6.885
L4.3
Sept. 20, 2004

Duality in tensegrities: [Roth & Whiteley 1981]

- there is an equilibrium stress that is nonzero on a particular cable or strut e
  $\Leftrightarrow$ every infinitesimal motion holds e fixed in length

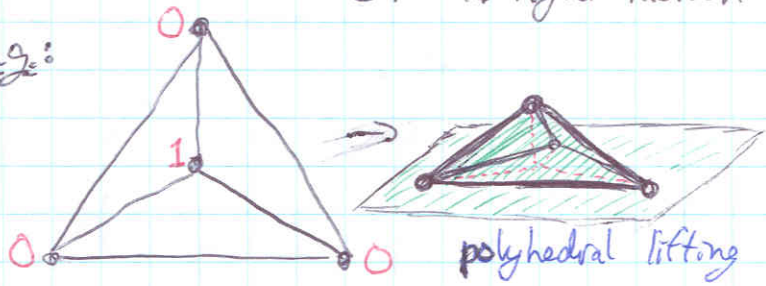
- a tensegrity is infinitesimally rigid
  $\Leftrightarrow$ there is an equilibrium stress that is nonzero on every strut/cable
  & the corresponding linkage is infinitesimally rigid
  ↳ replace cables, struts with bars

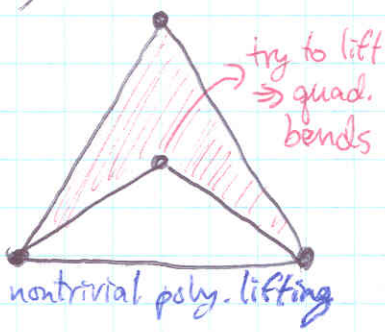
  - proofs based on LP duality
  - spider webs : pos. stress $\Leftrightarrow$ (globally) rigid [Connelly 1982]

Polyhedral lifting of a planar configuration (no edges cross)
= assignment of z coordinates to vertices such that each face is planar

- trivial lifting: $z=0$ for all vertices (or a rigid motion of this)

e.g.:



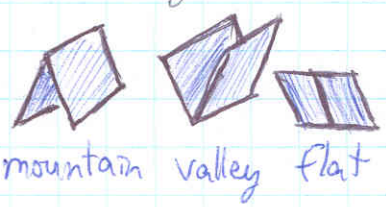


Maxwell-Cremona Theorem: [Maxwell 1864; Cremona 1872]

One-to-one correspondence between equilibrium stresses & polyhedral liftings (modulo rigid motion)

- valley edge ↔ negative stress
- mountain edge ↔ positive stress
- flat edge ↔ zero stress

(in a planar tensegrity)



PROJECT: implement program to illustrate
stress ↔ polyhedral lifting correspondence
and/or stress ↔ infinitesimal motion relation

PROJECT: virtual tensegrity building toy — follow inf. motion?