

Mooser's Train Crease Pattern + Order of Attach

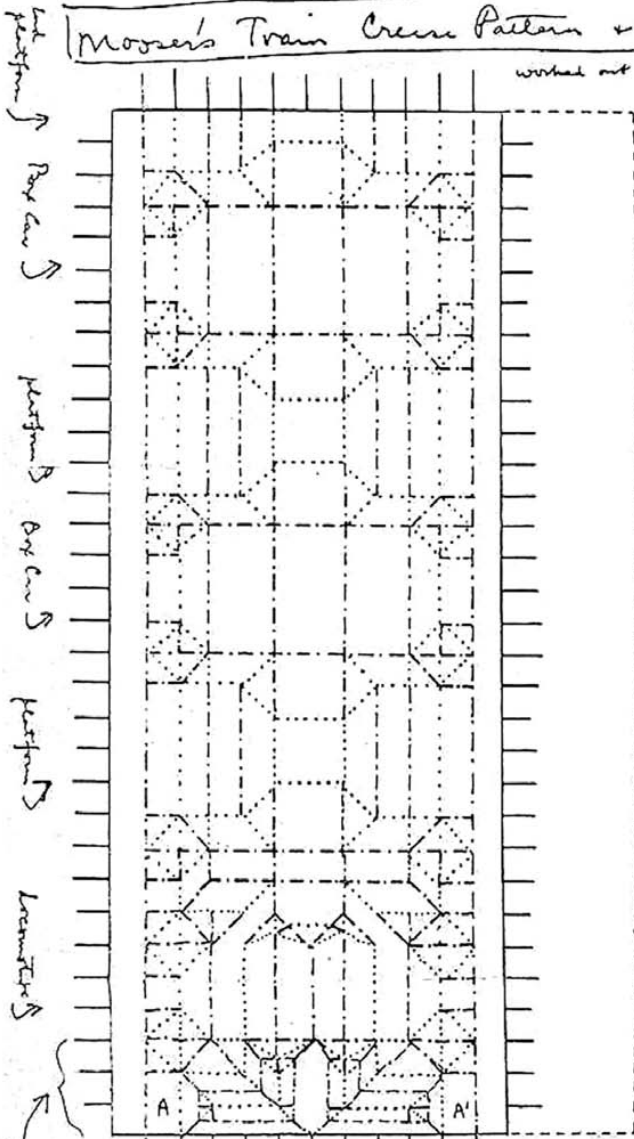
worked out by R. K. McLain, March 20, 1967
 Princeton, Ky. 41822

Begin with ② x ① squares.
 Divide ② into 32 squares.
 Divide ① into 16 squares.
 Remove 4 squares the long way.
 You now have 32 x 12 squares.

Min. fold under 1 square
 the long way on each side.
 Now make the crease pattern
 as indicated. Each toy car
 requires 10 squares long
 and 12 squares wide. The
 locomotive requires 12 x 12.

Now ~~model~~ ^{model} the model made
 as you would clay.
 Several things must go
 at once so that a fine
 crease pattern without
 excessive creases is
 helpful. Be patient + gentle

When modelling is completed,
 square + partially folded
 fold the wheels + turn
 under the end piece a little
 (see correlation with A + A')
 Direct towards the platform
 between cars, lock the
 end of the last car by
 valley folding inward
 the platform part, lock
 the underside by folding
 inward the extra material
 between + behind the wheels.
 Bend the locomotive's snout



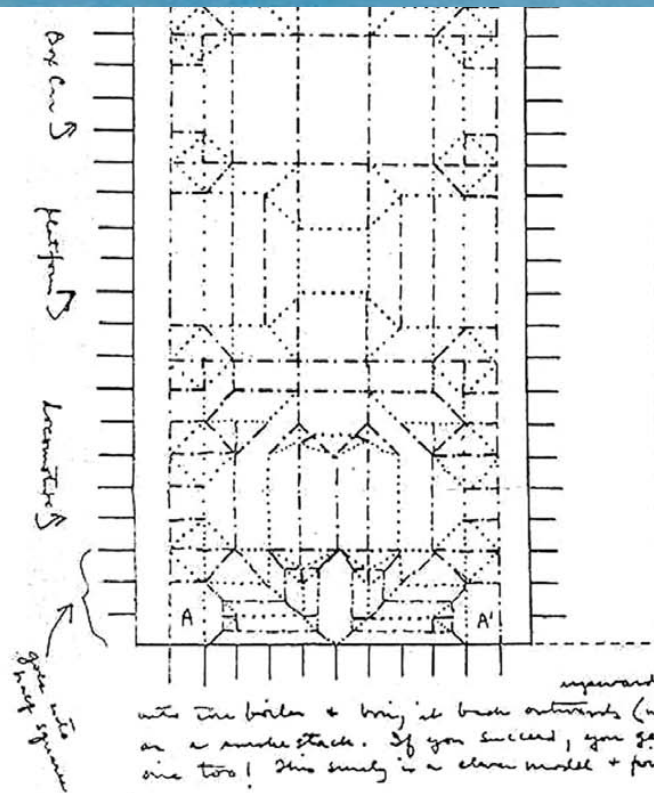
upwards, penetrate (with a cut) it inward
 into the boiler + bring it back outward (with another cut) (and a valley fold)
 on a model stack. If you succeed, you get the prize for diligence! See the
 one too! This study is a clear model + points the way to future 3D origami.

Perhaps the crease pattern could be scratched onto paper (making valley folds only
 on both sides of two papers) with a knife denting, but not cutting through.

Mooser's
 Train
 Raymond
 McLain,
 1967



Mooser's
Train
Raymond
McLain,
1967



Now ~~model~~ ^{model} the model ~~model~~ as you would, clay. Several things must go at once so that a fine crease pattern without extensive creases is helpful. Be patient + gentle

When moulding is completed, synch + partially fold fold the wheels + then under the end piece + tuck (see correlation with A + A') Don't invert the platform between cars, lock the end of the last car by valley folding inward the platform part, lock the underside by folding inward the extra material between + behind the wheels. Bend the locomotive's snout

upwards, penetrate (with a cut) it inward into the boiler + bring it back outward (with another cut) (and a valley fold) on a made stack. If you succeed, you get the prize for diligence! See the one too! This study is a clear model + points the way to future 3D origami.

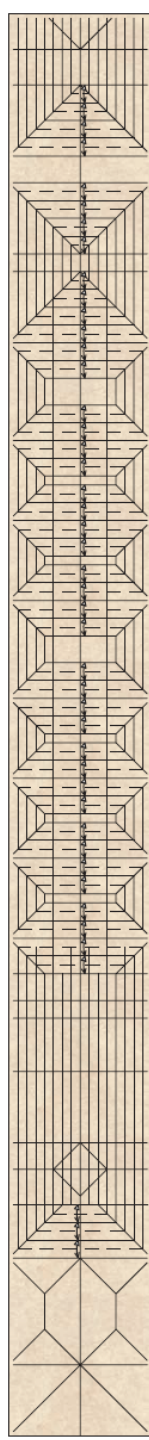
Perhaps the crease pattern could be scratched onto paper (making valley folds only on both sides of two papers) with a knife denting, but not cutting through.

folding by
Robert Lang

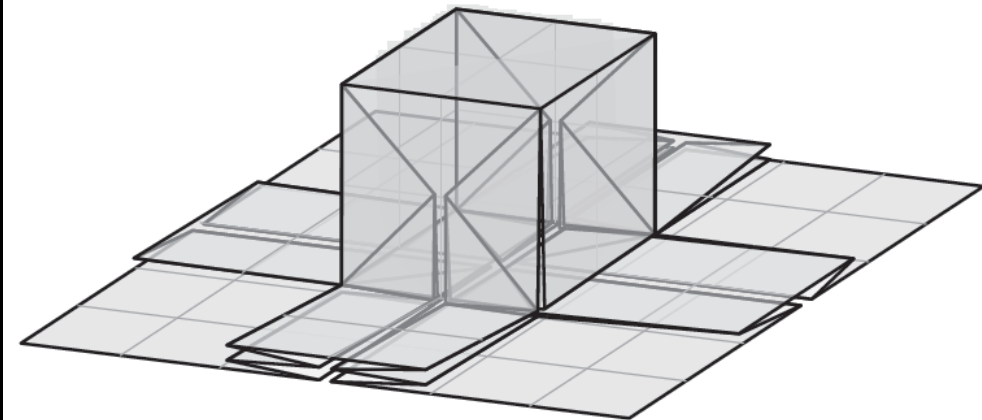


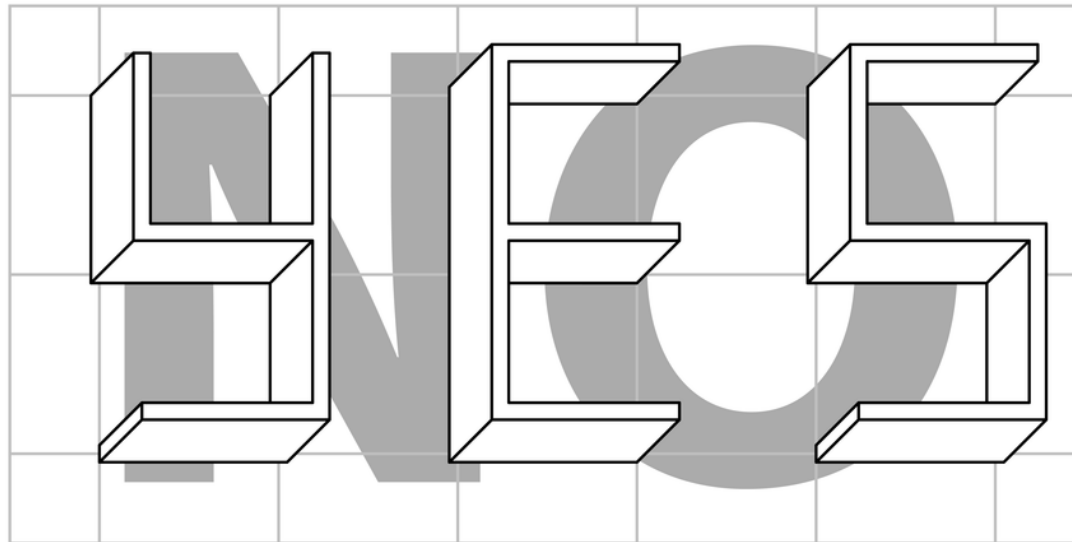
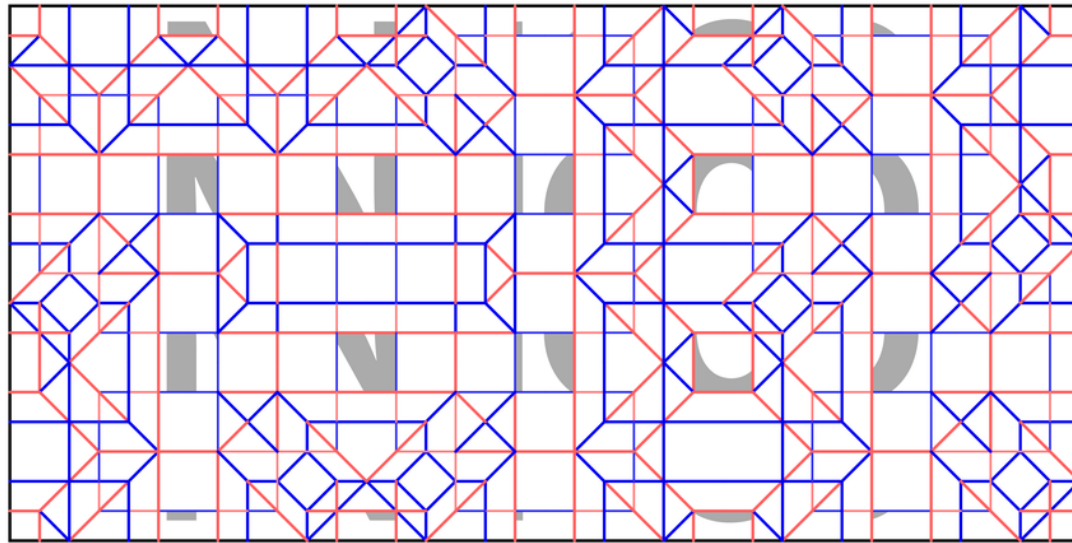
Black Forest Cuckoo Clock,
opus 182

Robert Lang, 1987



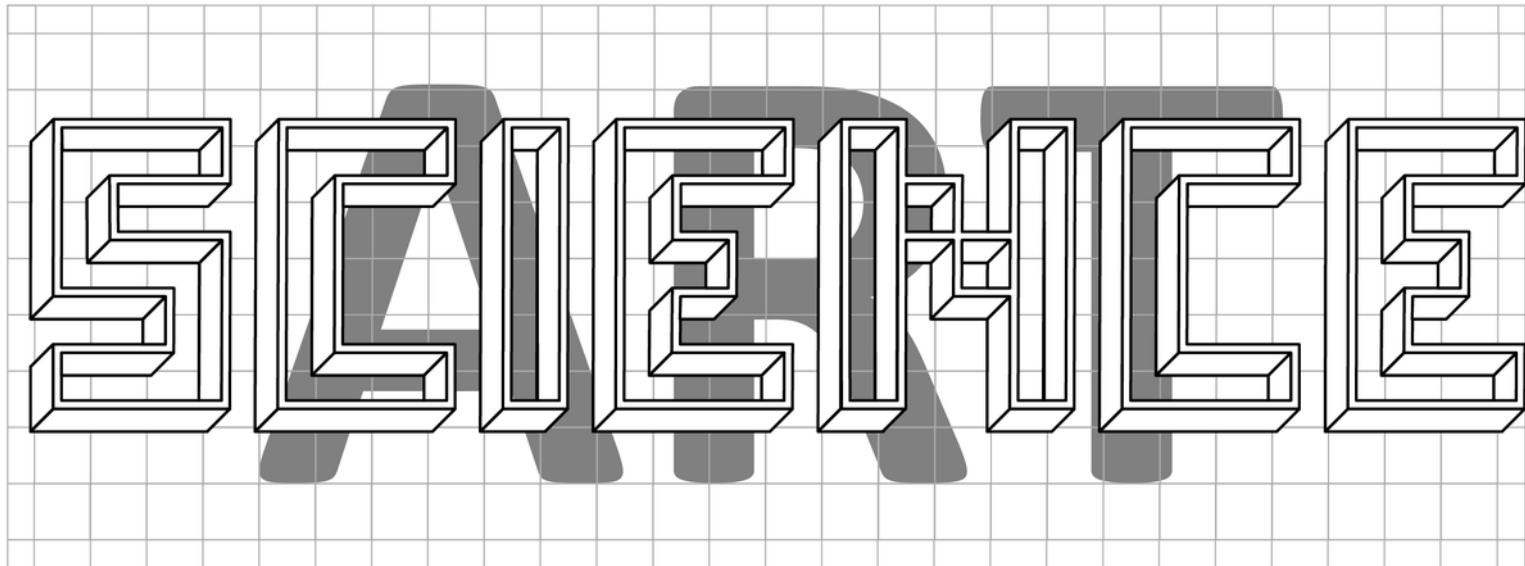
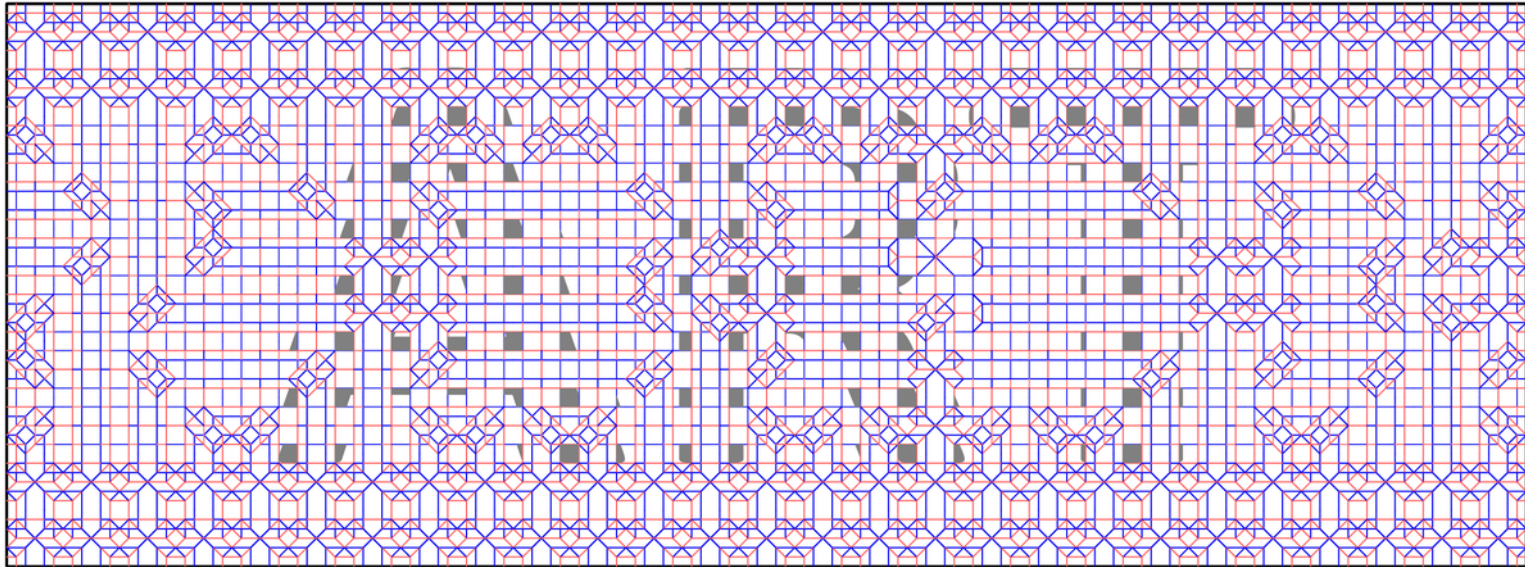
Are there known universal hinge patterns to build poly-some-other-shapes-that-are-not-cubes?

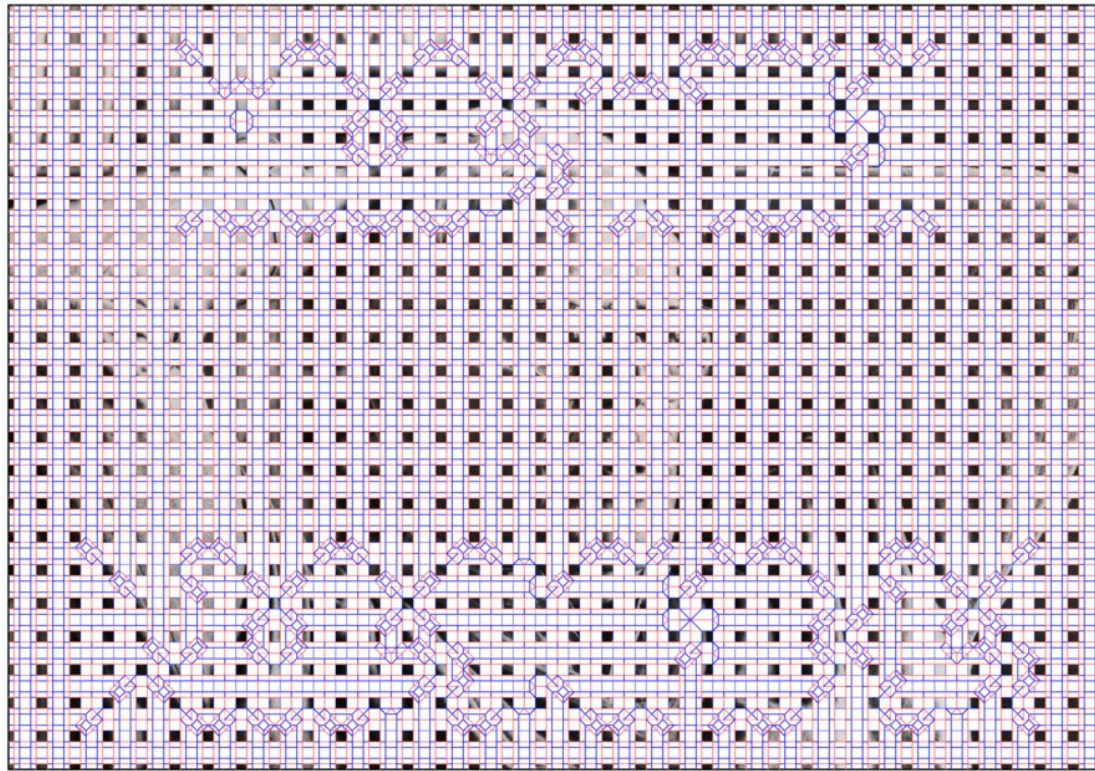




Yes/No

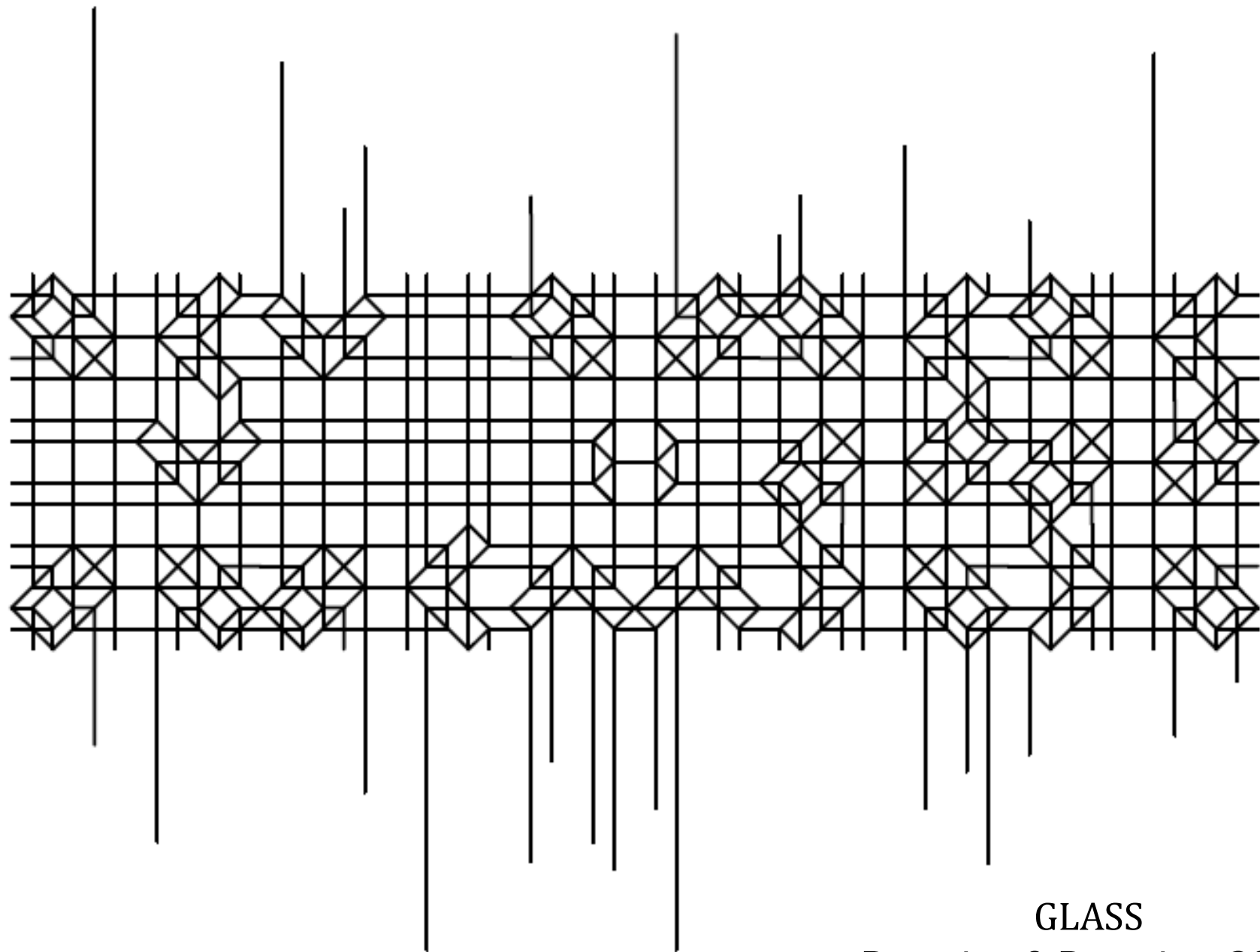
Demaine,
Demaine,
Stengle
2011





Martin
Gardner

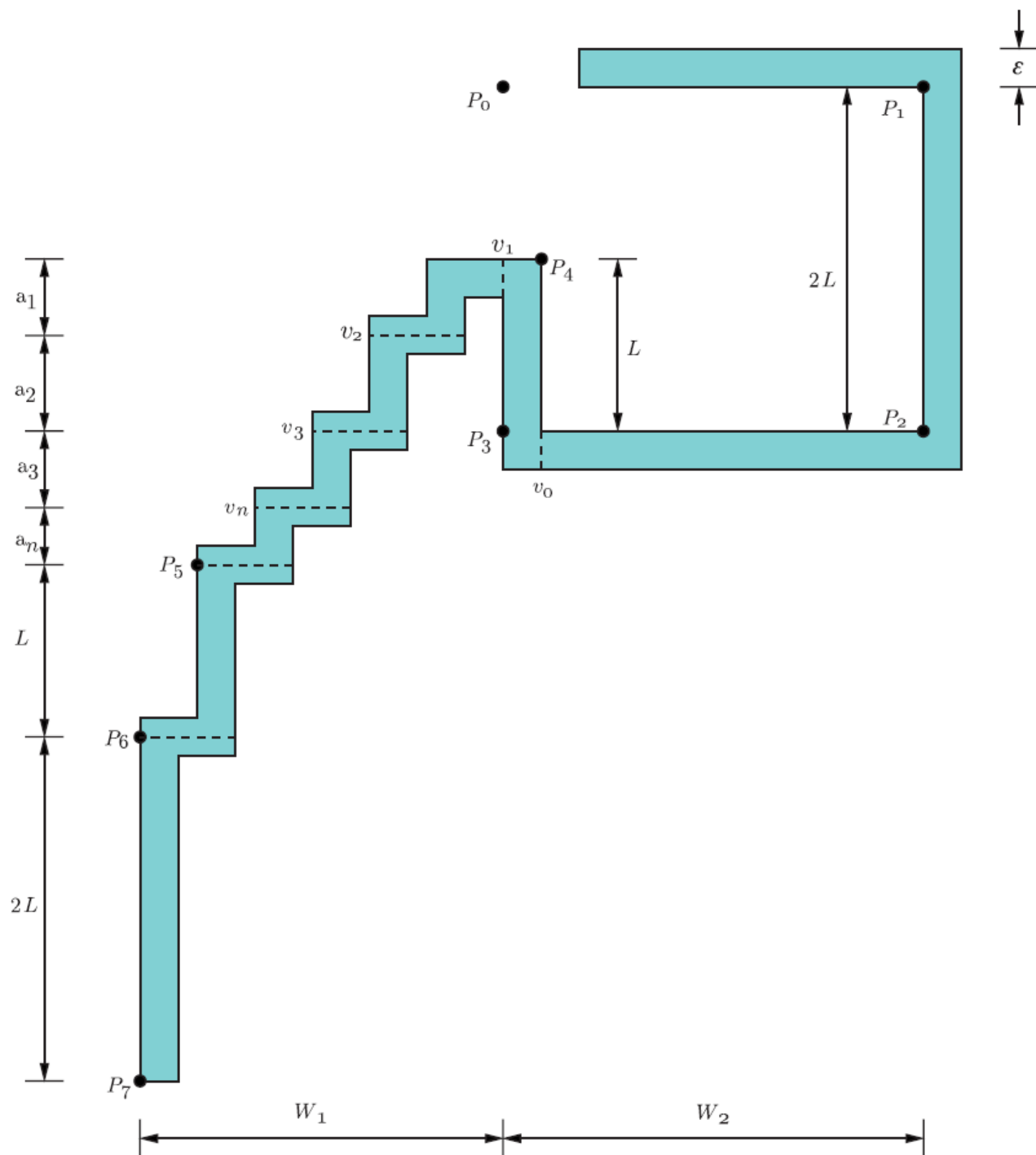
Demaine,
Demaine
2012



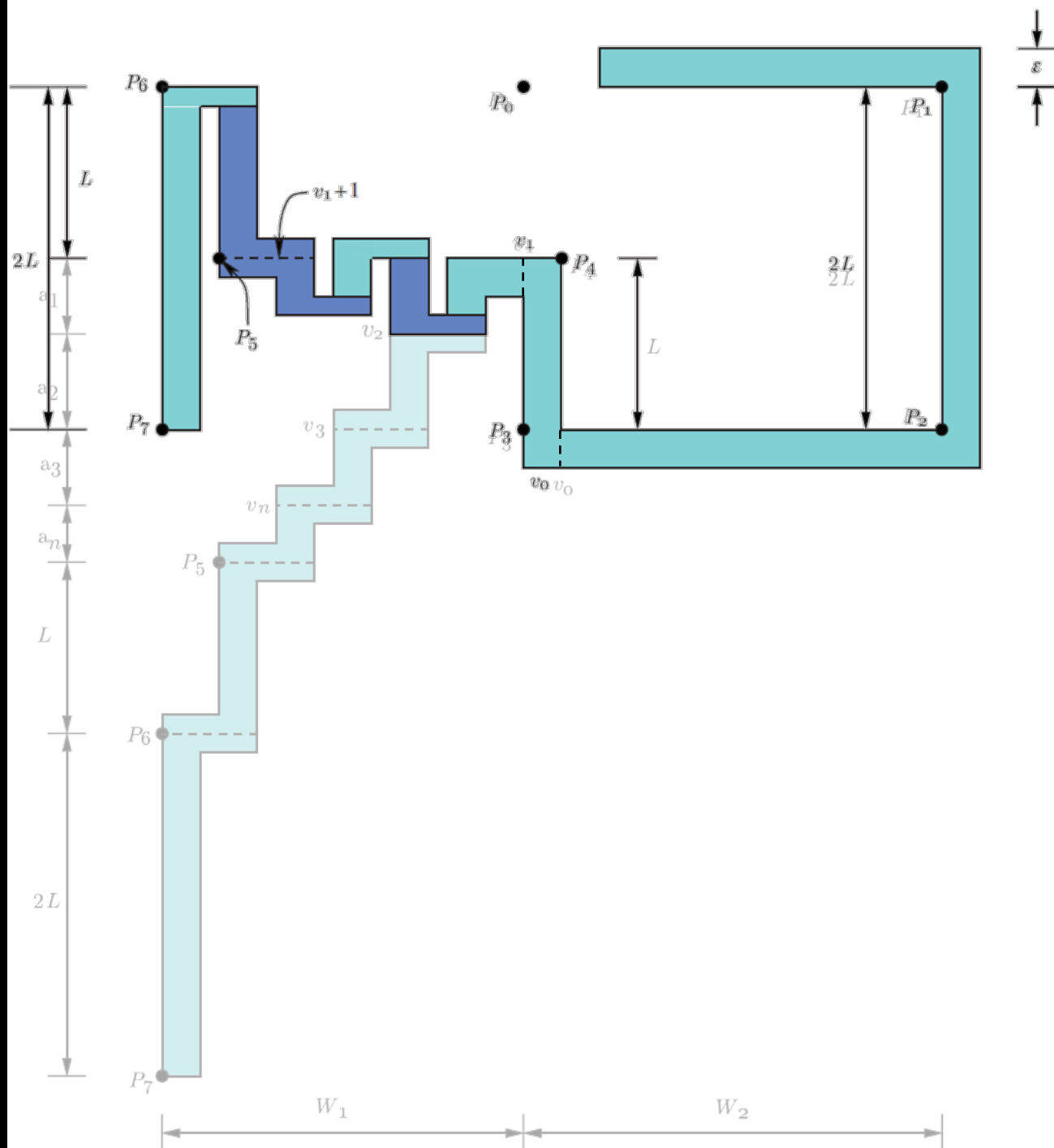
GLASS
Demaine & Demaine, 2012

I didn't understand the point of NP-hardness. Are there examples of actual problems that can't be calculated?

**Could we go through one of the
NP proofs with a little less
hand waving?**

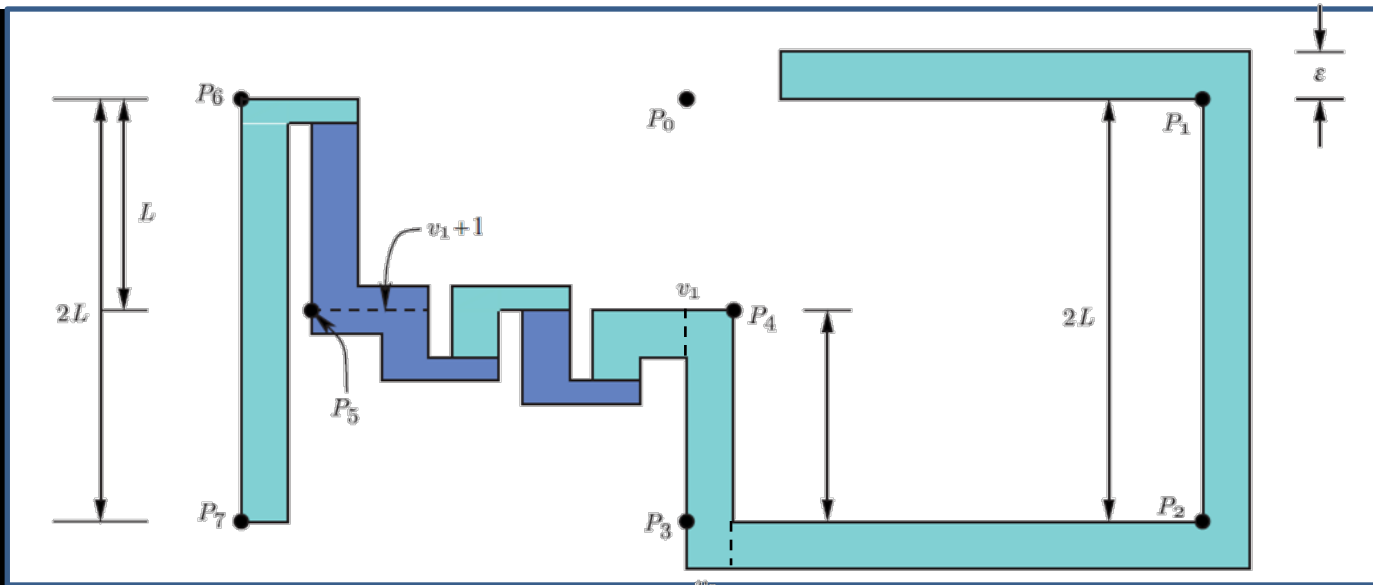


[Arkin,
 Bender,
 Demaine,
 Demaine,
 Mitchell,
 Sethia,
 Skiena
 2000]

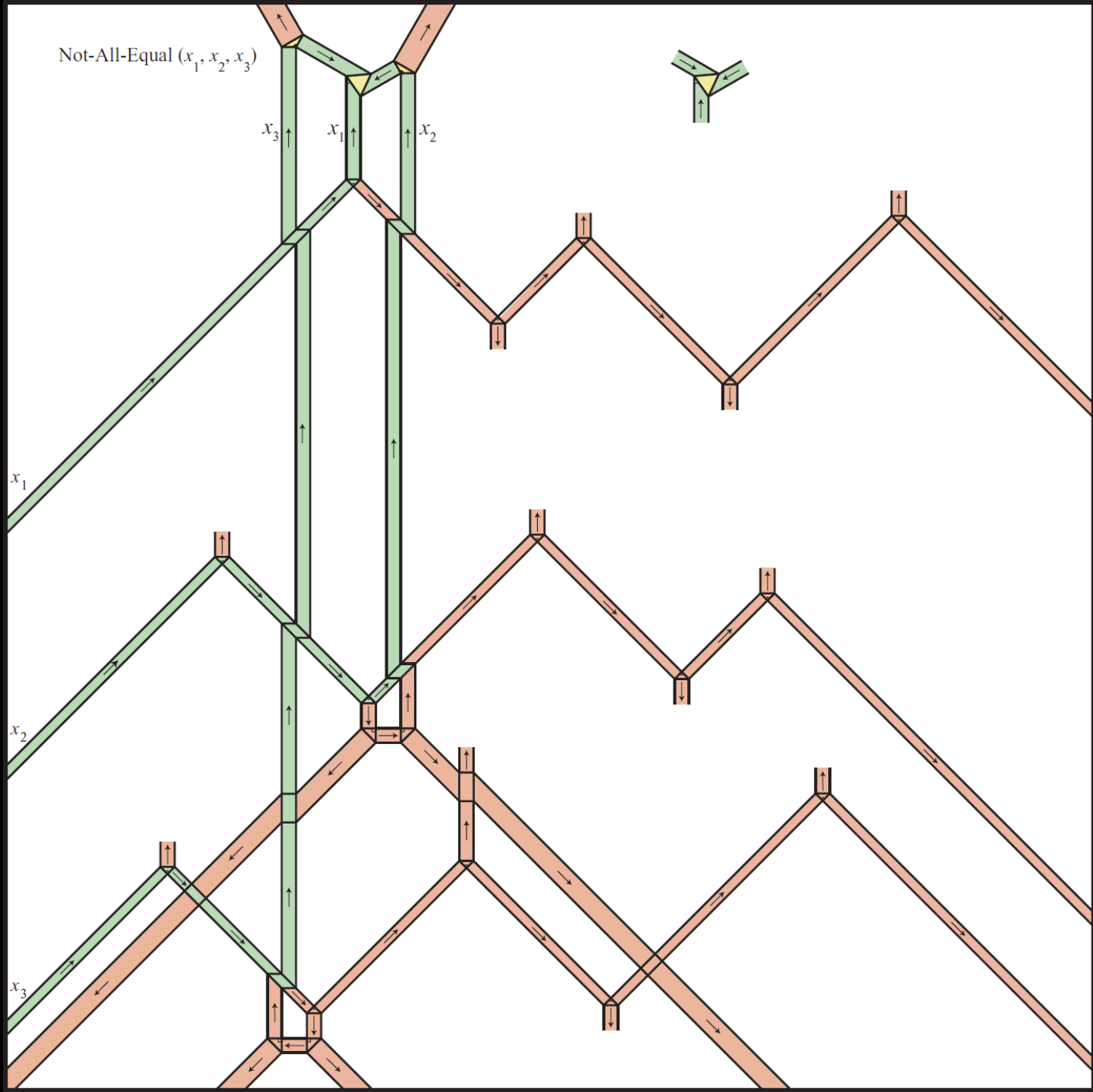


[Arkin,
 Bender,
 Demaine,
 Demaine,
 Mitchell,
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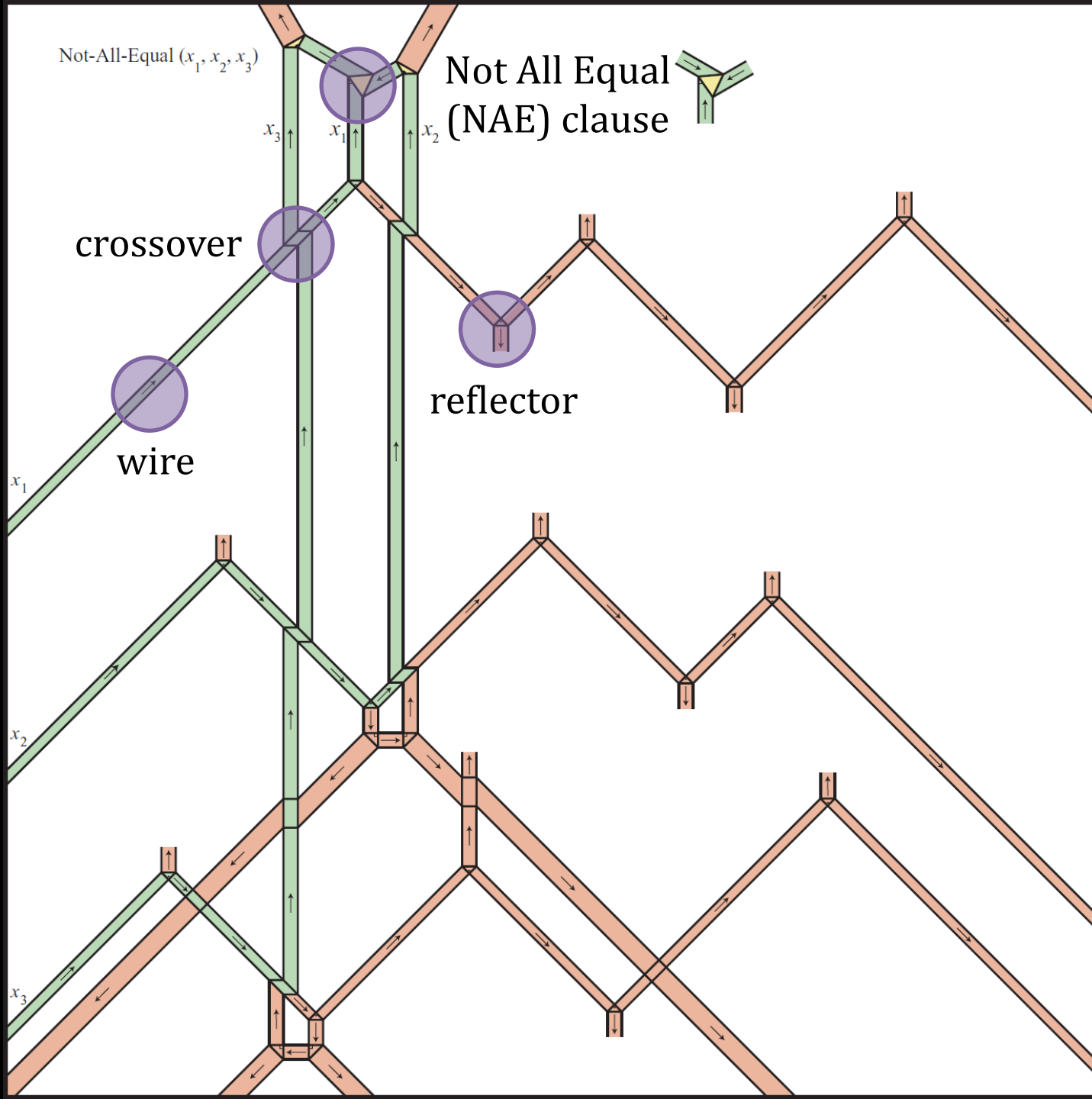
Minor question: in the orthogonal paper reduction, doesn't this require not folding some of the creases, if we want to make 2 consecutive strips the same direction?



Not-All-Equal (x_1, x_2, x_3)



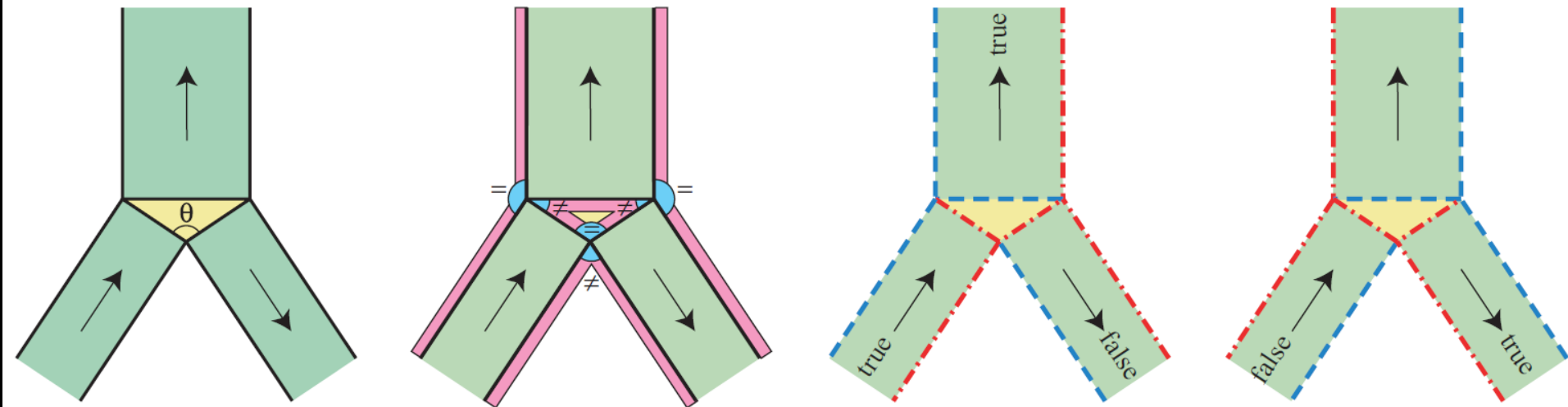
[Bern &
Hayes
1996]



[Bern &
Hayes
1996]

In the reflector gadget, it looks like all the left sides of the wires, where left is taken relative to the free end of the wire, are equal. How does the reflector negate one of them, then?

[Bern & Hayes 1996]



**It looks like the global flat
foldability proof proves that**

globally flat-foldable

⇒ NAE satisfiability

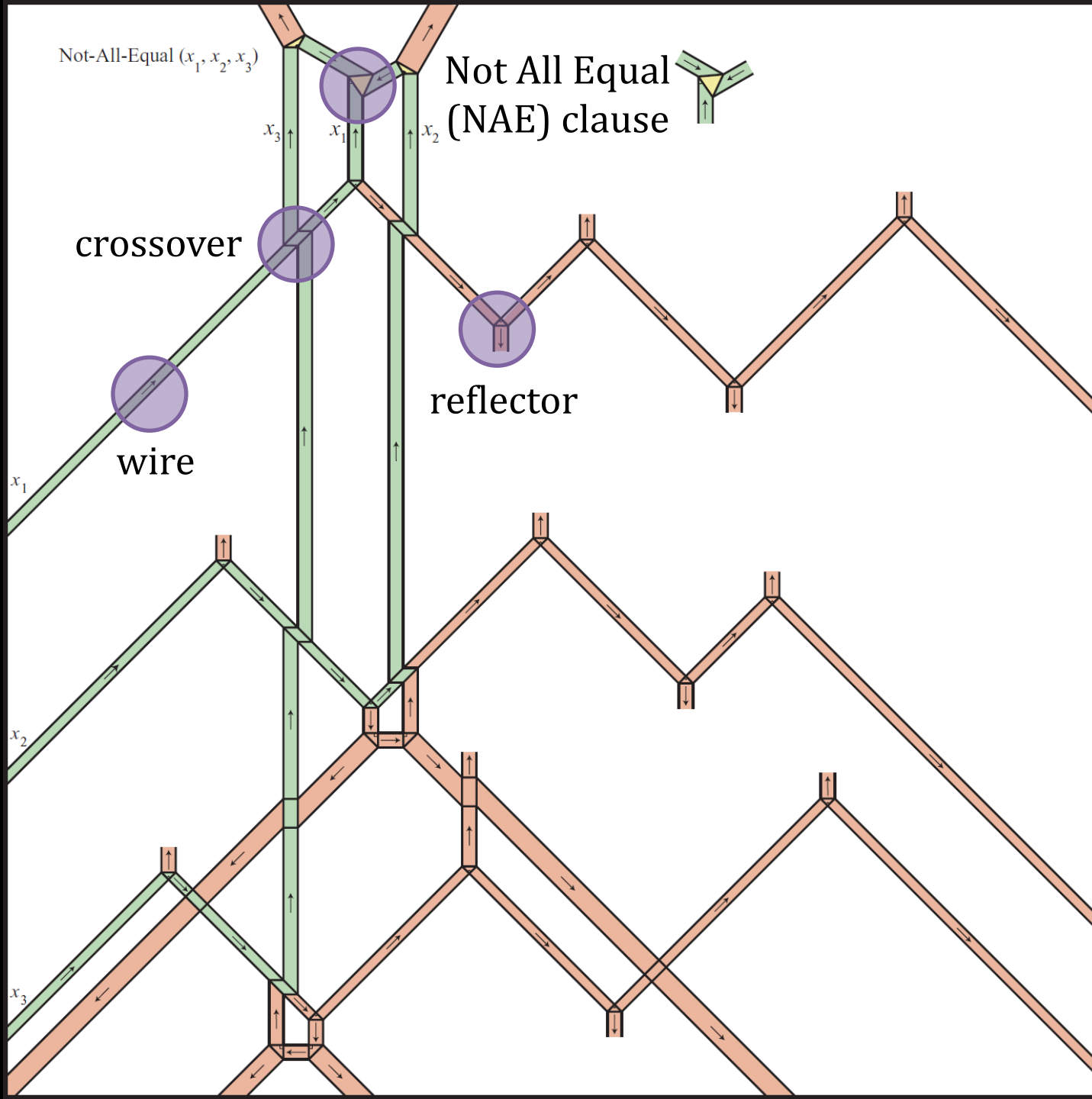
⇒ locally flat-foldable,

but I don't see where

NAE satisfiability

⇒ globally flat-foldable.

**(It looks like all that matters is
the order of sheets, though, and
that those all work out.)**



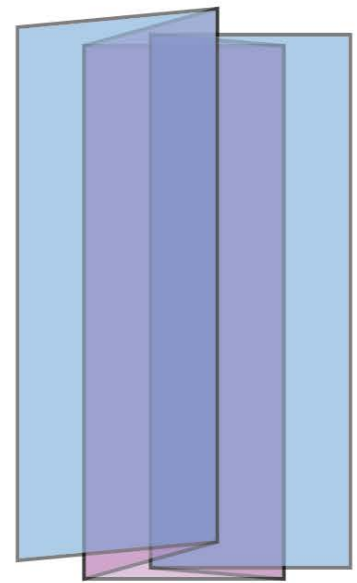
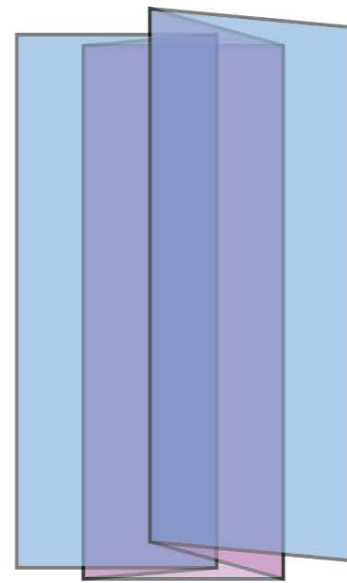
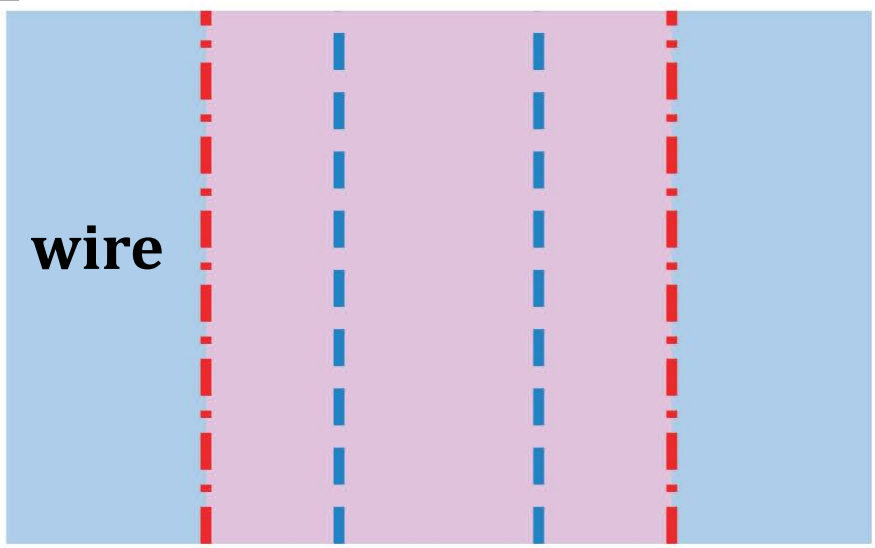
[Bern &
Hayes
1996]

For global flat foldability, I understand how the gadgets prove (1), but how do they prove (2)?

Global flat foldability:

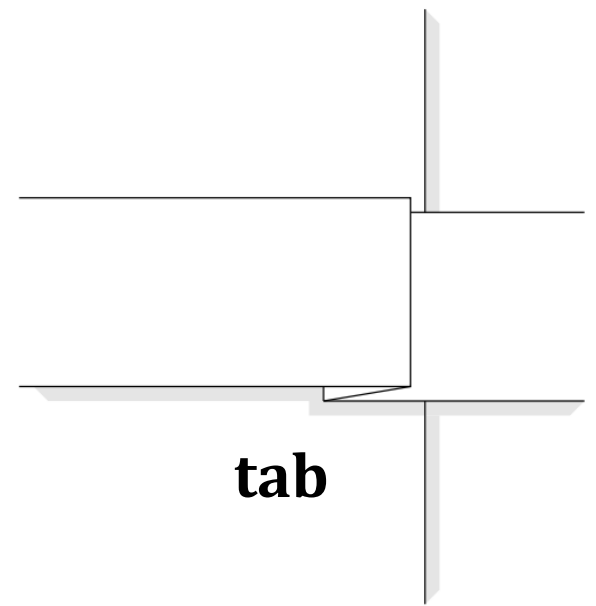
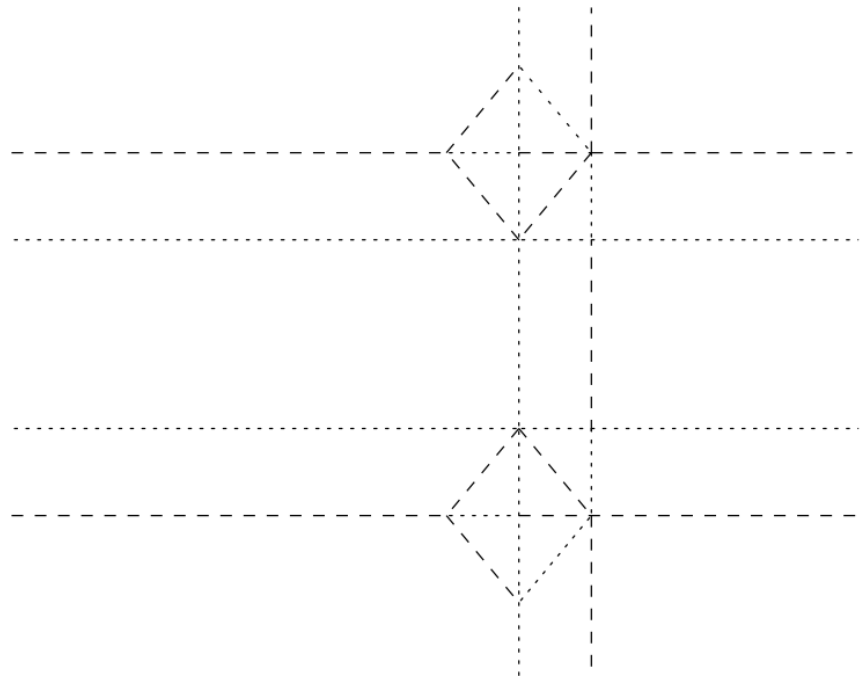
[Bern & Hayes 1996]

- ① deciding flat foldability of given crease pattern is strongly NP-hard
- ② constructing valid layer ordering for given flat-foldable mountain-valley pattern is strongly NP-hard



true

false

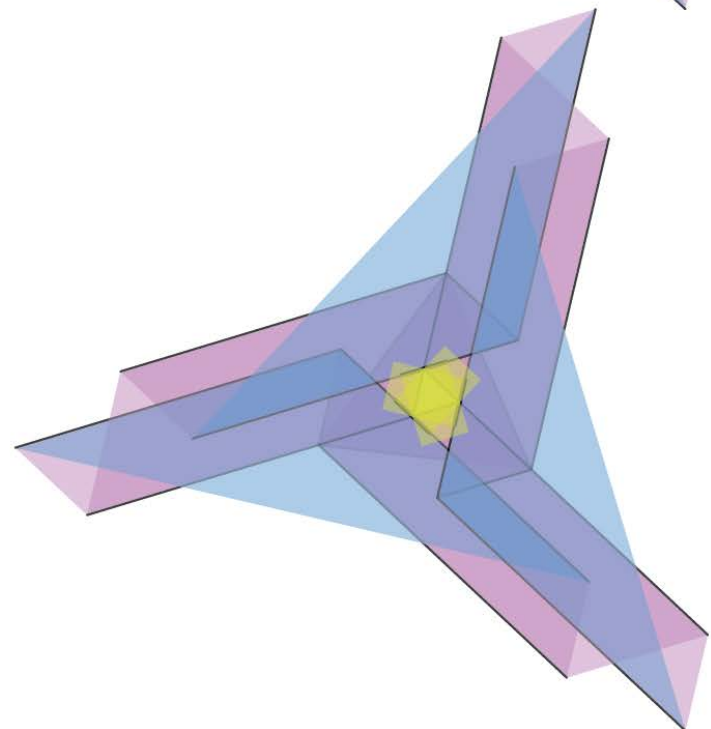
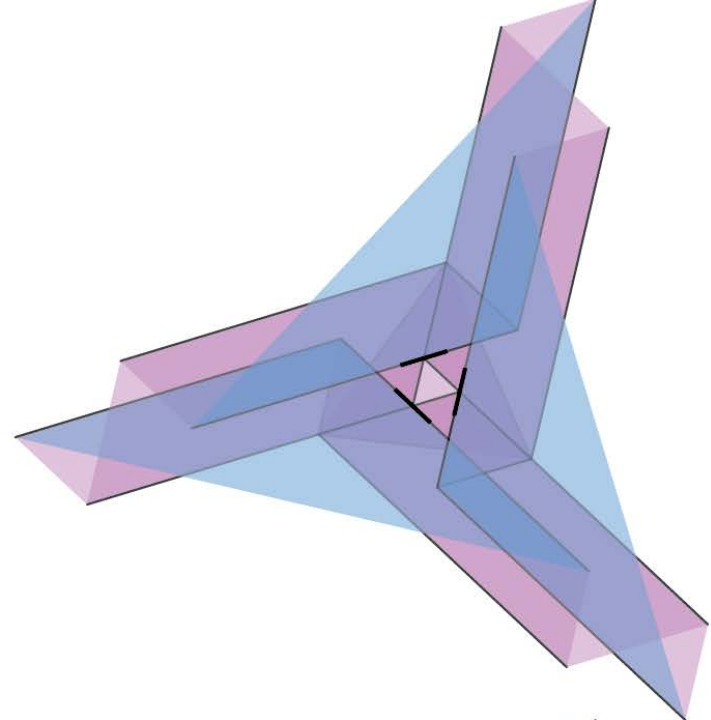
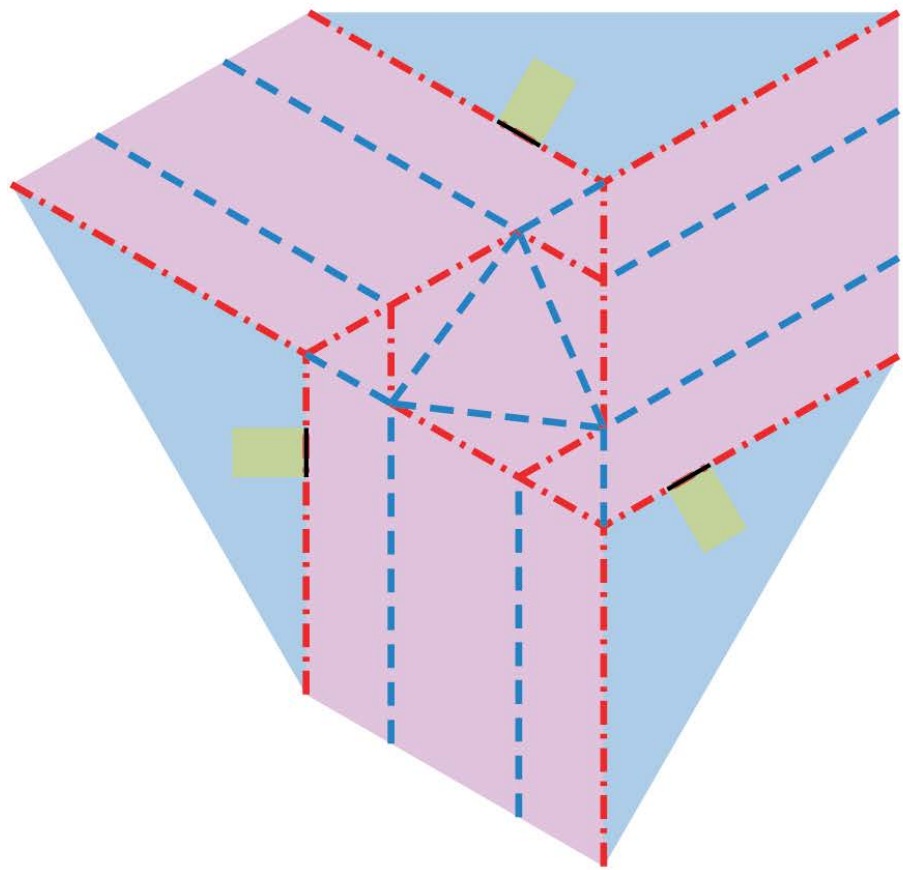


tab

[Bern & Hayes 1996]



NAE clause



[Bern & Hayes 1996]

2D map folding: [Arkin et al 2004]

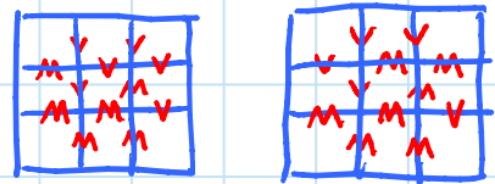
- ↳ rectangular paper with axis-parallel creases
- again every crease pattern is flat foldable:
zig-zag in x then y

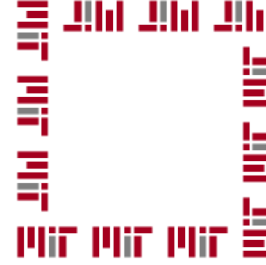


OPEN: characterize flat-foldable mountain-valley patterns — even $2 \times n$! [Edmonds 1997]

Simple folds are not as powerful in 2D:

(in contrast to 1D, where we can simulate crimp/end folds)

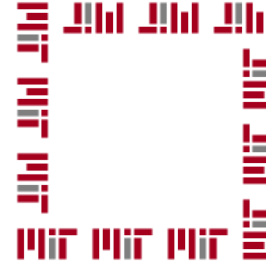
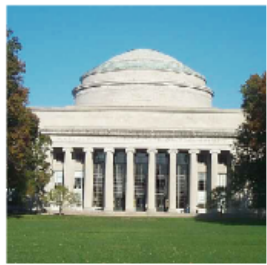
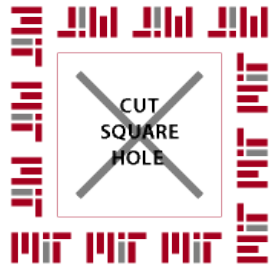
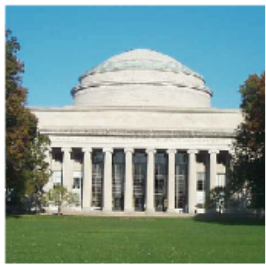
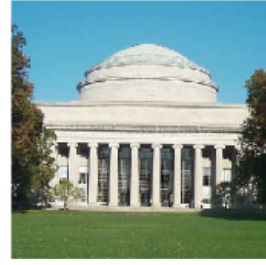




MIT New Lab Folding Puzzle

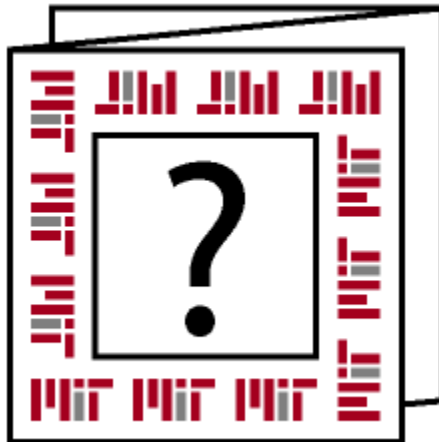
Your goal is to fold the 3x3 puzzle into a one-square packet so that the top and bottom of the packet both show the same image of MIT, through a "frame" of MIT logos. (See reverse.) There is only one solution. Only one identical pair of images will work. You can only fold along the black lines.

Designed by Erik Demaine & Martin Demaine, 2003

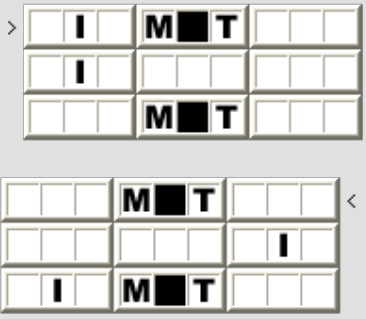


Front

Back



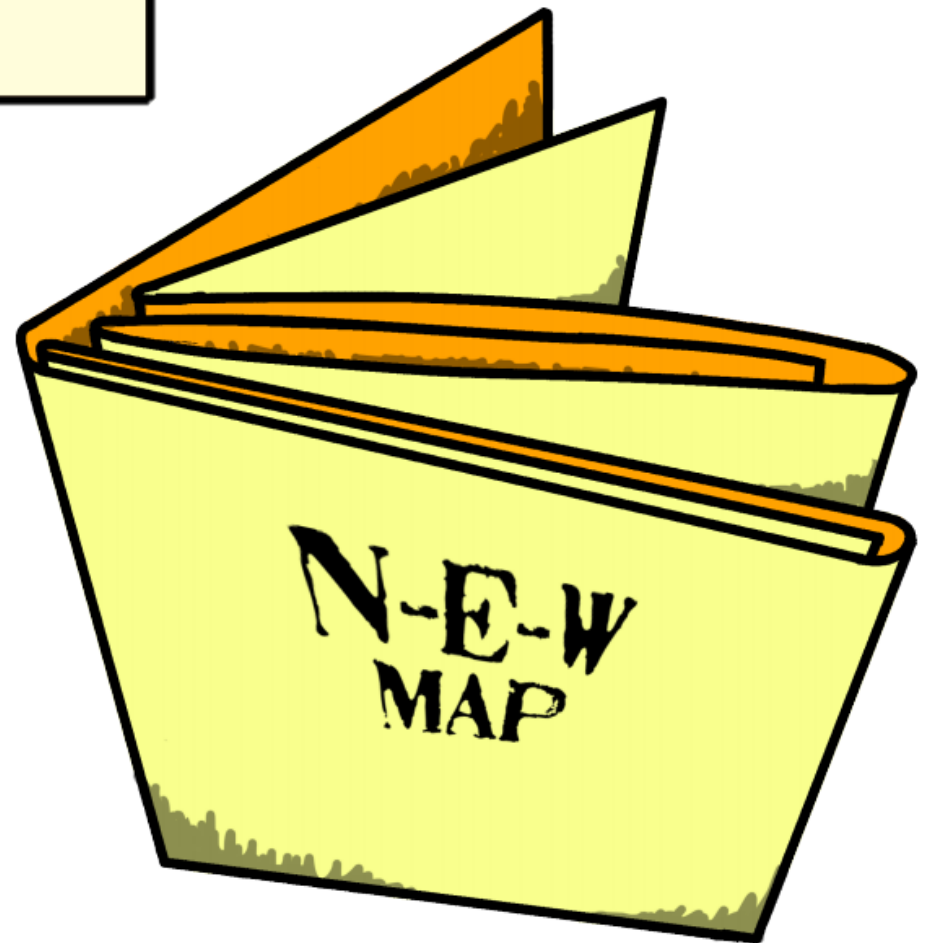
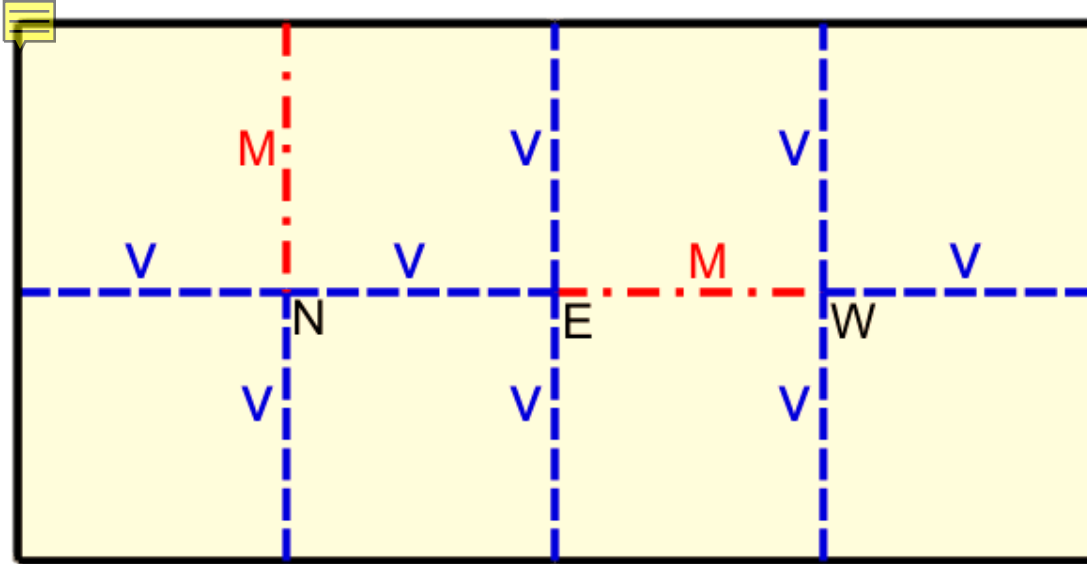
[Demaine & Demaine 2003]



Warning: The following buttons reset all labels

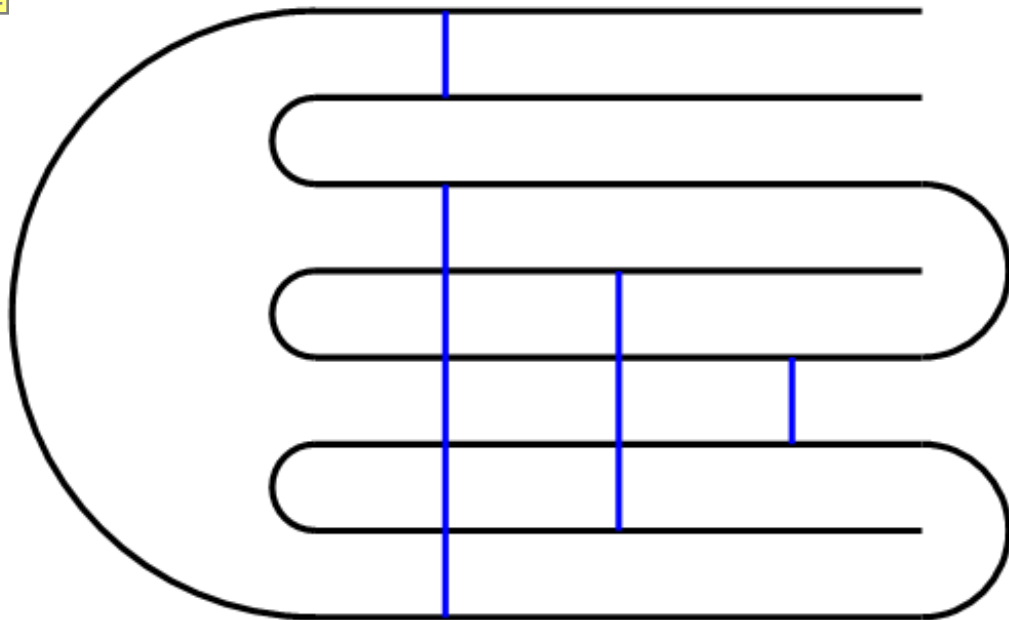
- Increase width
- Decrease width
- Increase height
- Decrease height
- Add label
- Remove label

1,368
folded
states

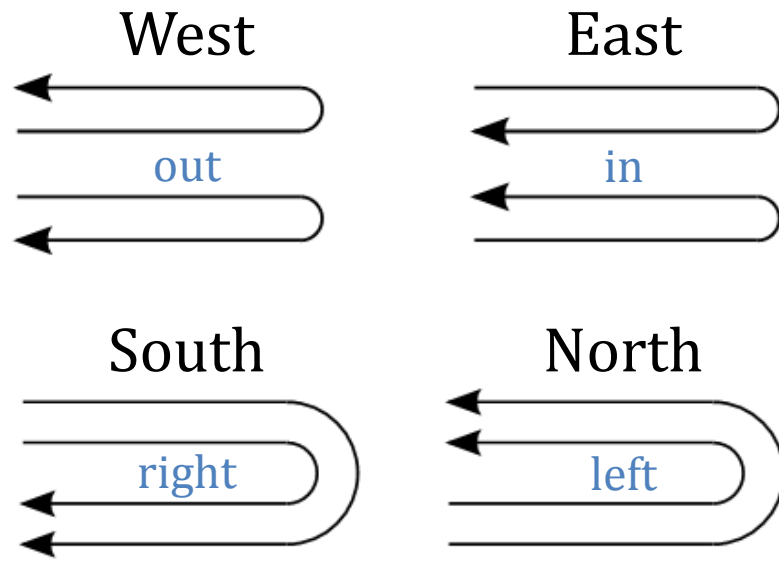
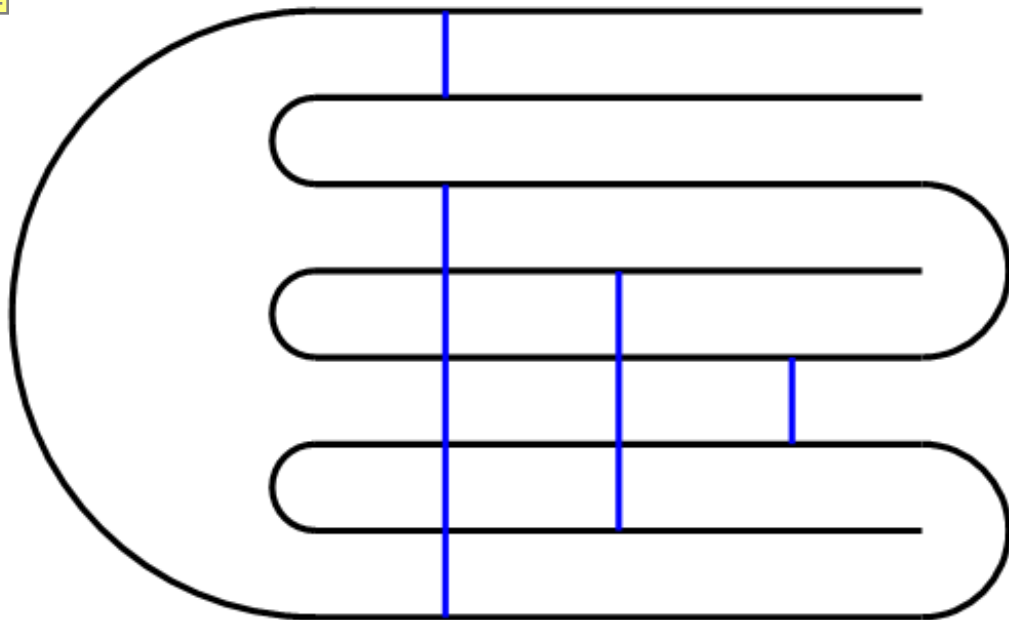


NEWS labeling

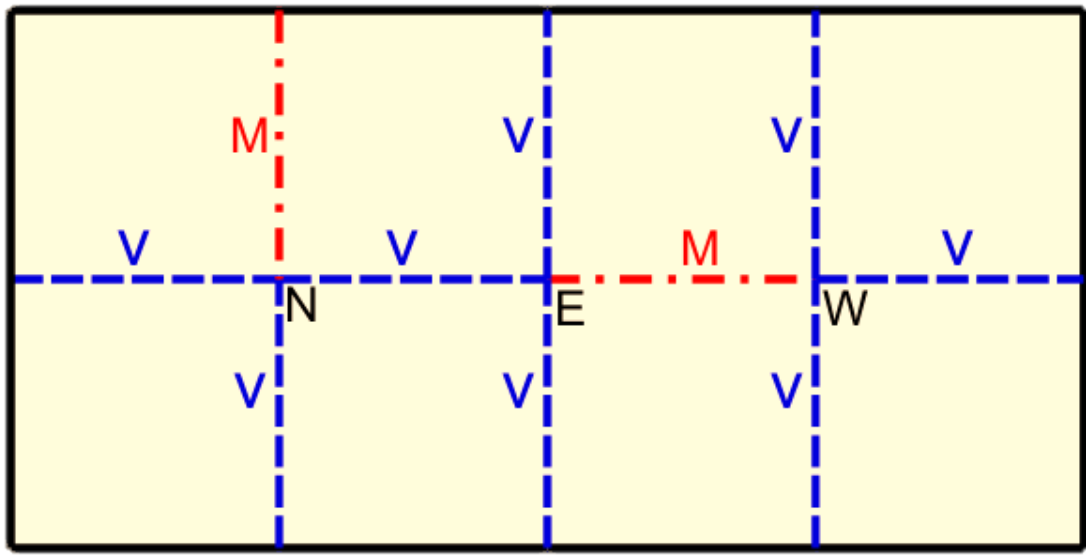
[Demaine, Liu, Morgan 2012]

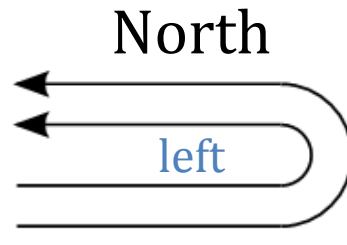
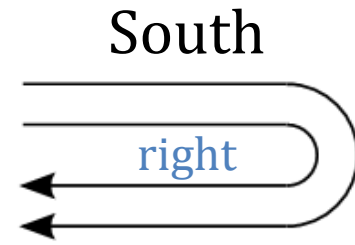
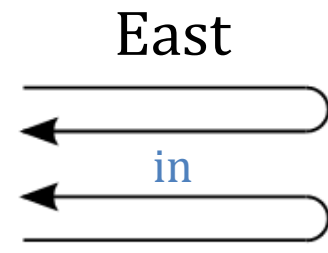
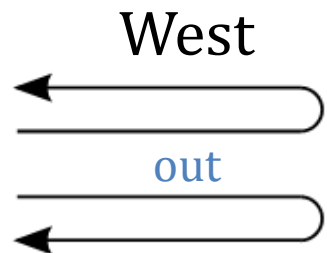
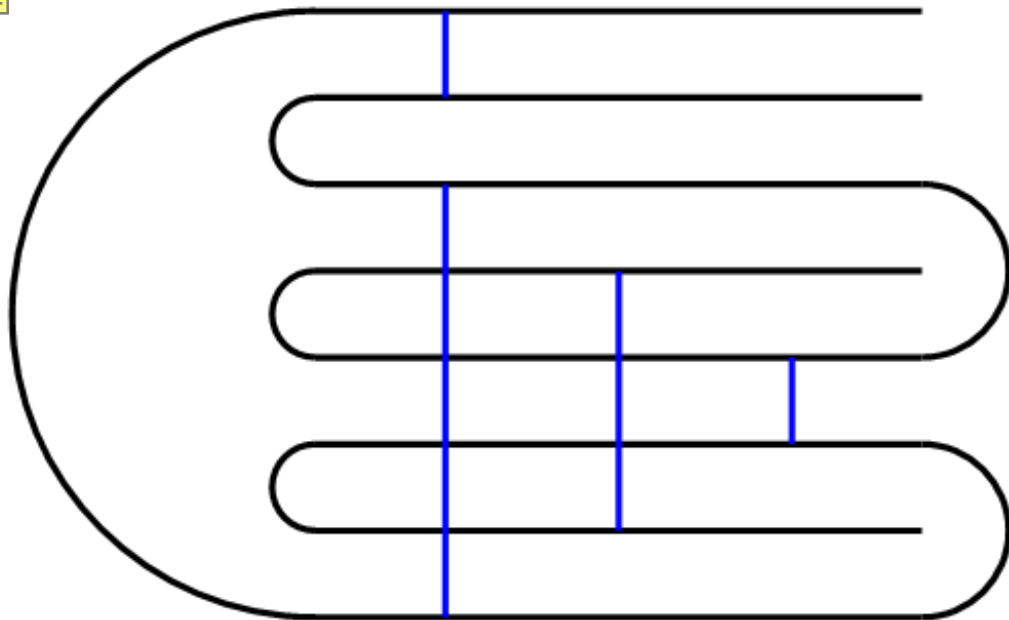


top edge view

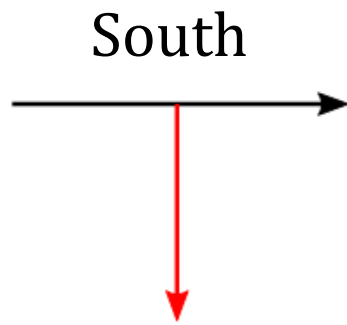
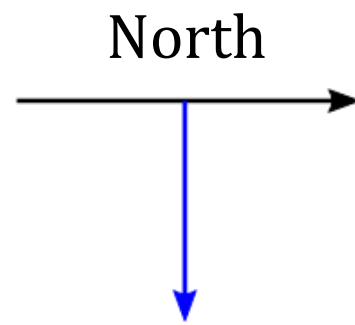
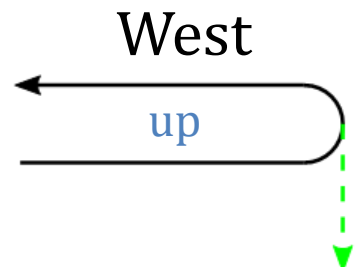
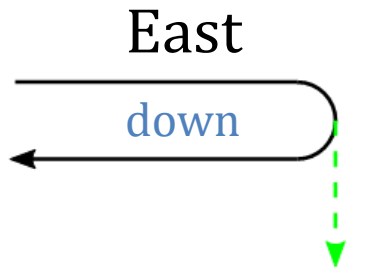
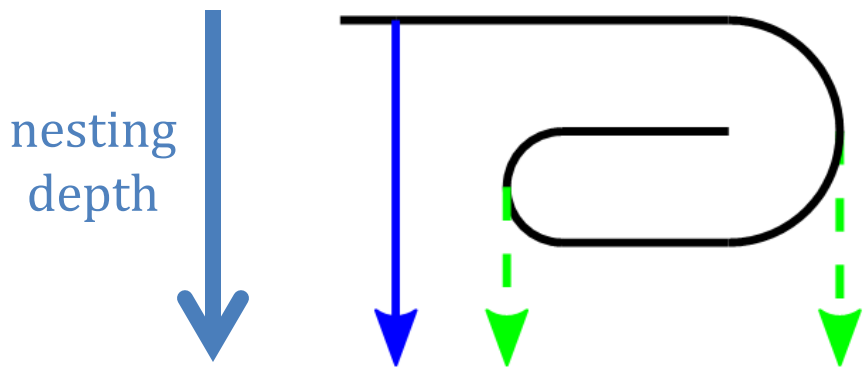


top edge view

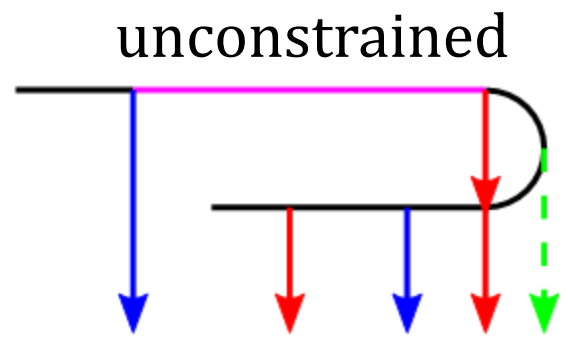
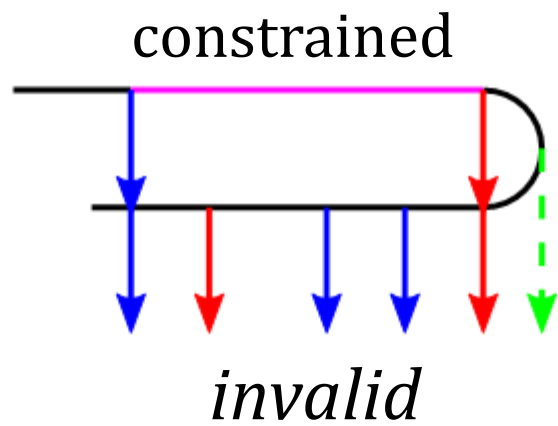
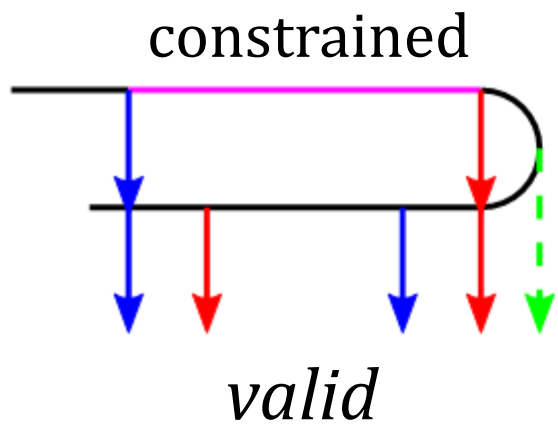




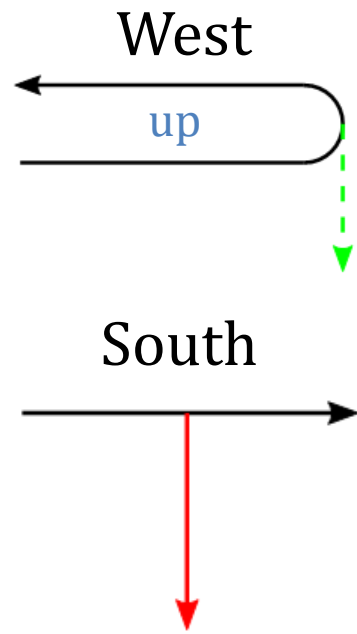
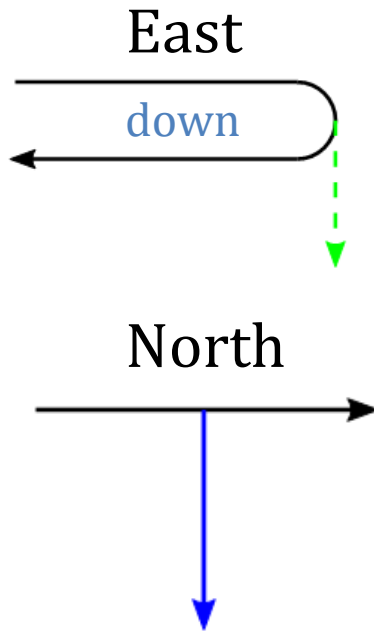
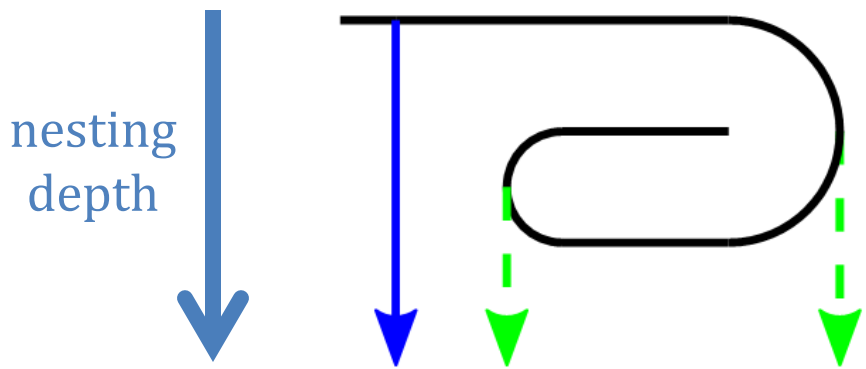
ray diagram

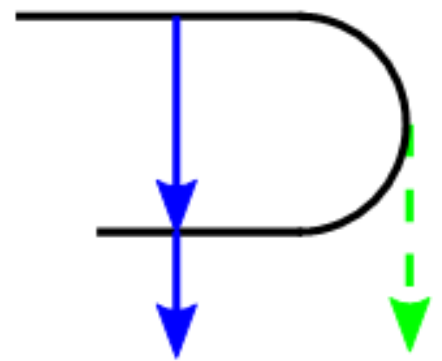
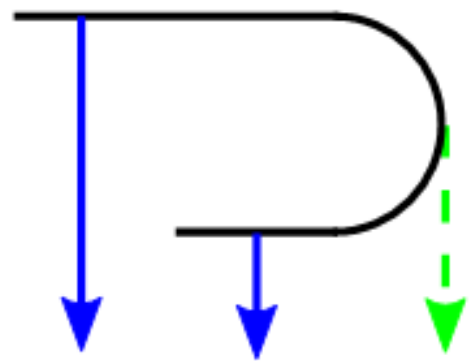
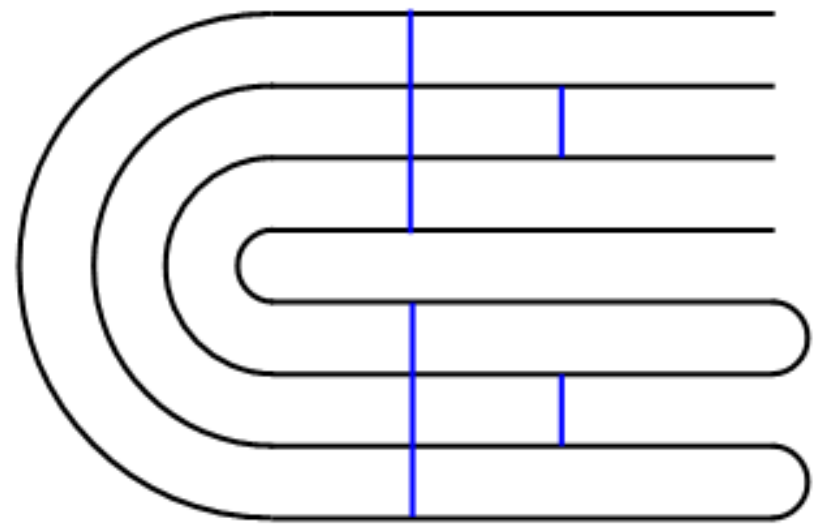
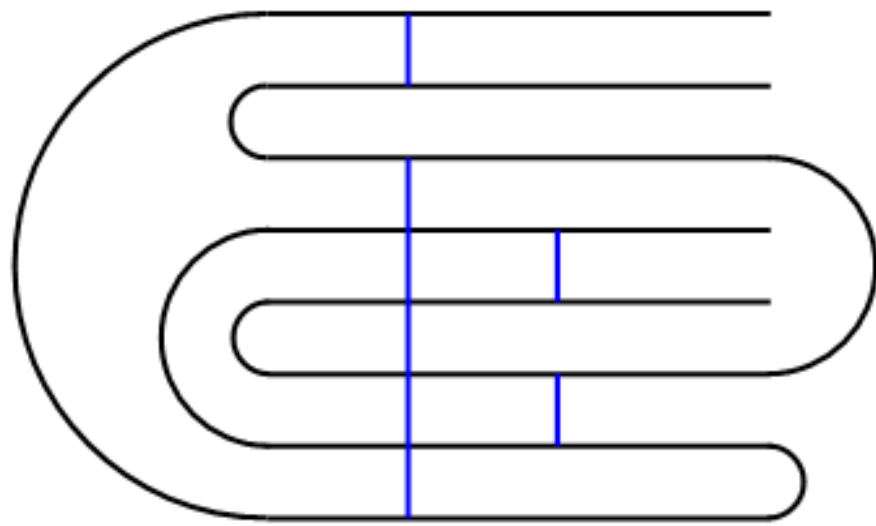


[Demaine, Liu, Morgan 2012]

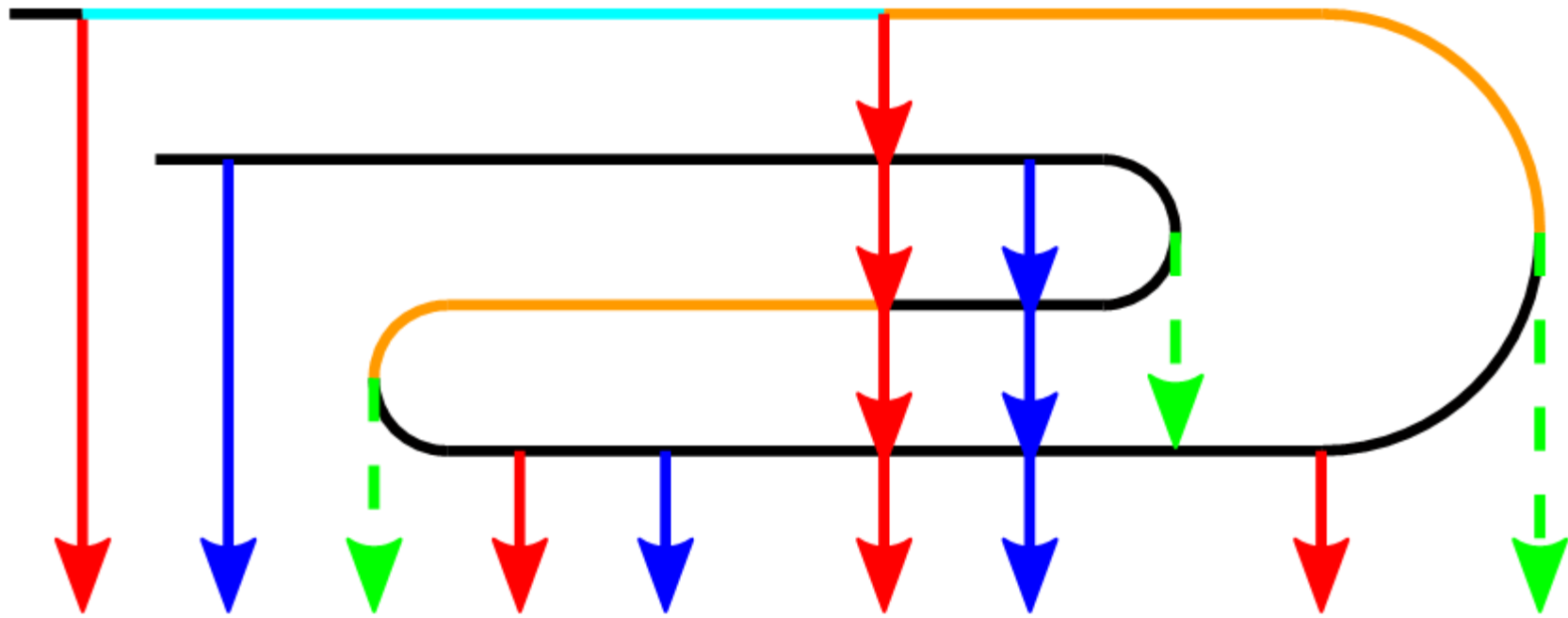


ray diagram

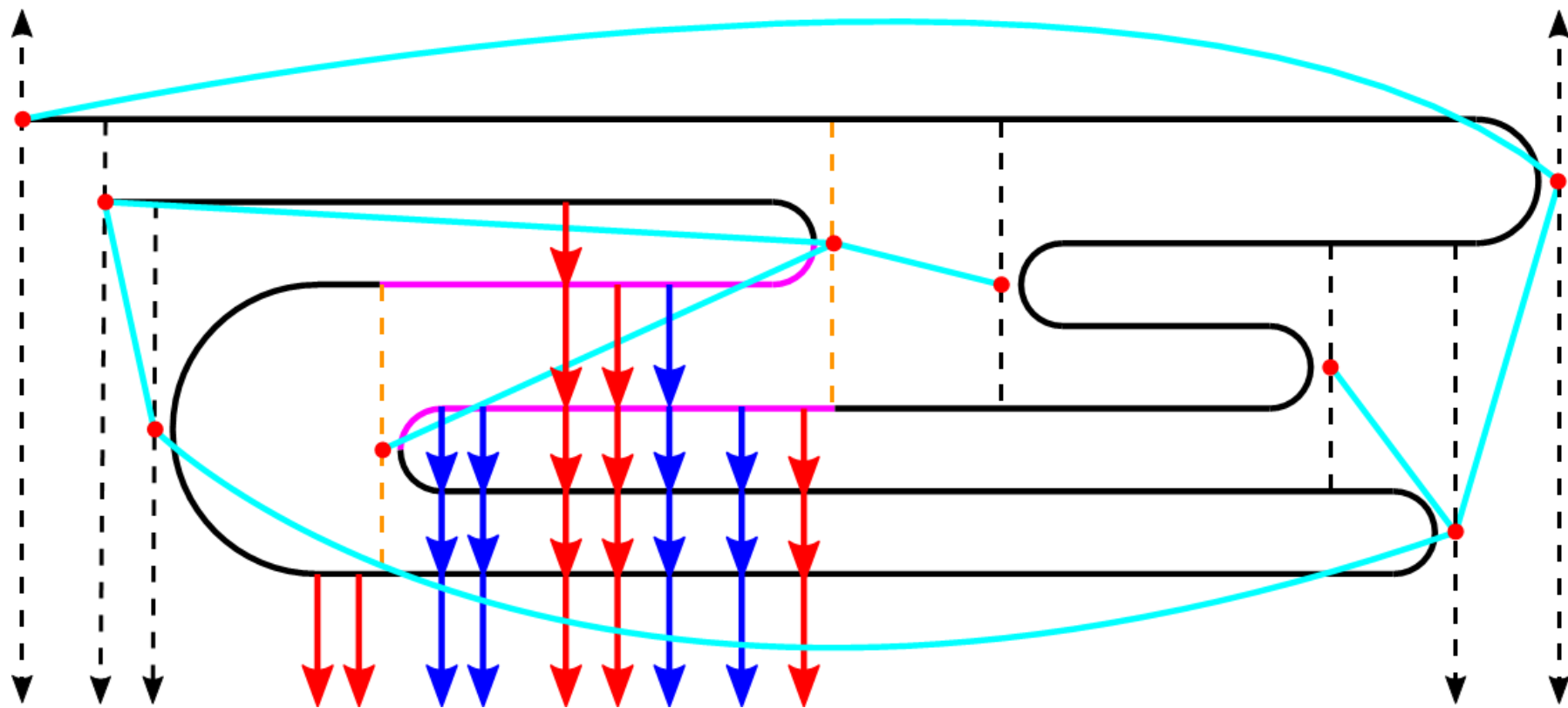




[Demaine, Liu, Morgan 2012]



SSESNSNSWSNWNNSN



[Demaine, Liu, Morgan 2012]