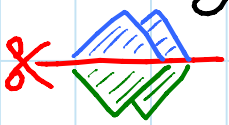
6.849	Class 8	Oct. 2, 2012

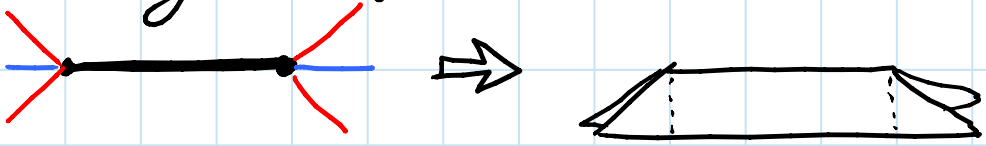
- Fold & cut software [David Benjamin & Anthony Lee 2010]
  - DEMO (6.849 project)
  - PROJECT: improve UI, make Java applet; port to JavaScript; force degeneracies; or compute folded state & M/V/unfold
  - JOrigami: disks [Silveira, Cosentino, Coelho, Aoki]

- Odd-degree vertices?
  - even degree ⇔ face 2-colorable ⇔ alternating above/below side assignment ⇔ uncreased cut edges ⇔ scissor cuts



(separate material on both sides of line)

  - mathematical/laser cuts (removing line) can do odd-degree vertices

e.g. 

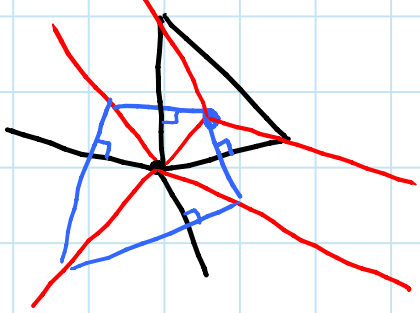
  - if graph doesn't disconnect from the removal of any 1 edge (planar 2-edge-connected) then = union of two even graphs

[Demaine, Demaine, Lubiw 1998, thanks to Jim Geelen & Dan Younger]

- Linear corridors → tree
  - corridor → edge (or ray) [flap]
  - width w → length w
  - perpendicular → vertex [hinge]
    (connected comp.)
  - similar to TreeMaker CP → shadow tree

- Tree folding → origami folding
  - expand each edge to accordion folding
  - stitch together at perpendiculars

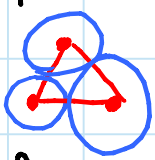
- Irrational ratio happens with prob. 1? YES
  - but first need closed loop of perpendiculars
  - CONJECTURE: with prob. 1, only get loops around one cut vertex (normal circular corridor)



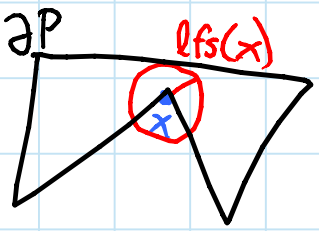
← e.g.

- Examples: students & HELL

- Disk packing → tri/quad decomposition
  - disk center → vertex
  - kissing disks → edge
  - 3- or 4-gap → triangle or quad.



- How many disks? $O\left(\int_{x \in \partial P} \frac{dx}{lfs(x)}\right)$



  - lfs(x) = <u>local feature size</u>
    = radius of smallest disk centered at x hitting a nonincident edge of P

- Disk packing method vs. tree method

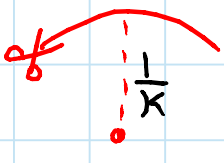
– disks	– disks & rivers
– easy to place (but many)	– hard to place
– input = polygon	– input = tree
– regions = tri. & quad.	– regions = convex (or tri.)
– both align boundaries of universal molecules	

- Straight skeleton method vs. tree method

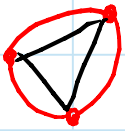
– arbitrary polygons/graphs	– convex polygons
– no control on tree/lengths	– control
– POLYGON PACKING ≈ combination of two (straight skeleton + gussets to control)	

[Demaine, Demaine, Lang] [Origami Design Secrets 2e]

- <u>OPEN</u>: fold flat & cut of fixed curvature K
  - make all unions of arcs of this curvature?

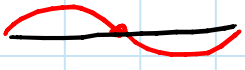


  - intuition:



arc → fold & cut

  - but:



- Flattening
  - 3D fold & cut ⇒ flat folded state (folding motions NOT preserved) ← OPEN ← solved already
  - NEW: convex polyhedra can be continuously flattened [Itoh, Nara, Vîlcu 2011]
  - PROJECT: animate their motion
  - OPEN: nonconvex polyhedra?

PROJECT: fold & cut alphabet
e.g. 3 or 4 simple folds / letter
or CP for entire word/page

PROJECT: paper cutting art via fold & cut
(à la Peter Callesen)

6.849 Geometric Folding Algorithms: Linkages, Origami, Polyhedra
Fall 2012