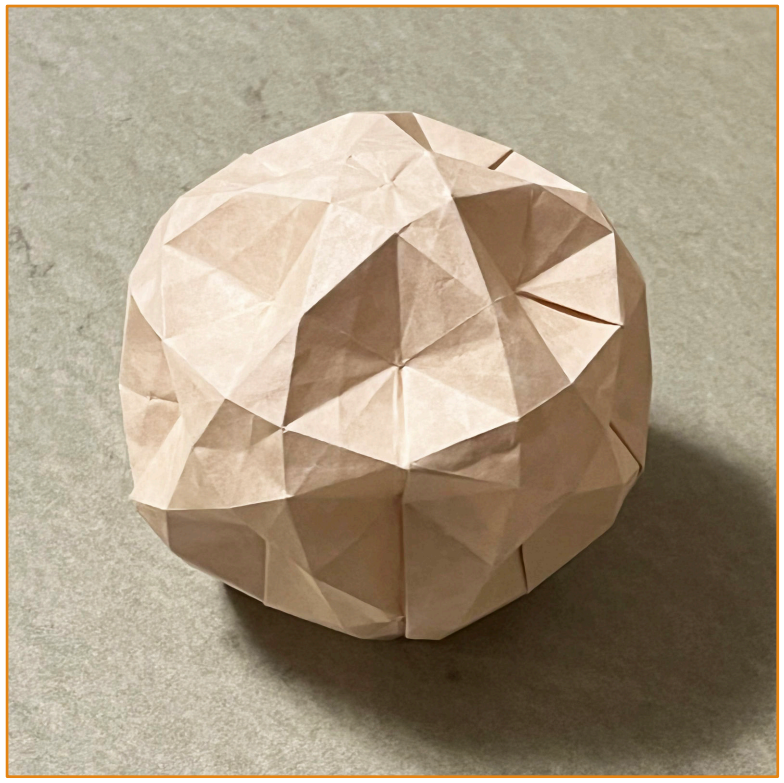
# Starballz

Use both stellation and sunken-like folds

Many local vertex angles are 360 degrees



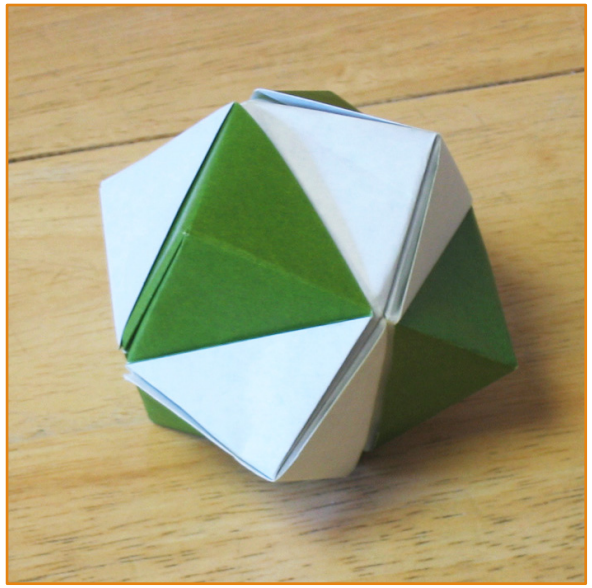


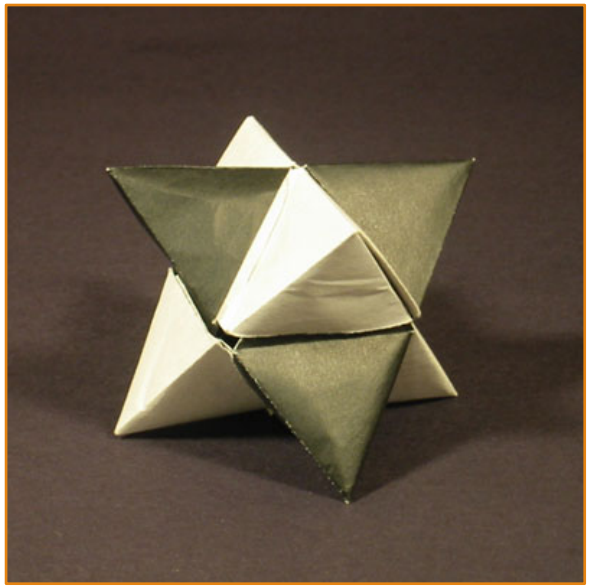


# Color Change

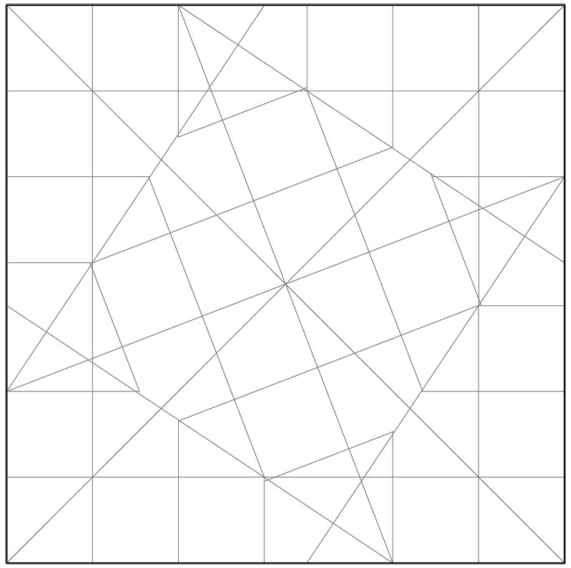
First create color change regions on a flat pattern

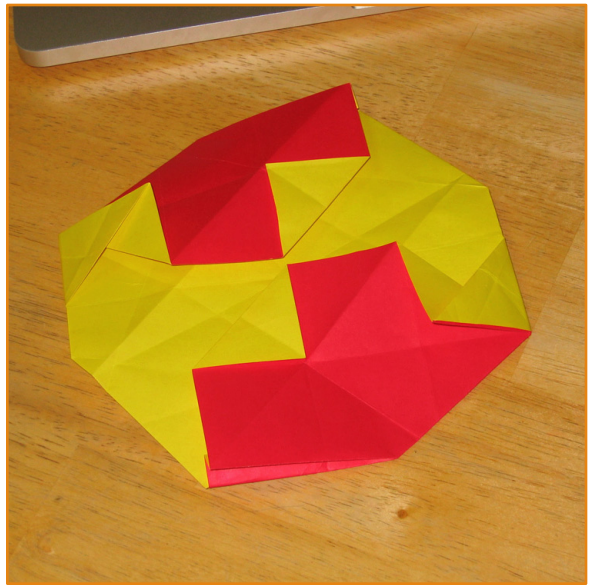
Then fold the 3-D form from that

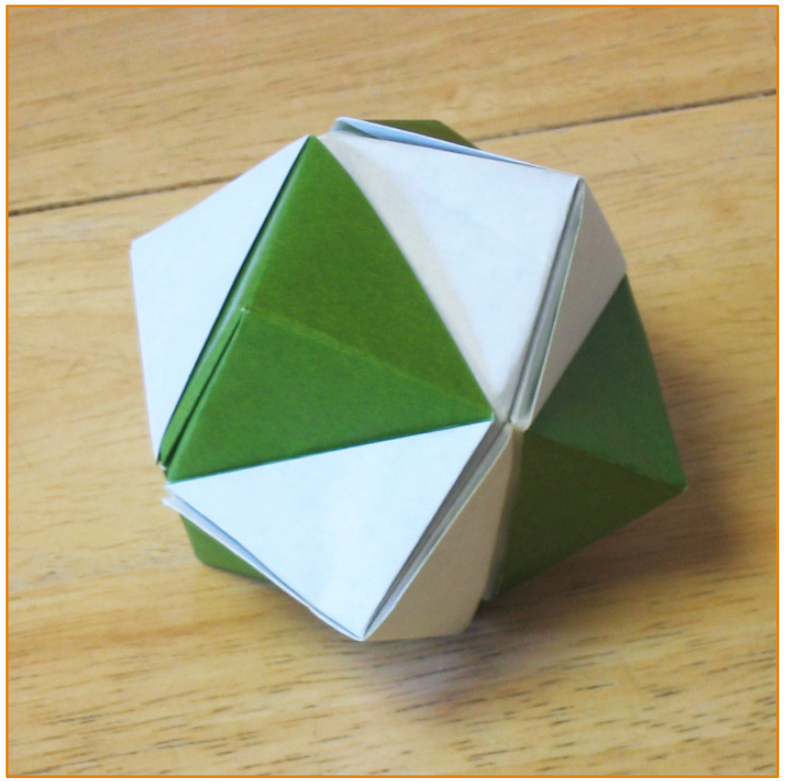




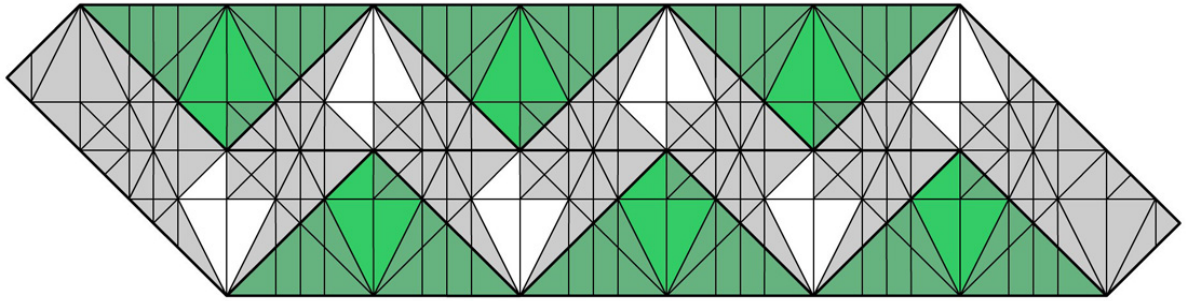
# Color Change – Stellated Octahedron







# Color Change – Dual Cube

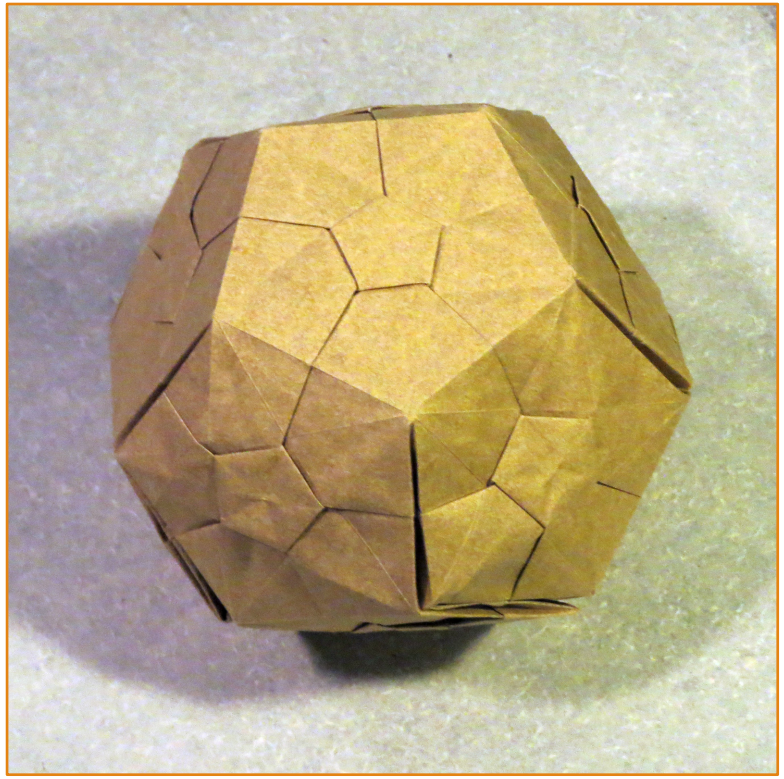


# Combining Polyhedra w/ Tessellations

A fun alternative to modulars

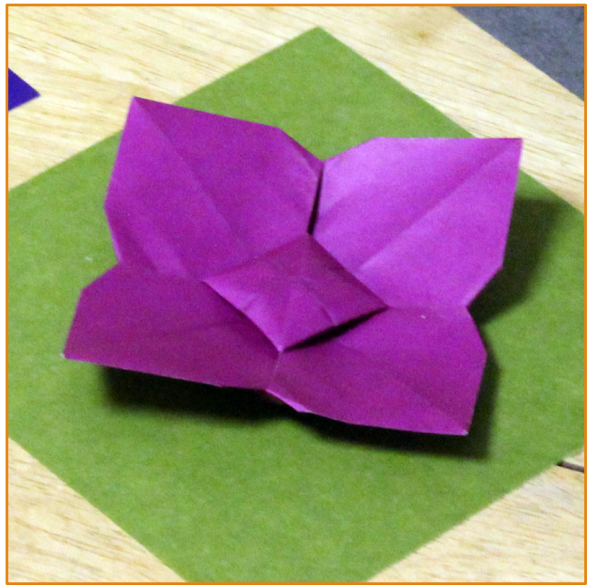
First embed the tessellation in the right places in the sheet

Then take that and create the 3-D form



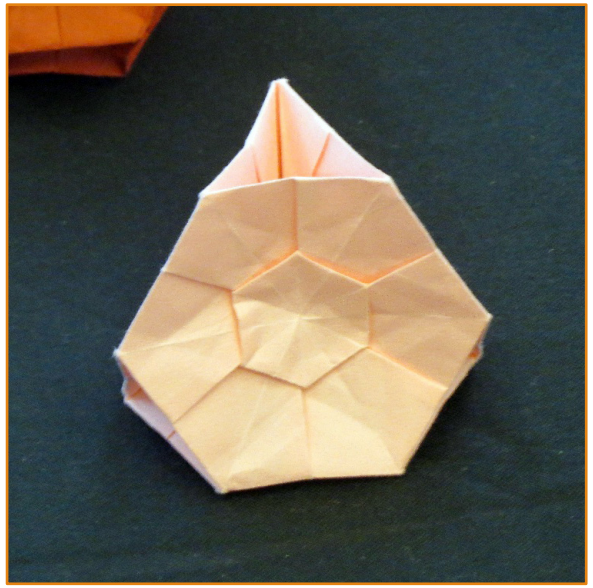
# Flowerballs

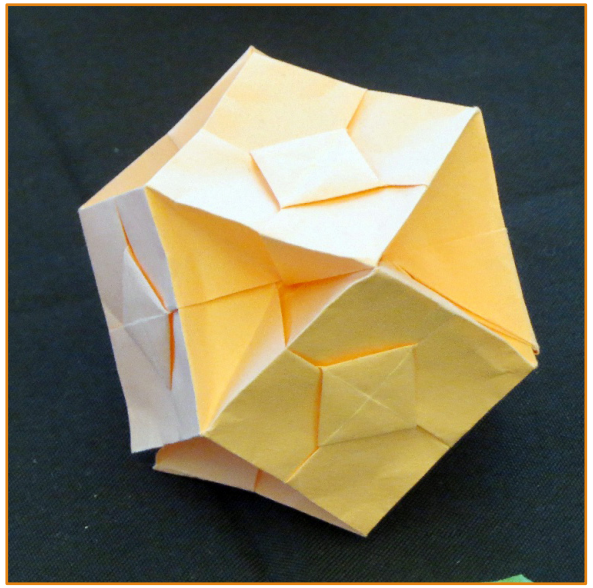
Dodecahedron with square and pentagon modules

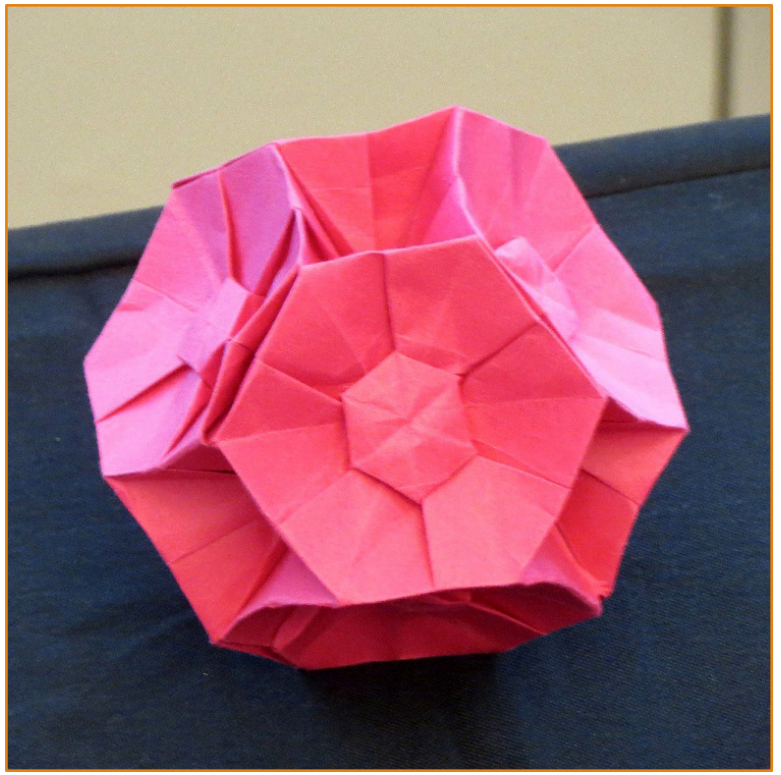


# Flowerballs

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?