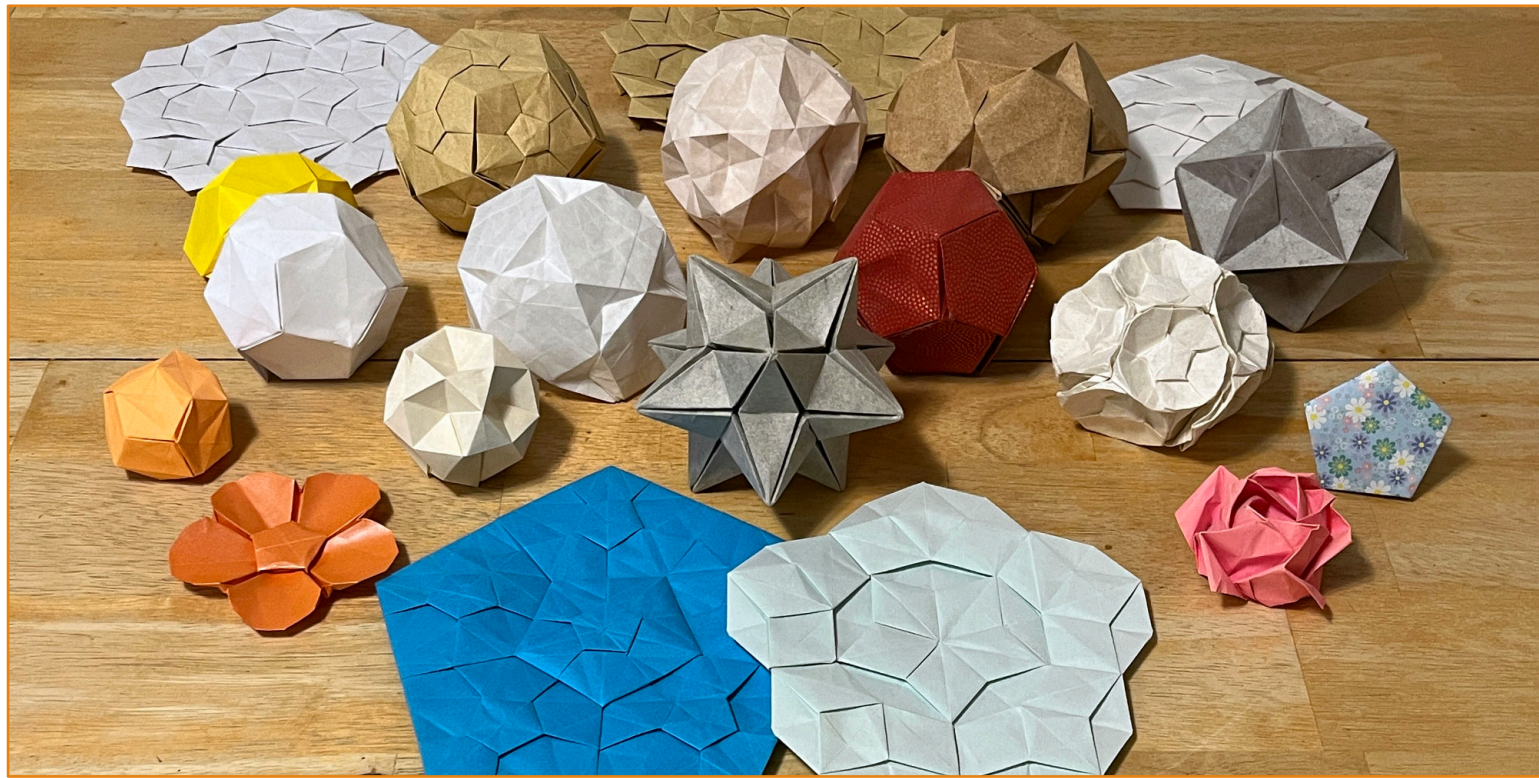


Folding with Fivefold Geometry

JOHN SZINGER



Folding with Fivefold Geometry



Background

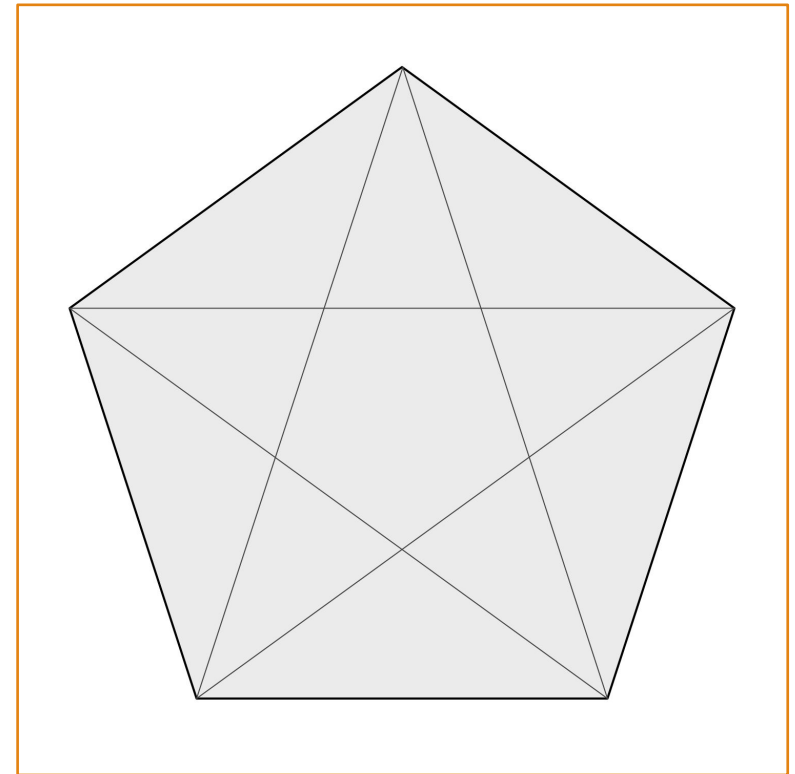
Why Fivefold Symmetry?

- It's fun and challenging, and can lead to new and unexpected discoveries

Folding + Geometric Principles

- Golden ratio galore
- Pentagons cannot tile a plane. You can't actually make a grid of pentagons
- But you get some really cool triangles and rhombi

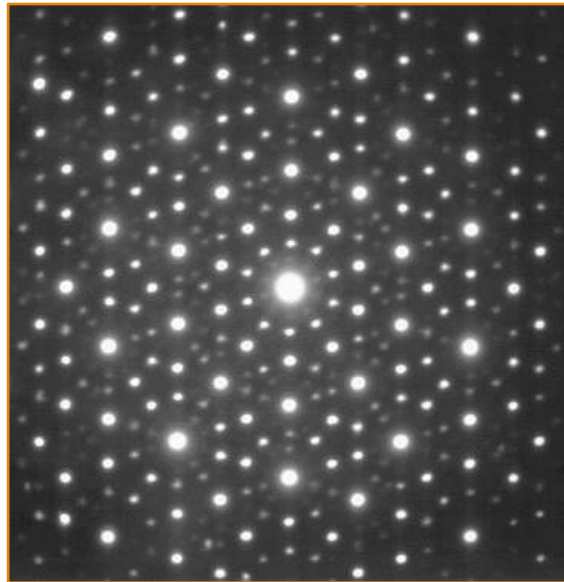
Fivefold geometry is very hard – but very fun!



Fivefold Symmetry in Nature

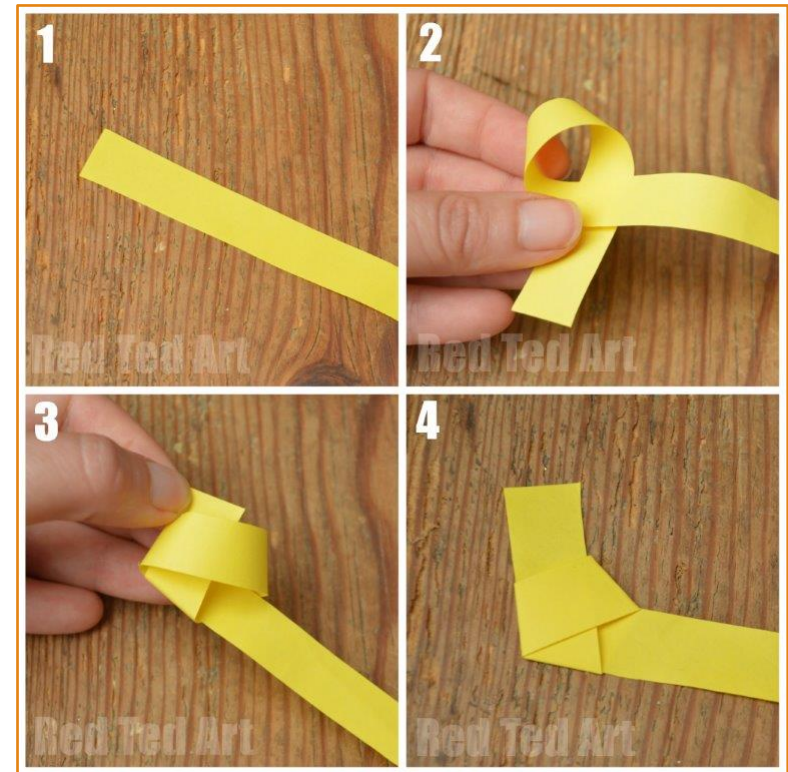
Plants – the golden ratio is common in plant geometry, giving rise to fivefold structures

Quasicrystals - minerals



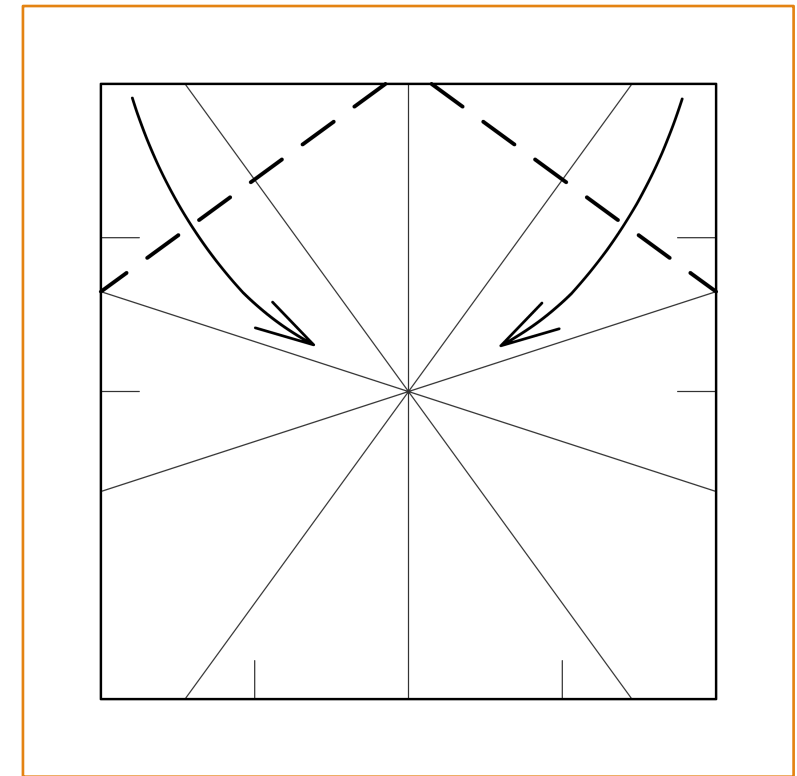
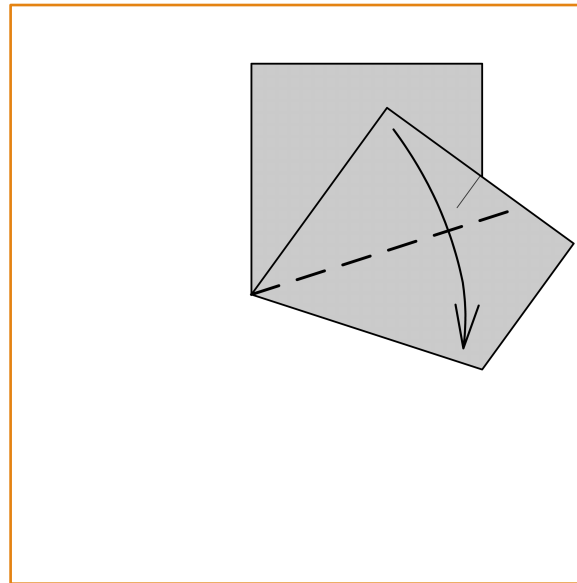
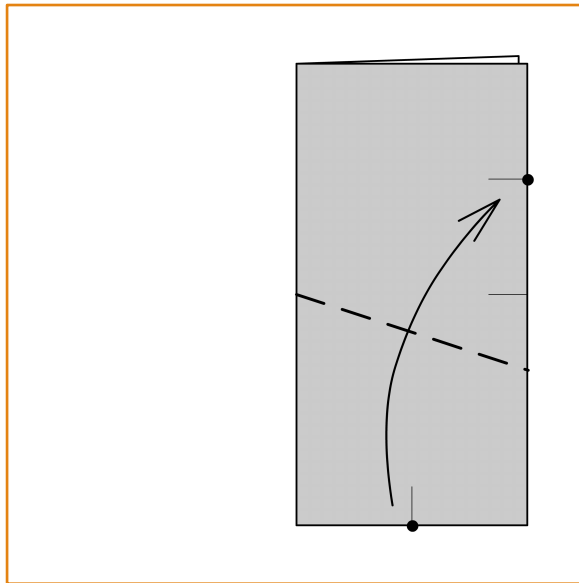
How to Fold a Pentagon

Making a pentagon from a strip (Puffy Stars)



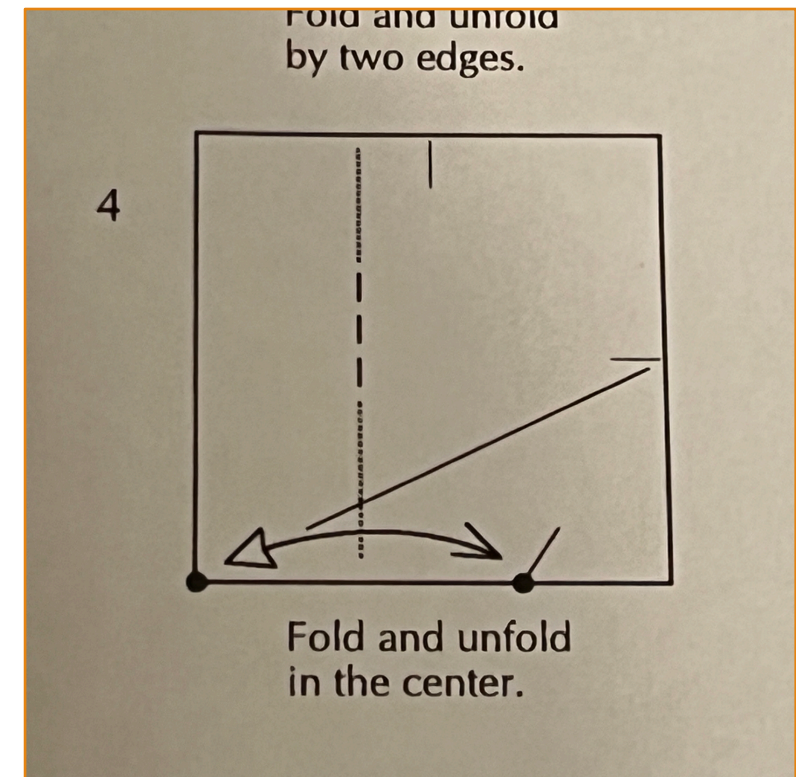
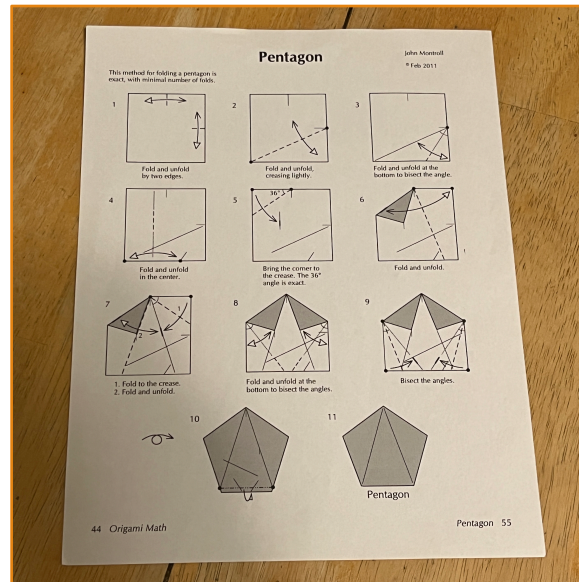
How to Fold a Pentagon from a Square

A very good approximation, based on the fact that the slope of an 18 degree angle is very close to 3:1.

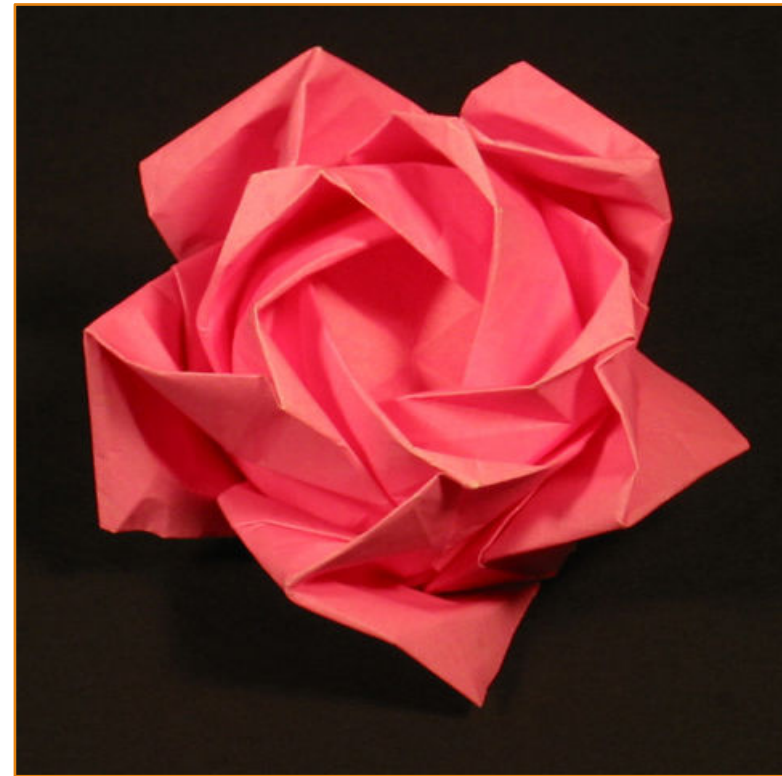


How to Fold a Pentagon from a Square

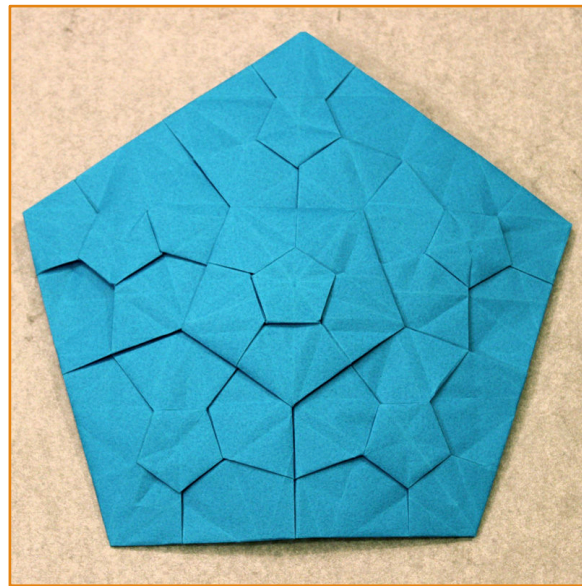
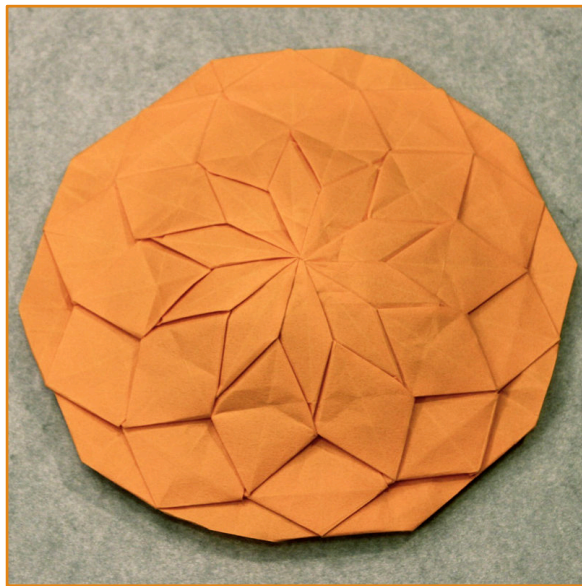
John Montroll has a mathematically perfect method based on first finding the golden mean latent in a square.



Models – Plants and Flowers

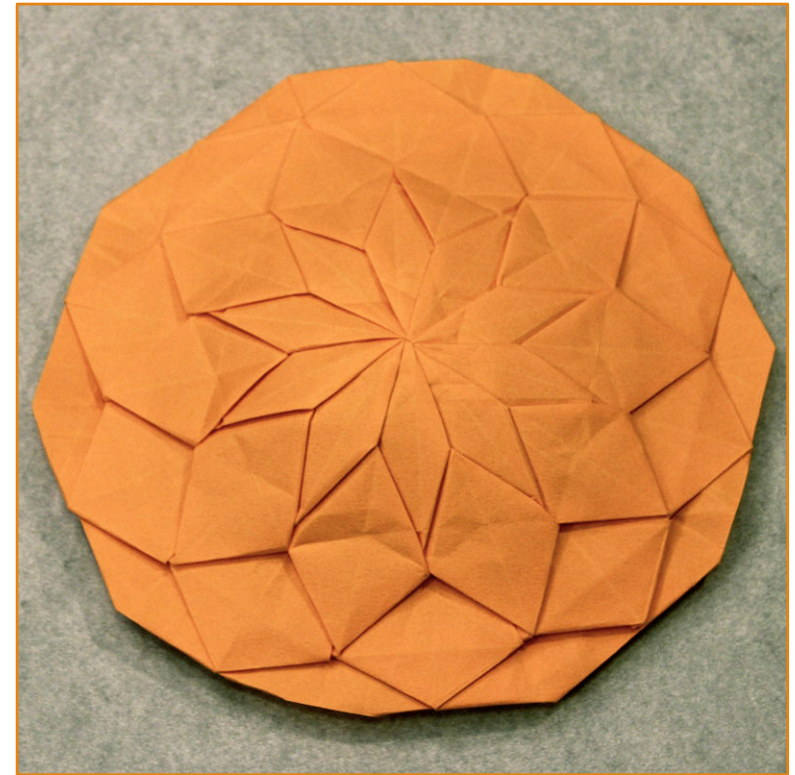
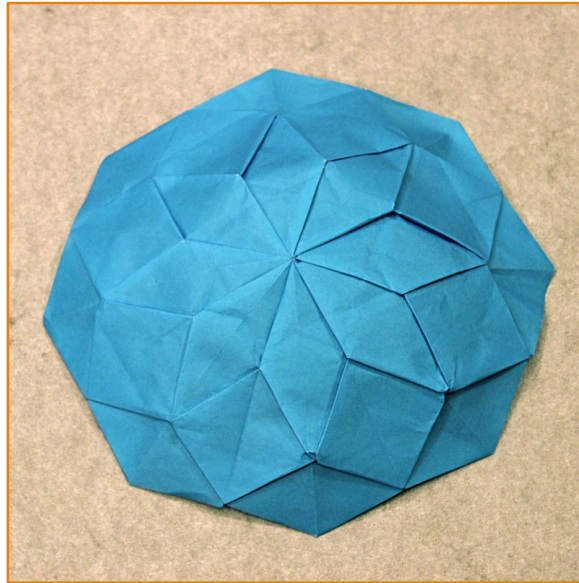
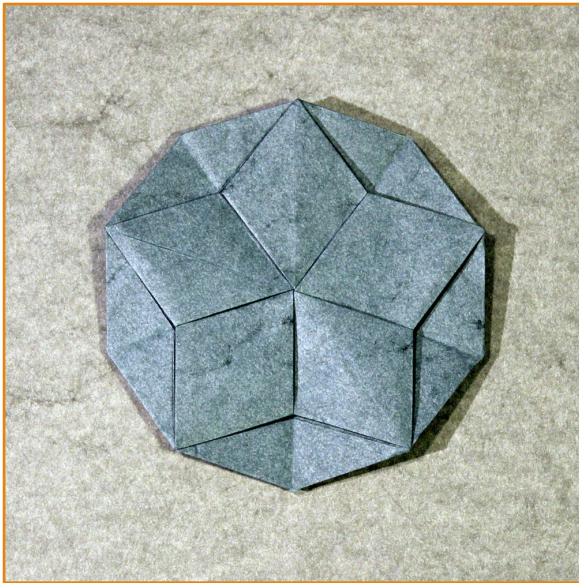


Models - Tessellations



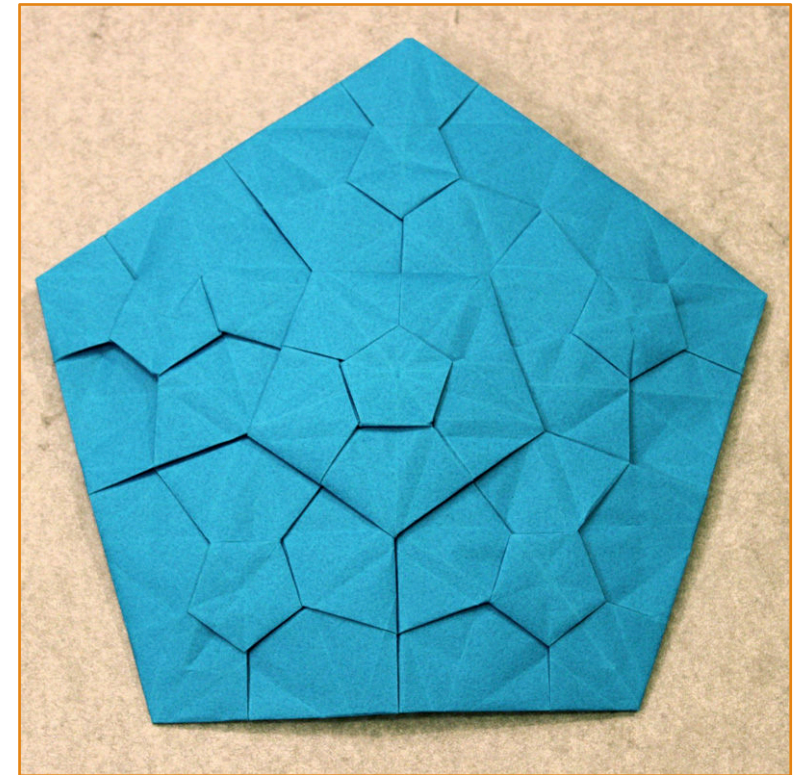
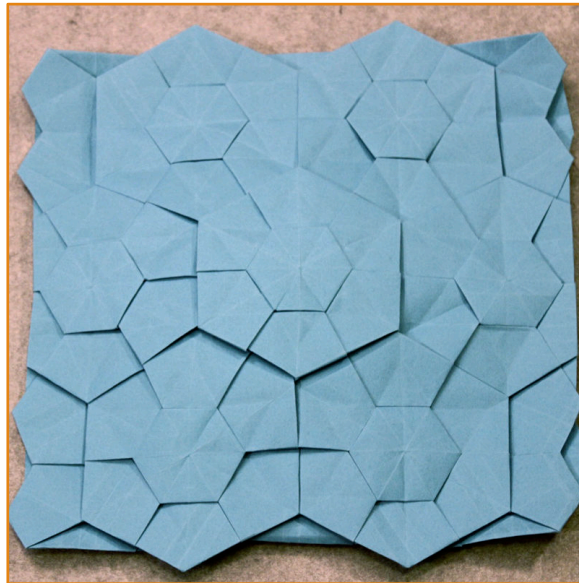
Mandala Tessellations

Feature polar symmetry and an array of progressively evolving parallelograms.



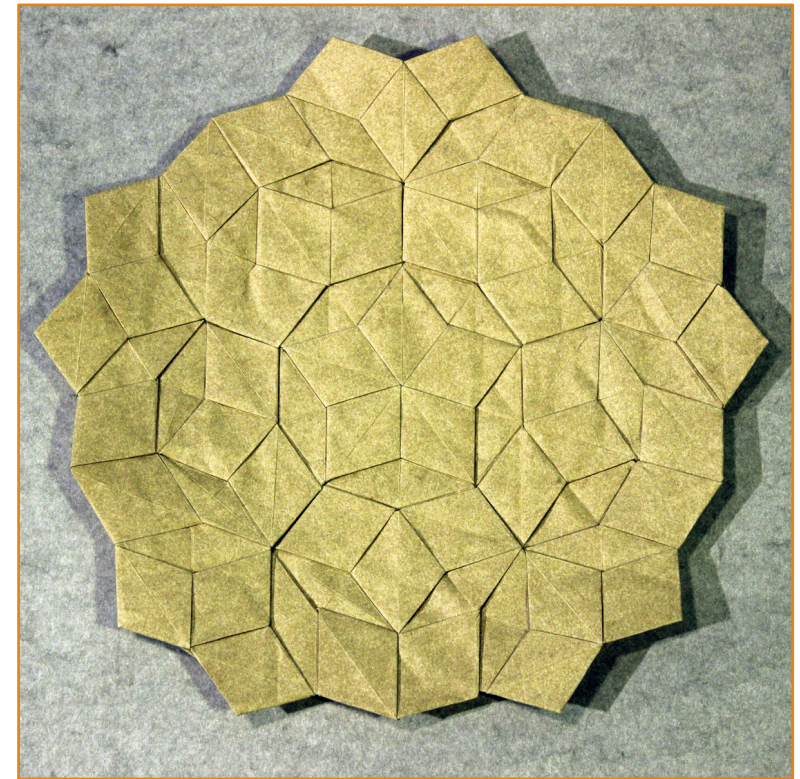
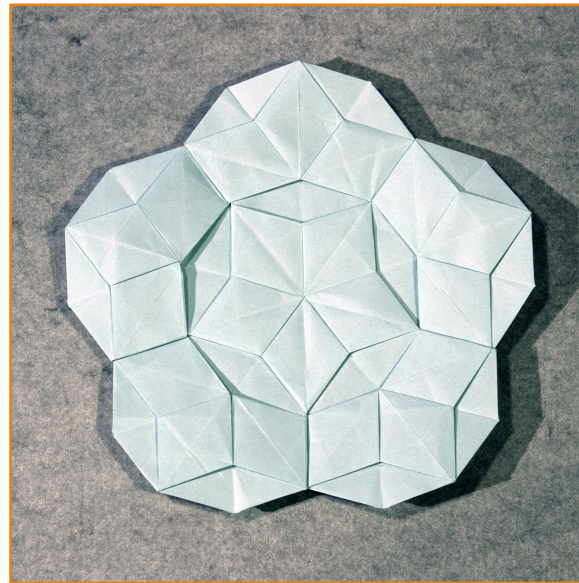
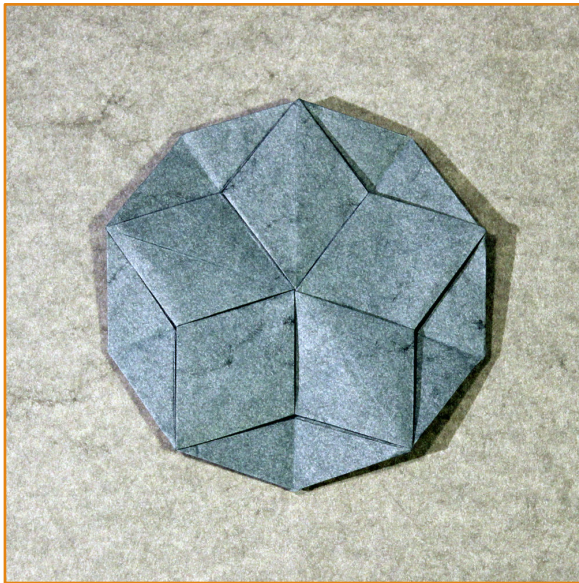
Fractal Tessellations

Made by subdividing the cells of of a grid into smaller cells.



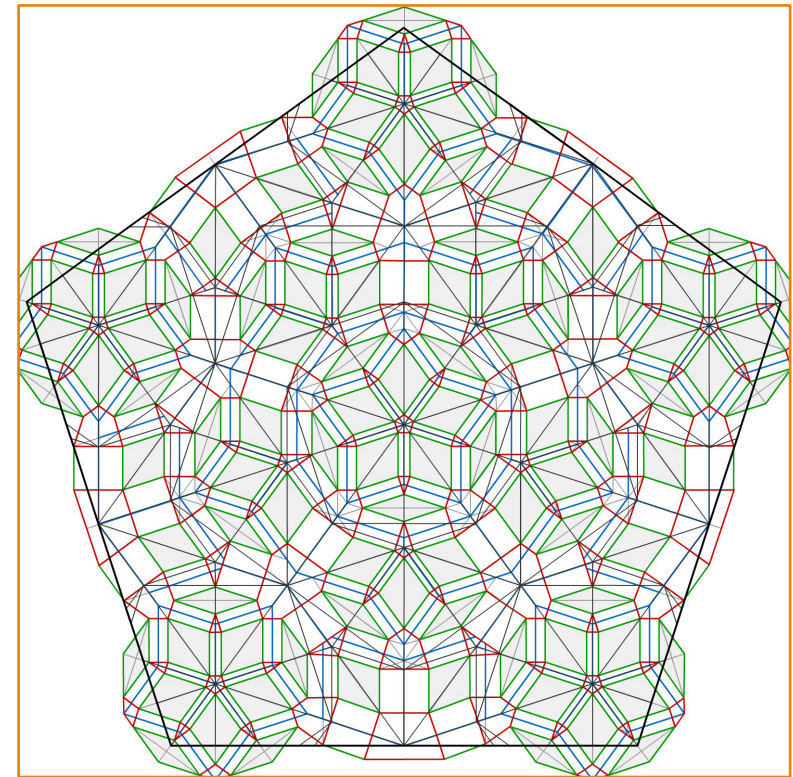
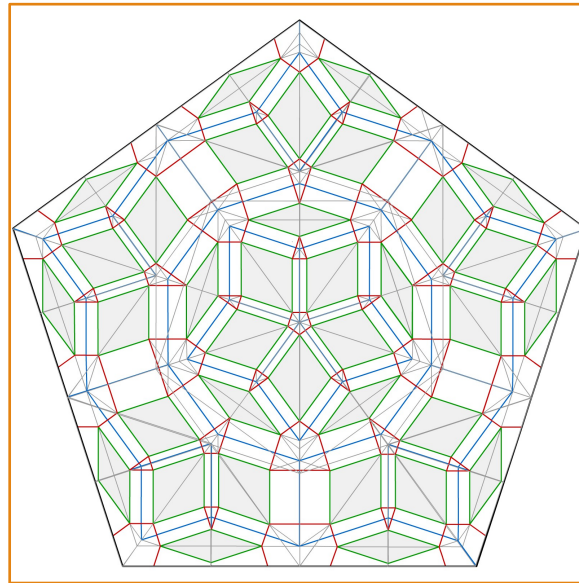
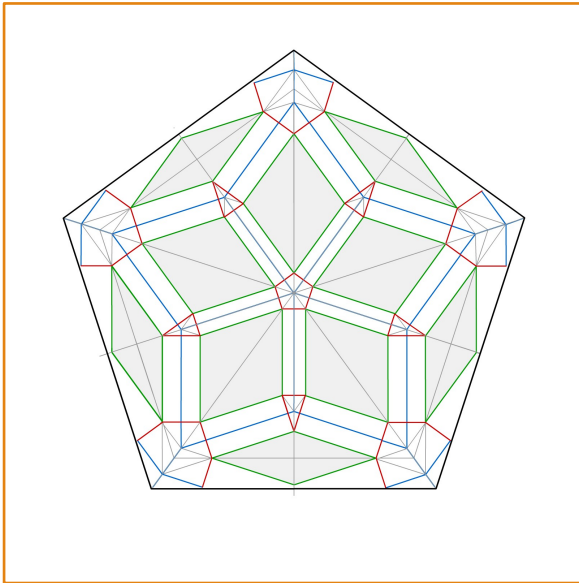
Penrose Tilings

Tiling use two rhombi, defined by local joining rules. The first three iterations shown, this could go on to infinity!



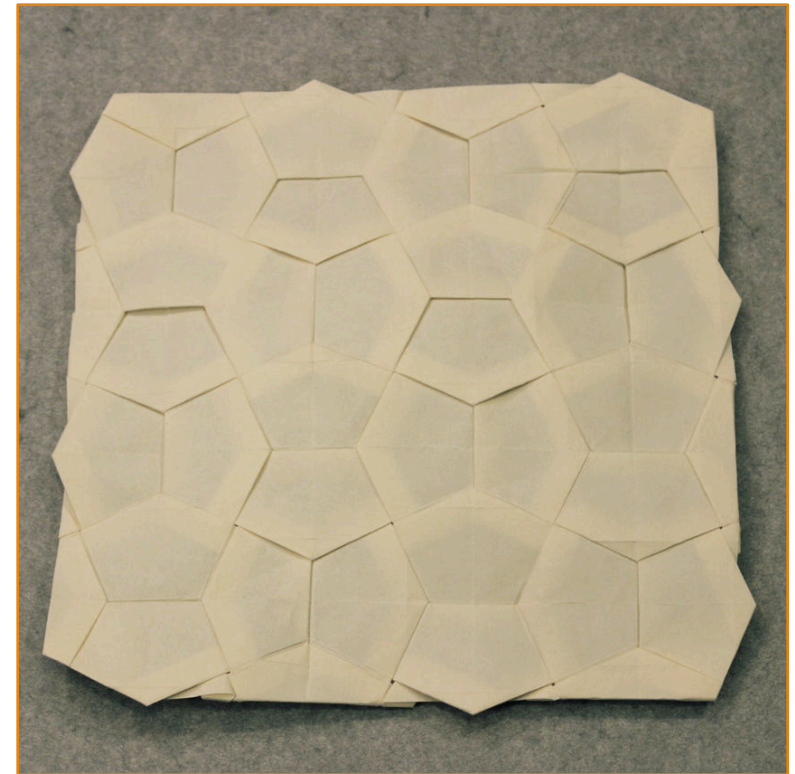
Penrose Tilings – Crease Pattern

The width of the gusset between the cells is dependent on the angles where they join at the vertex.

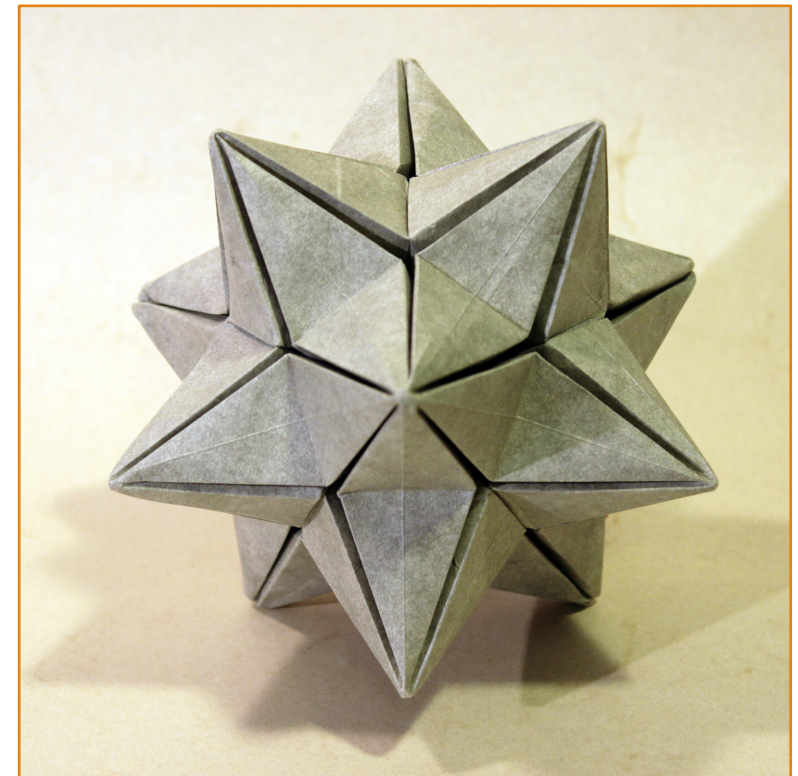
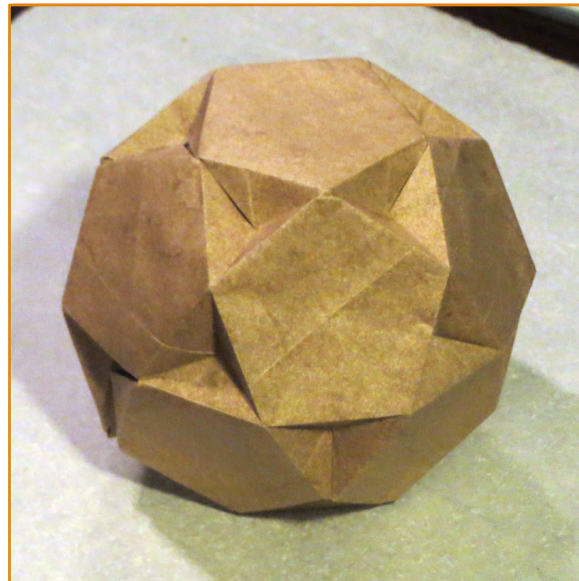


Other Tessellations

Some tessellations use pentagons but do not have fivefold symmetry, such as this Cairo Tessellation.



Single-Sheet Polyhedra

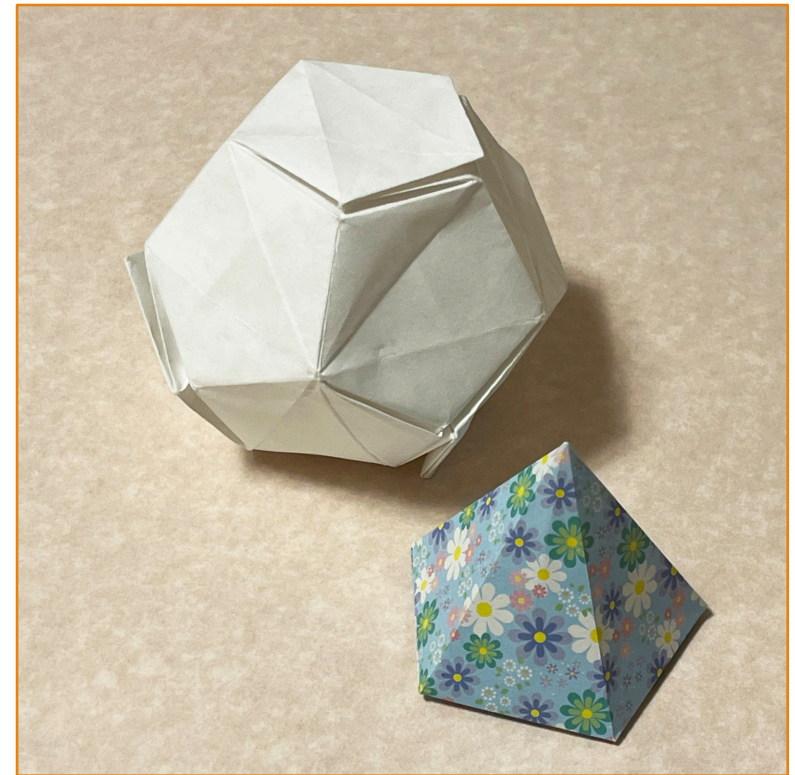


Pyramid and Dodecahedron

The Pentagonal Pyramid CP is latent in the pentagram.

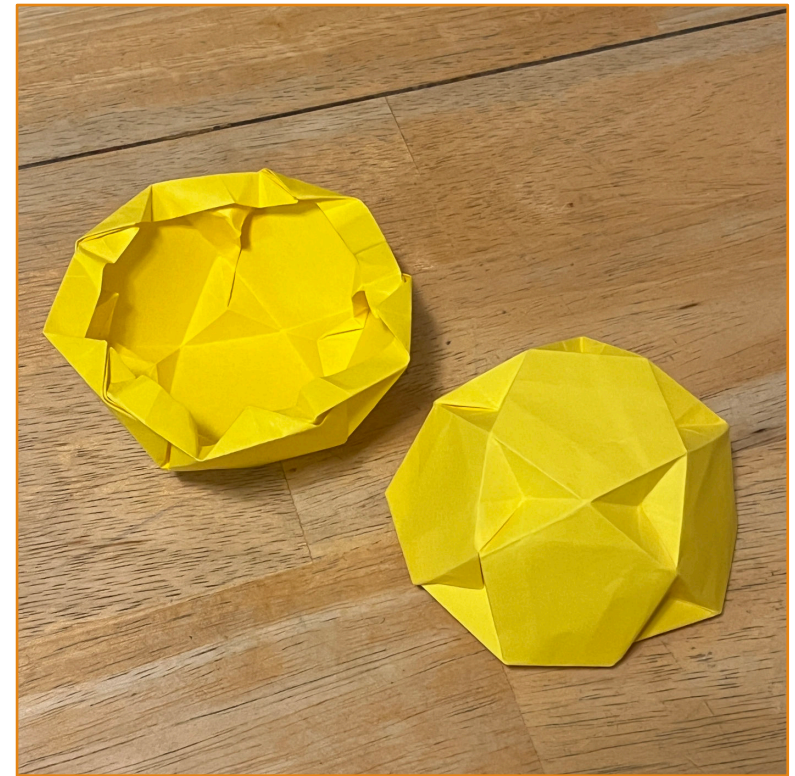
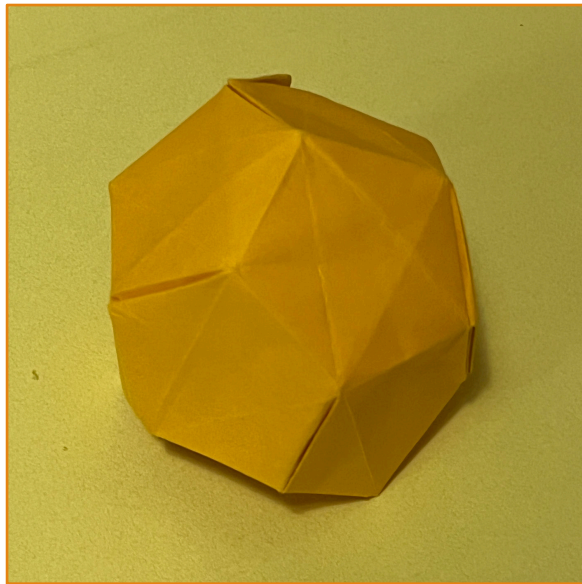
The Dodecahedron is much harder.

- There are many ways to fold a Dodecahedron, with different symmetries and layouts.
- The Dodecahedron can be a base for many other models. The best layout depends on the use.

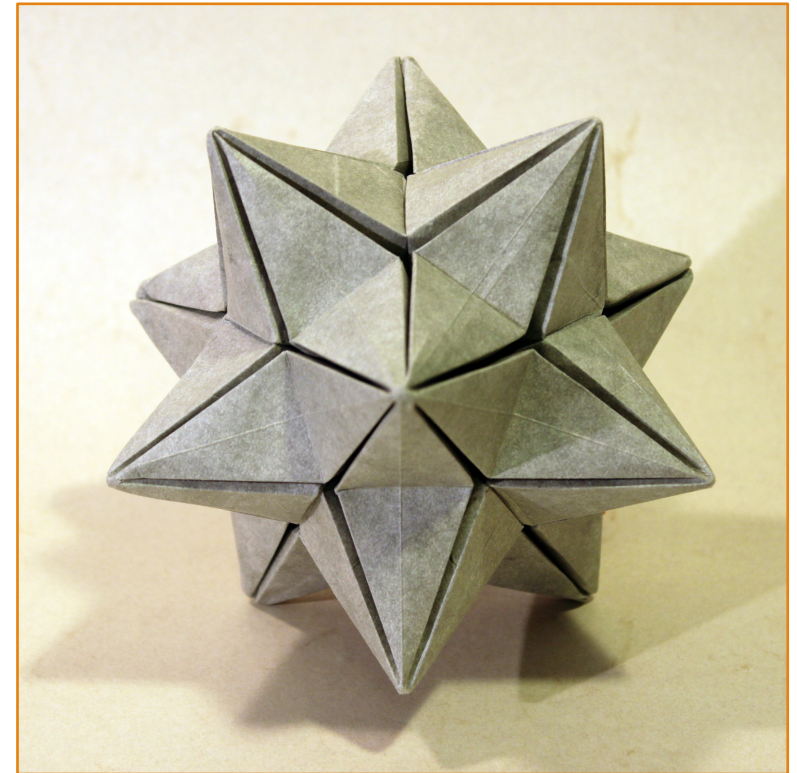
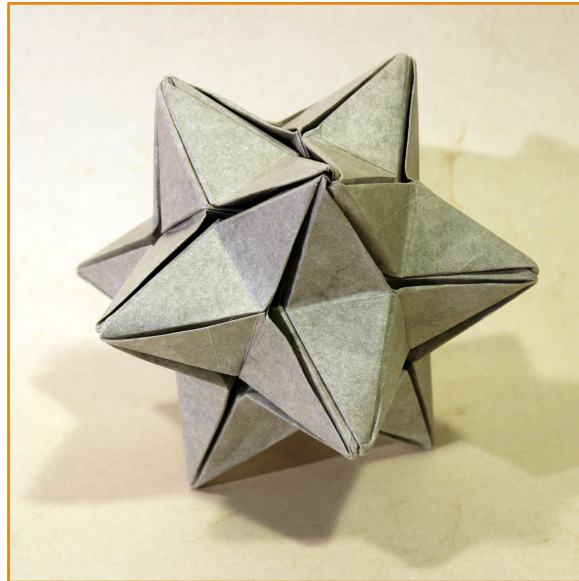
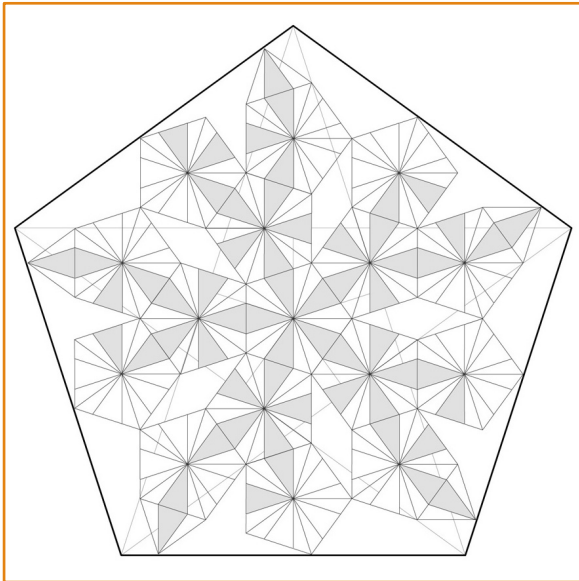


Domes and Bowls

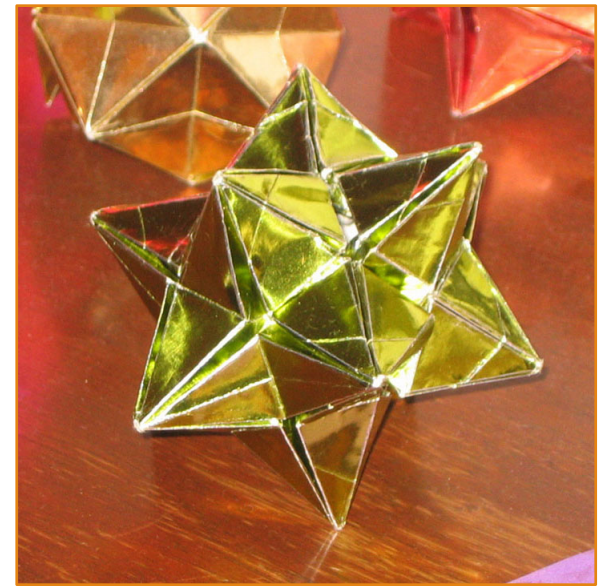
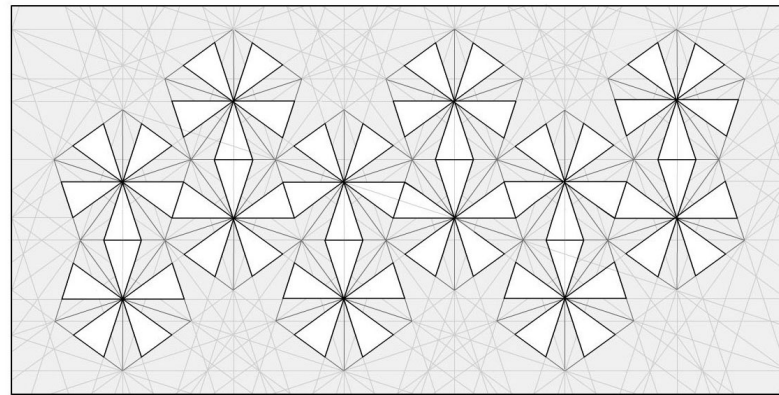
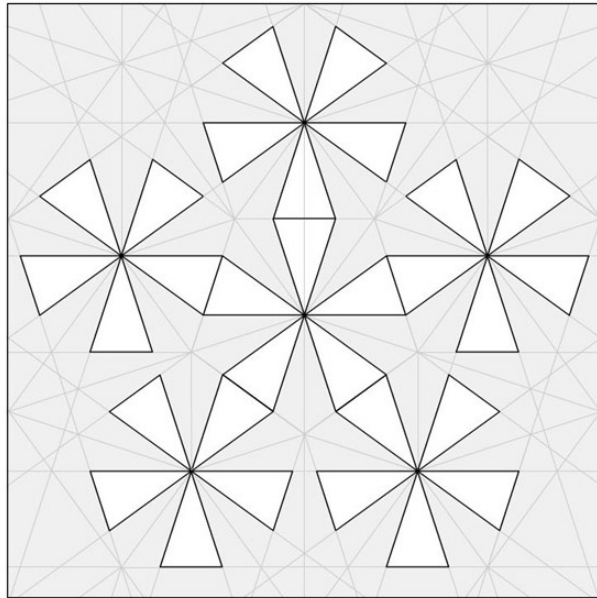
Can be used studies for models with complicated geometries, or complete models in their own right.



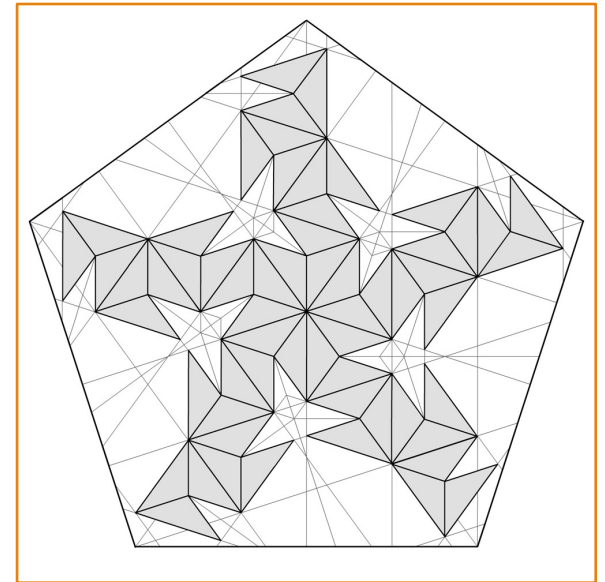
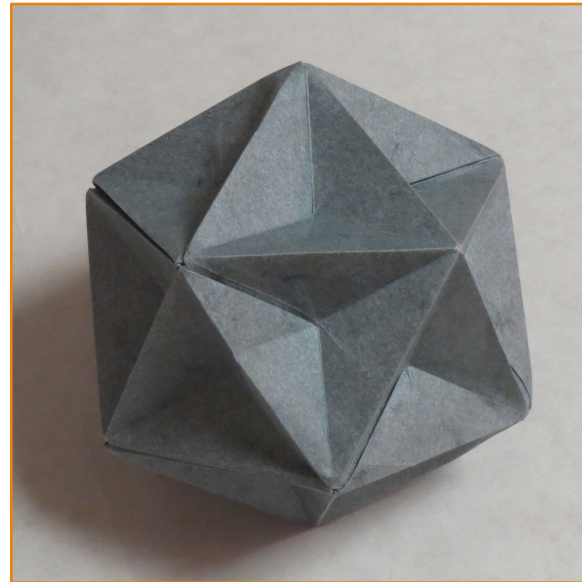
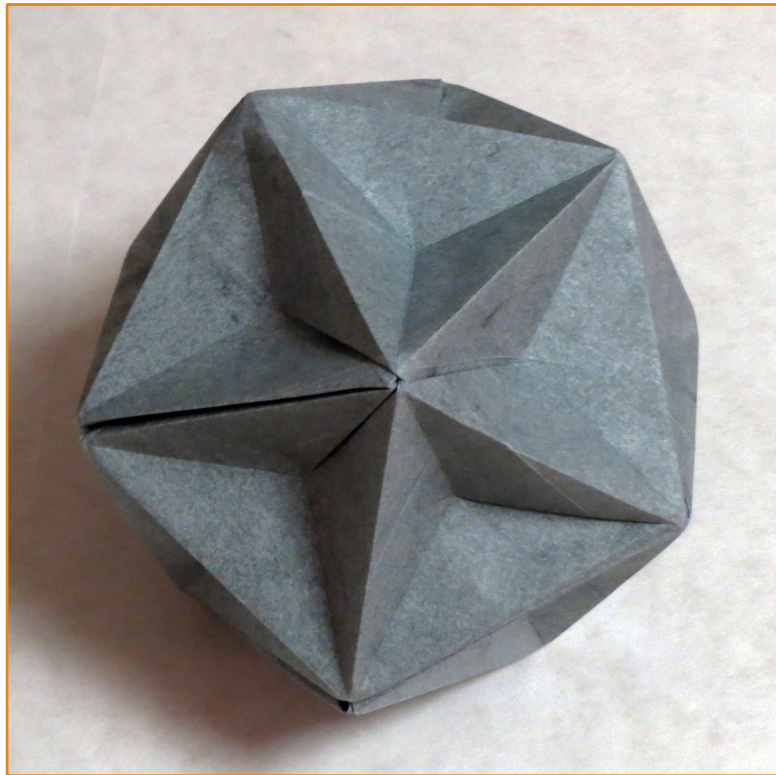
Stellated Dodecahedron



Stellated Dodecahedron - Studies

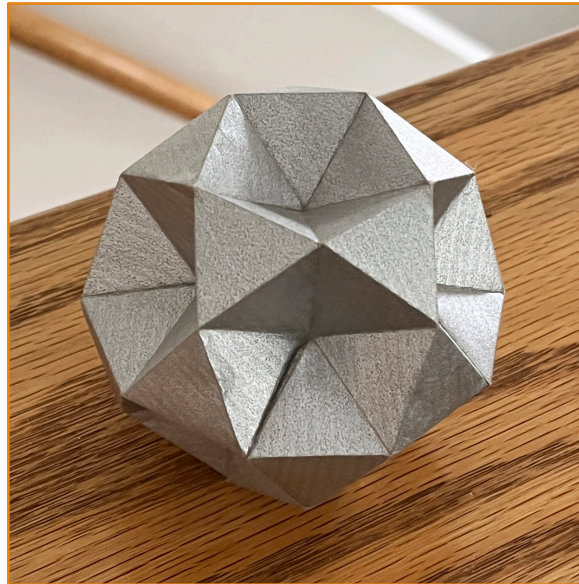


Great Dodecahedron



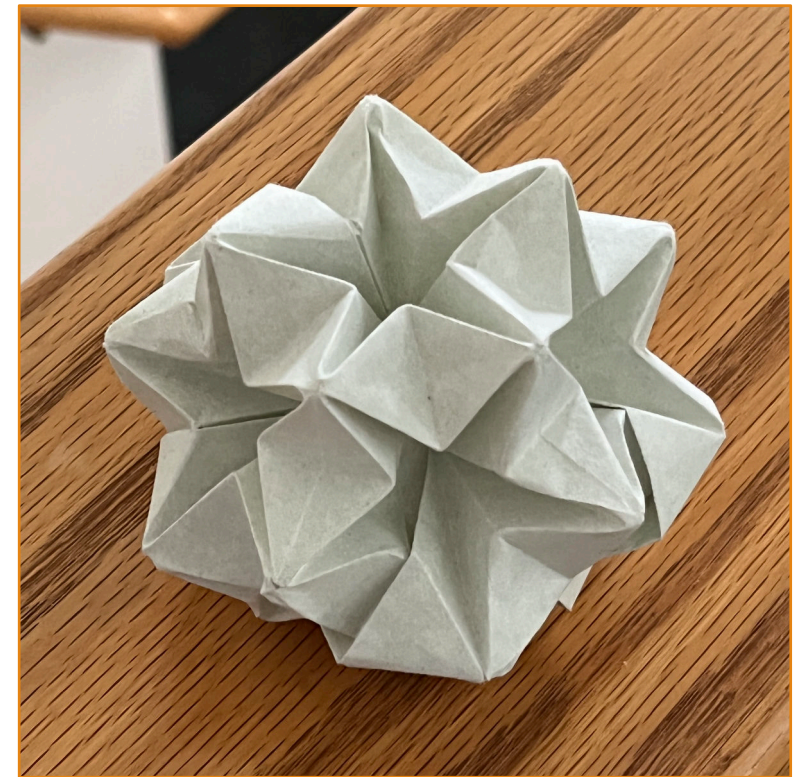
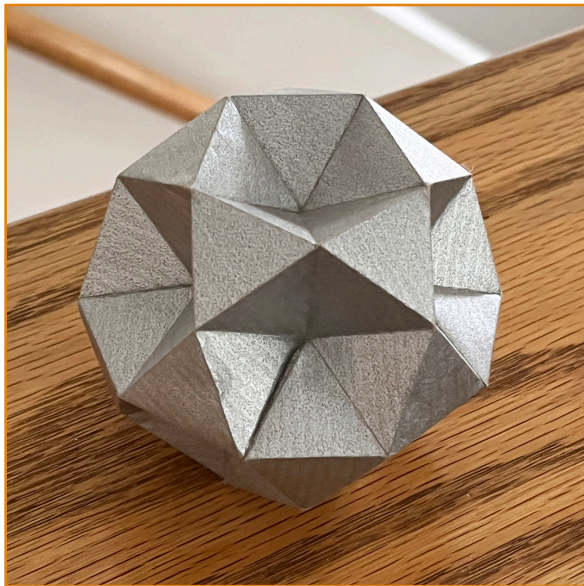
Dimpled Dodecahedron

Dual of the Dimpled Icosahedron, a very challenging shape to fold.



Aside – Icosahedral Symmetry

Folded with a triangular or hexagonal grid, but can suggest pentagonal symmetry in polyhedra.



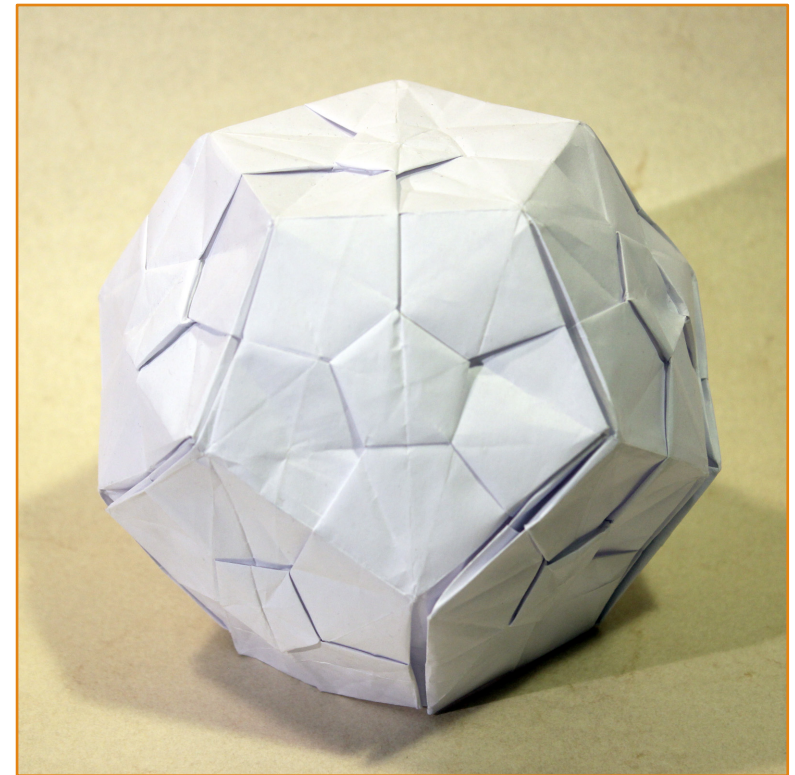
Tessellated Polyhedra

Developed from Fractal Tessellations

A fun alternative to modulars

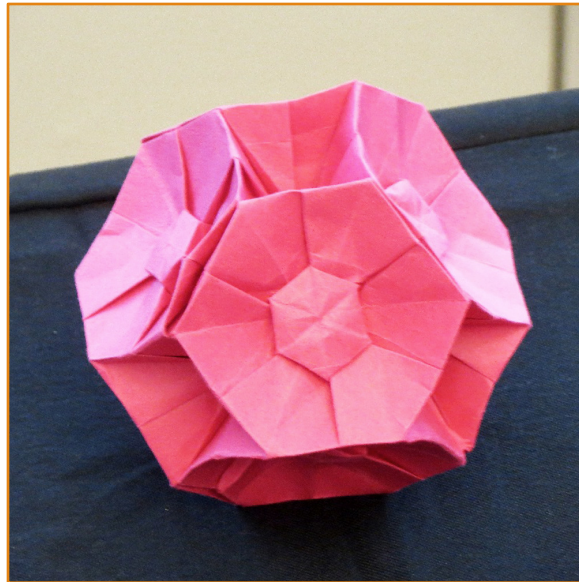
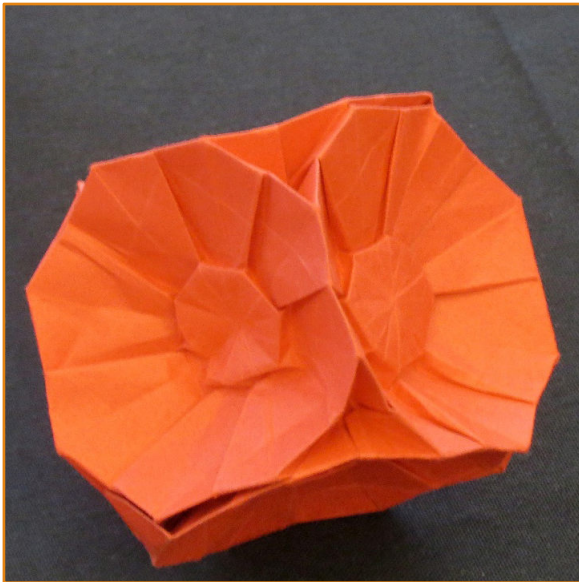
First embed the tessellation in the right places in the sheet

Then take that and create the 3-D form

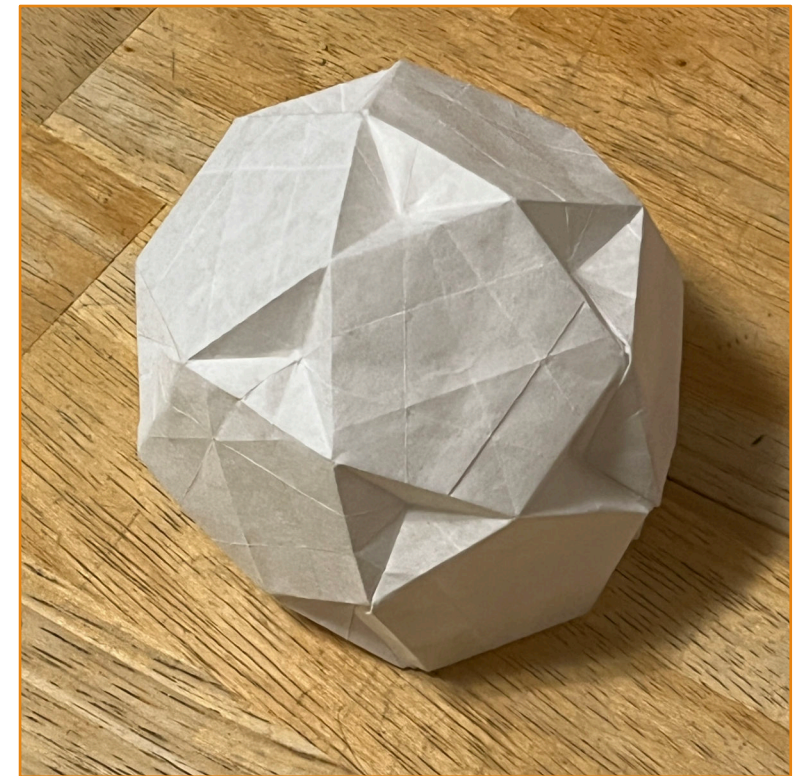
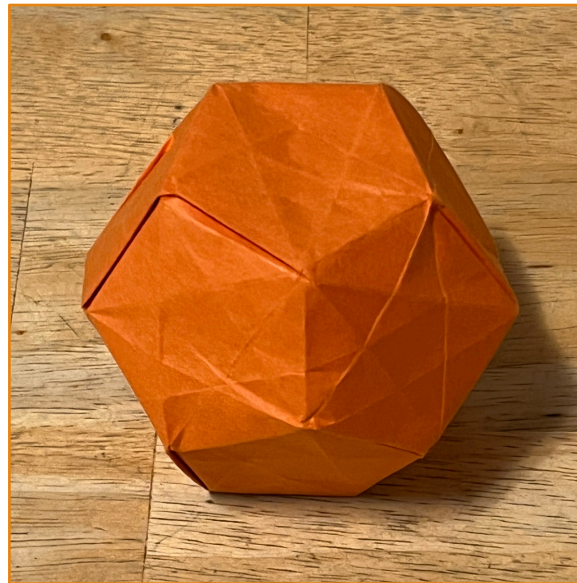


Flowerballs

Can be made with multiple symmetries using the same principle.

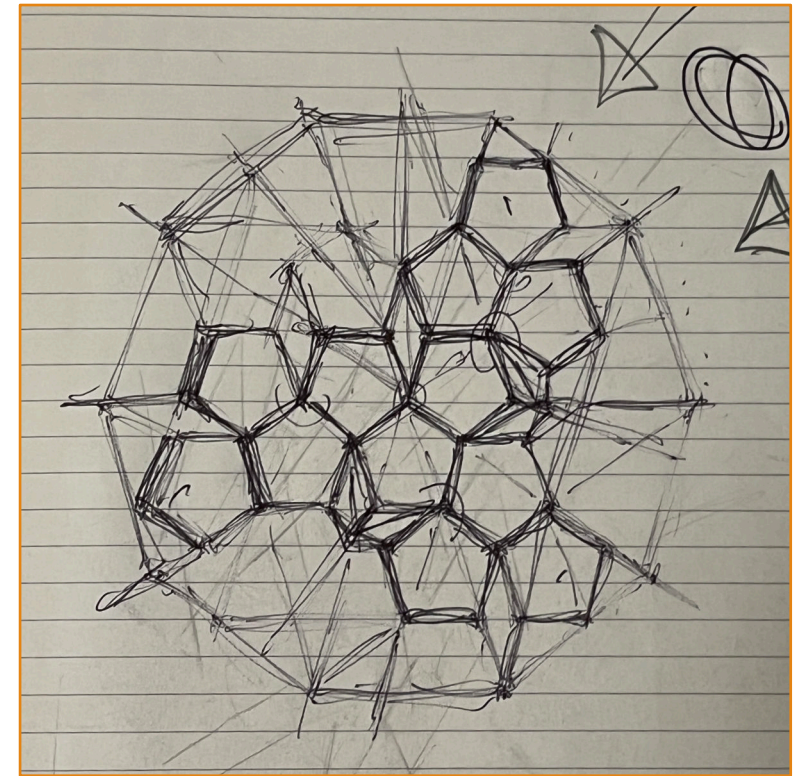
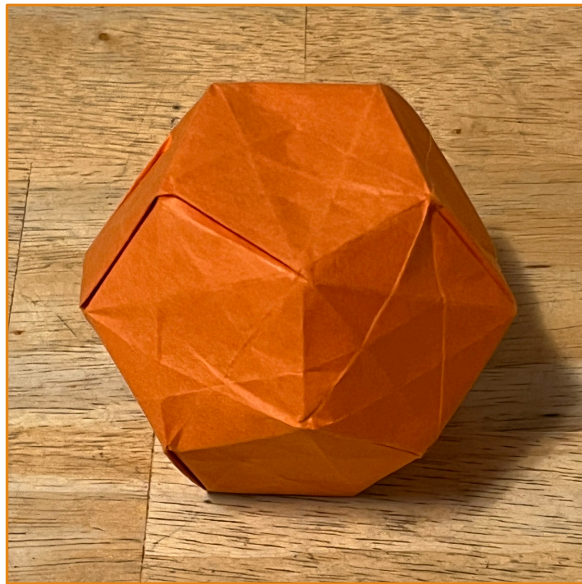


New Directions



Vertex-Centered Dodecahedron

Folded from a decagon; three vertices come together at the close.



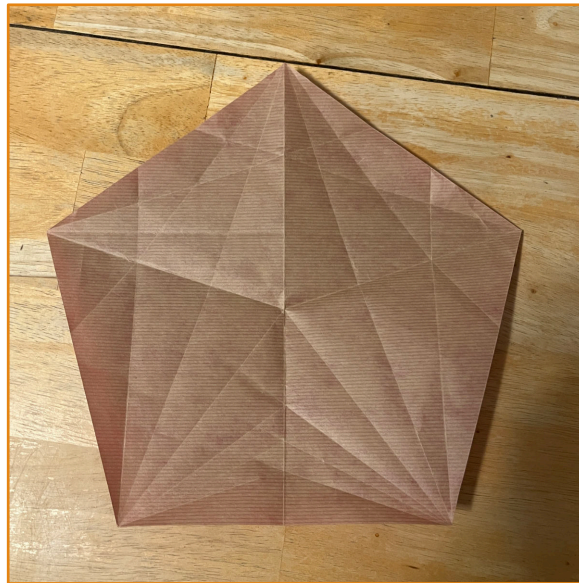
Vertex-Centered Dimpled Dodecahedron

Very hard to close.



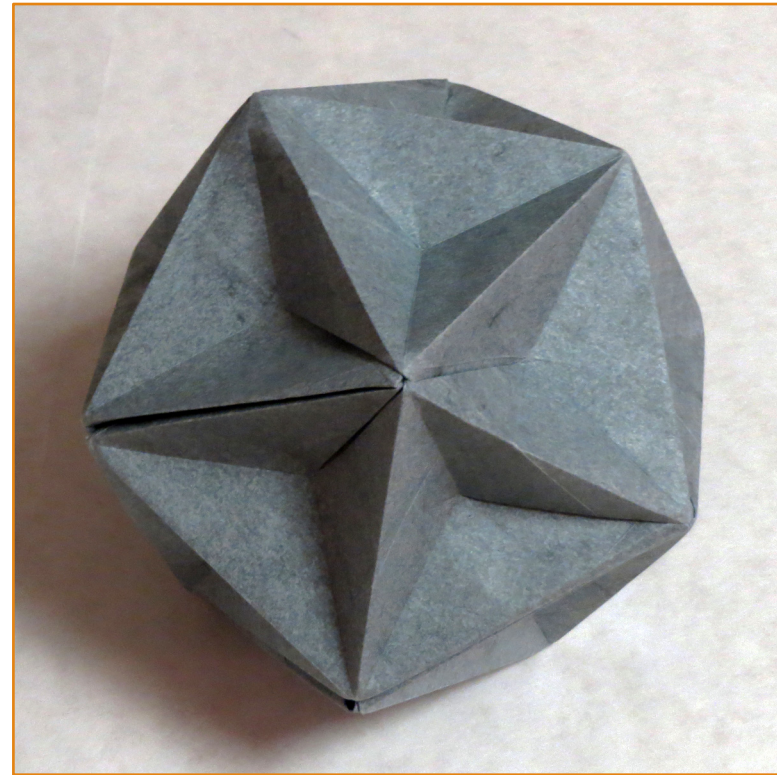
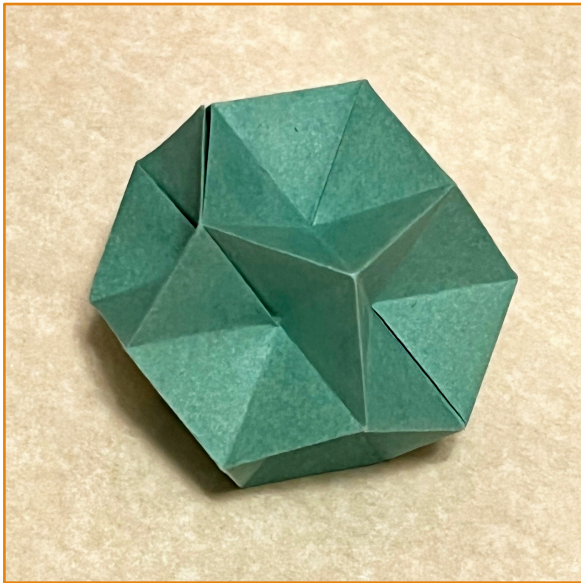
Star People

Human figure base from a pentagon



Star Heads

Human face base from a pentagon



Discussion

Any questions?

