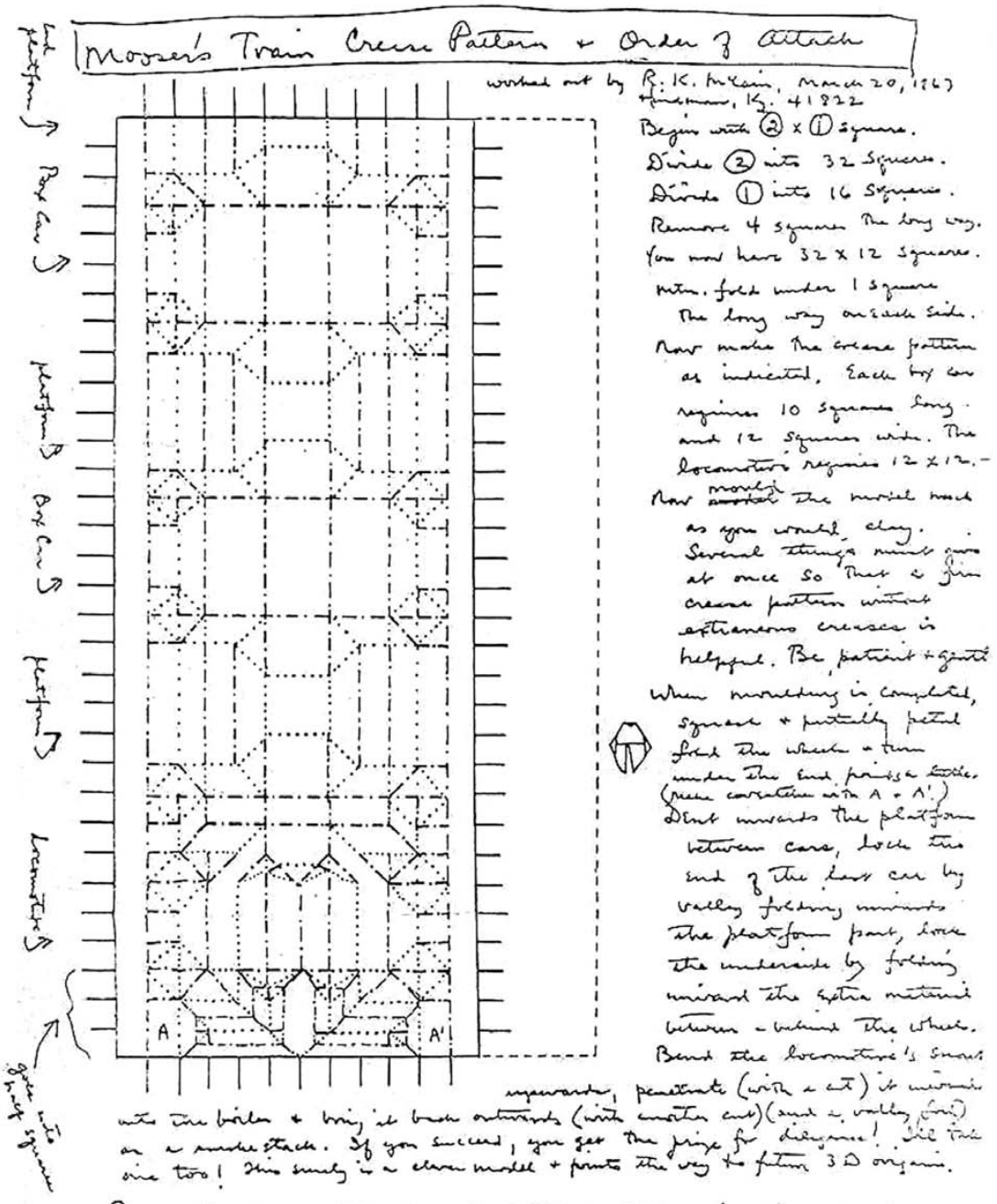
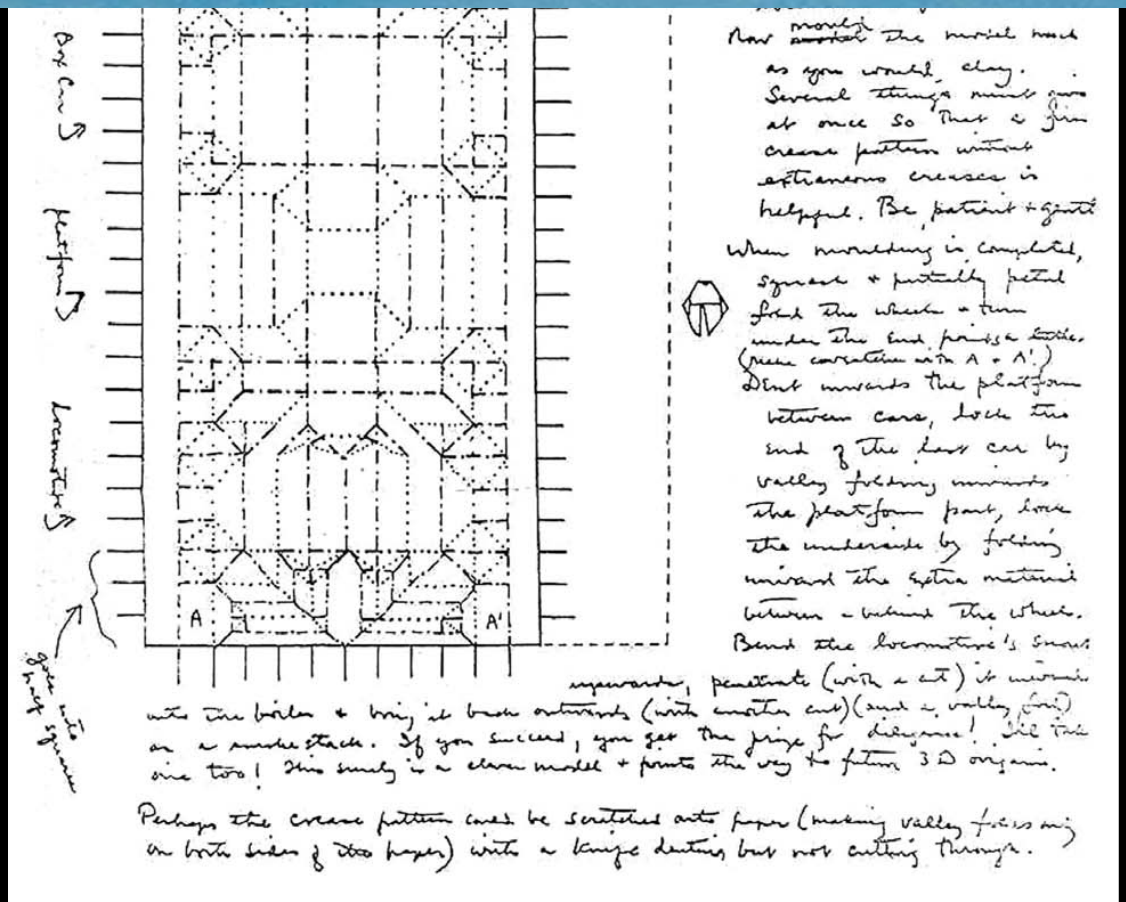
Mooser's Train

Raymond McLain, 1967





folding by Robert Lang

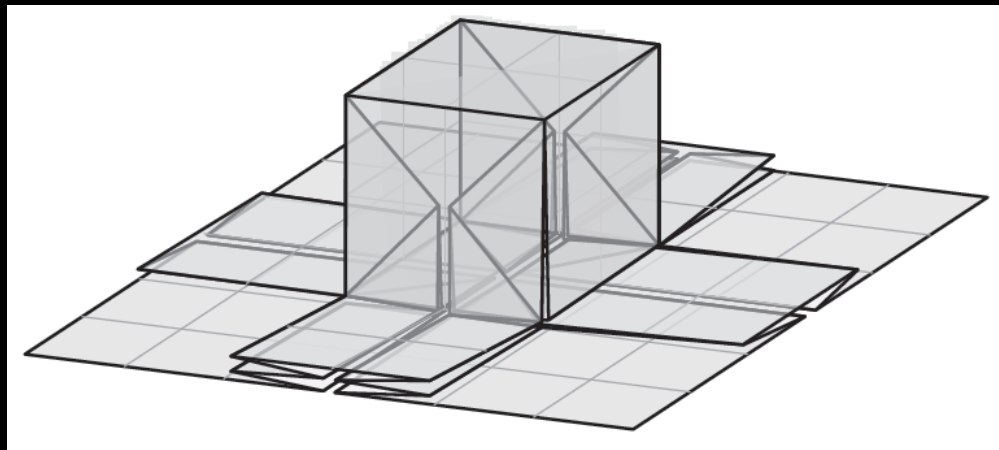
Mooser's Train

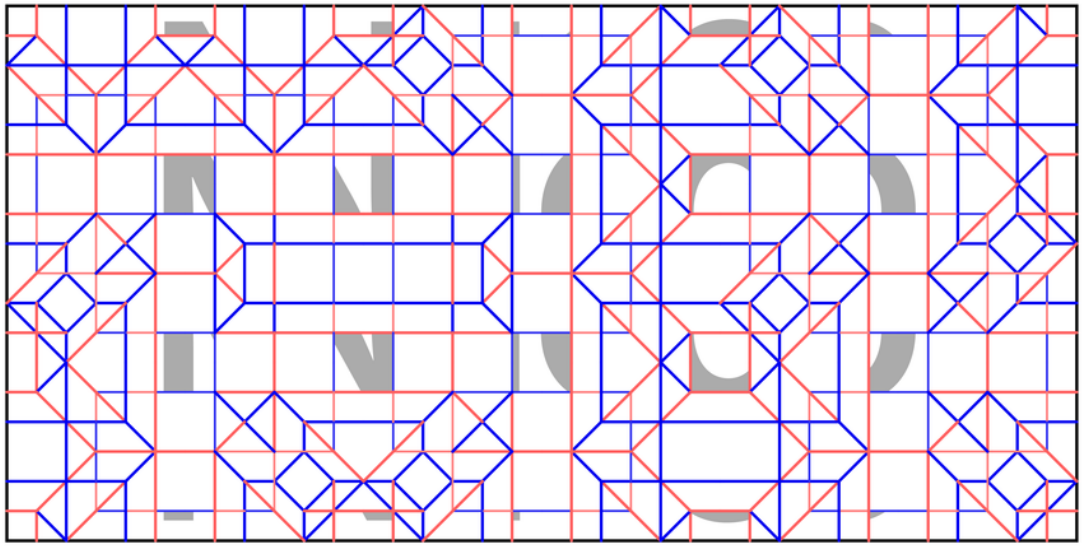
Raymond McLain, 1967

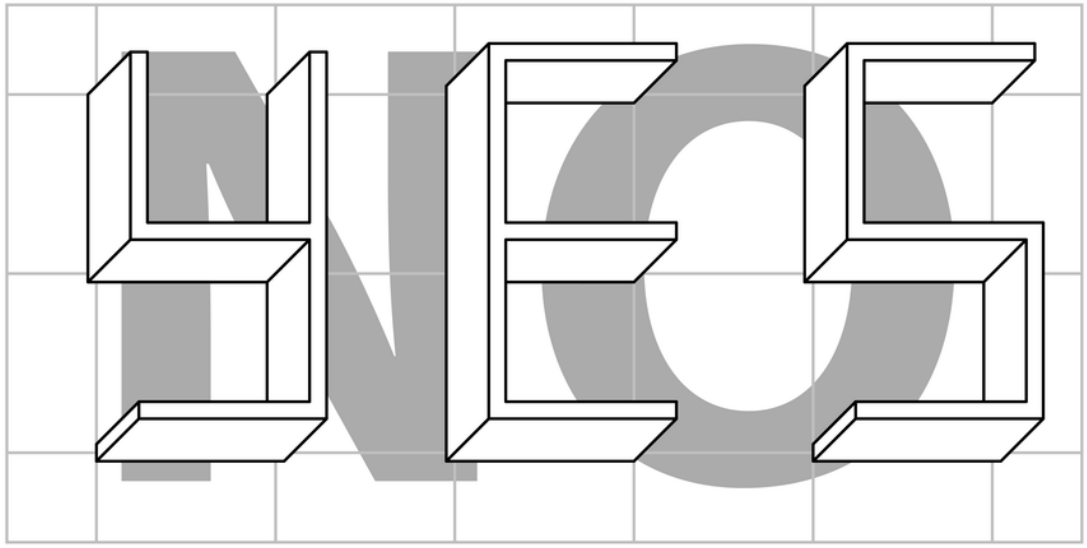
Black Forest Cuckoo Clock,
opus 182

Robert Lang, 1987

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

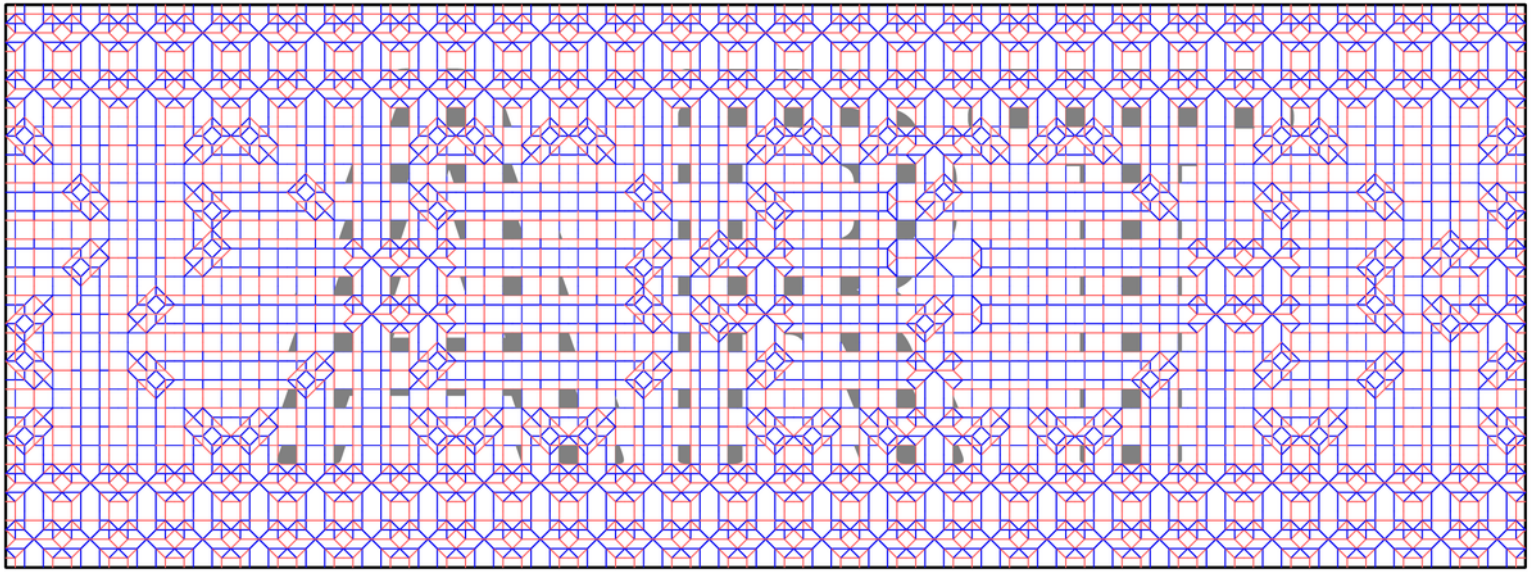


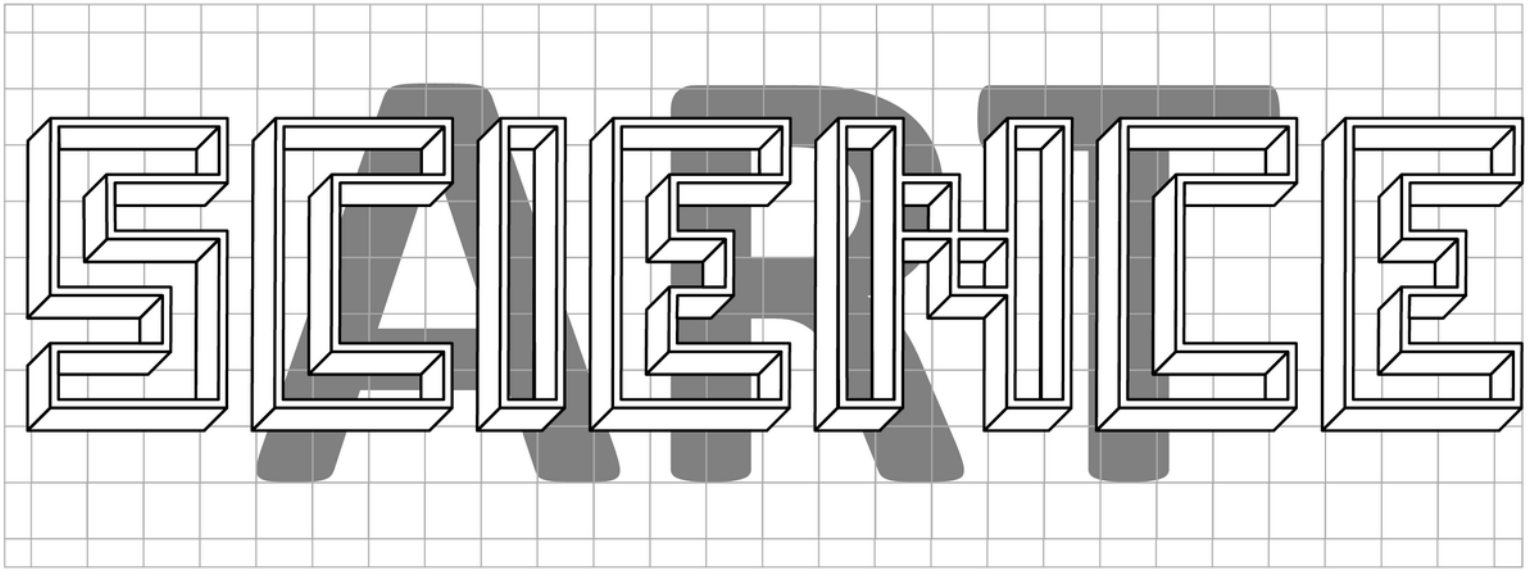




Yes/No

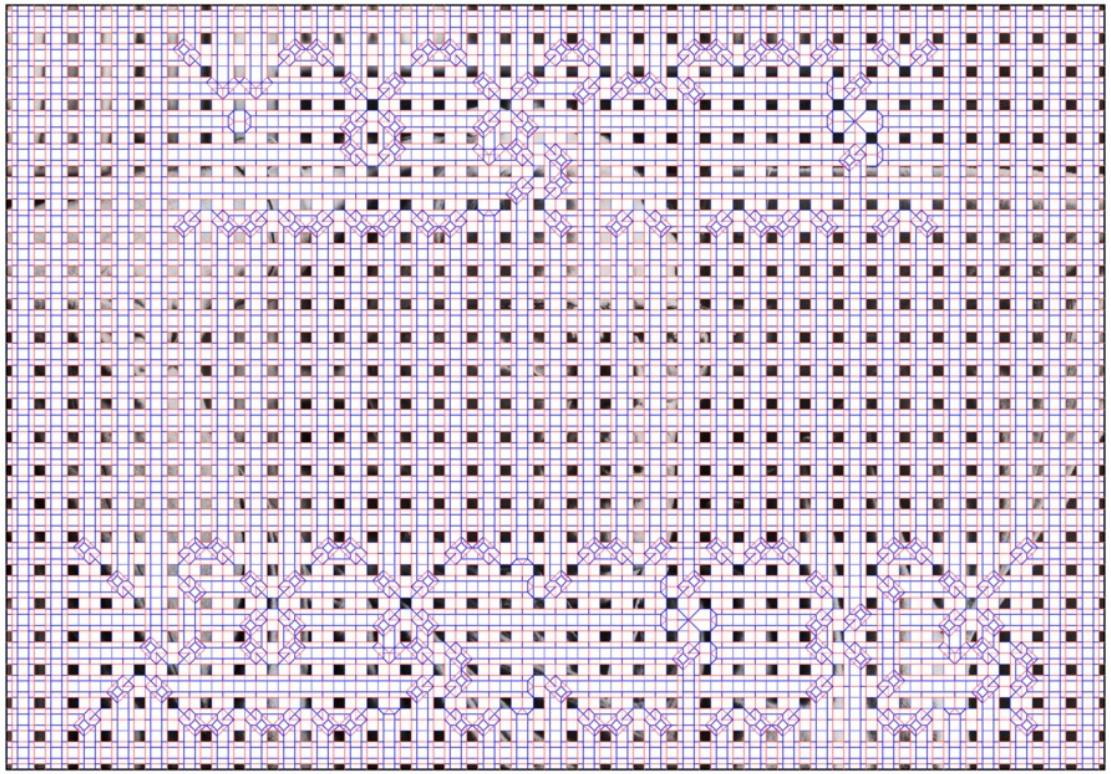
Demaine,
Demaine,
Stengle
2011

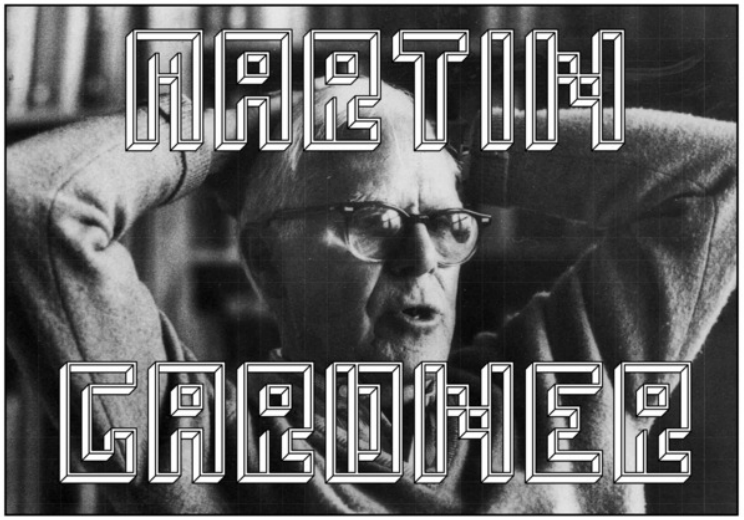




Science/Art

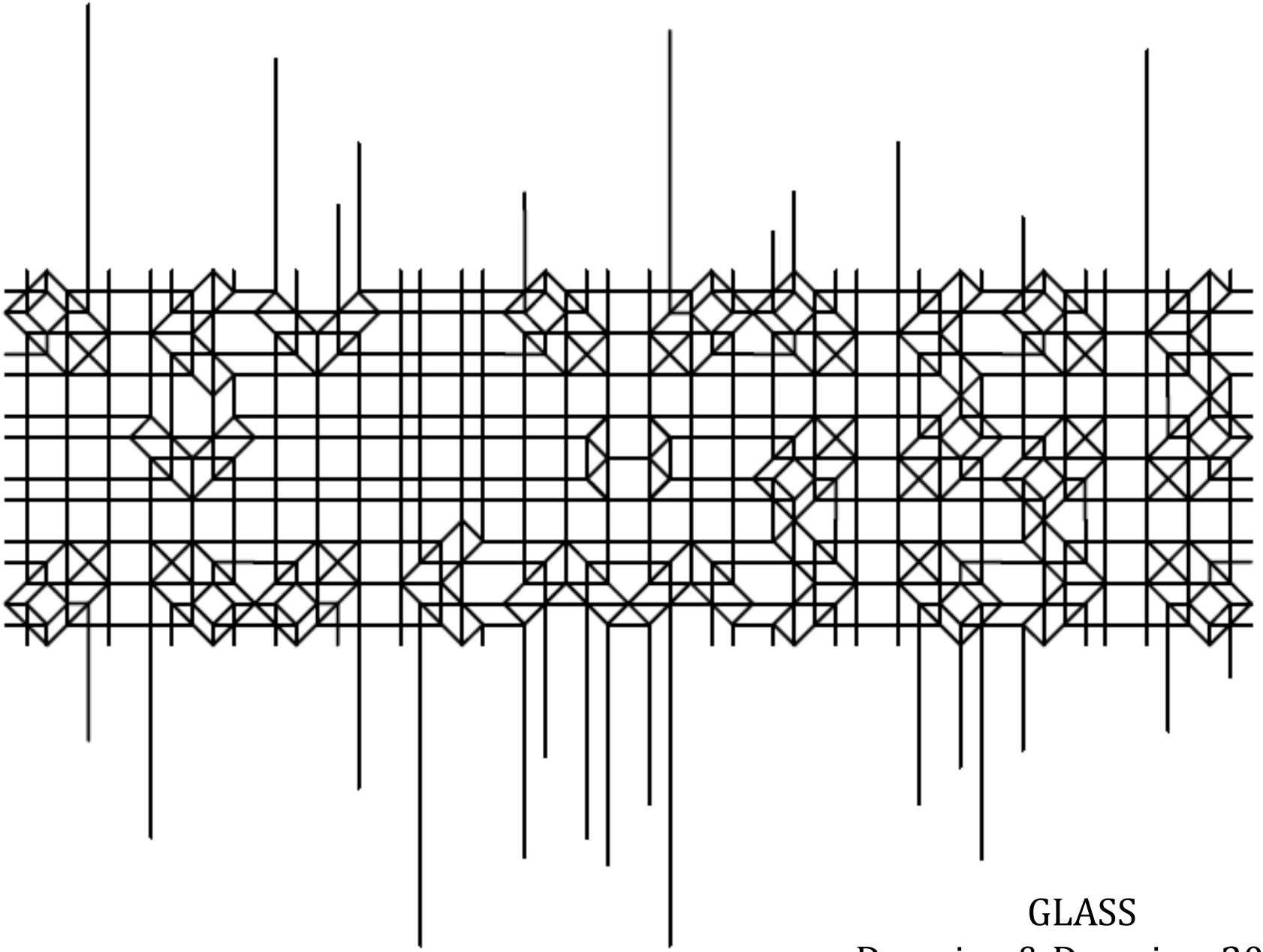
Demaine & Demaine, 2011





Martin Gardner

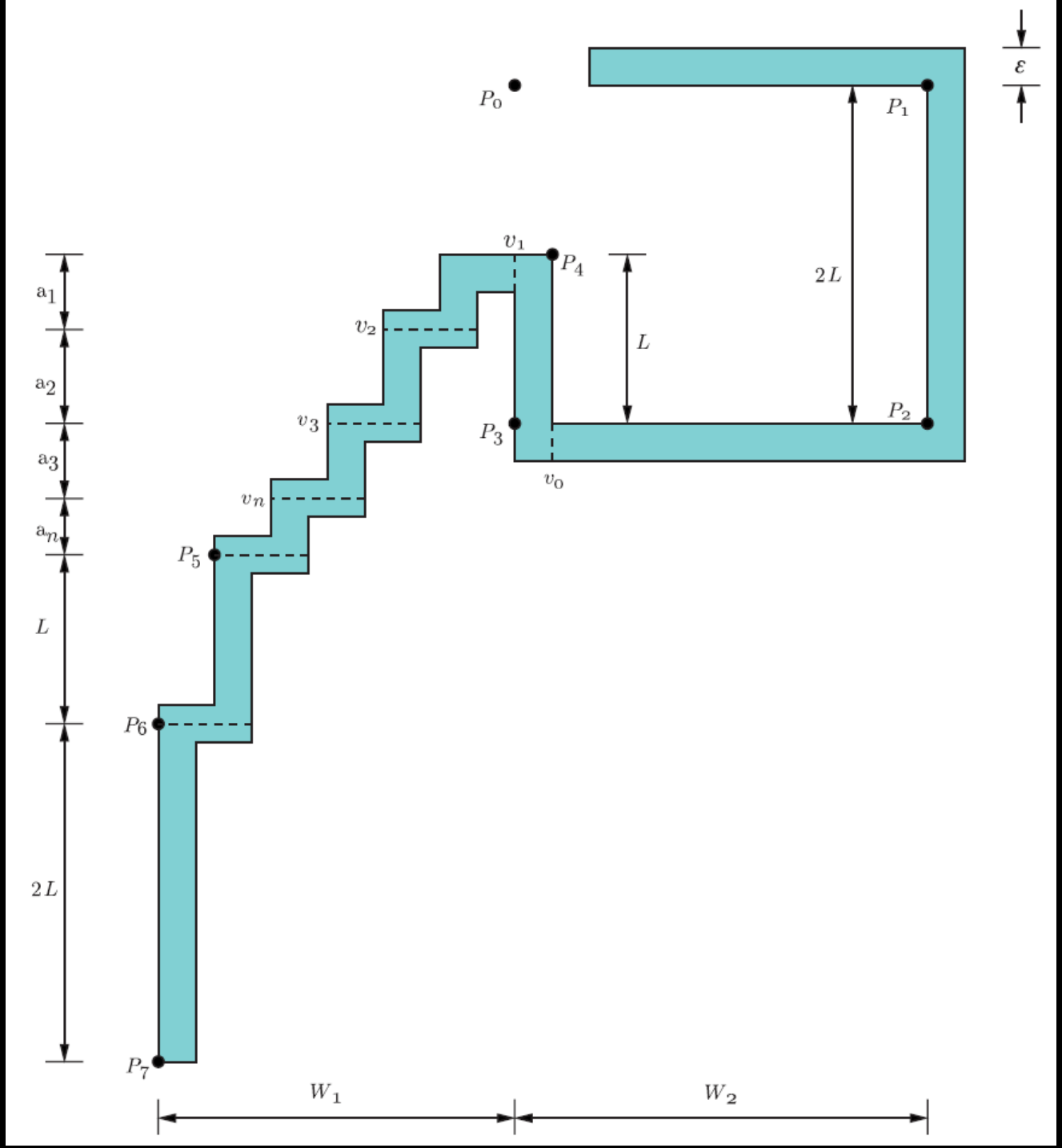
Demaine, Demaine 2012



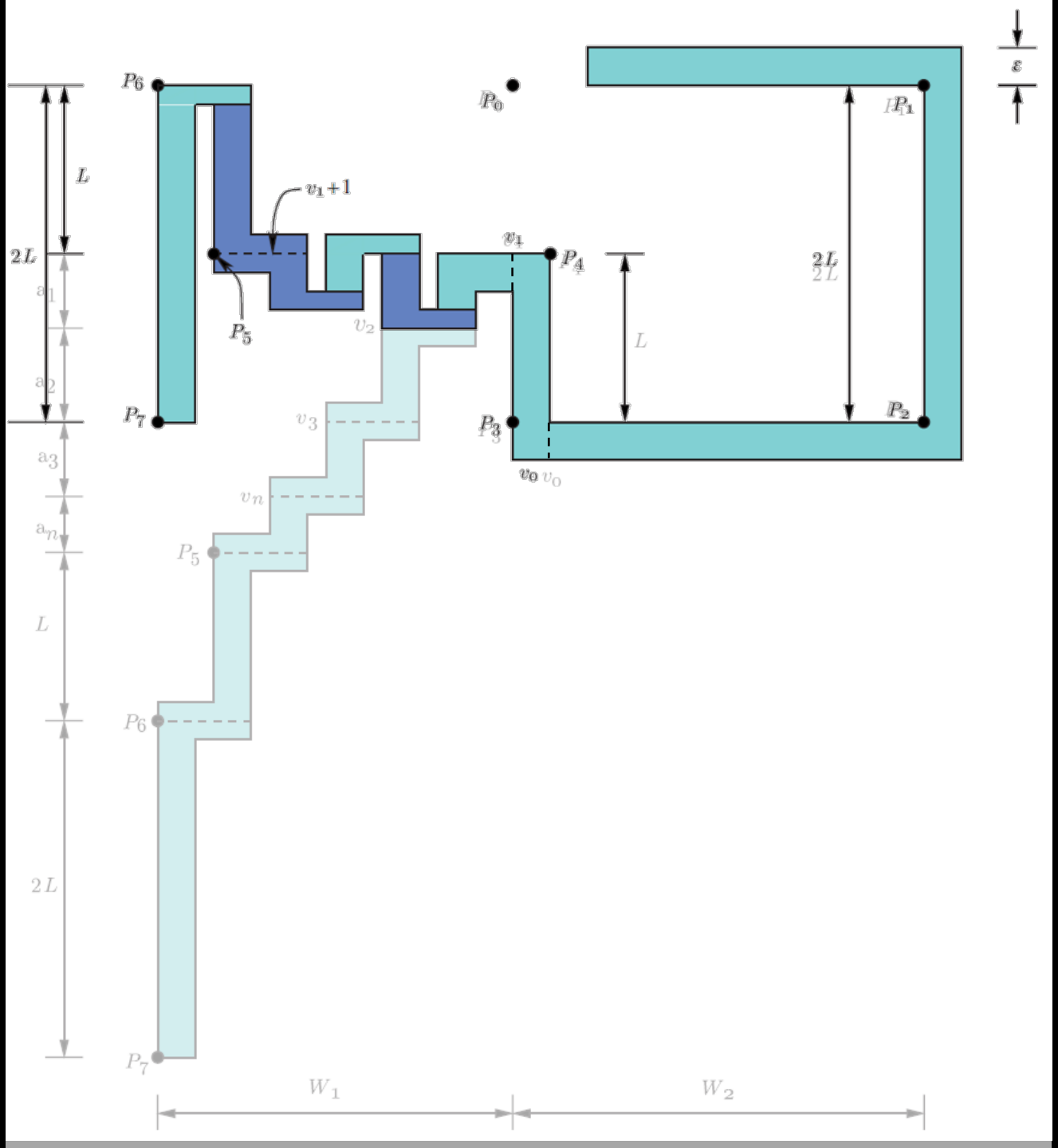
GLASS
Demaine & Demaine, 2012

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?

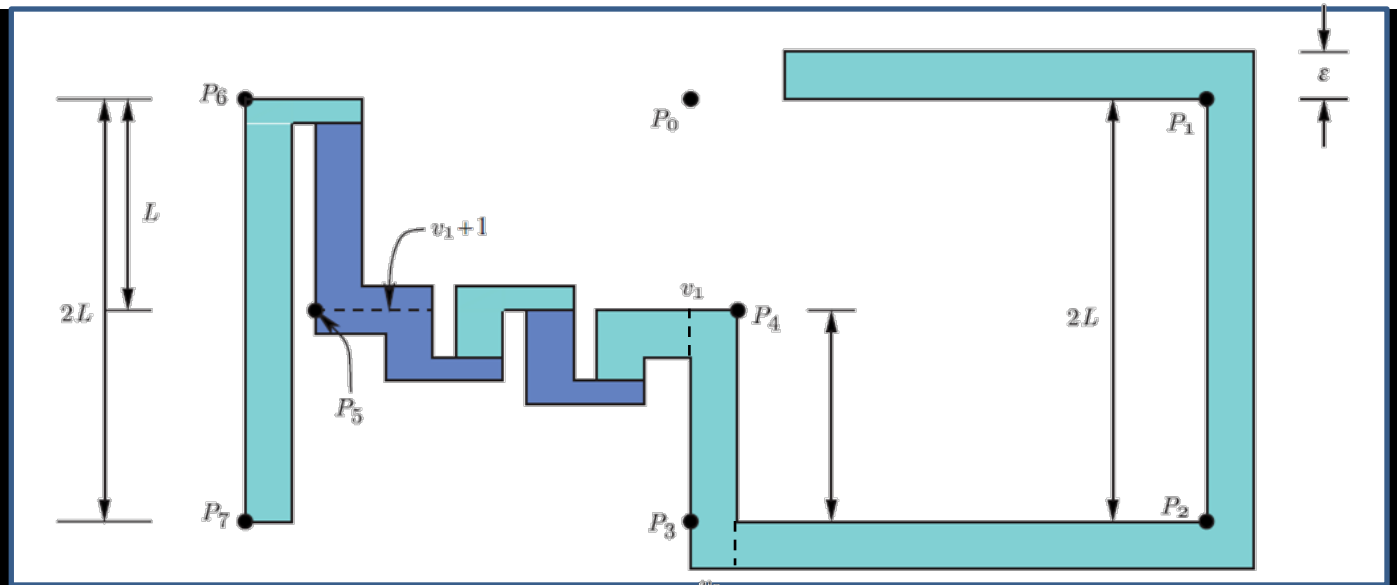


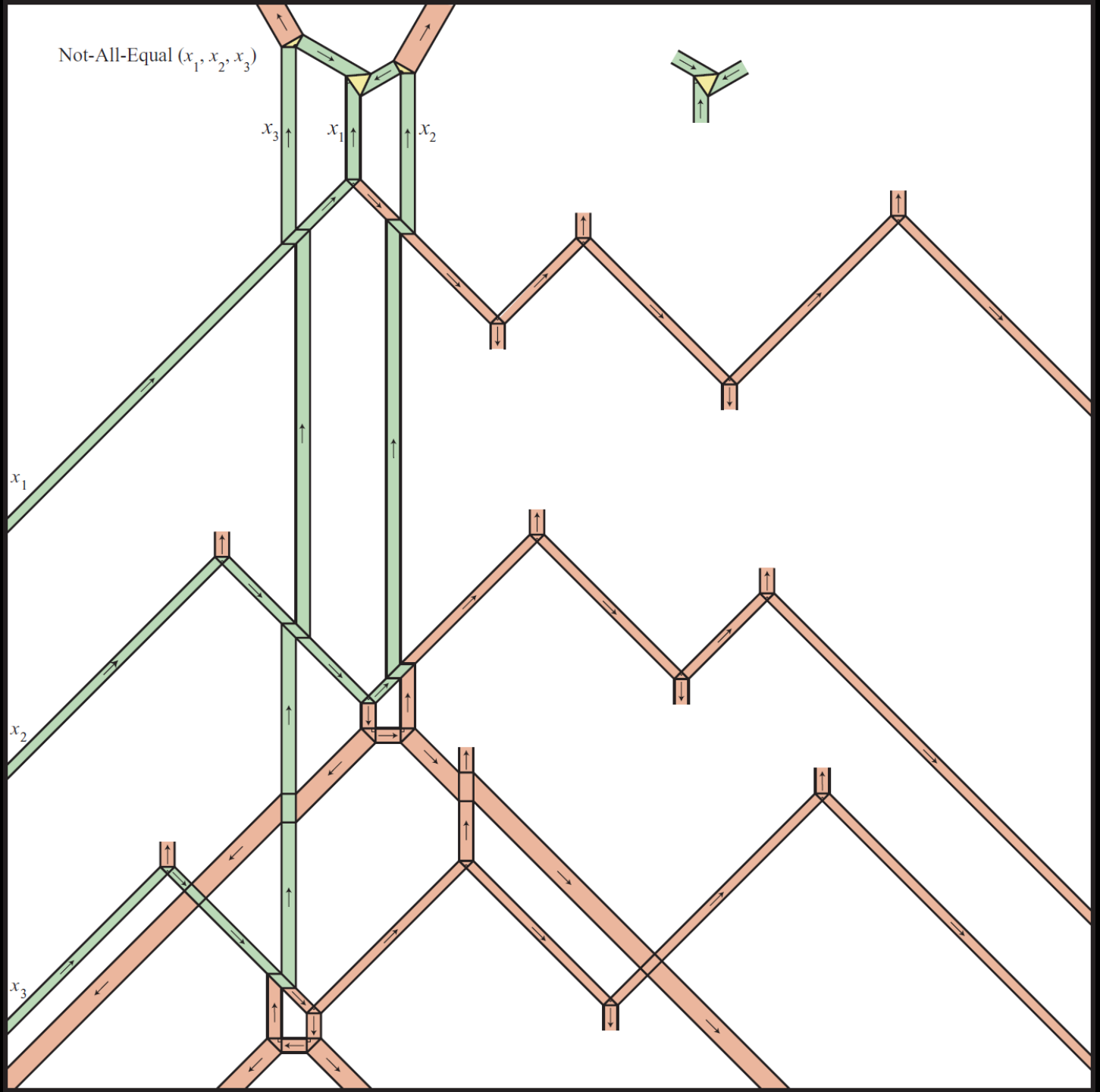
[Arkin, Bender, Demaine, Demaine, Mitchell, Sethia, Skiena 2000]



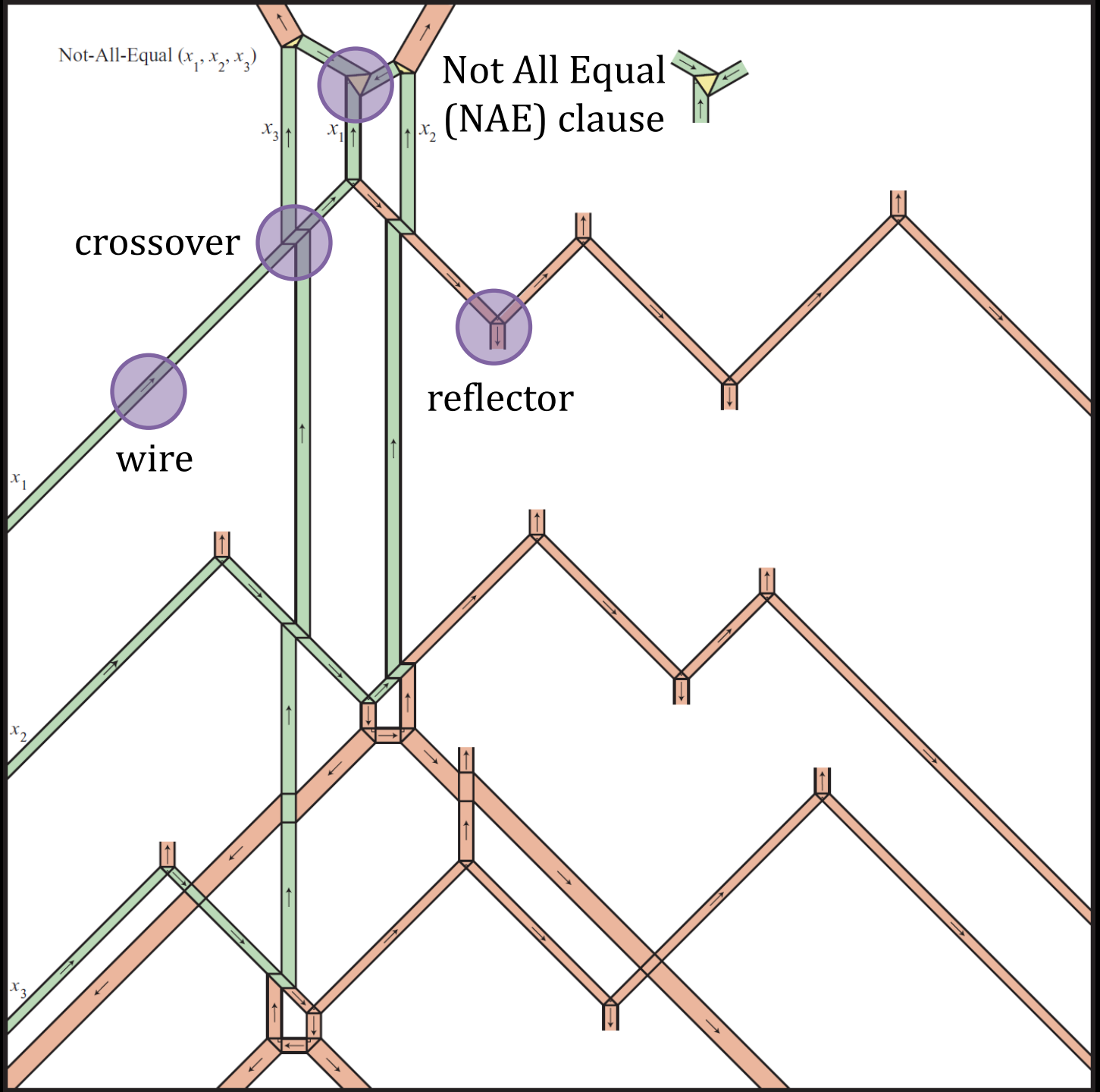
[Arkin, Bender, Demaine, Demaine, Mitchell, Sethia, Skiena 2000]

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?





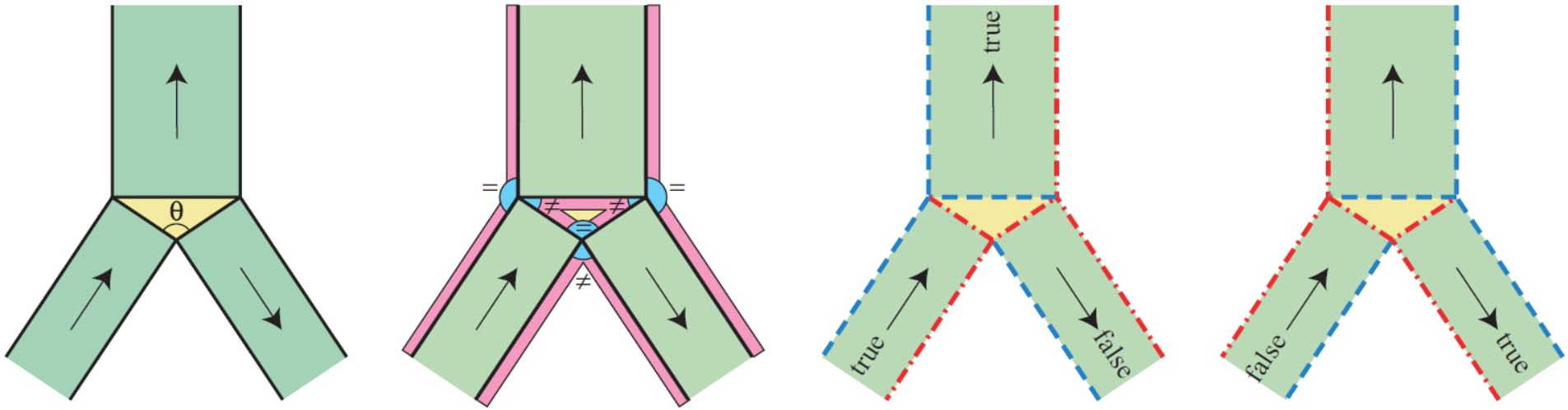
[Bern & Hayes 1996]



[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

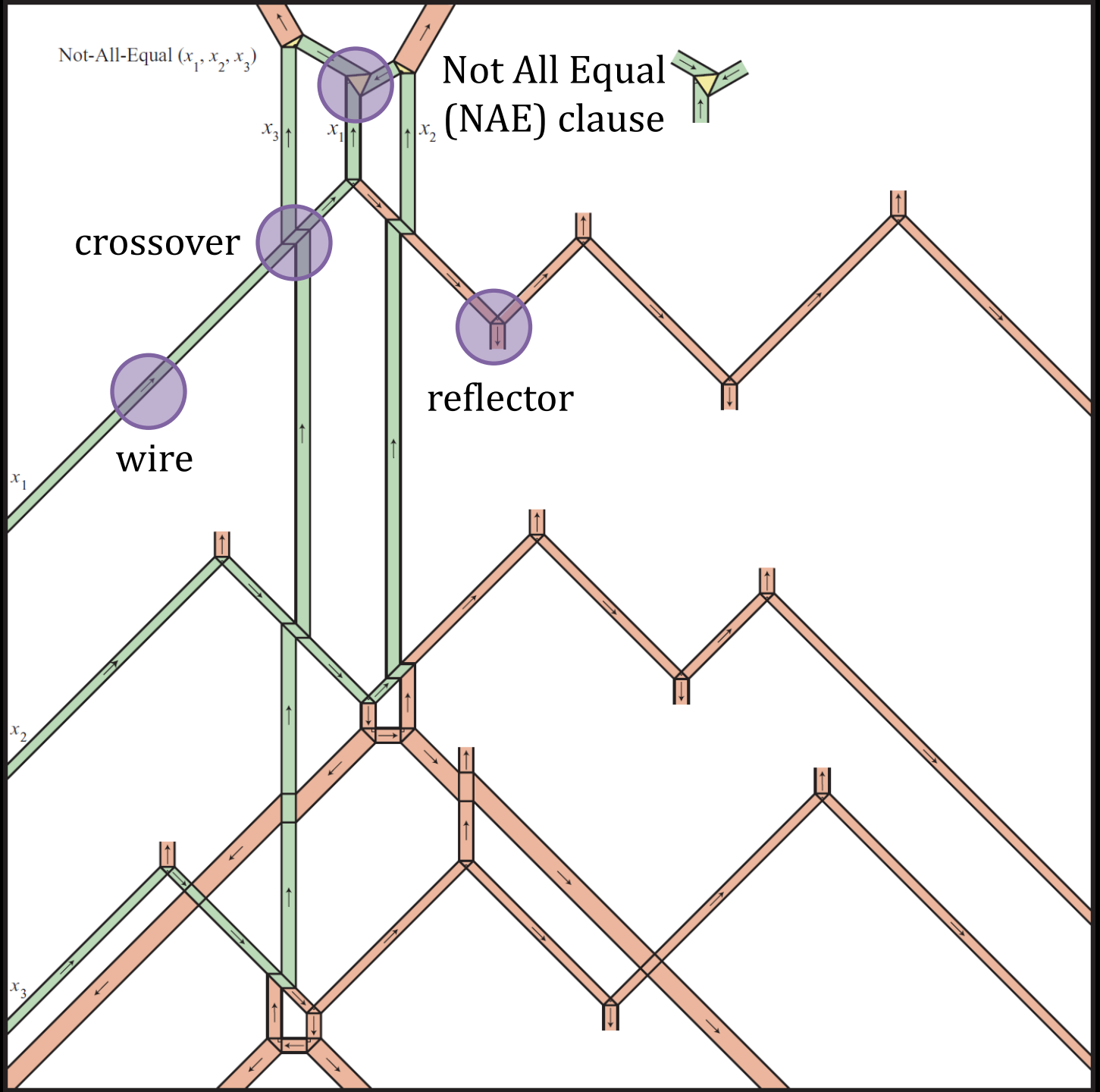
⇒ locally flat-foldable,

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.)



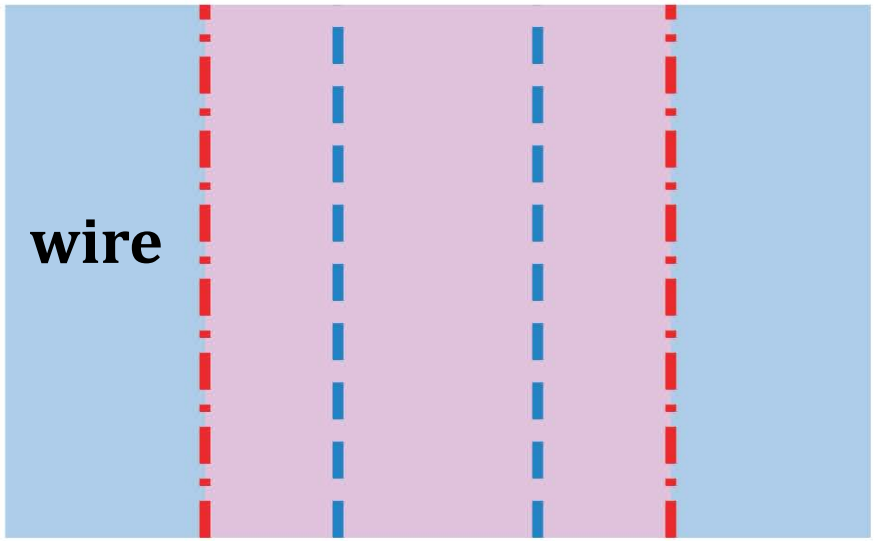
[Bern & Hayes 1996]

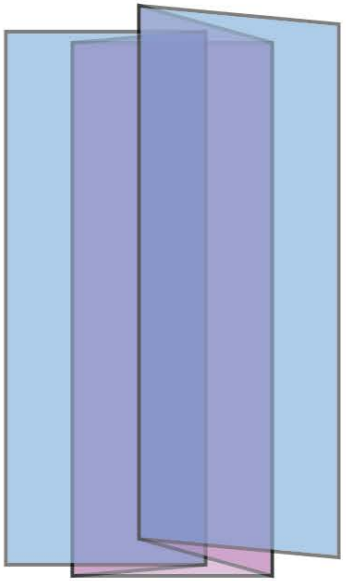
For global flat foldability, I understand how the gadgets prove (1), but how do they prove (2)?

Global flat foldability: [Bern & Hayes 1996]

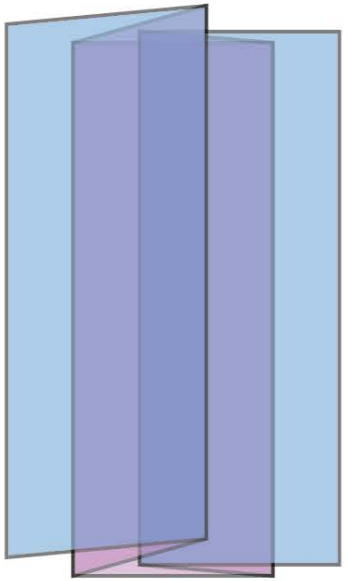
① deciding flat foldability of given crease pattern is strongly NP-hard

② constructing valid layer ordering for given flat-foldable mountain-valley pattern is strongly NP-hard





true



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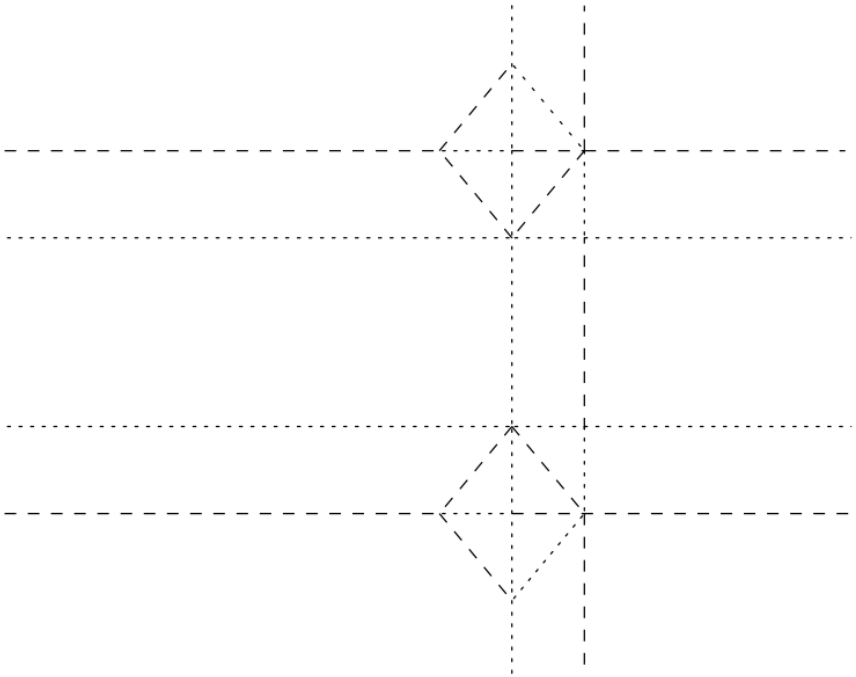
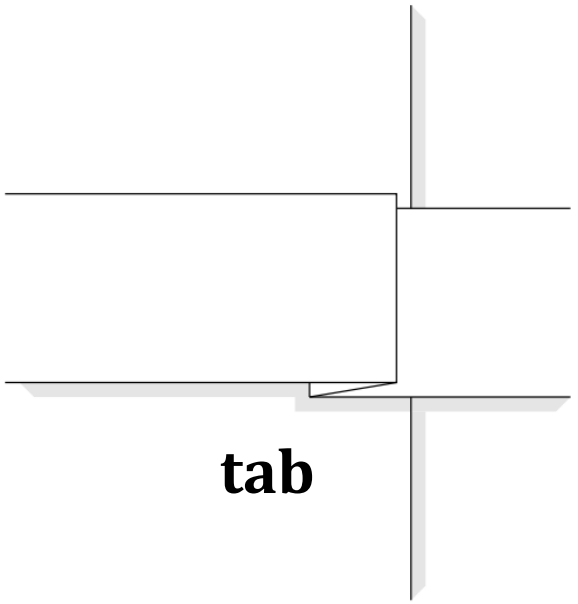
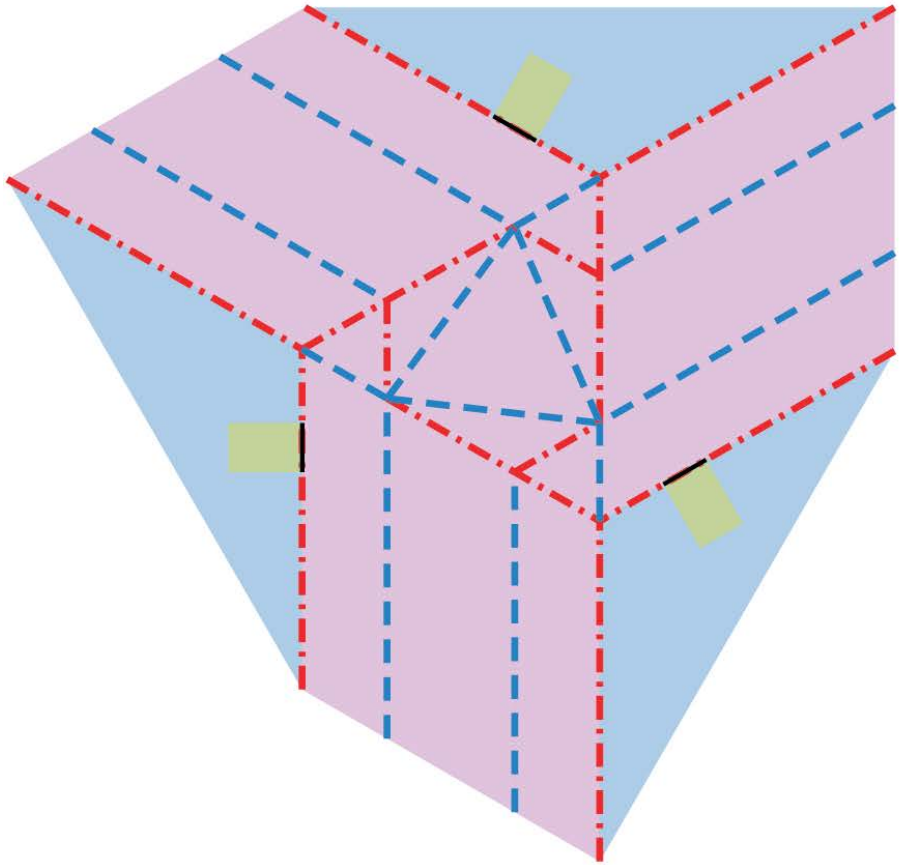


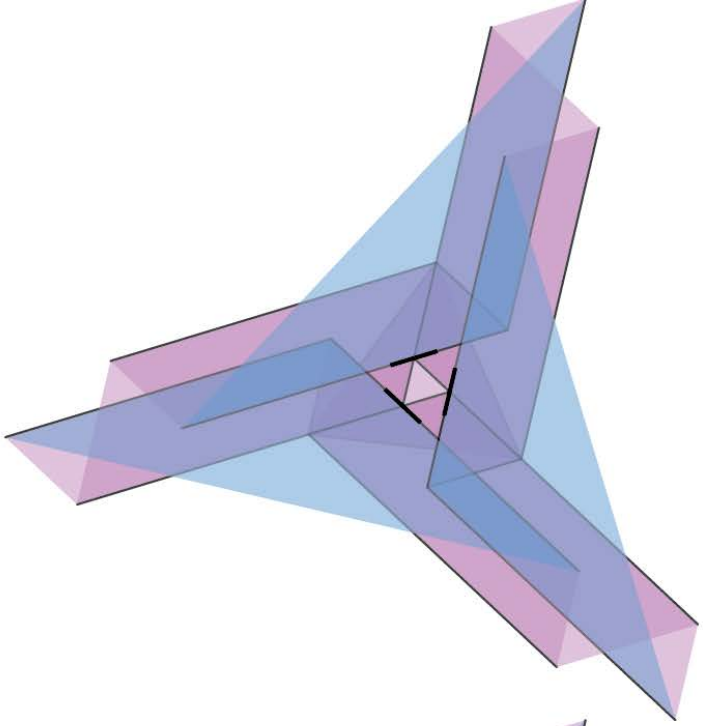


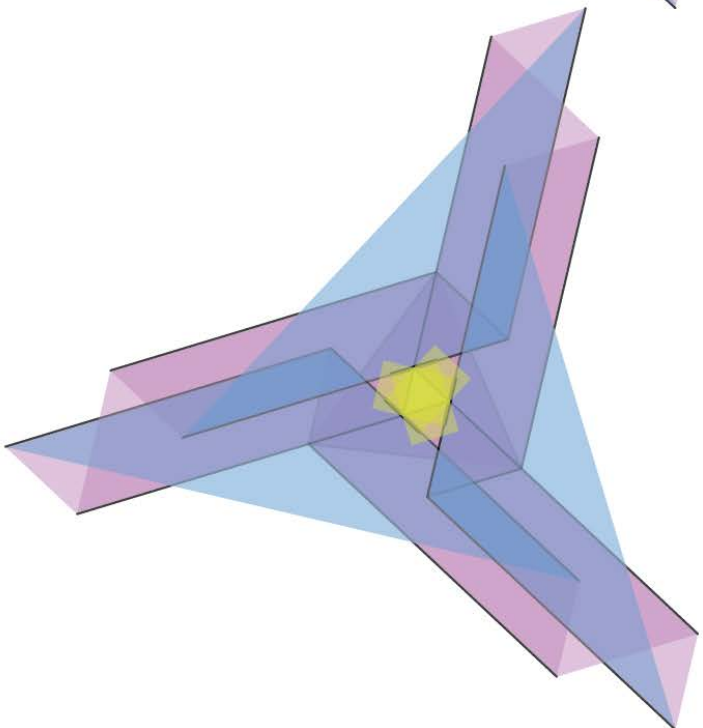
tab

[Bern & Hayes 1996]

NAE clause







[Bern & Hayes 1996]

2D map folding: [Arkin et al 2004]

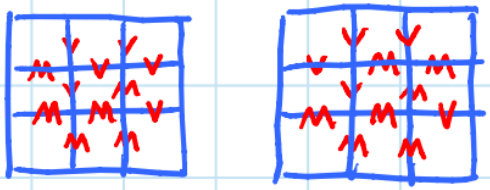
↳ rectangular paper with axis-parallel creases

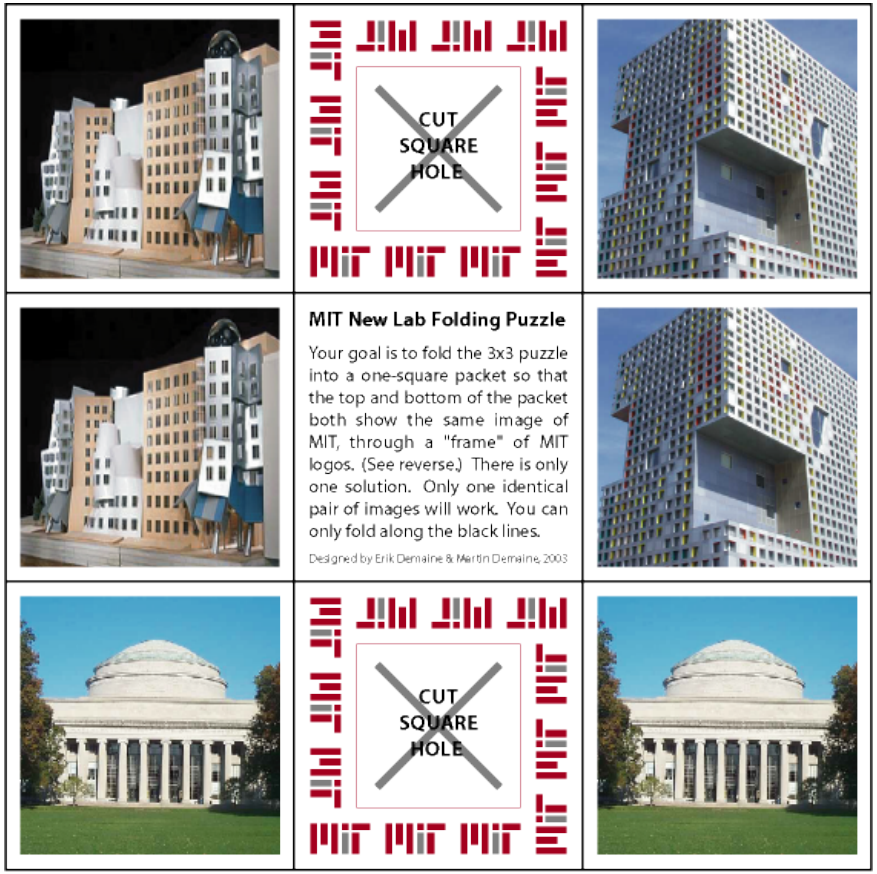
– again every crease pattern is flat foldable:
zig-zag in x then y

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

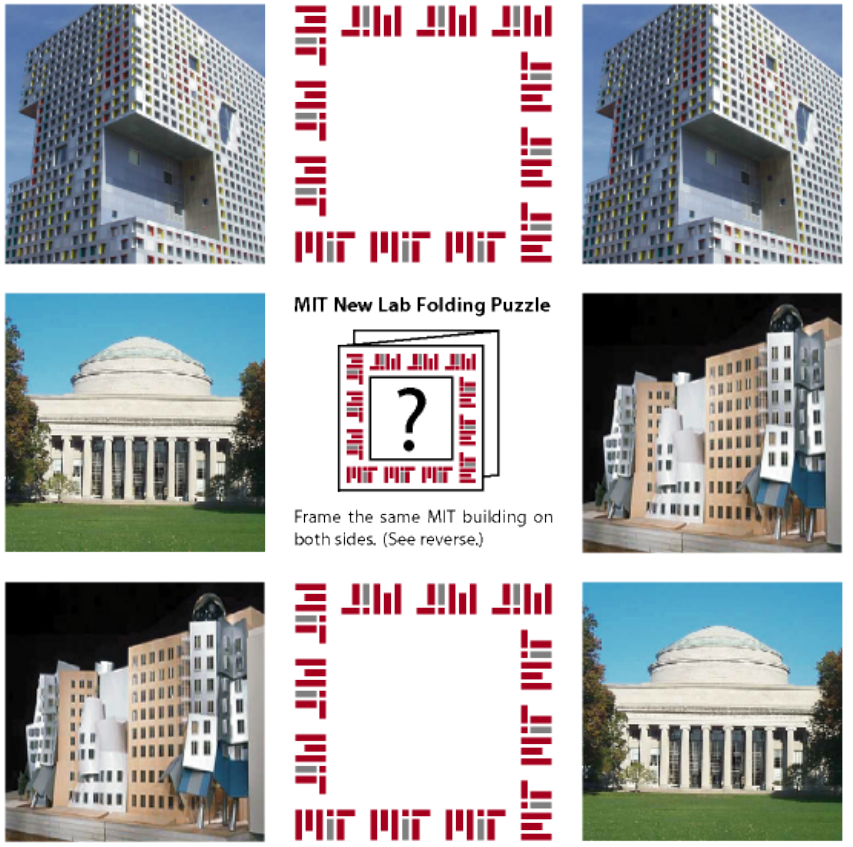
Simple folds are not as powerful in 2D:

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

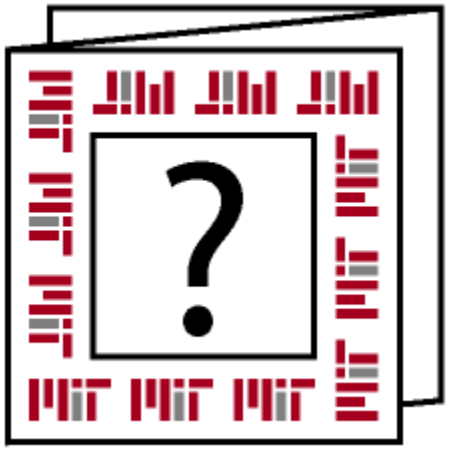




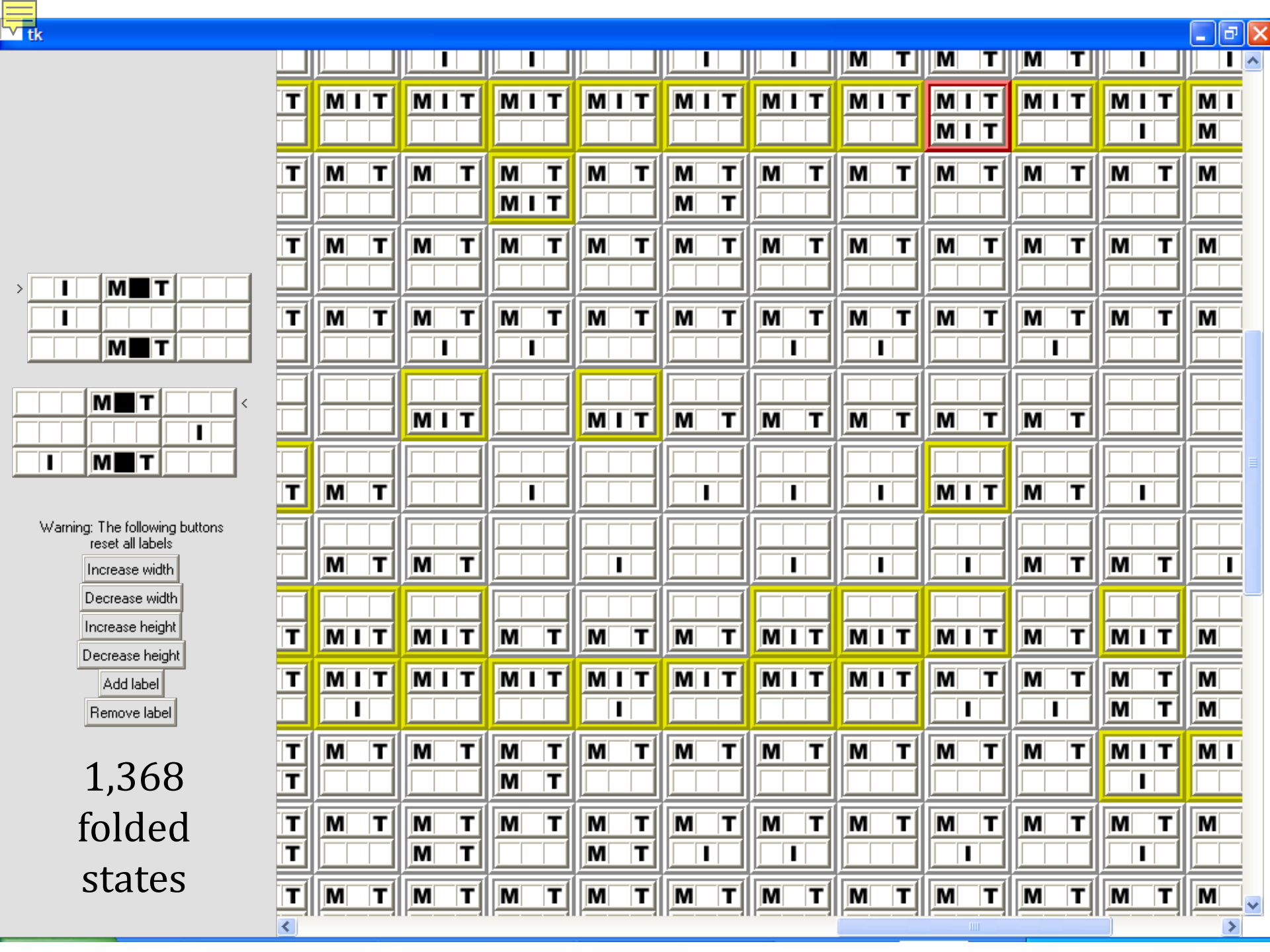
Front

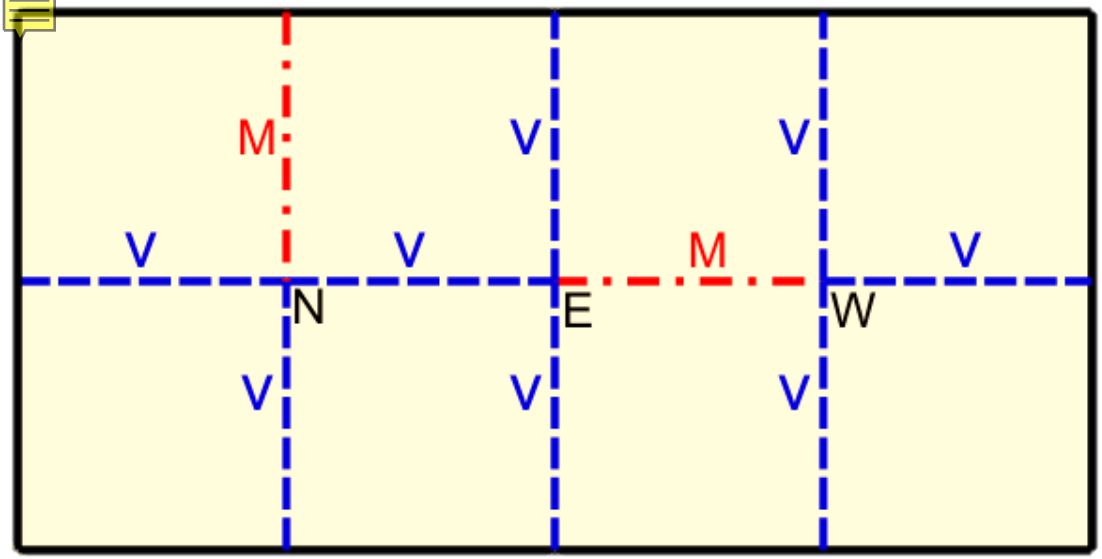


Back



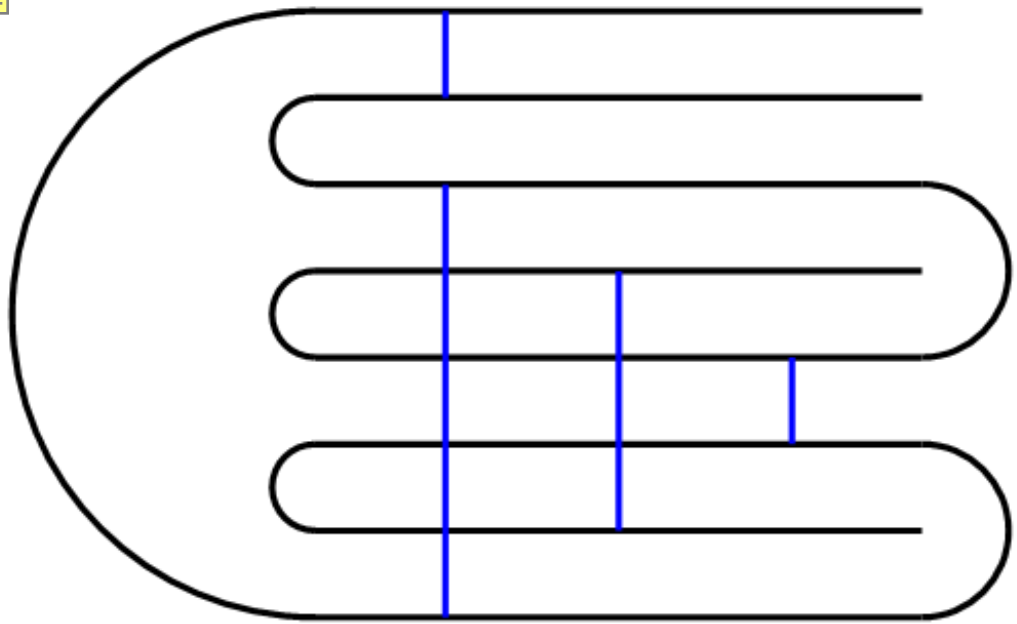
[Demaine & Demaine 2003]


tk
Warning: The following buttons reset all labels
Increase width
Decrease width
Increase height
Decrease height
Add label
Remove label
1,368 folded states



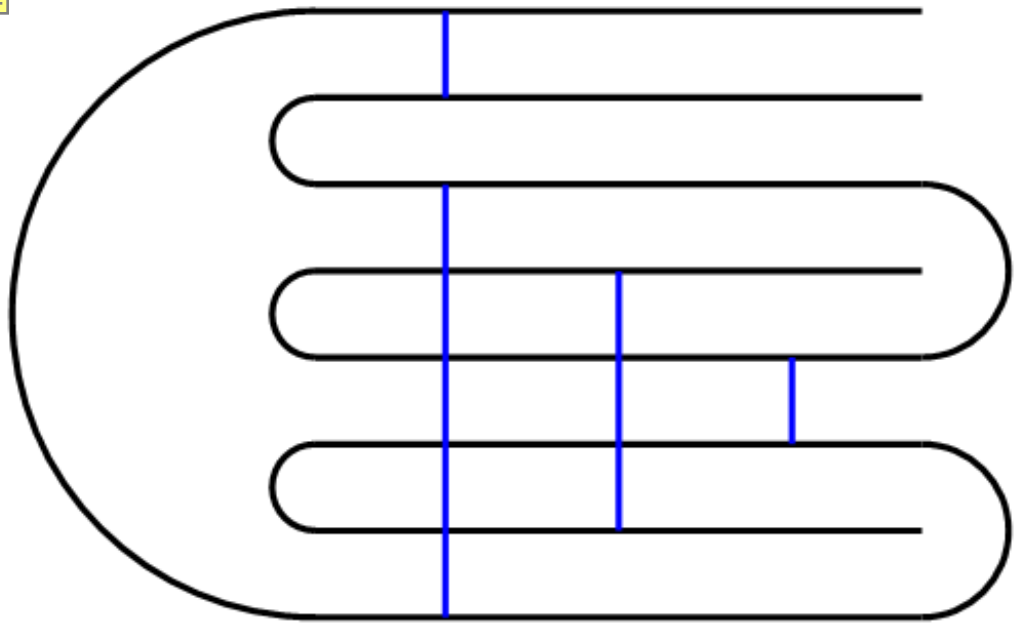
NEWS labeling

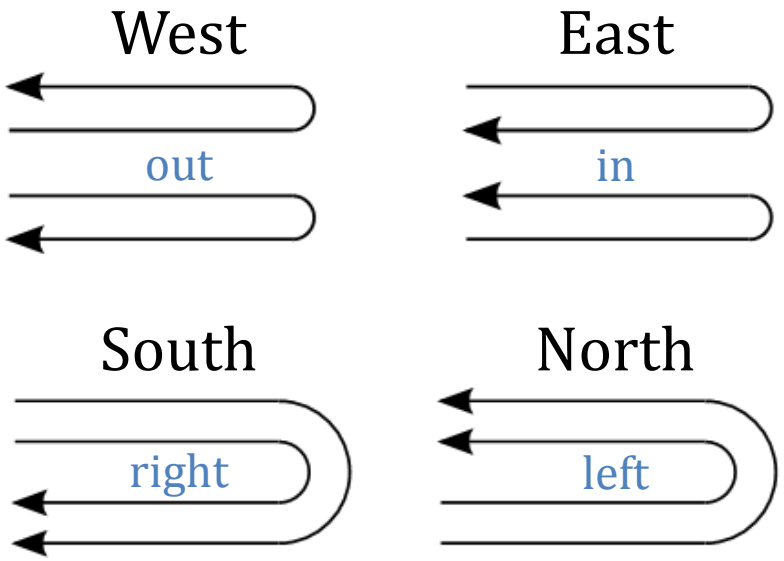
[Demaine, Liu, Morgan 2012]



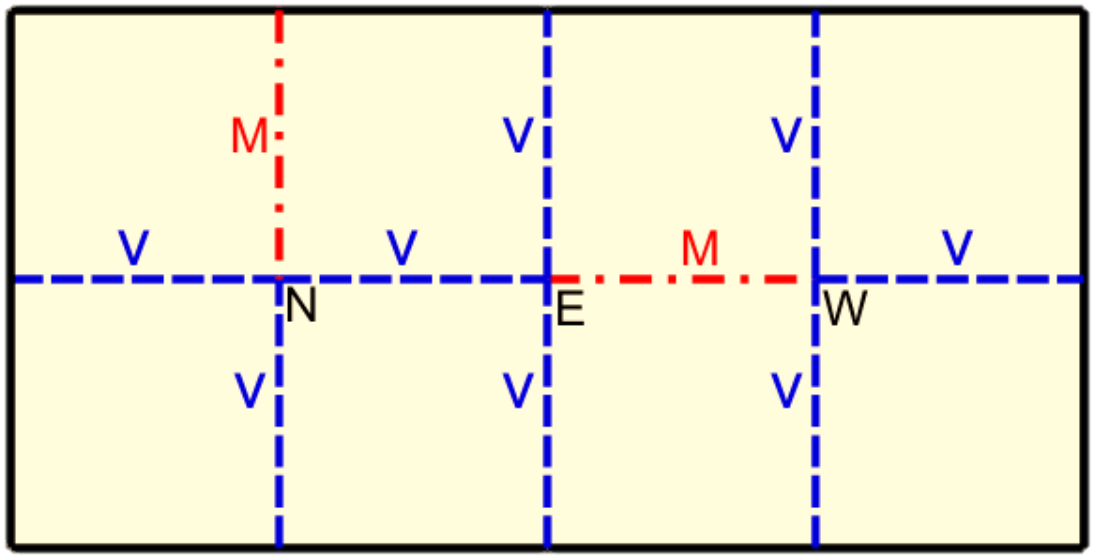
top edge view

[Demaine, Liu, Morgan 2012]

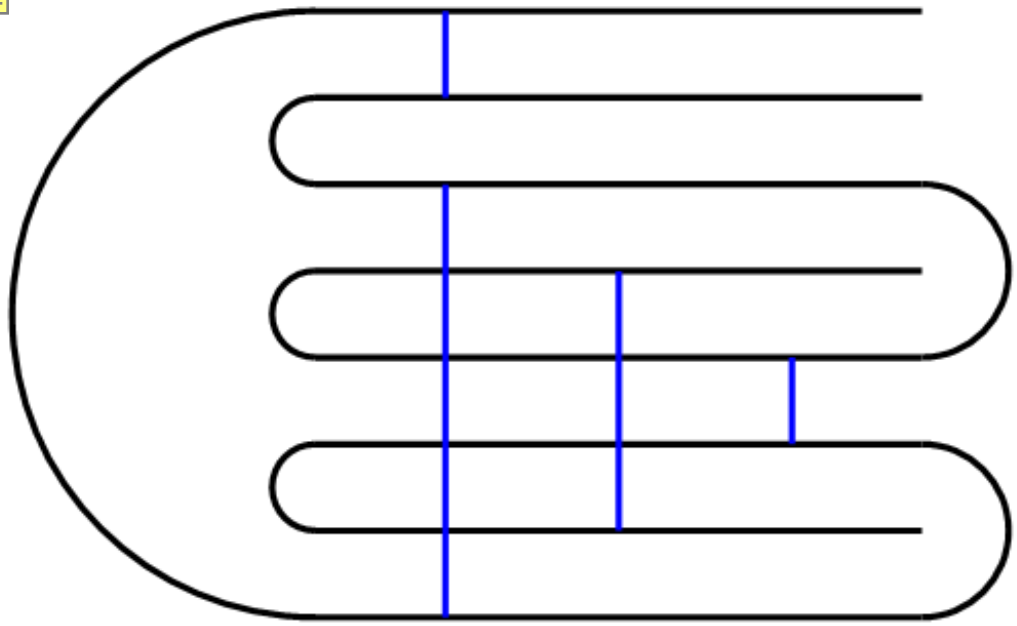


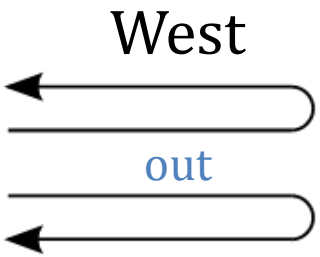


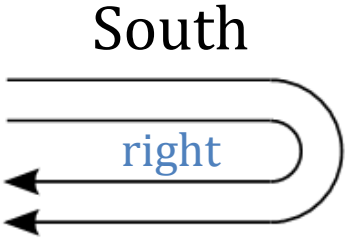
top edge view

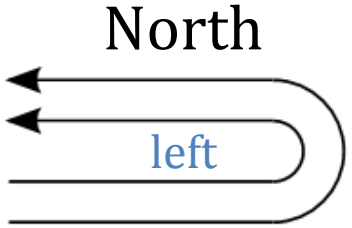


[Demaine, Liu, Morgan 2012]

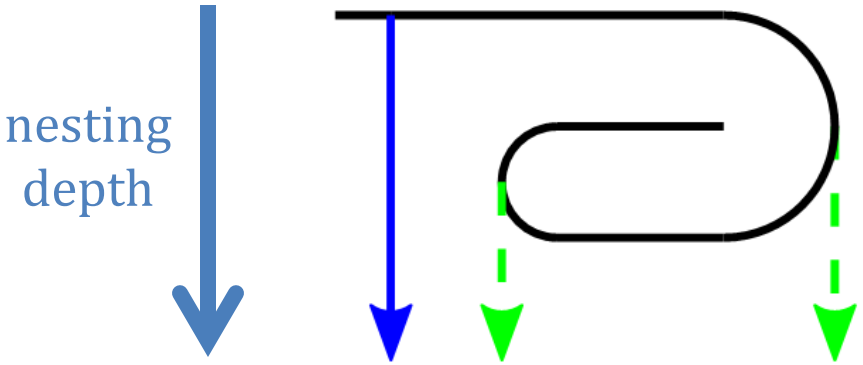


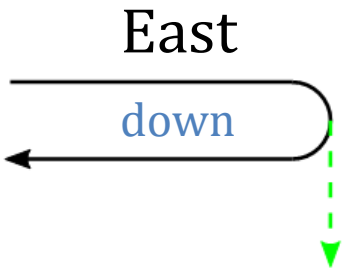


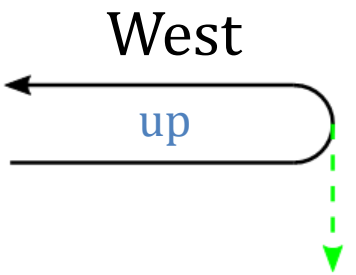


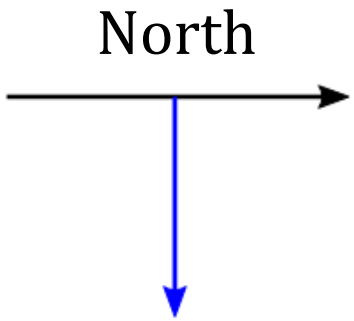


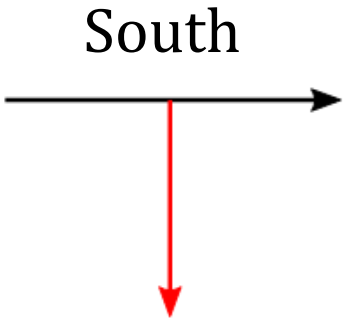
ray diagram



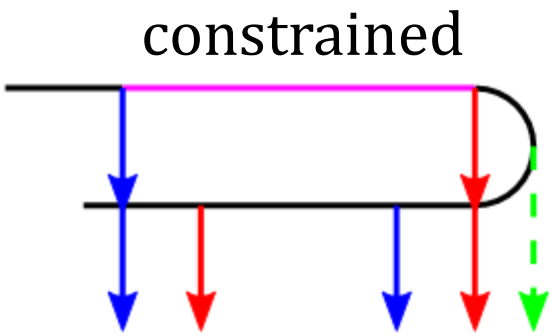




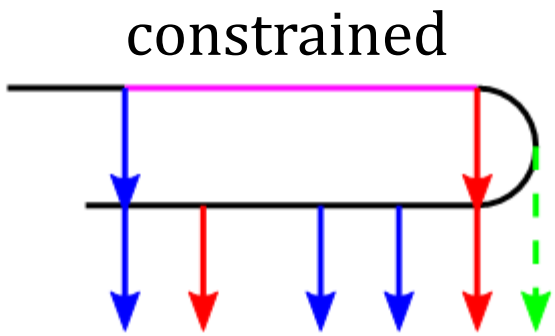




[Demaine, Liu, Morgan 2012]



valid



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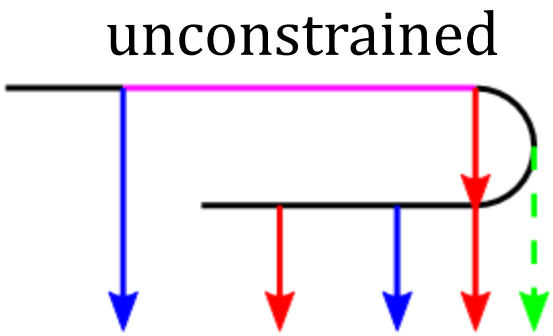
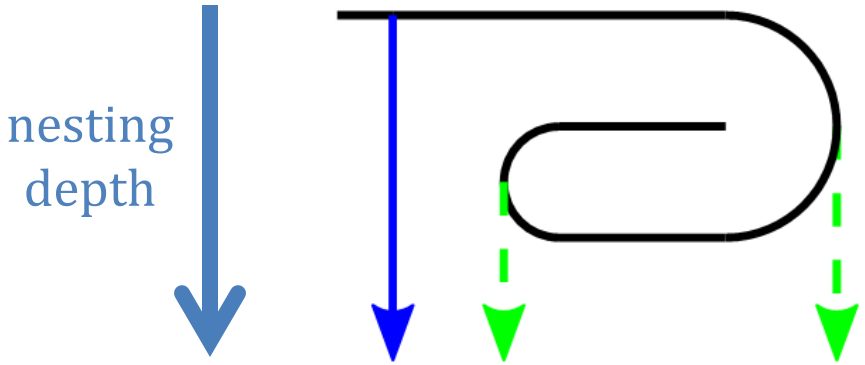
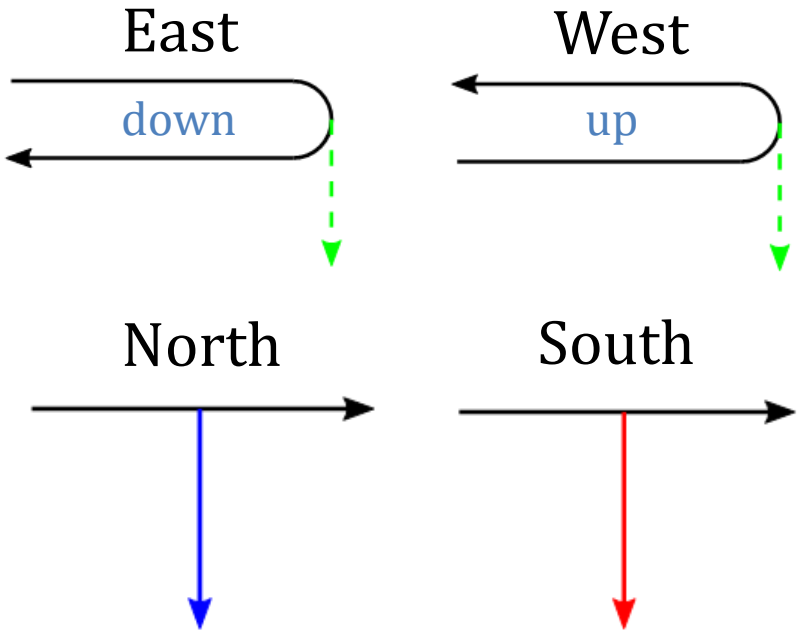
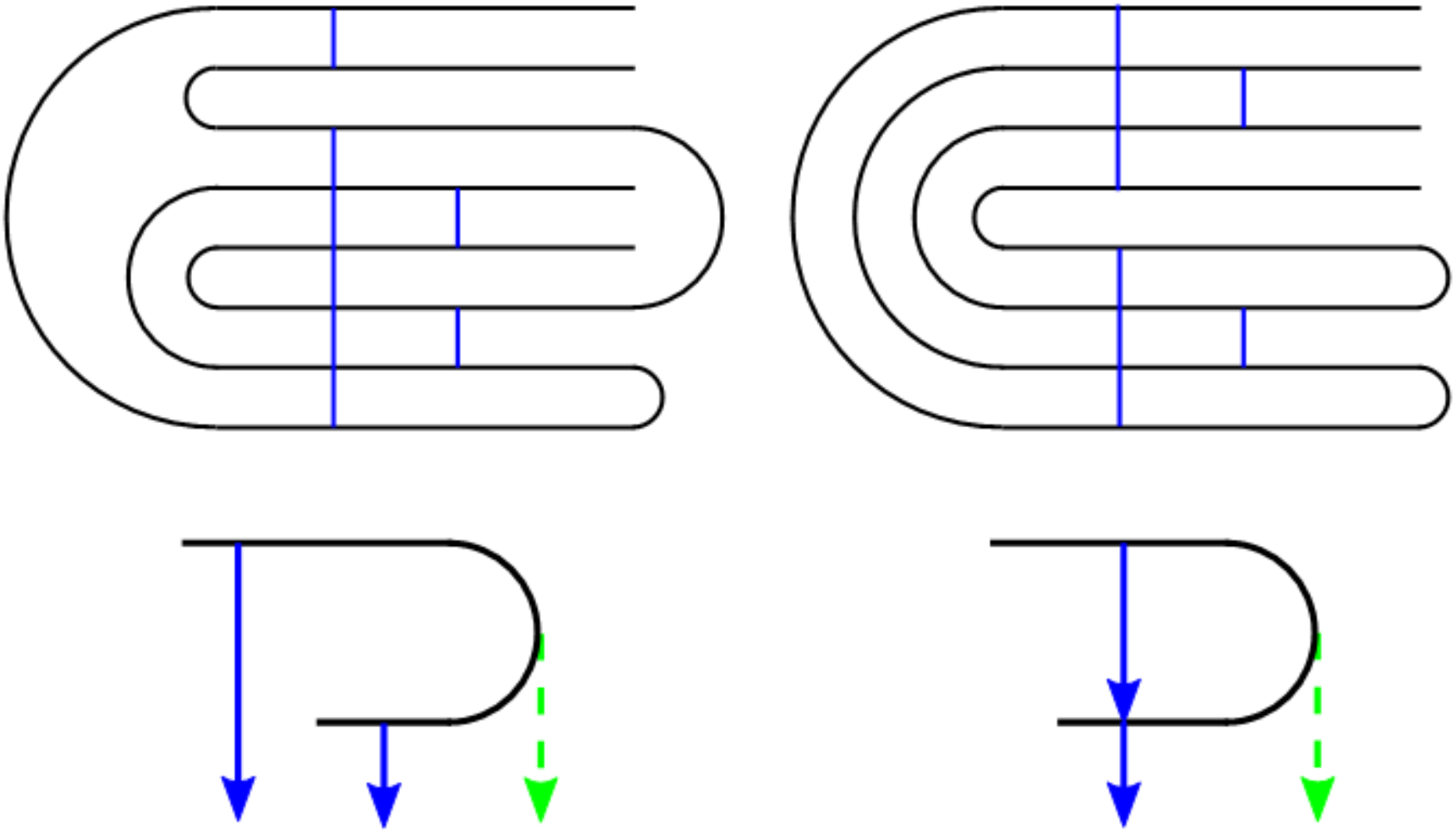


ray diagram

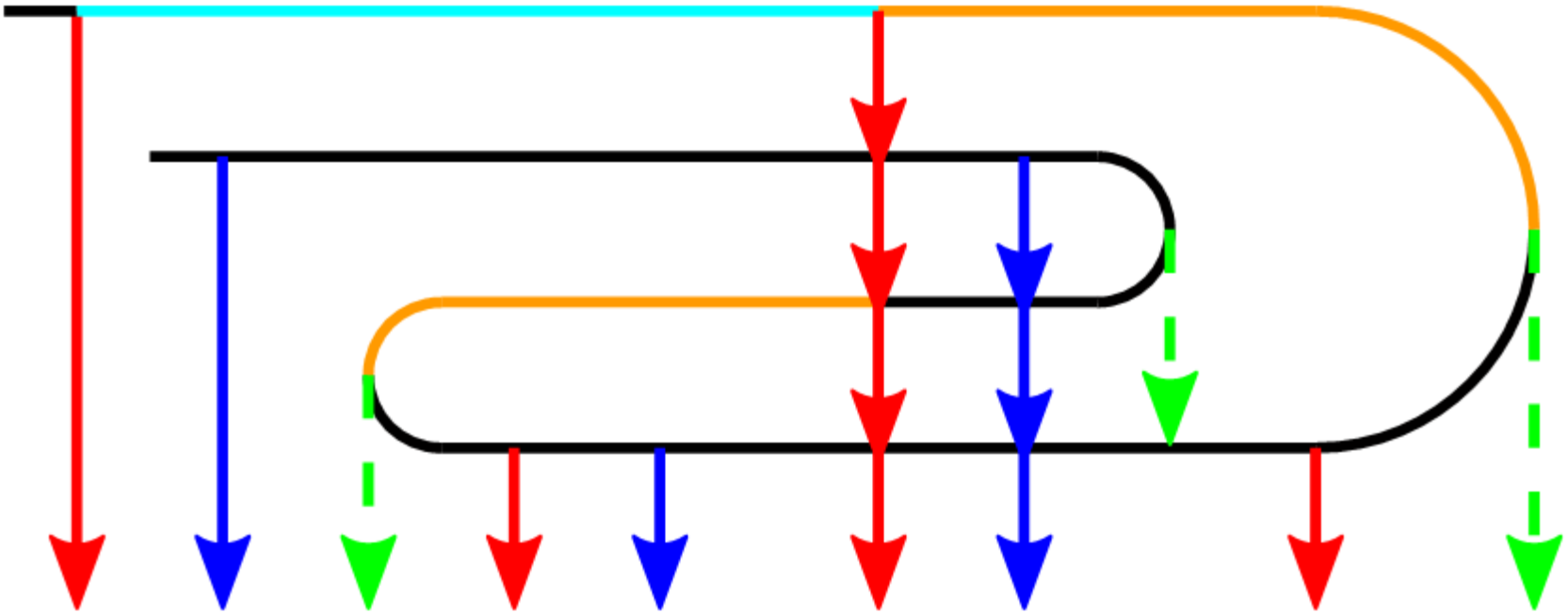




[Demaine, Liu, Morgan 2012]

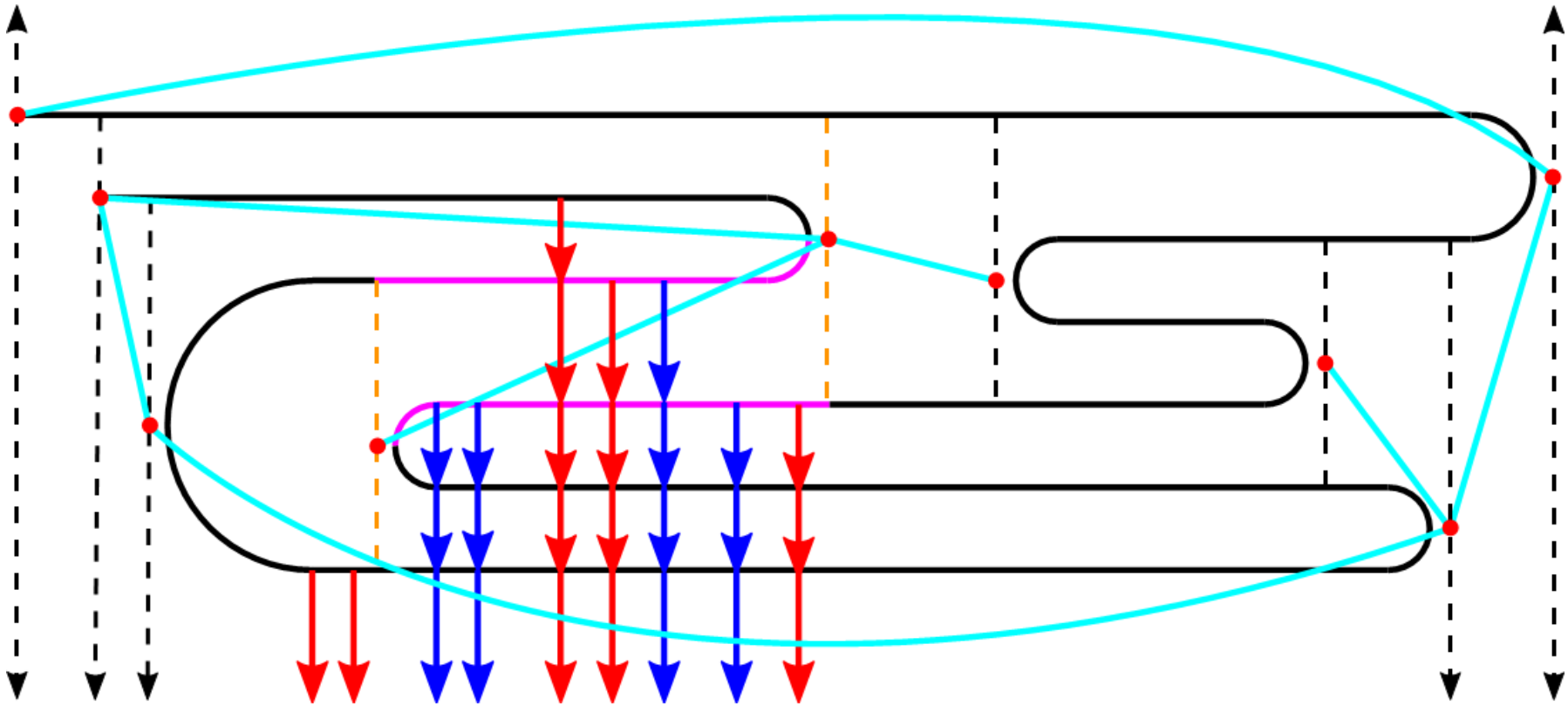


[Demaine, Liu, Morgan 2012]



SSESNSNSWSNWNSN

[Demaine, Liu, Morgan 2012]



[Demaine, Liu, Morgan 2012]