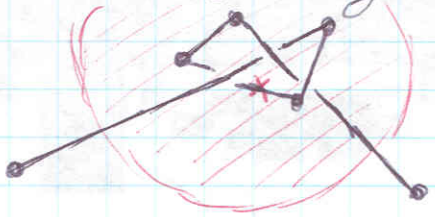
6.885
L5.3
Sept. 22, 2004

Knitting needles are locked when each end bar length > Σ middle bar lengths [Cantarella & Johnston 1998]



Proof: Draw ball $\mathcal{B}$ centered at midpoint of middle bars, radius = $\varepsilon + \frac{1}{2}\Sigma$ middle bar lengths.

⇒ middle vertices remain inside $\mathcal{B}$
& end vertices remain outside $\mathcal{B}$

⇒ any motion could be augmented by an unknotted rope connecting two ends & remaining outside $\mathcal{B}$.

⇒ straightening motion would untie trefoil knot ※ □

- this example requires edge length ratio $1 : 3+\varepsilon$.

OPEN: minimum possible edge length ratio for which locked 3D chains exist?

OPEN: is there a locked equilateral 3D open chain?
↳ all edges same length

OPEN: what if the edges are constant-width cylinders? [O'Rourke]

OPEN: what about (unknotted) closed chains? [M. Demaine]
(thick or thin)

OPEN: what about (thin) equilateral chains woven in "1D"? [E. Demaine]
(infinitesimal)

PROJECT: experiment with unfolding these kinds of chains using energy-based methods

OPEN: characterize locked 3D chains
- again PSPACE-hard for connectivity between two particular configurations [Alt, Knauer, Rote, Whitesides 2004]