WARM-UP

Can you cut an arrow-shape out of a piece of paper with a single straight-line cut?

Step 1: Draw an arrow

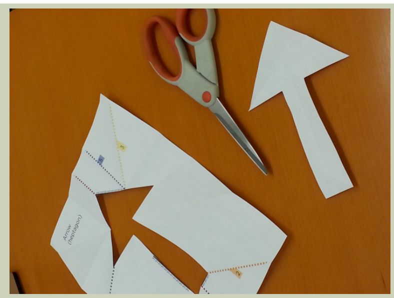
Step 2: Attempt to fold it up so that you can cut it out all at once.

AWESOME TWIST-AND-CUT RESULTS FROM @HOME EXPERIMENTS?

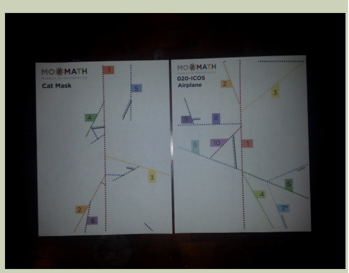
EUCLID AND DEMAINE

Computational Geometry and Origami

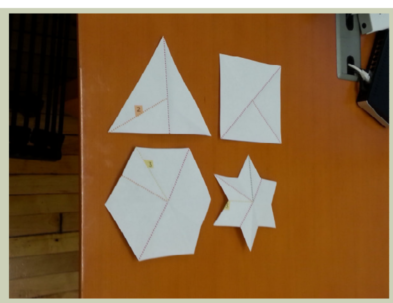
THE ONE-CUT ARROW



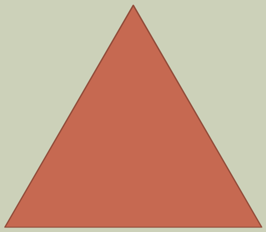
ONE-CUT POLYGONS



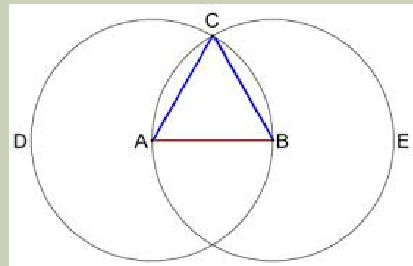
REGULAR, CONVEX POLYGONS



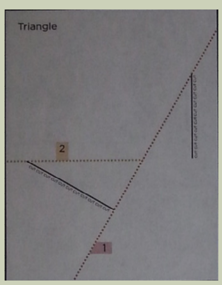
CONSTRUCTING AN EQUILATERAL TRIANGLE



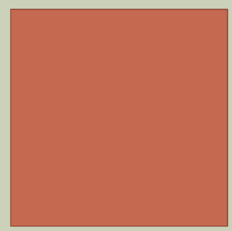
CONSTRUCTING AN EQUILATERAL TRIANGLE



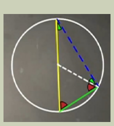
CUTTING OUT AN EQUILATERAL TRIANGLE

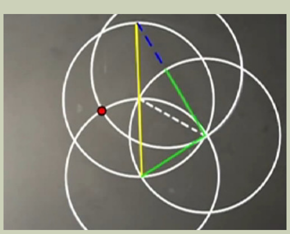


CONSTRUCTING A SQUARE



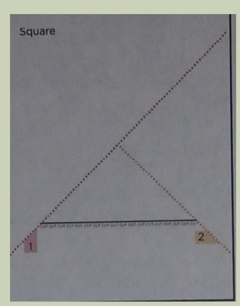
CONSTRUCTING A SQUARE



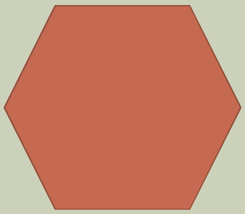


- MIT K12 Videos: http://video.mit.edu/watch/play-ball-the-house-that-euclid-built-10961/ ("The House that Euclid Built")

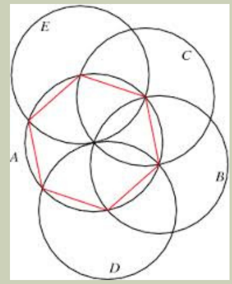
CUTTING OUT A SQUARE



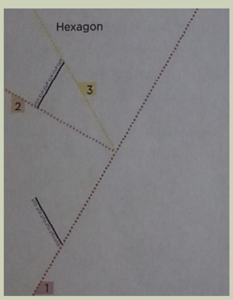
CONSTRUCTING A REGULAR HEXAGON



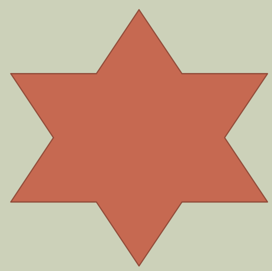
CONSTRUCTING A REGULAR HEXAGON



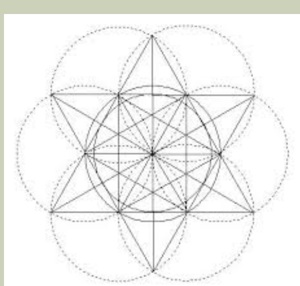
CUTTING OUT REGULAR HEXAGON



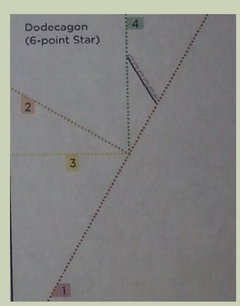
CONSTRUCTING A 6-PT STAR



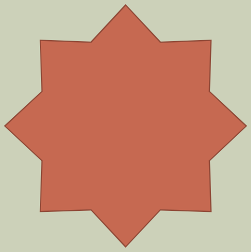
CONSTRUCTING A 6PT STAR



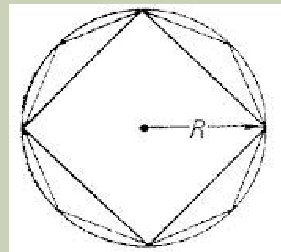
CUTTING OUT A 6PT STAR



CONSTRUCTING A REGULAR OCTAGON OR AN 8-POINTED STAR



CONSTRUCTING A REGULAR OCTAGON OR AN 8-POINTED STAR



CUTTING OUT A REGULAR N-GON

How many folds does it take to cut out a regular N-GON – what angles do you make the folds and the cut at?

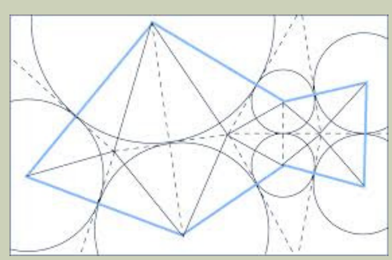
Extra Extension: How many different-looking crease patterns that use the minimal number of folds make the same regular polygons?

PART 2: IRREGULAR POLYGONS

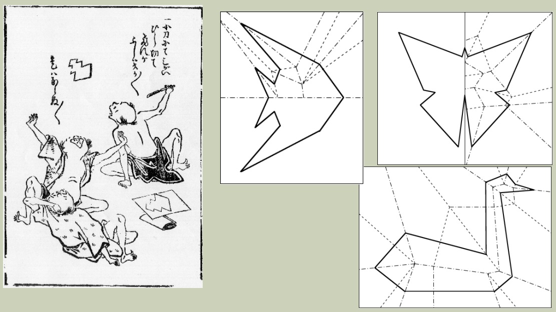
And "flat foldability"

IT'S ALL ABOUT…

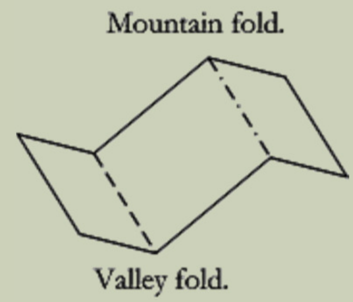
CIRCLES!



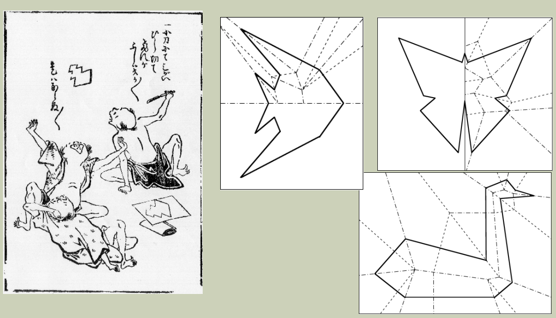
ONE-CUT EXAMPLES THAT REQUIRE PRE-CREASING



MOUNTAIN VS. VALLEY



TRY ONE OUT



1D FLAT FOLDING – COLLEGIATE LEVEL COMPUTATIONAL ORIGAMI

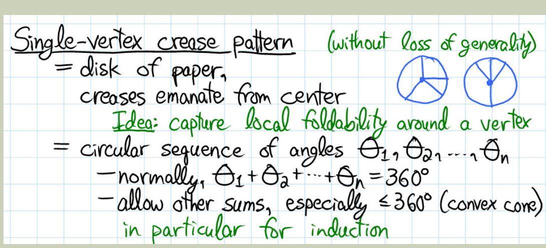
Folding a strip of paper – what patterns and spacing of mountain and valley folds are possible?

Step 1: Find a crease pattern that's impossible to fold

Super Extra Spicy:
Step 2: Characterize ALL of the patterns that cannot be folded

Super Extra Spicy:
What crease patterns can be flat folded if the paper is a ring instead of a finite segment?)

2D FLAT FOLDING



Eric Demaine's Lectures are available online, this is from the 3rd lecture: courses.csail.mit.edu/6.849/fall10/lectures/L03.pdf

2D FLAT FOLDING

Single Vertex Crease Patterns:

General Theorem: A single vertex crease pattern is foldable by angles θ_1 θ_2 θ_3 … θ_n is flat foldable if and only if n is even and the sum of the odd angles is equal to the sum of the even angles.

Mountain/Valley Assignments:
M-V = +/- 2

2D FLAT FOLDING

WORKING IT OUT IN STAGES

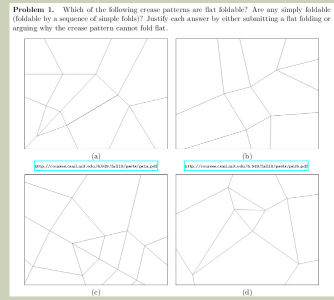
1) Why must the degree be even?

2) A Special Case: A 4-degree vertex: prove that opposite segments must each be a pair of angles that sum to 180.

3) Generalize to 2n-degree vertices

4) Why does M-V = +/- 2

6.849 FIRST PROBLEM SET, FIRST PROBLEM


Problem 1. Which of the following crease patterns are flat foldable? Are any simply foldable (foldable by a sequence of simple folds)? Justify each answer by either submitting a flat folding or arguing why the crease pattern cannot fold flat.

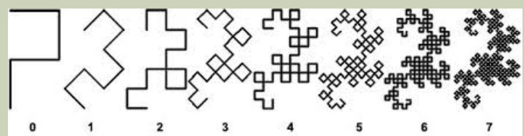
FOLDING A FRACTAL

Instructions:

- Take a strip of paper
- Fold it in half to the right
- Fold the result in half to the right
- …etc…
- Unfold, but don't flatten the strip – correct each crease until it is exactly a right angle.

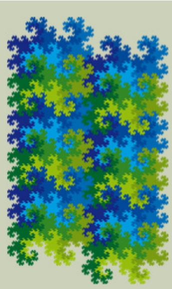
Exercise:
What will the pattern of Mountain vs. Valley creases be?

FOLDING A FRACTAL

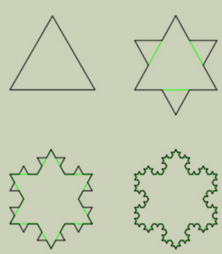


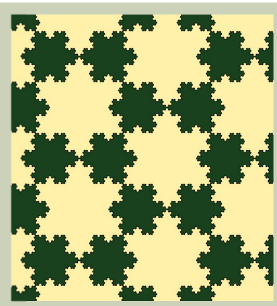
FOLDING A FRACTAL

The Dragon Curve:

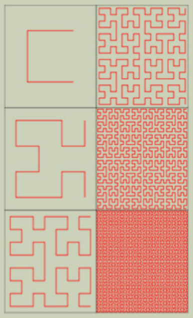


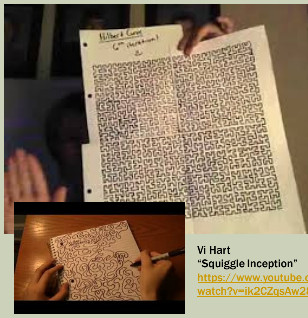
MORE FRACTAL FOLDING AND TILING





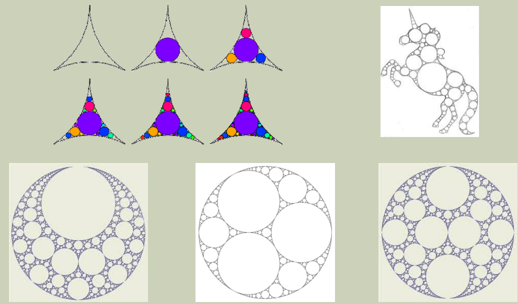
MORE FRACTALS: THE HILBERT CURVES





Vi Hart
"Squiggle Inception"
https://www.youtube.com/watch?v=ik2CZqsAw28

MORE FRACTALS: THE APOLLONIAN GASKET



IN THE NEXT ROUND OF SESSIONS… TESSELLATIONS!

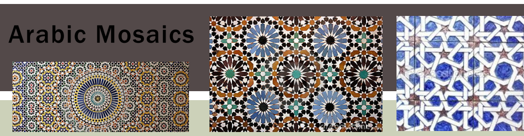
TESSELLATIONS

Tessellation: a set of shapes which fit together to cover a surface without any gaps or overlaps.

Monohedral Tessellation: a tessellation in which all of the tiles are congruent (exactly the same)

PARQUET DEFORMATIONS

Arabic Mosaics



Temari Balls

Escher Drawings