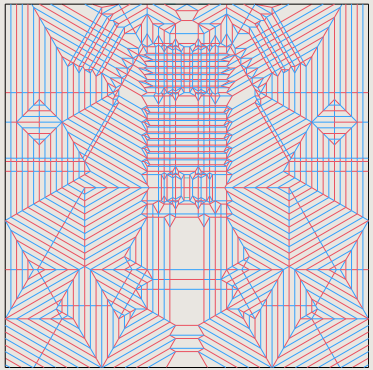
New techniques in Hex Pleating

for representational origami design

Brandon Wong

Uniaxial hex pleating





Non-uniaxial hex pleating



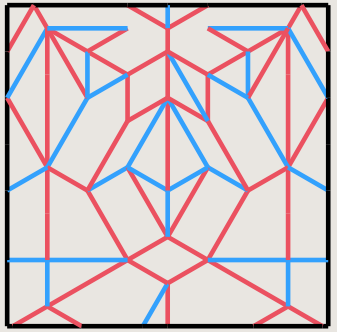




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3 Non-uniaxial hex pleating

4 Conclusion



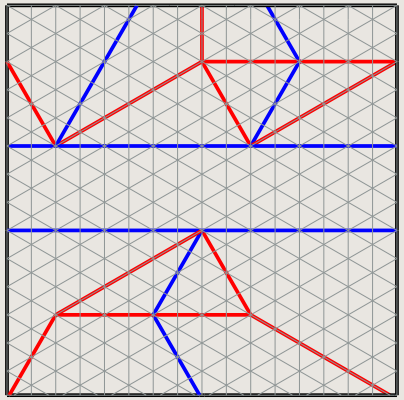
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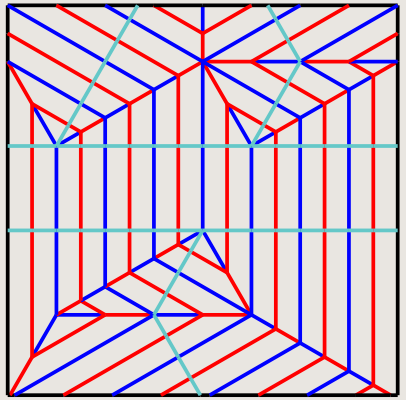
Introduction

Background, terminology, and conventions

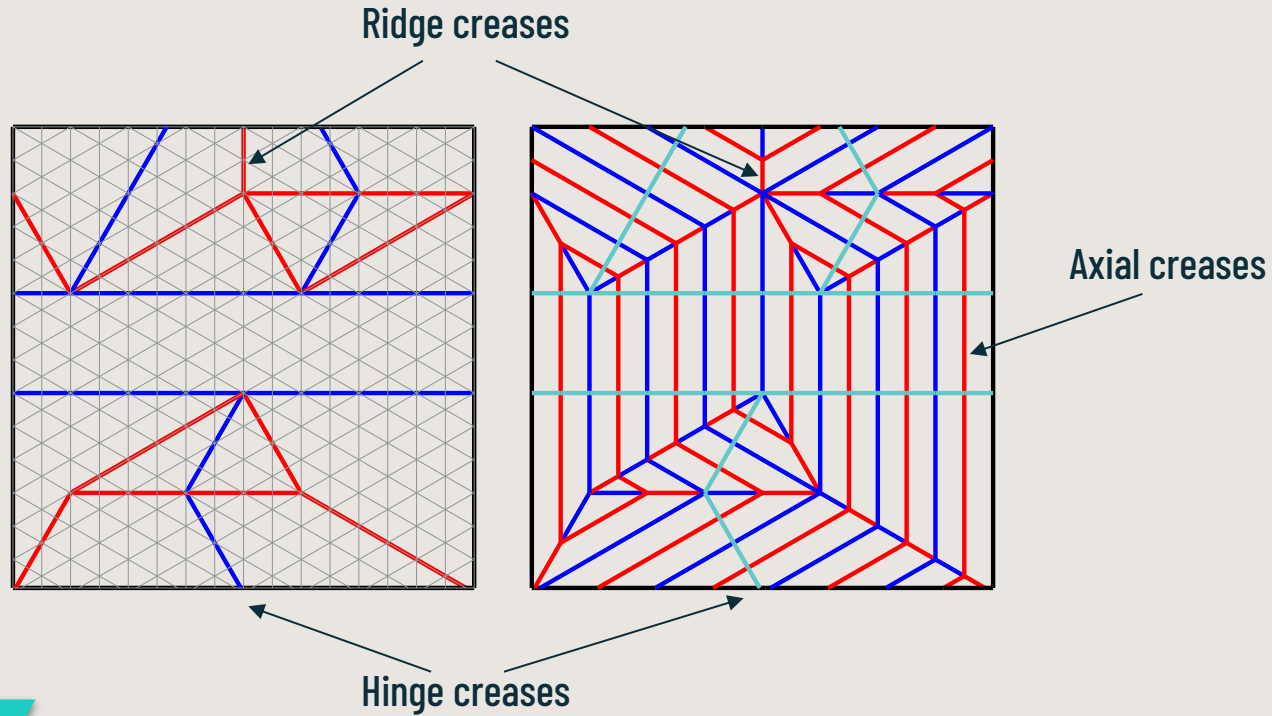
Hex pleating

"A form of polygon packing in which the major creases run at multiples of 30 degrees relative to one another" (Lang, *Origami Design Secrets*)

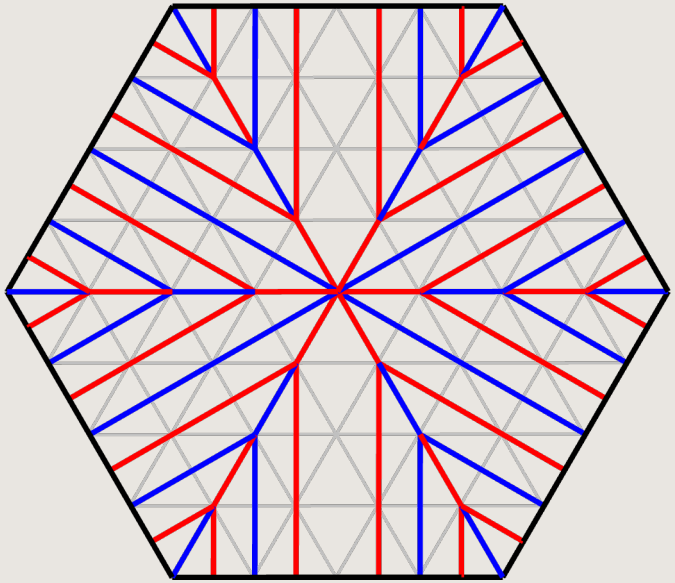




Background: Ridge, Hinge, and Axial creases

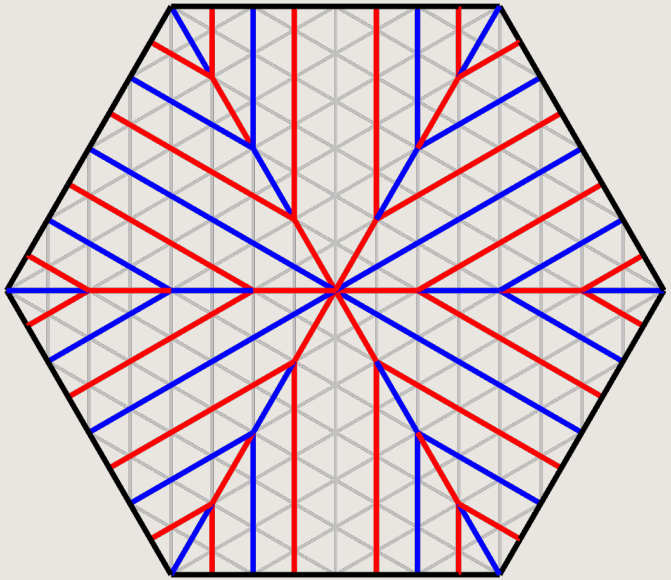


Grid orientation



Hinge grid orientation (used by Lang)

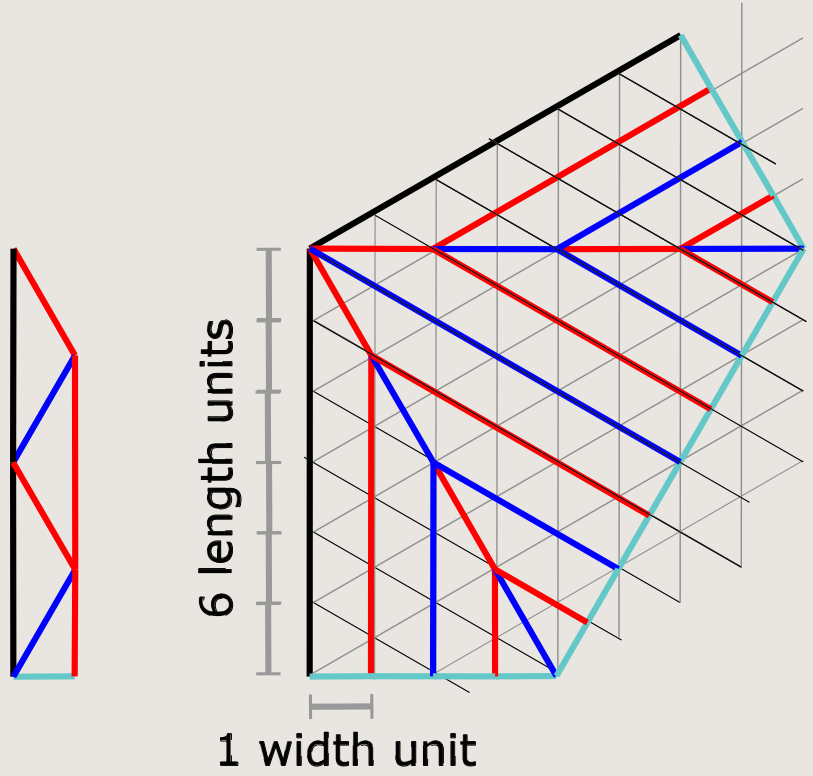
4 unit long flap



Axial grid orientation

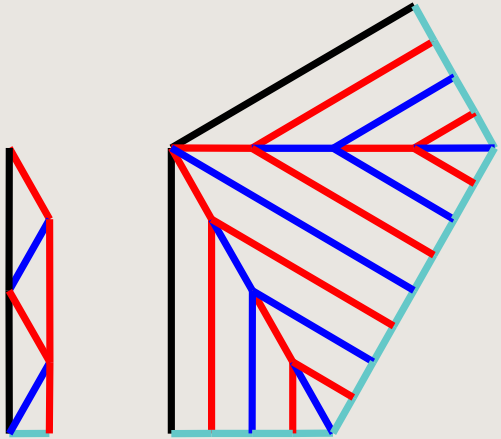
6 unit long flap

Length vs width units

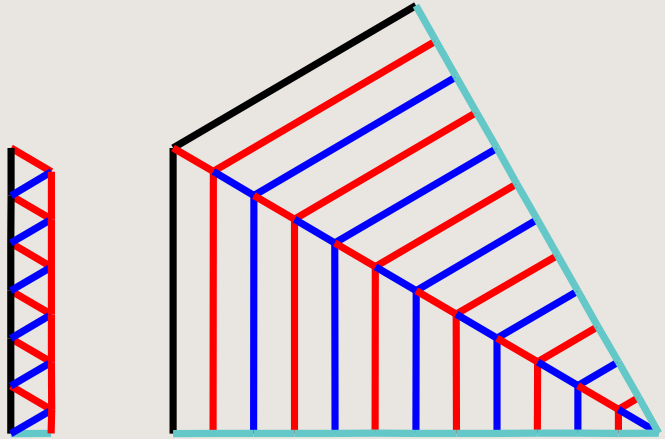


Steep vs Shallow Ridges

Steep ridge



Shallow ridge



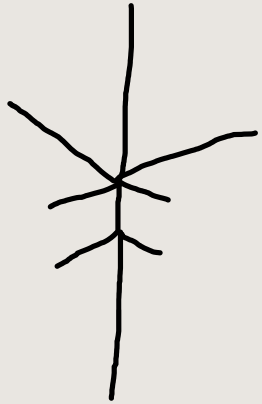
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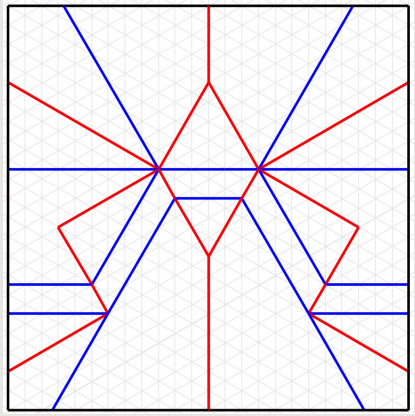
Uniaxial HP

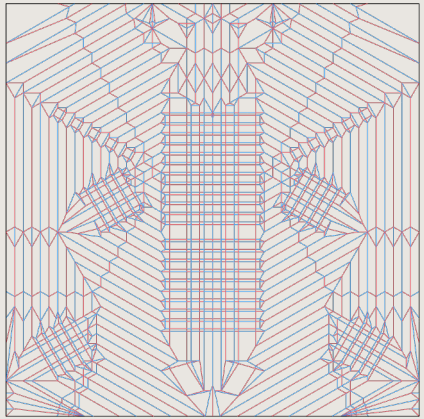
Basics, ridge misalignments,
ridge sliding, space allocation

Background: uniaxial design

Tree → Packing → Crease pattern → Fold

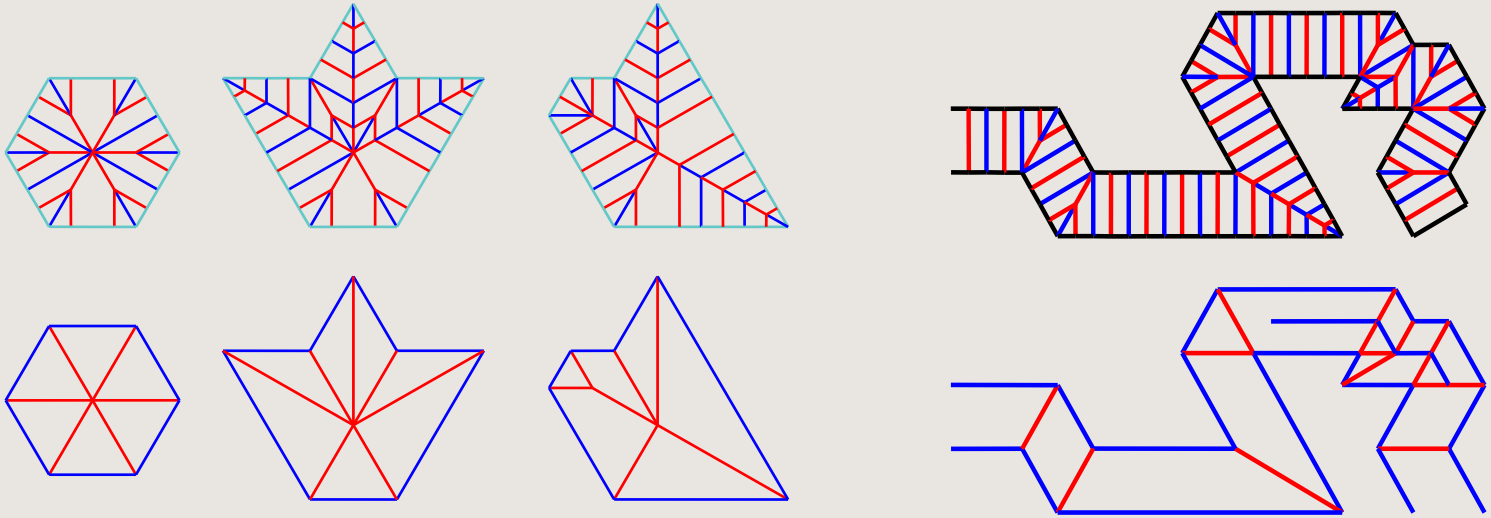






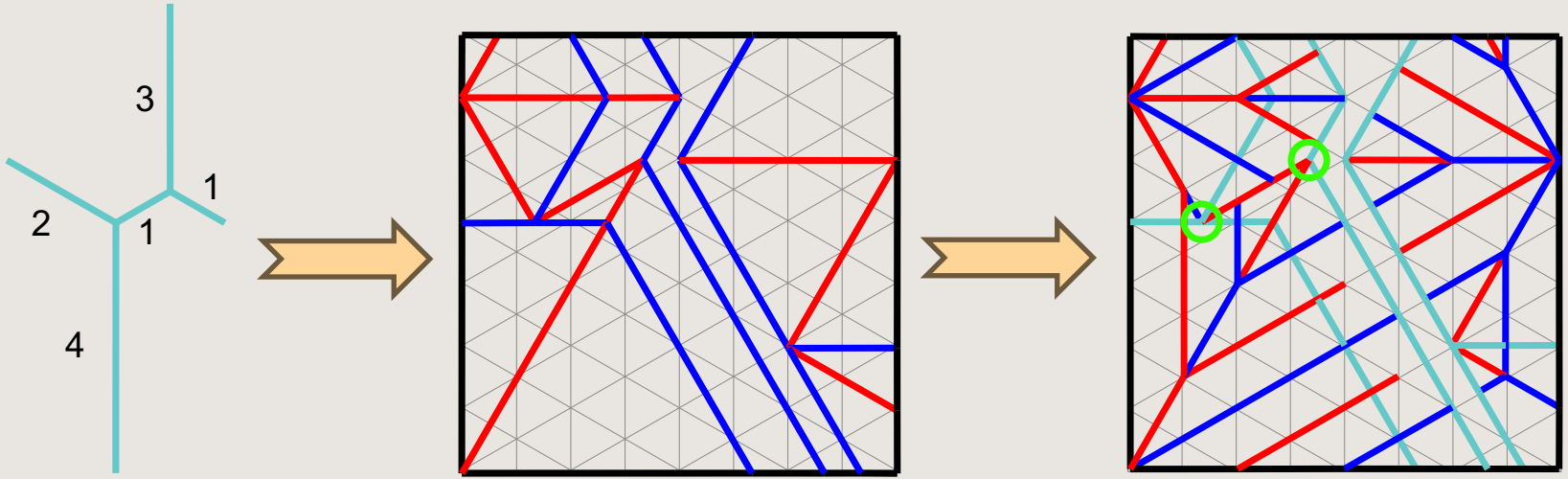


Background: Packing

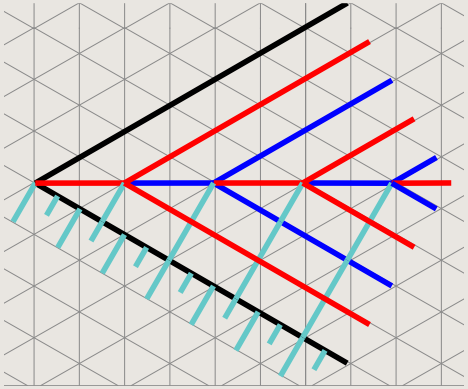


- Flaps can use a combination of steep and shallow ridges
- Polygons must fill the whole square, without overlapping

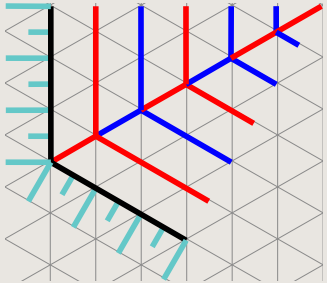
Ridge misalignments



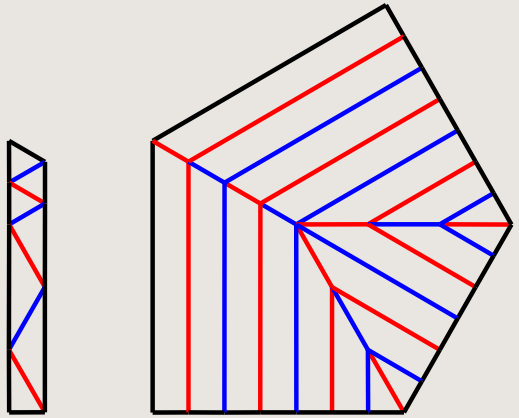
Ridge misalignments continued



1 steep ridge = 1.5 length units

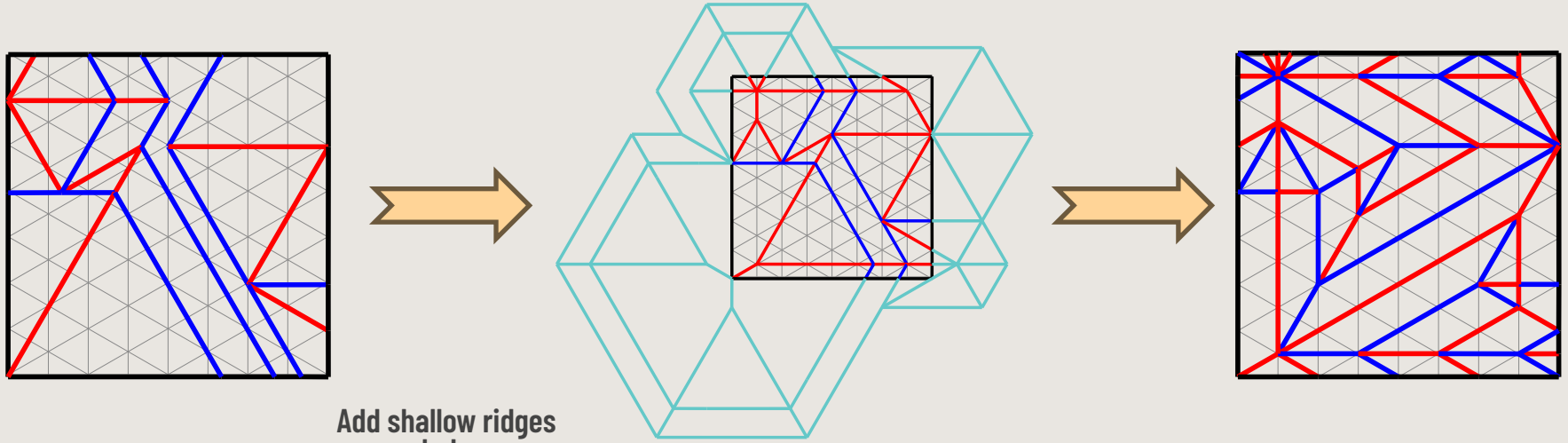


1 shallow ridge = 0.5 length units



4 (0.5) + 3 (1.5) = 6.5 length units

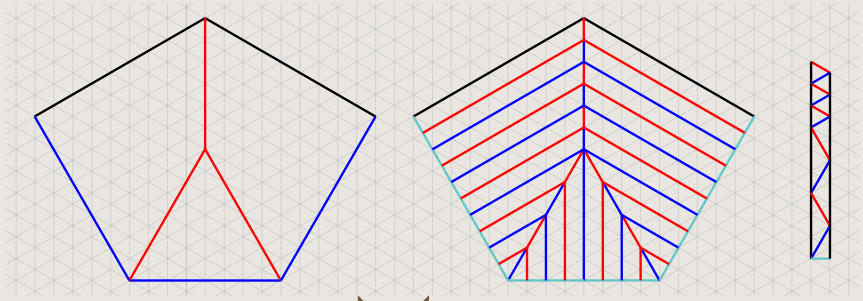
Ridge misalignments solution



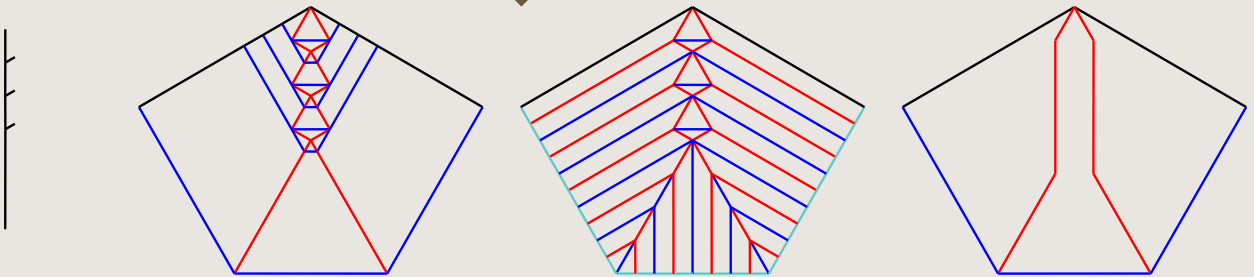
Add shallow ridges as needed

Combining steep and shallow ridges lets you pack flap lengths at increments of 0.5 units

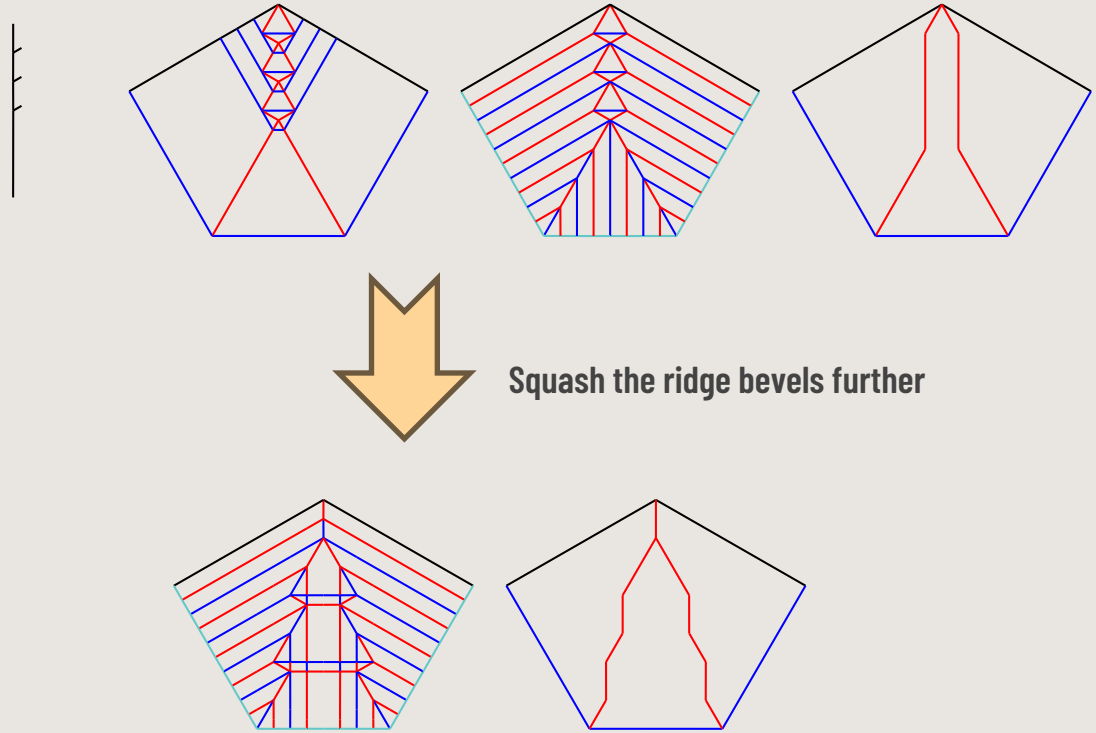
Ridge sliding



Squash the shallow ridges

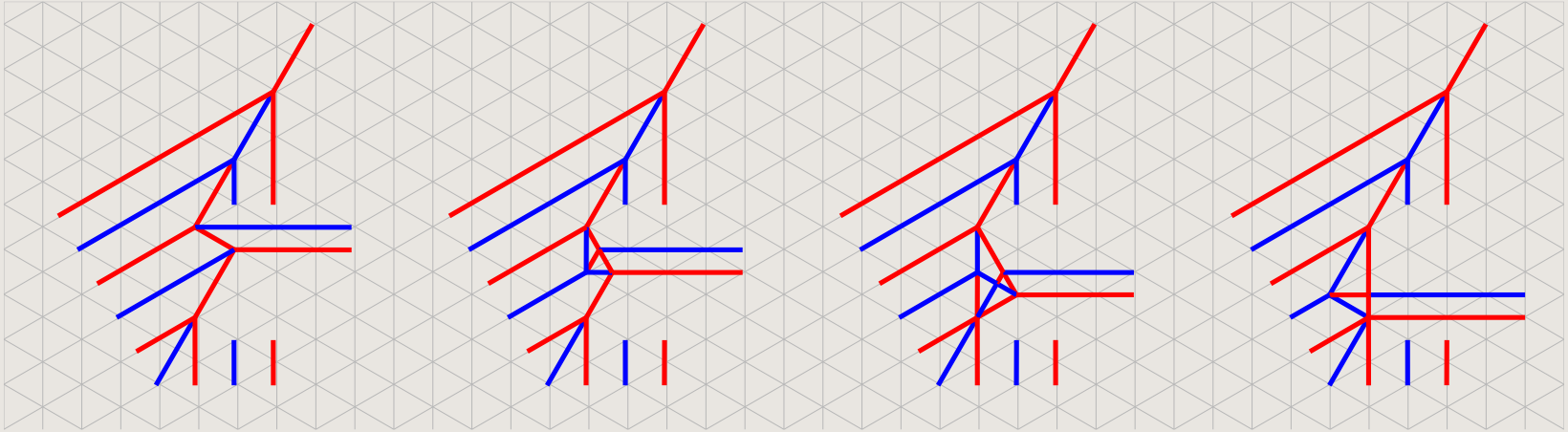


Ridge sliding (continued)



Ridge sliding

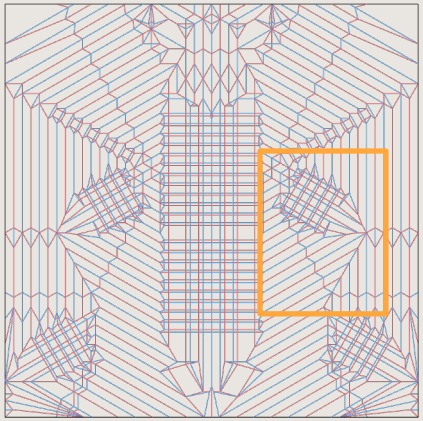
A ridge bevel can “slide” at increments of 0.5 units

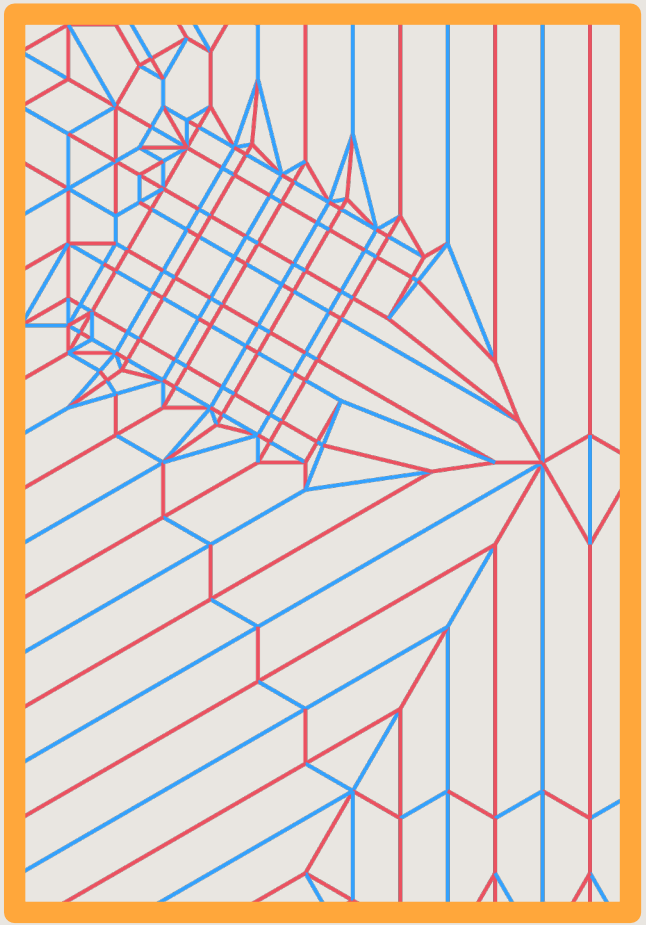


- Excess paper from shallow ridges can be redistributed within the flap

Example: scales

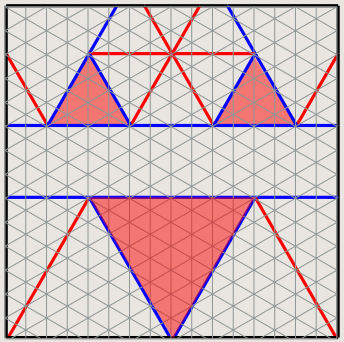


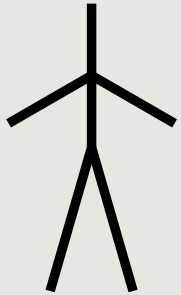




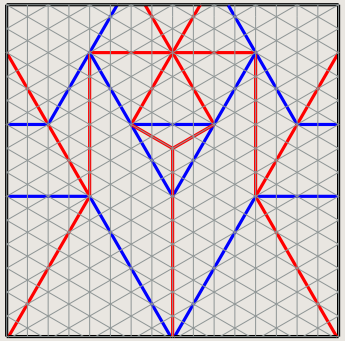
Space allocation

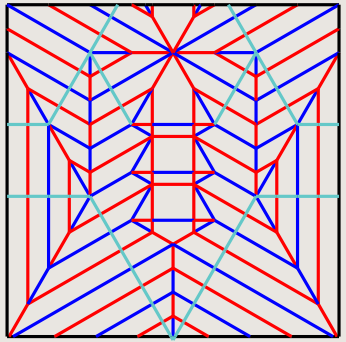
Red: unused space



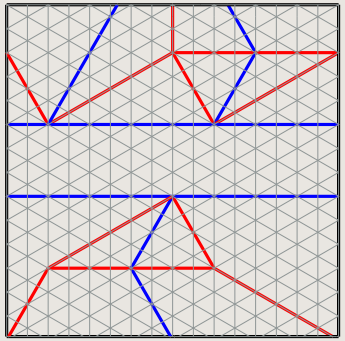


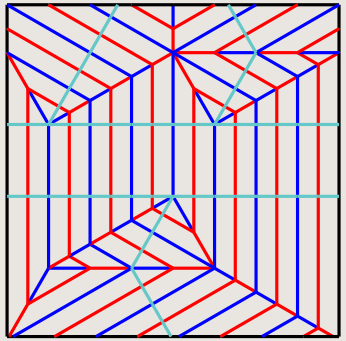
Space absorbed by river





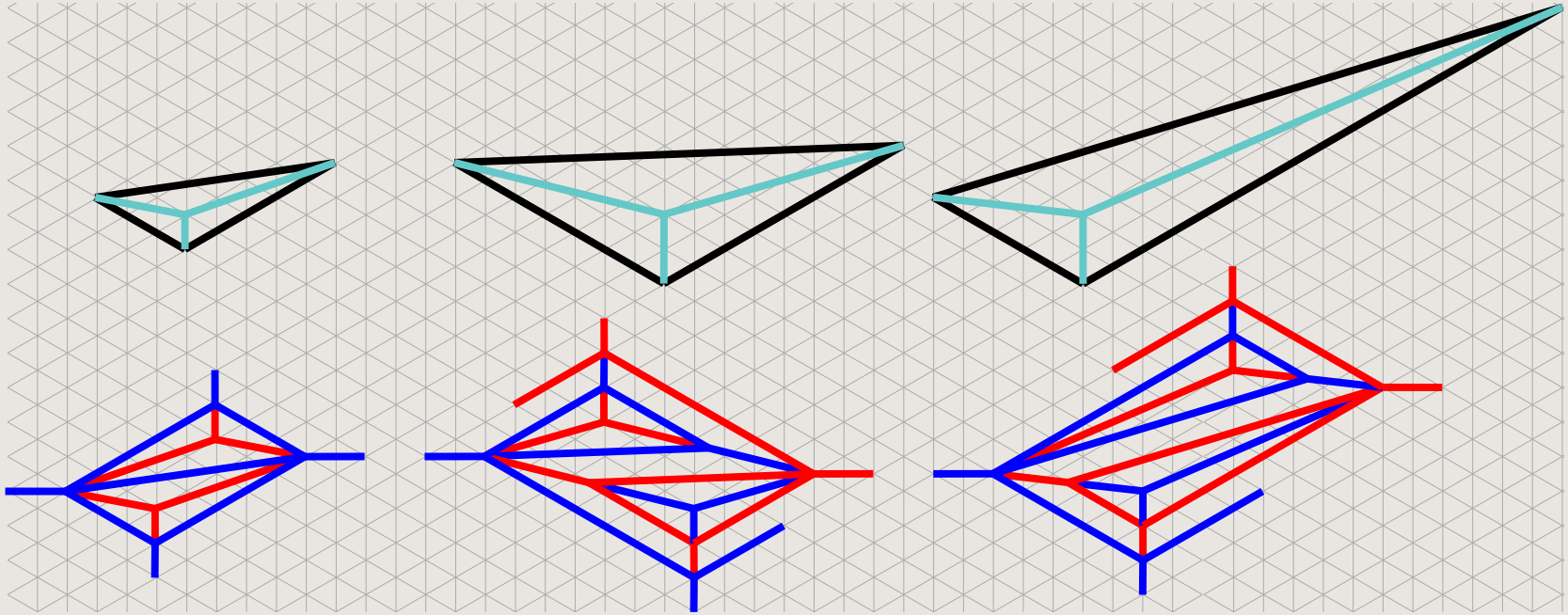
Space absorbed by limbs





Shallow ridges can be used to selectively “absorb” paper to features that need it

(Bonus: Pythagorean stretches)

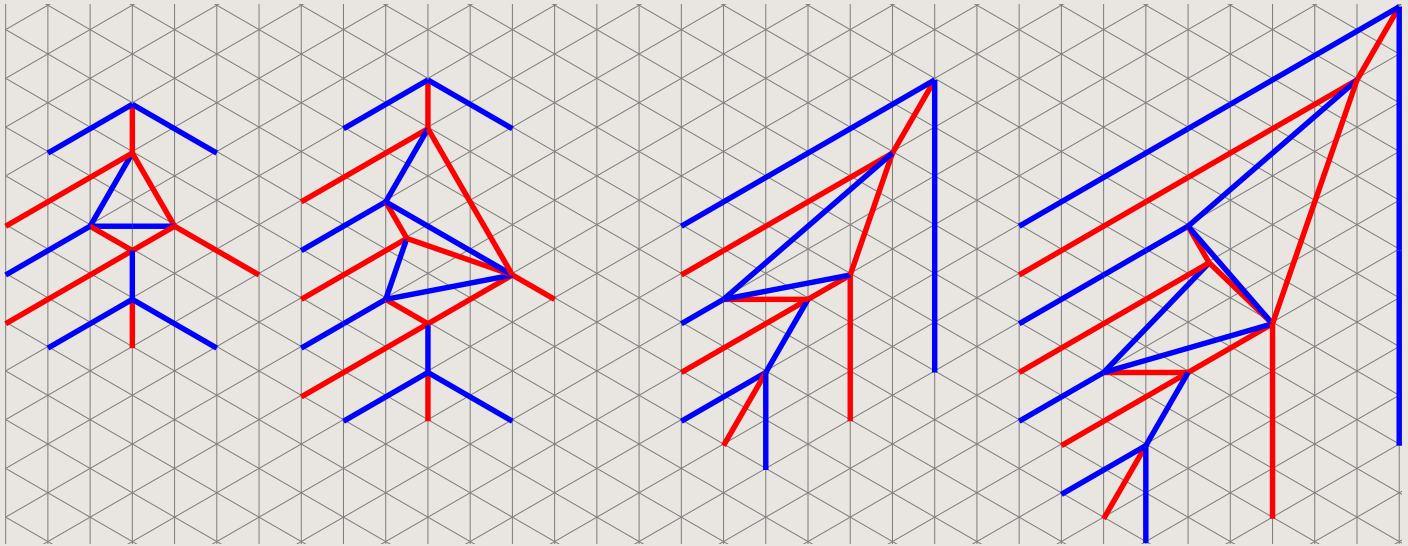


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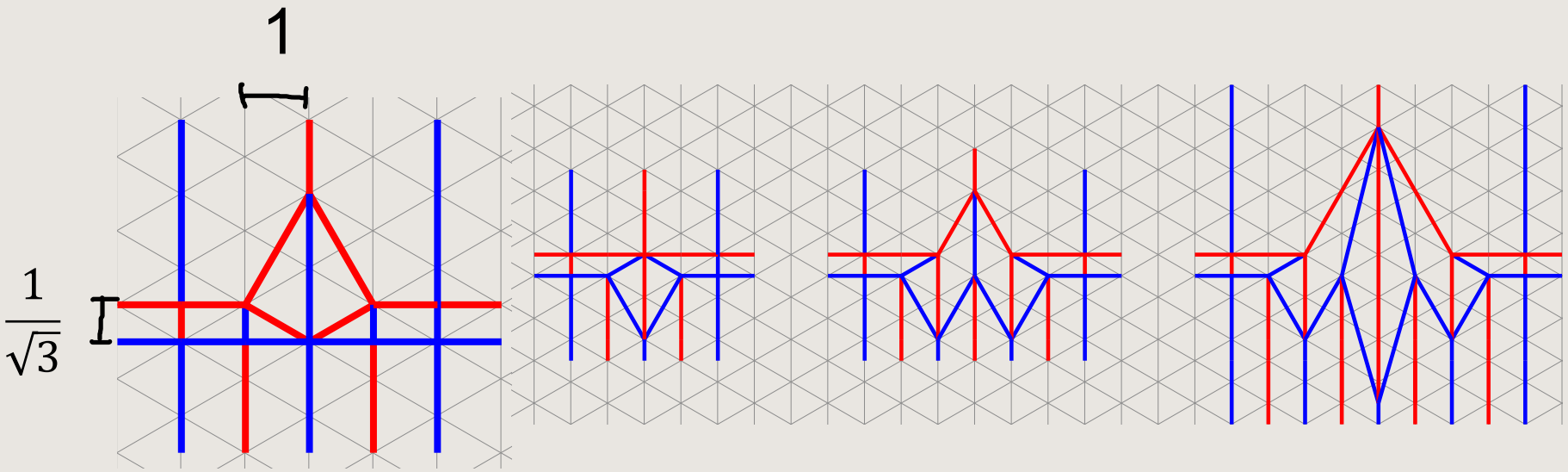
Non-uniaxial HP

Level shifters,
representational polyhedra

Ridge level shifters



Perpendicular pleat level shifters



- Level shifters are more efficient, and can be easily “built in” by using ridge bevels as the perpendicular pleat

Representational polyhedra







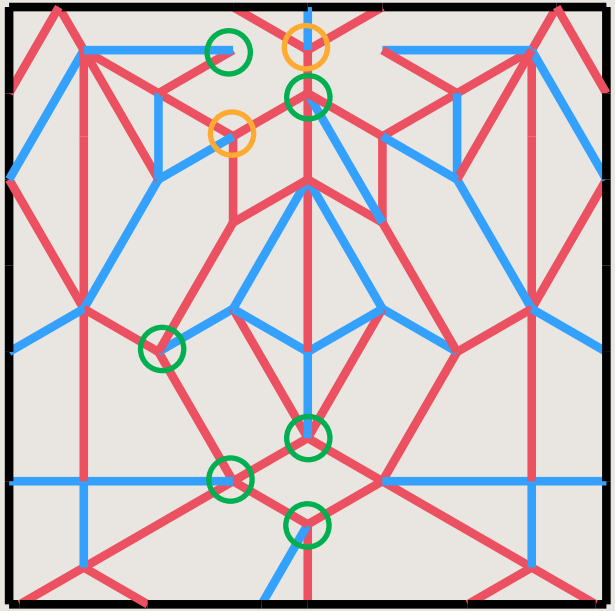


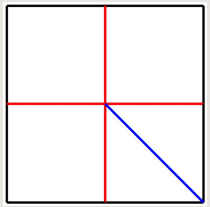




Angular defect







BP vertices can only have 90 degrees of angular defect (like cube)

Vertex with 60 degrees of angular defect (like icosahedron)

Vertex with 120 degrees of angular defect (like octahedron)