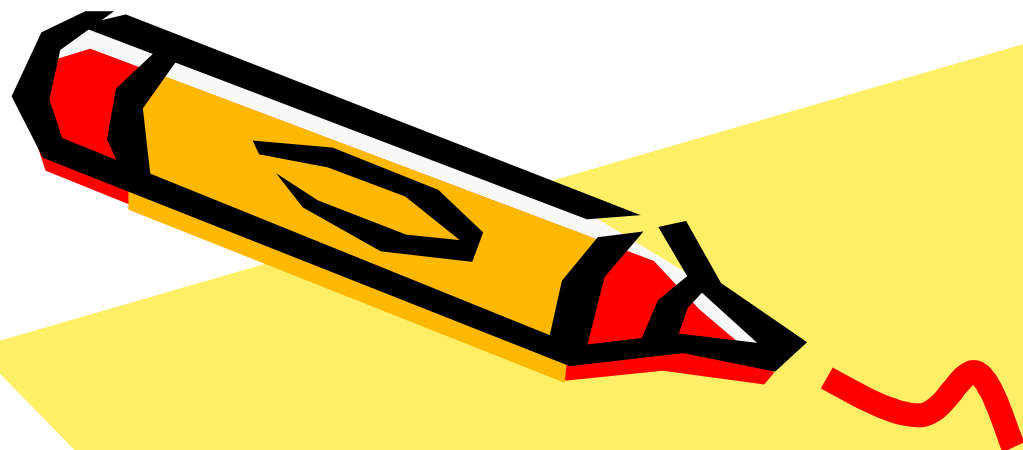




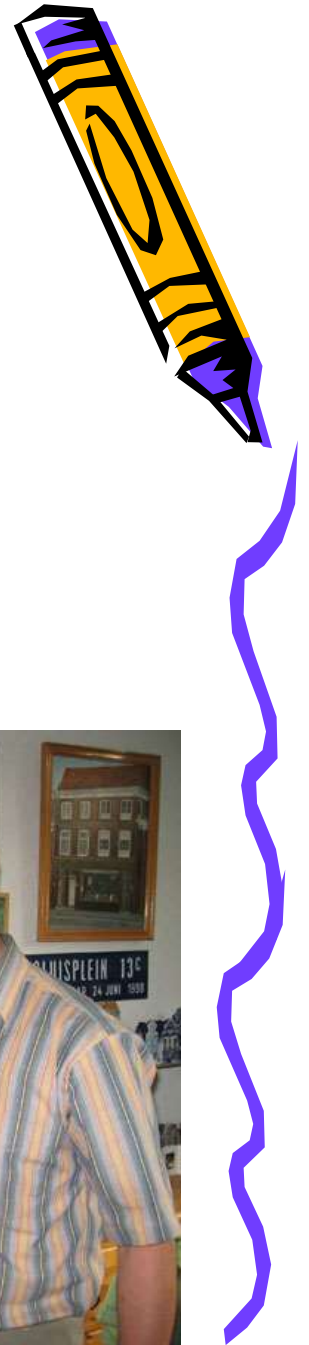
Geometry and Mechanical Puzzles

Dr. M. Oskar van Deventer
EuroCG, Utrecht, March 18th, 2019



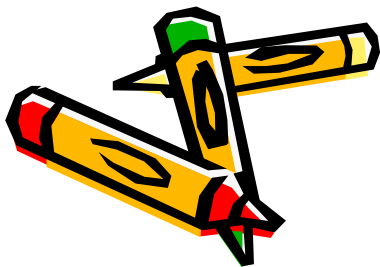
Oskar: puzzle designer

- Designing mechanical puzzles since 1987
- oskarvandeventer.nl/
- youtube.com/oskarpuzzle
- i.materialise.com/en/shop/designer/oskarpuzzle
- puzzlemaster.ca/browse/inventors/oskar/



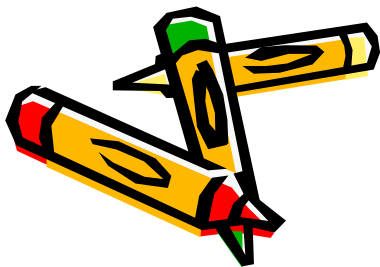
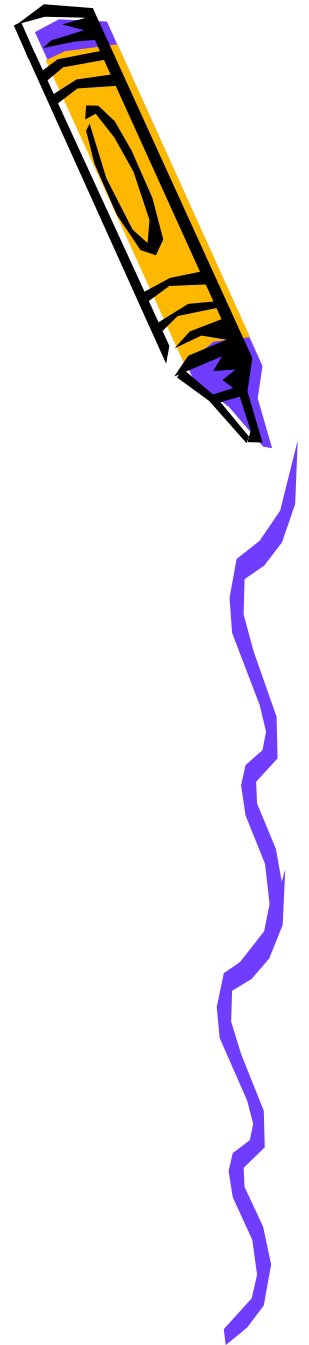
Puzzling fun with geometry

- Twisty puzzles
- Gears
- Interlocking



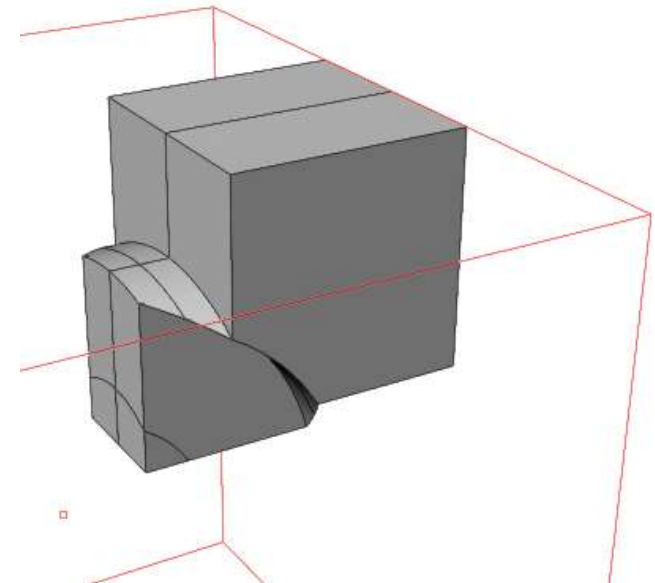
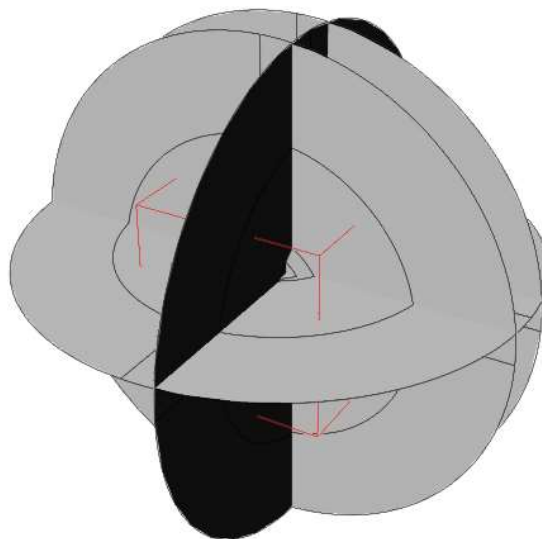
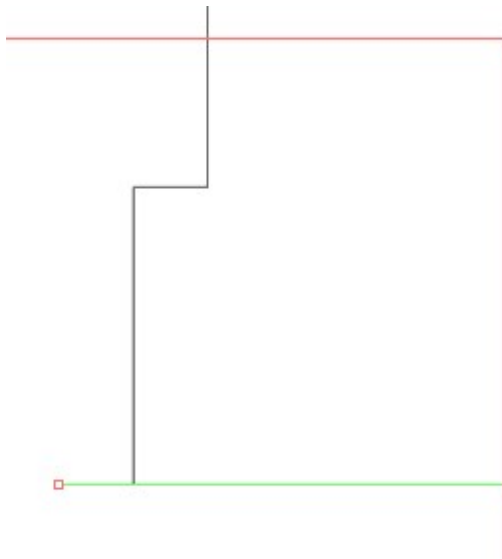
Twisty puzzles

Rubik's Cube



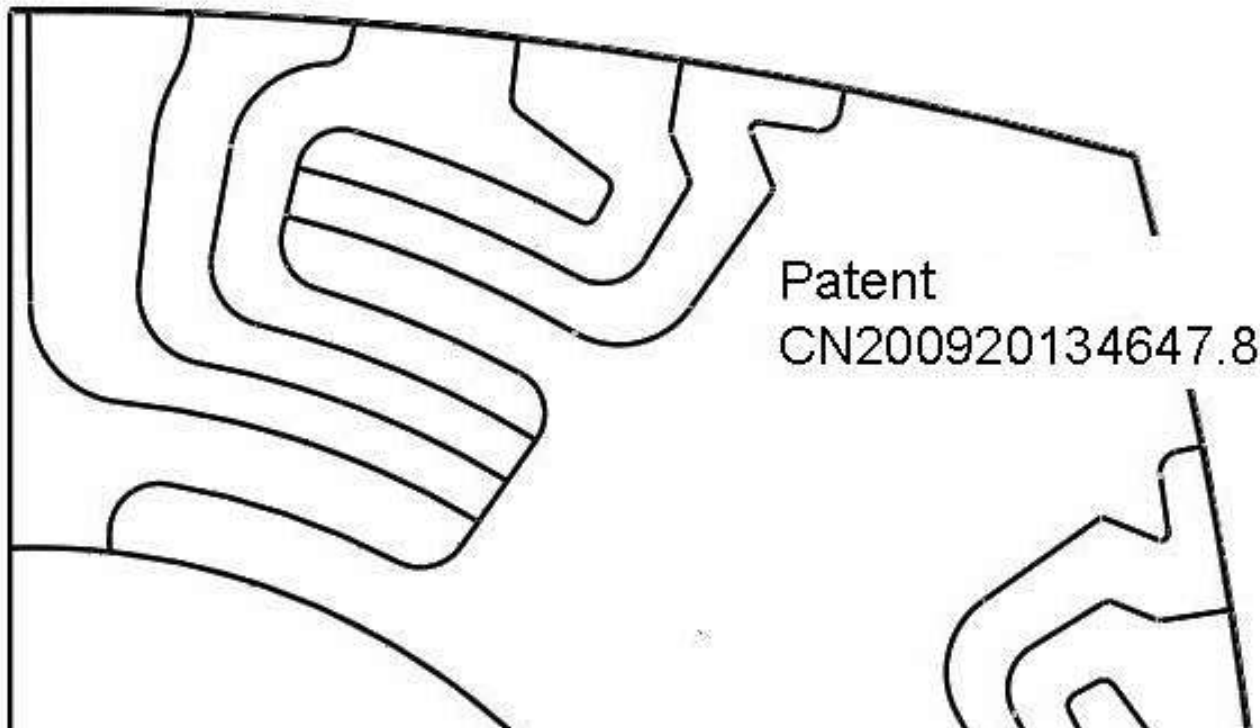
Designing twisty puzzles

- Recipe:
 - Design cut curves → the creative part!
 - Revolve, boolean intersections (Rhino, Solidworks)
 - Offsets, rounding, hollowing, meshing → just work
- Eitan Cher tutorial "A la Vi Hart":
 - http://www.youtube.com/watch?v=83a_DX8WDe8



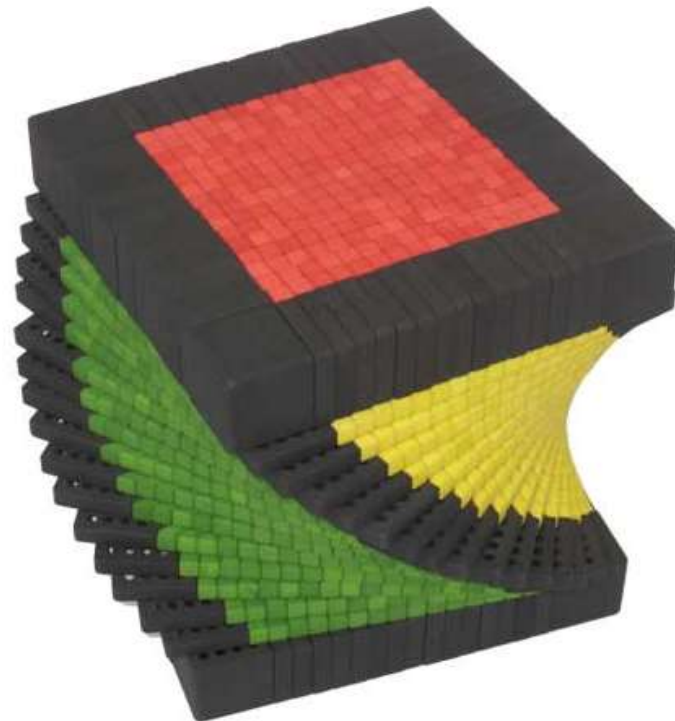
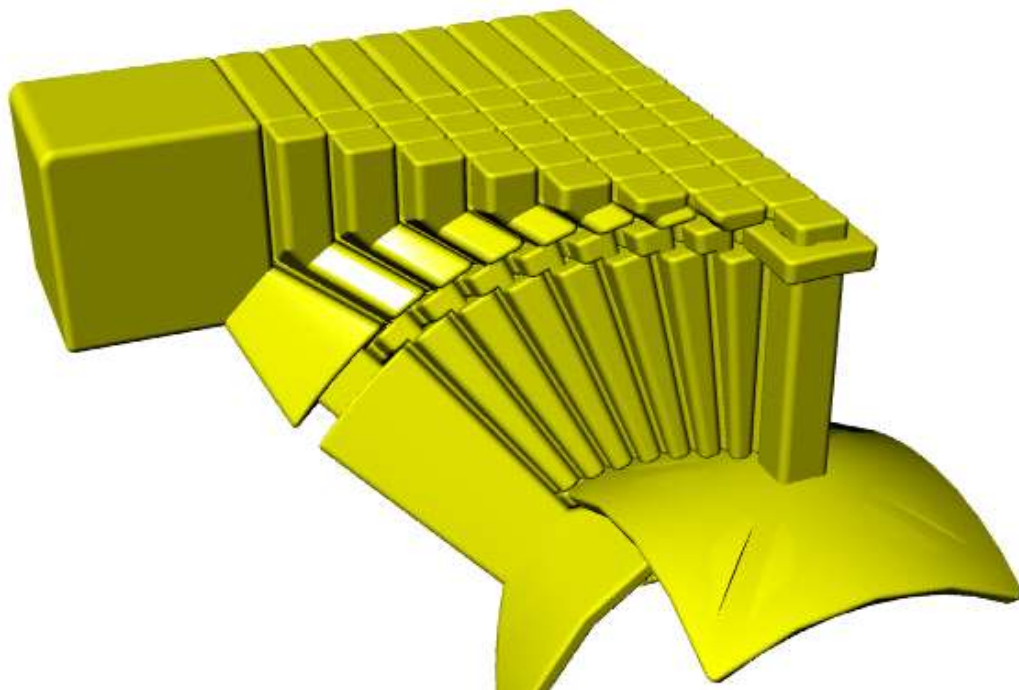
High-order

- Verdes patent: up to order 11
- Leslie Le: corner-hanging 12x12x12



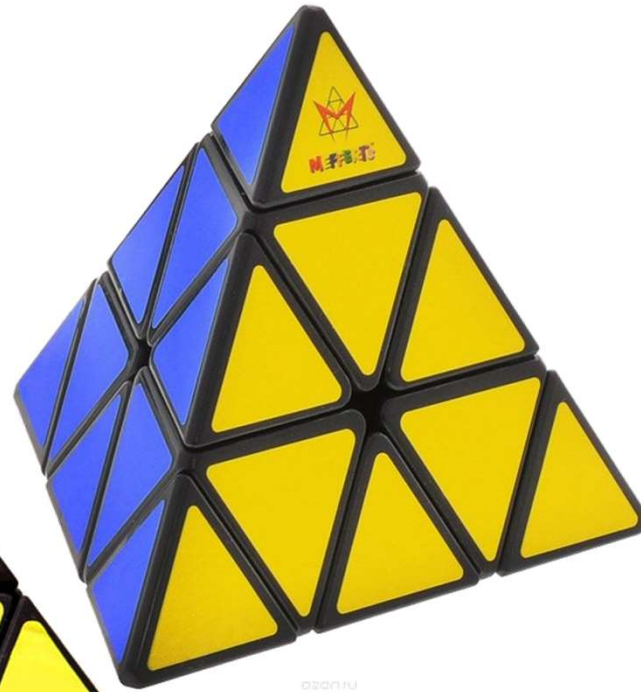
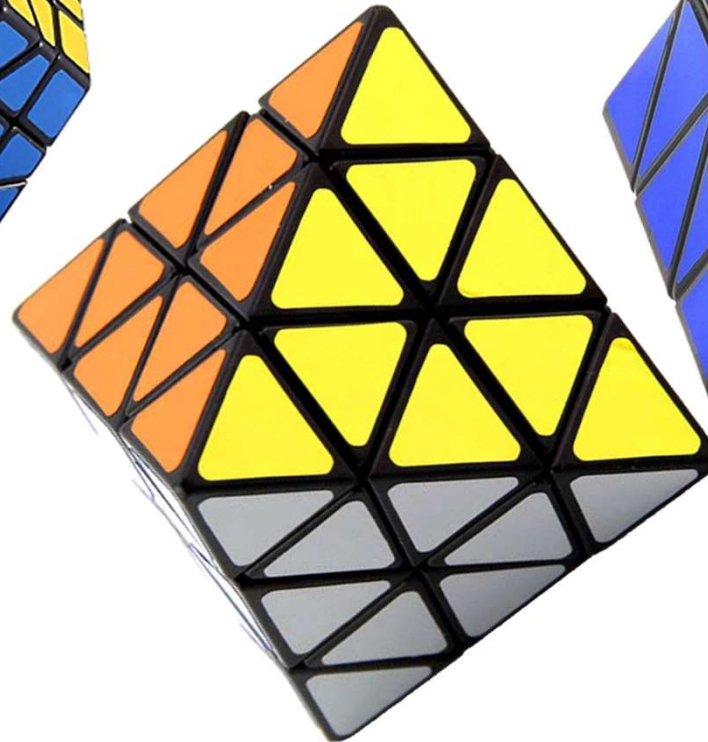
Floating anchors

- Oskar's Over The Top 17x17x17
- Long anchors keep pieces stable

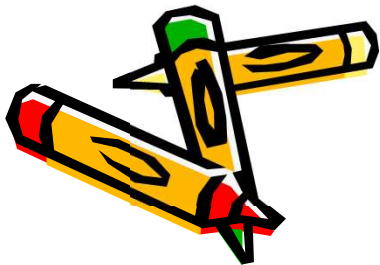
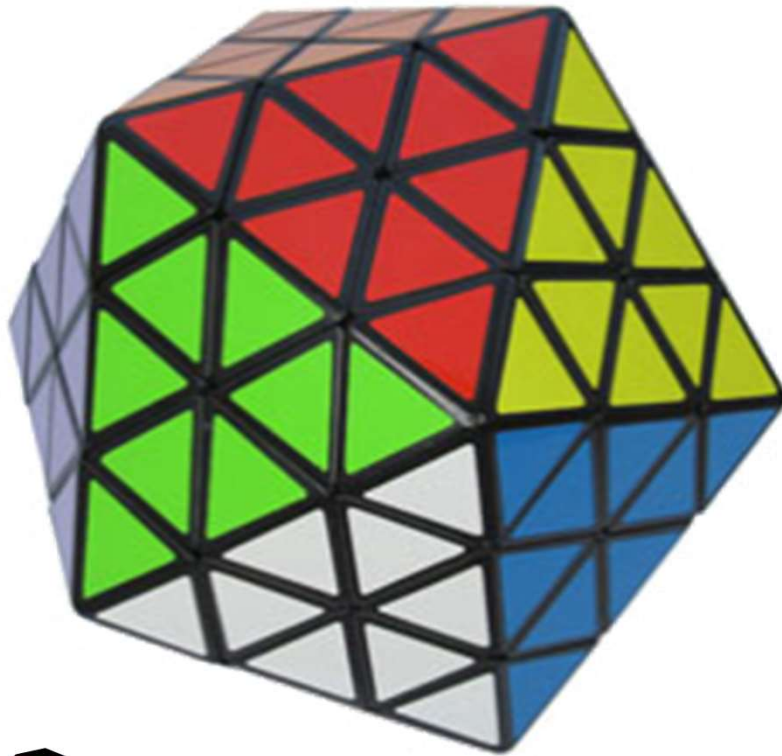


Twisty puzzles

Doctrinaire puzzles

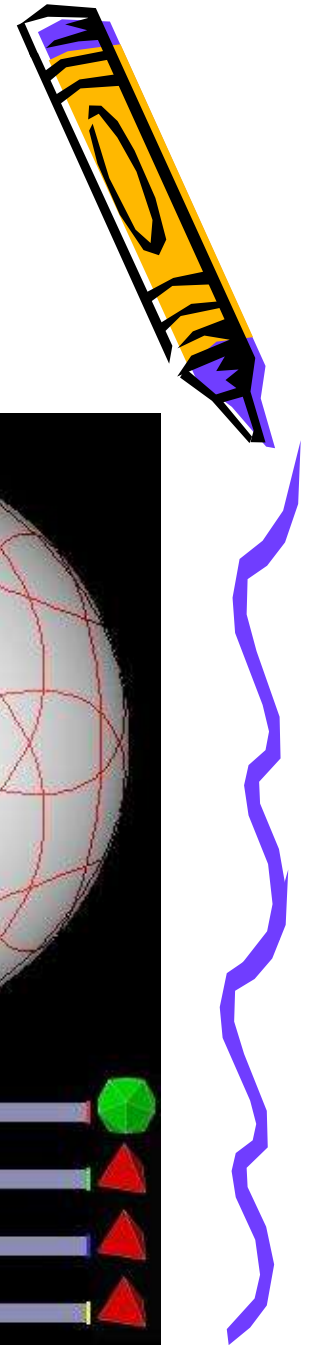
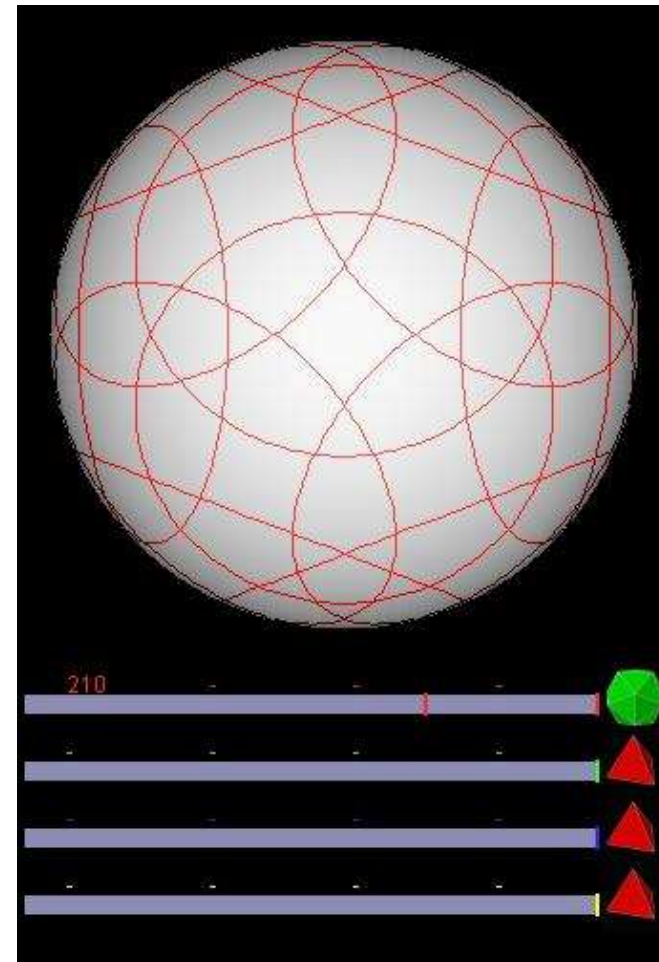
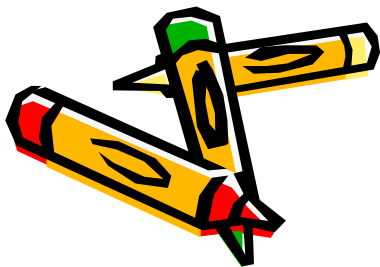


Twisty icosahedron?



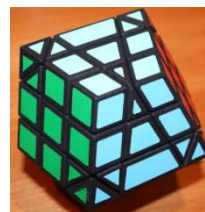
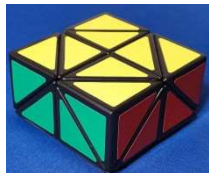
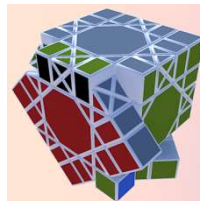
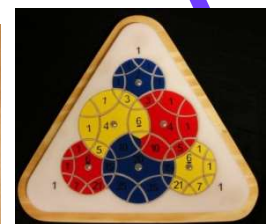
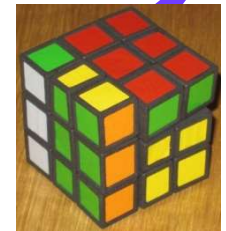
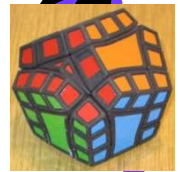
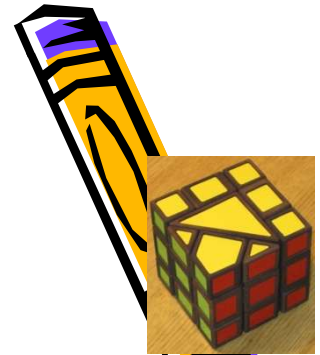
Twisty icosahedron?

Bram Cohen:
"A twisty puzzle
'jumbles' when it
cannot be unbandaged
into a doctrinaire
puzzle."

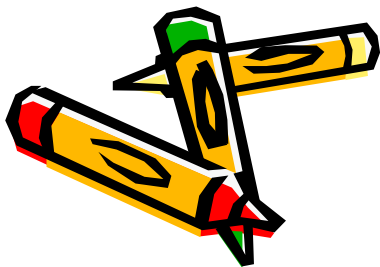
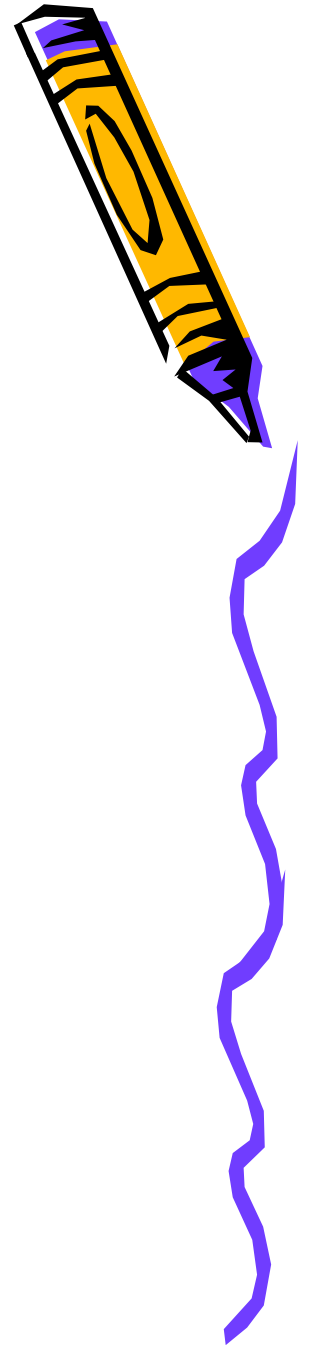


More jumbling

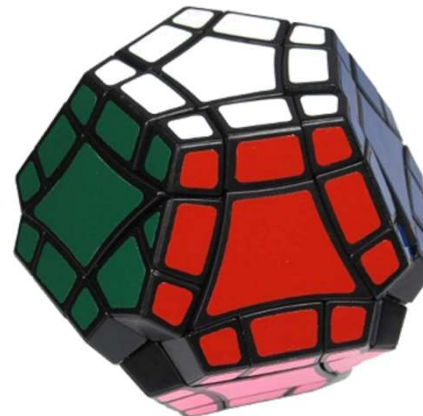
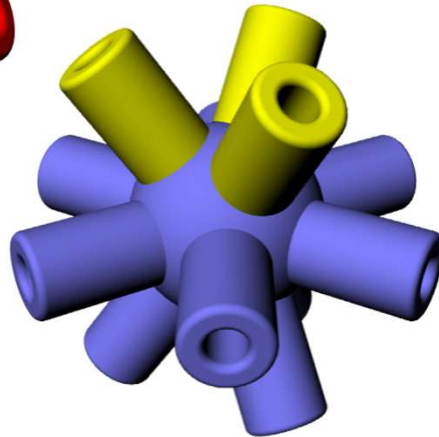
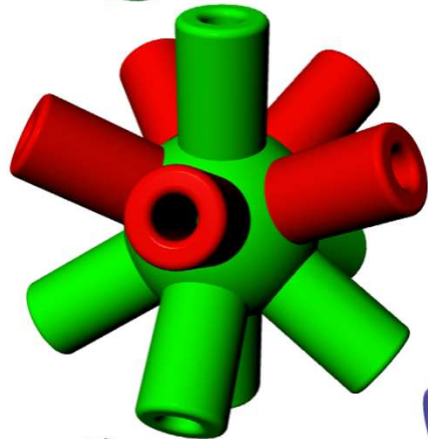
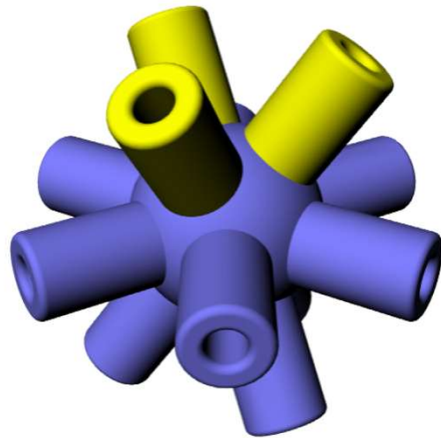
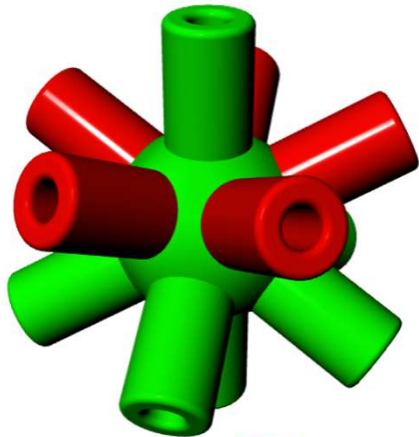
- Eitan Cher, Tom van der Zanden, Eric Vergo, Oskar, Bram Cohen, Carl Hoff, David Pitcher, Mark, Aleh Hladzilin, Andrew Cormier, Matt Galla, Tony Fisher, Gregoire Pfennig, Mike Armburst, Paul Smet, Chilen Chen, Martin Ming, Krystian Wilisowski, Vladimir Iaroslavski, Scott Elliott, Bob Hearn, and many others ...
- Enough material to do a PhD!



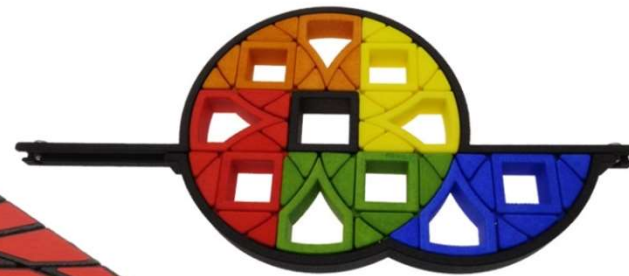
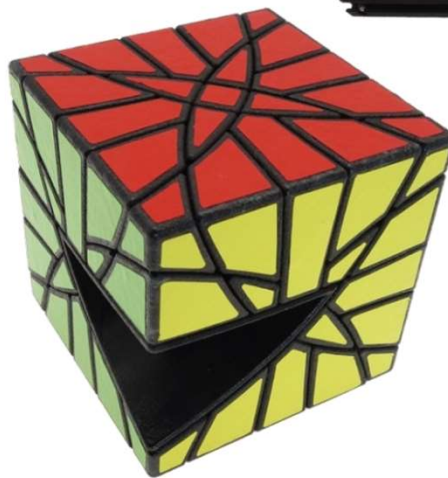
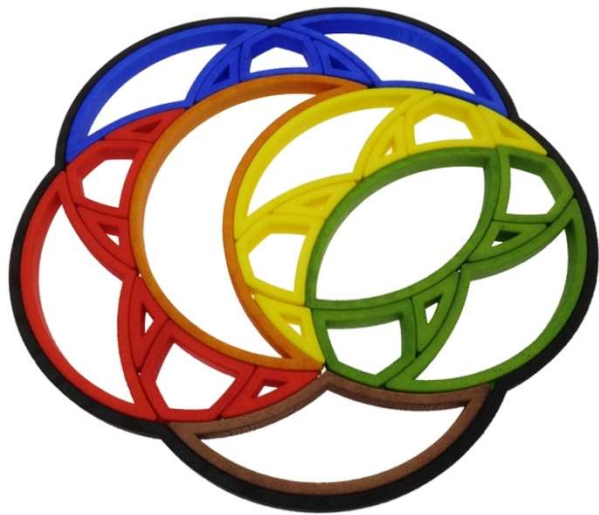
Brammed Block



Core modding

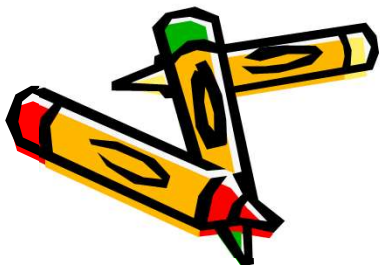


More non-jumbling



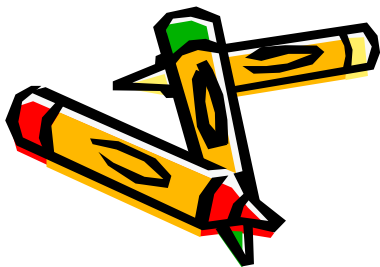
X-labacus

Is their folding geometrically exact?



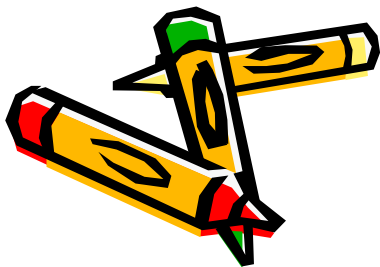
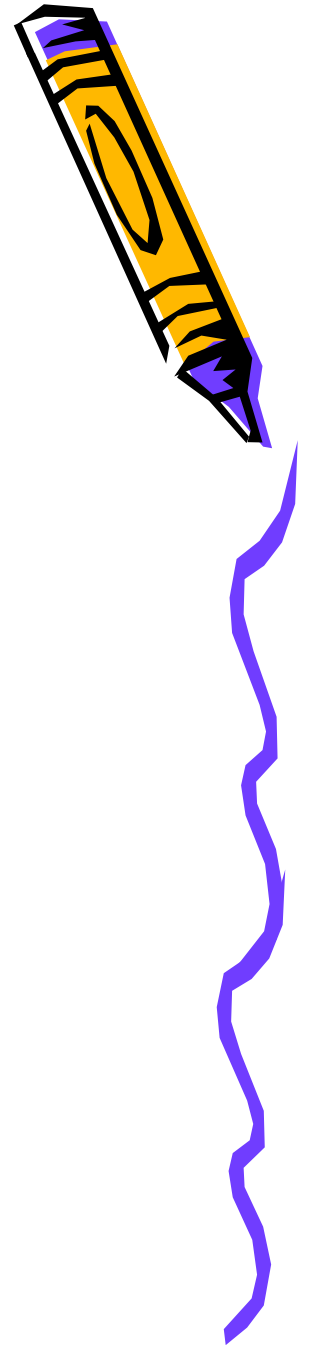
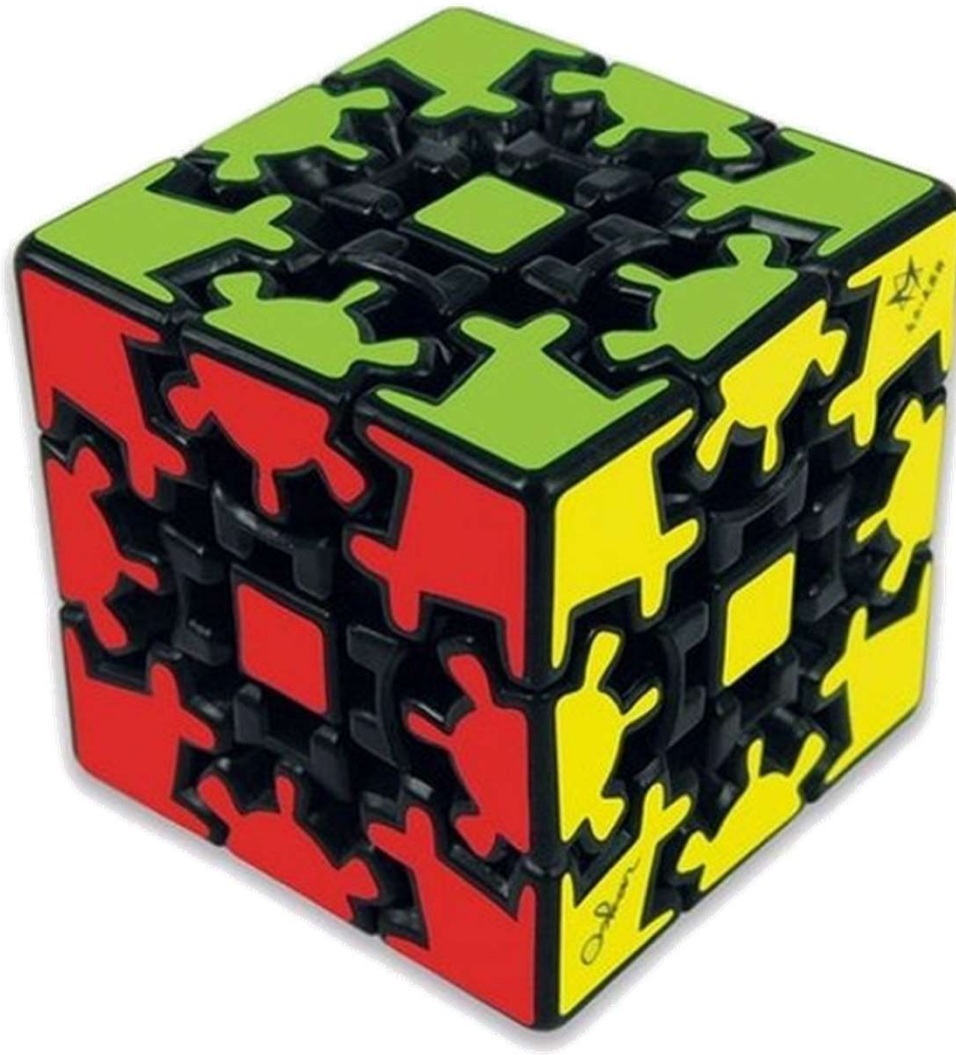
Fidgitz

Are its foldings geometrically exact?

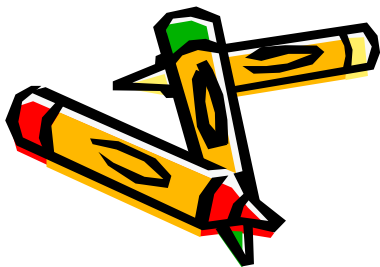
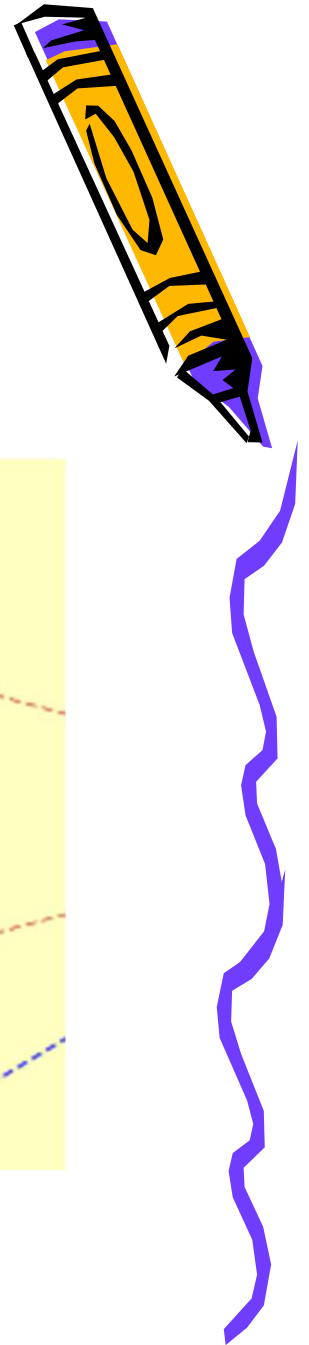
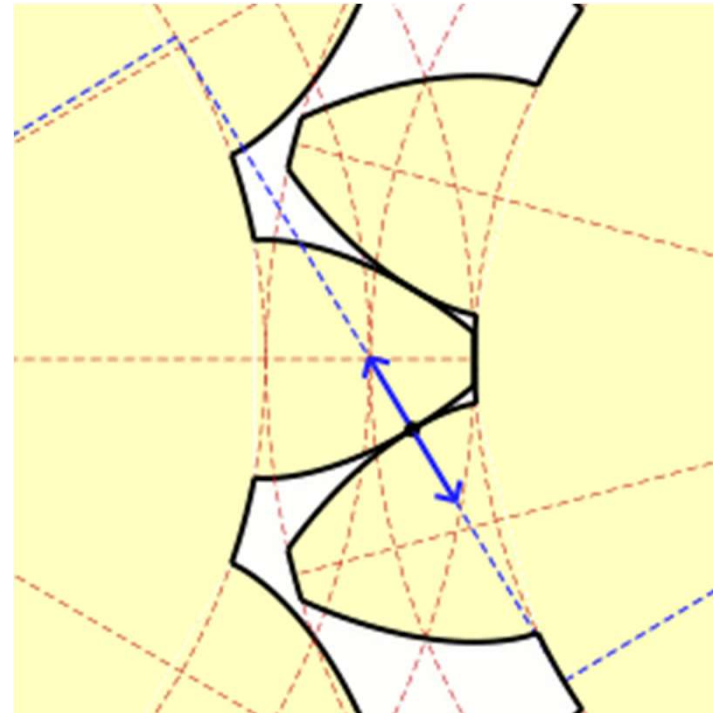
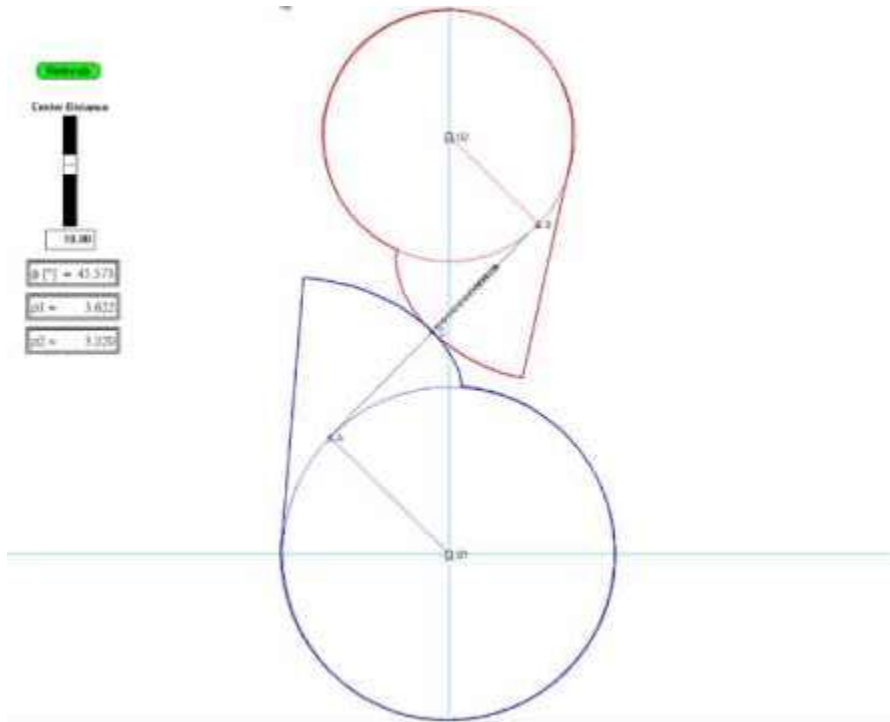


Twisty puzzles
Gears

Gear Cube

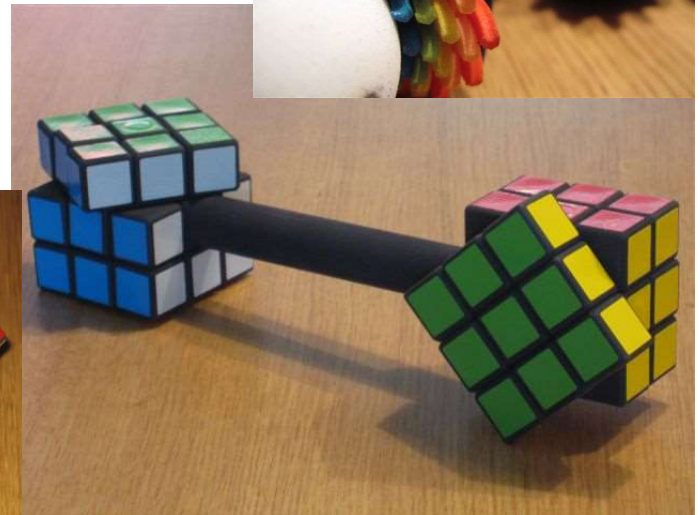
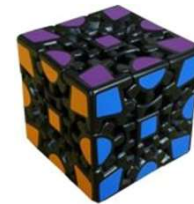
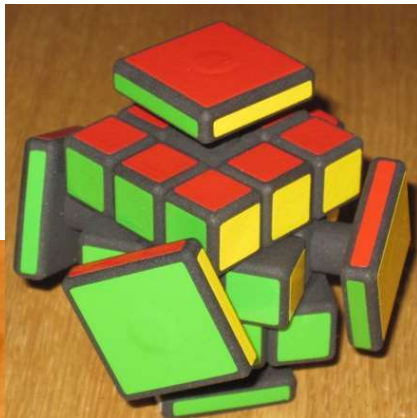
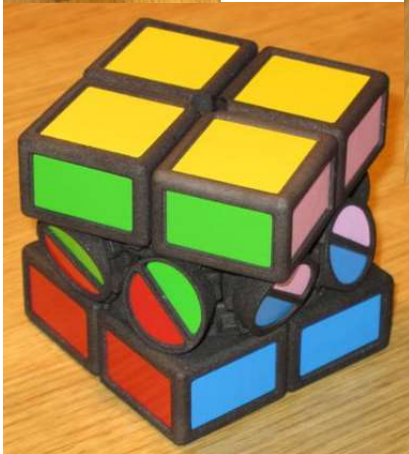
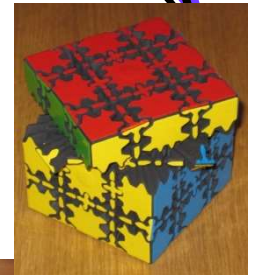


Involute teeth



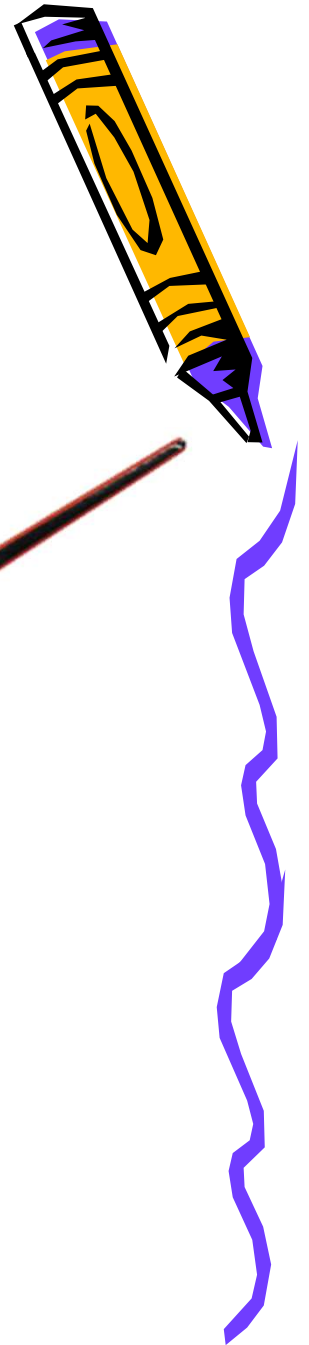
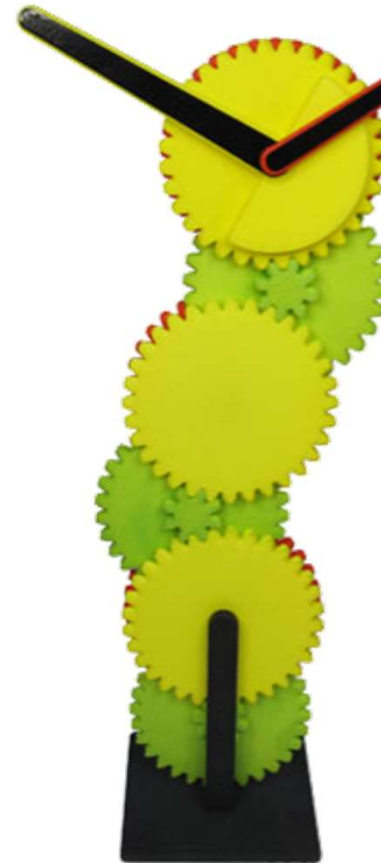
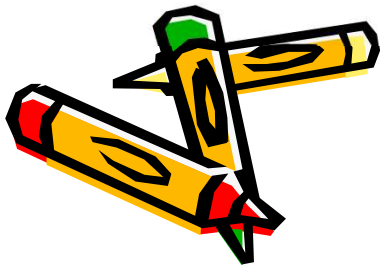
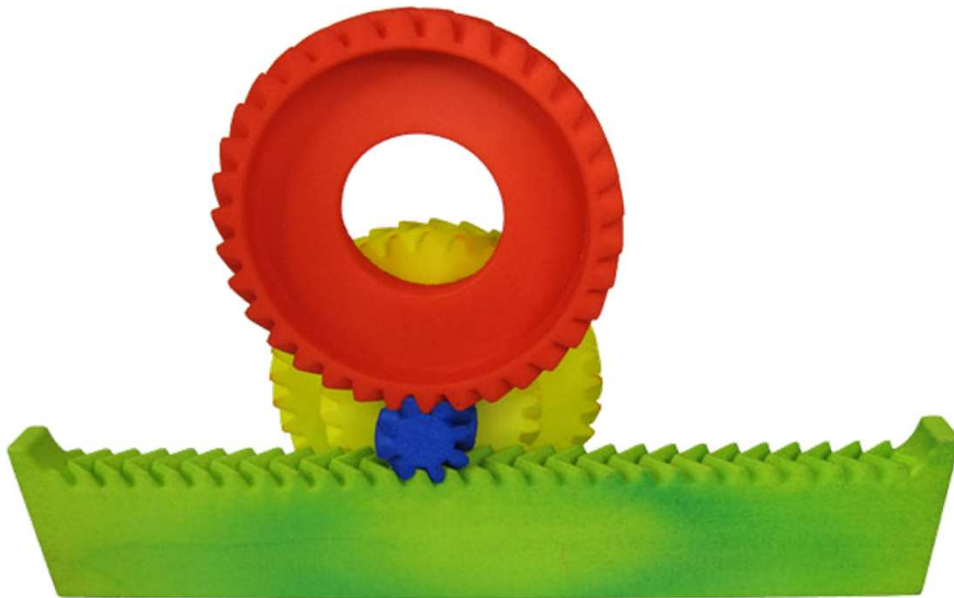
Gears

More gears



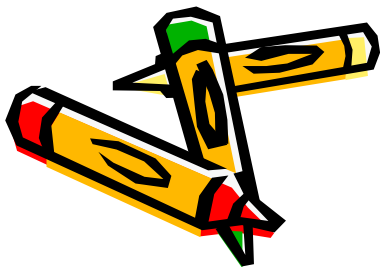
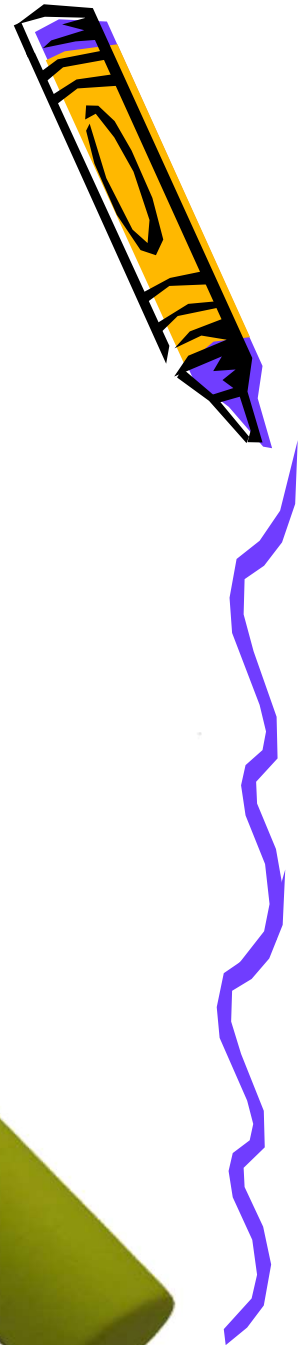
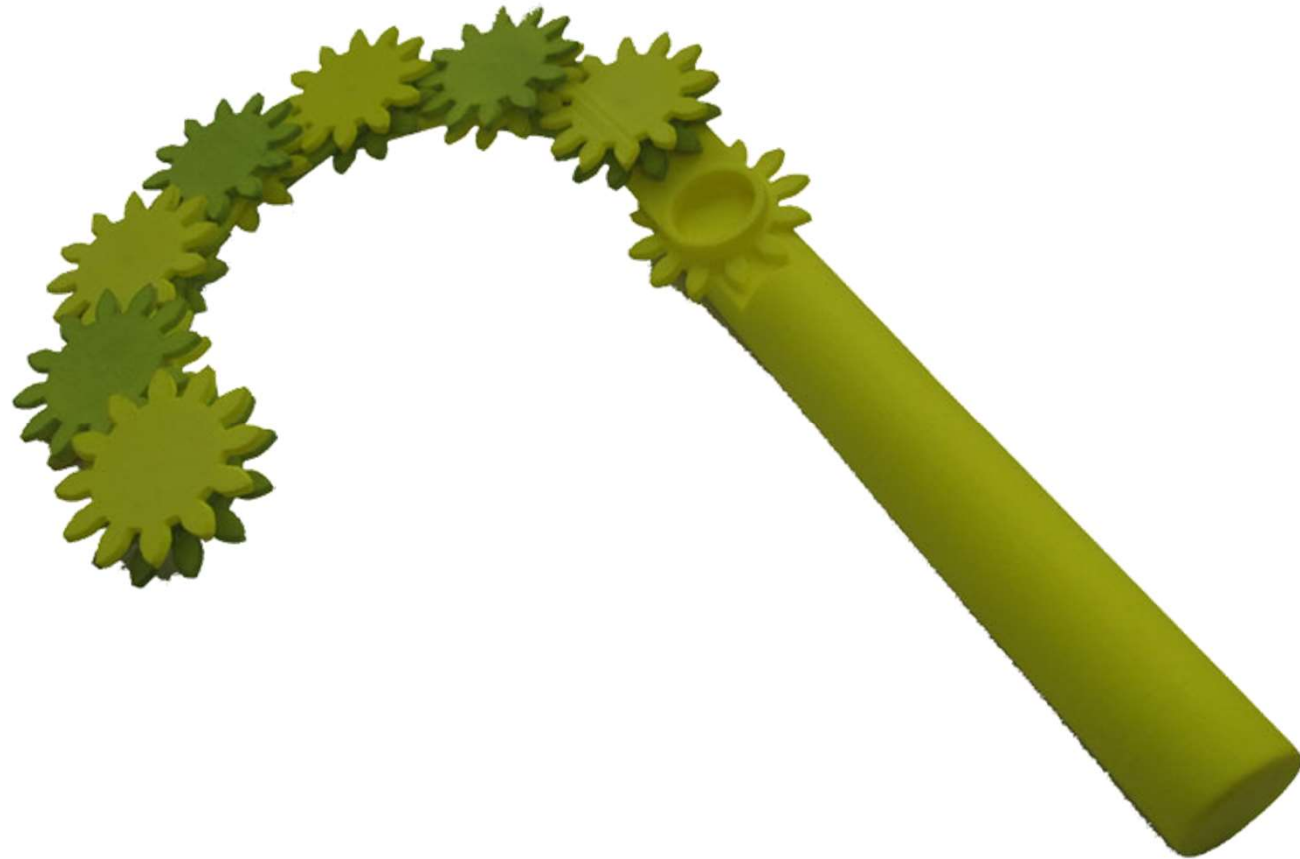
Gear Tower Clock

Why don't the gears fall?



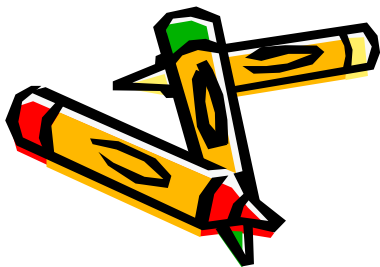
Geared Whiplash

What is the tip's trajectory?

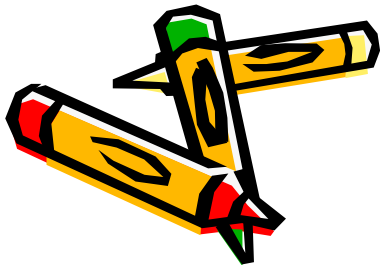
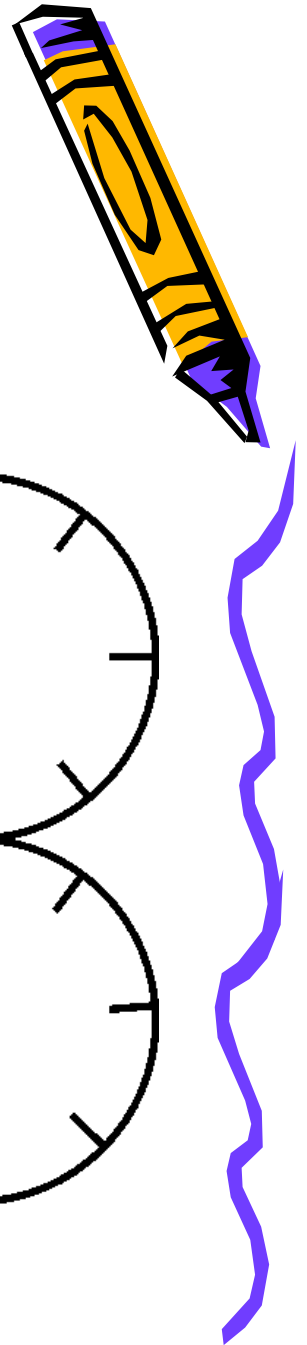
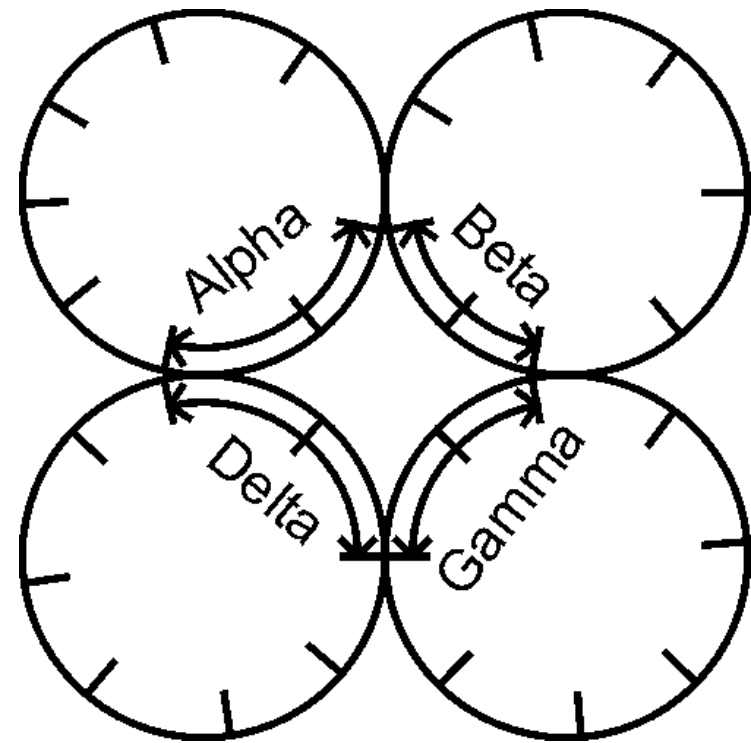


Seven Gear Loop

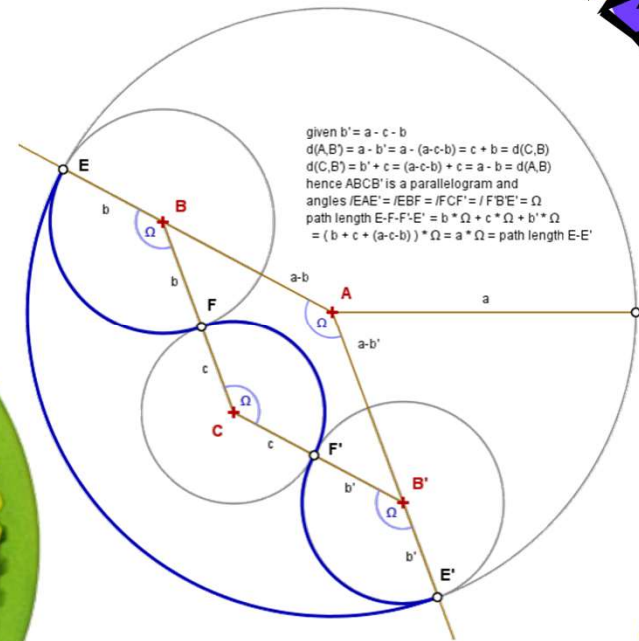
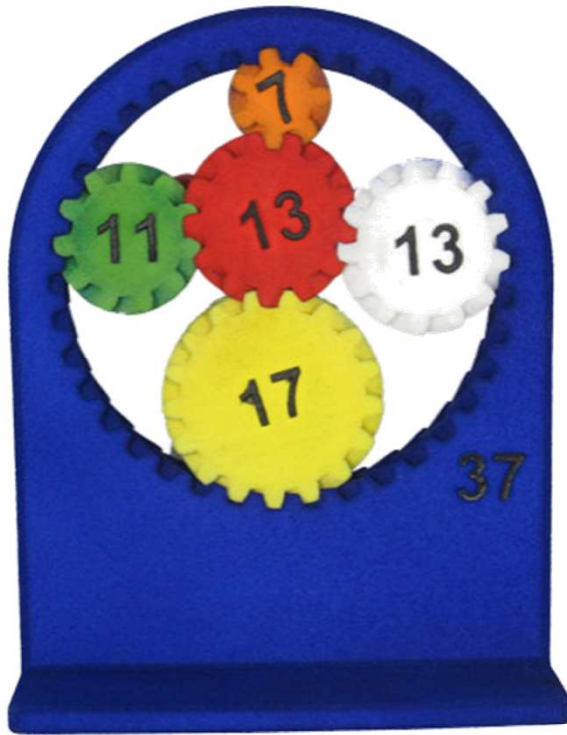
How about
five gears?



Transmission puzzle

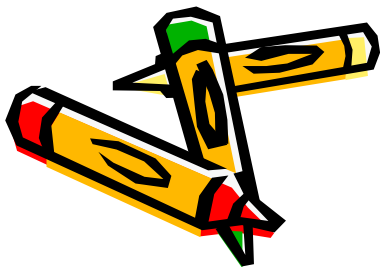
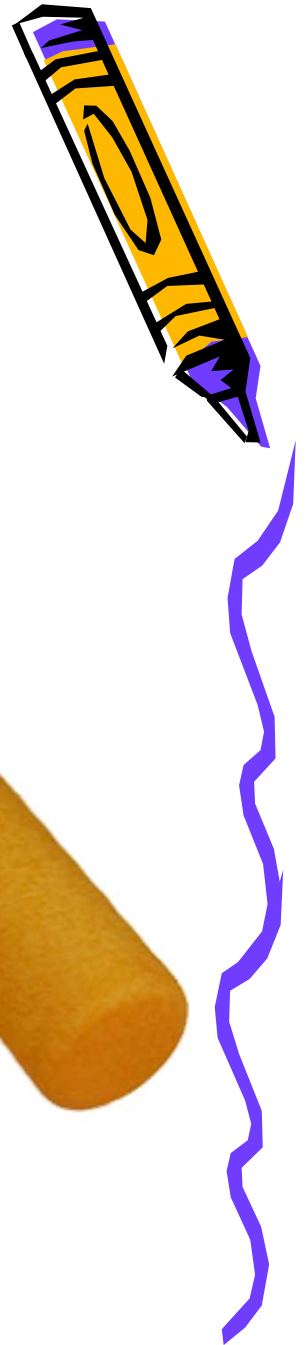


Somsky Gears



Pythagoras Gears

$$2\sqrt{2}+1 \approx 27/7$$

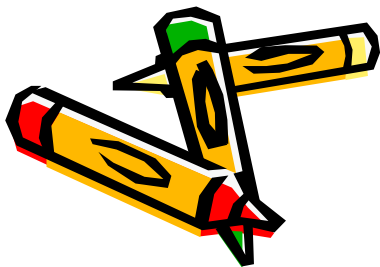


Irrational gears

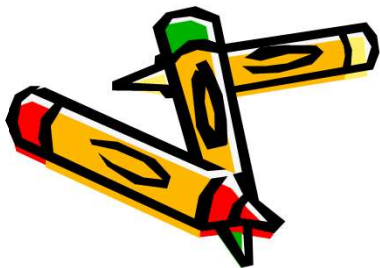
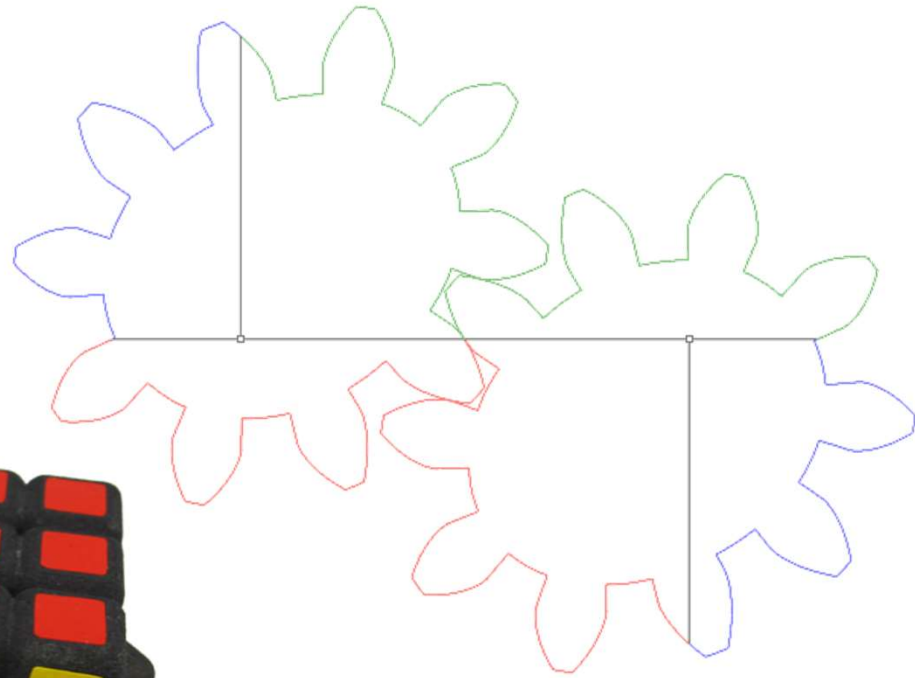
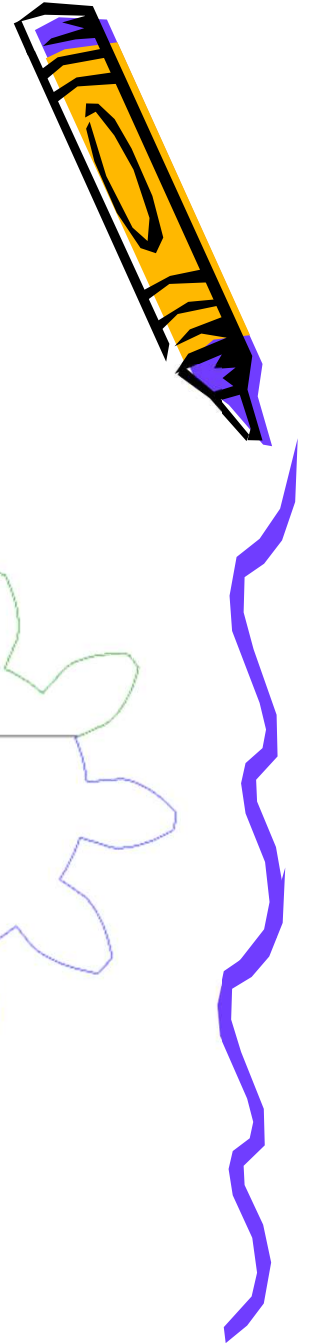
Golden ratio: most irrational number

$$\phi = 1.61803398875.. \approx 21/13$$

$$\phi = 10.47213617.. / \\ 6.47213617..$$



Irregular gears

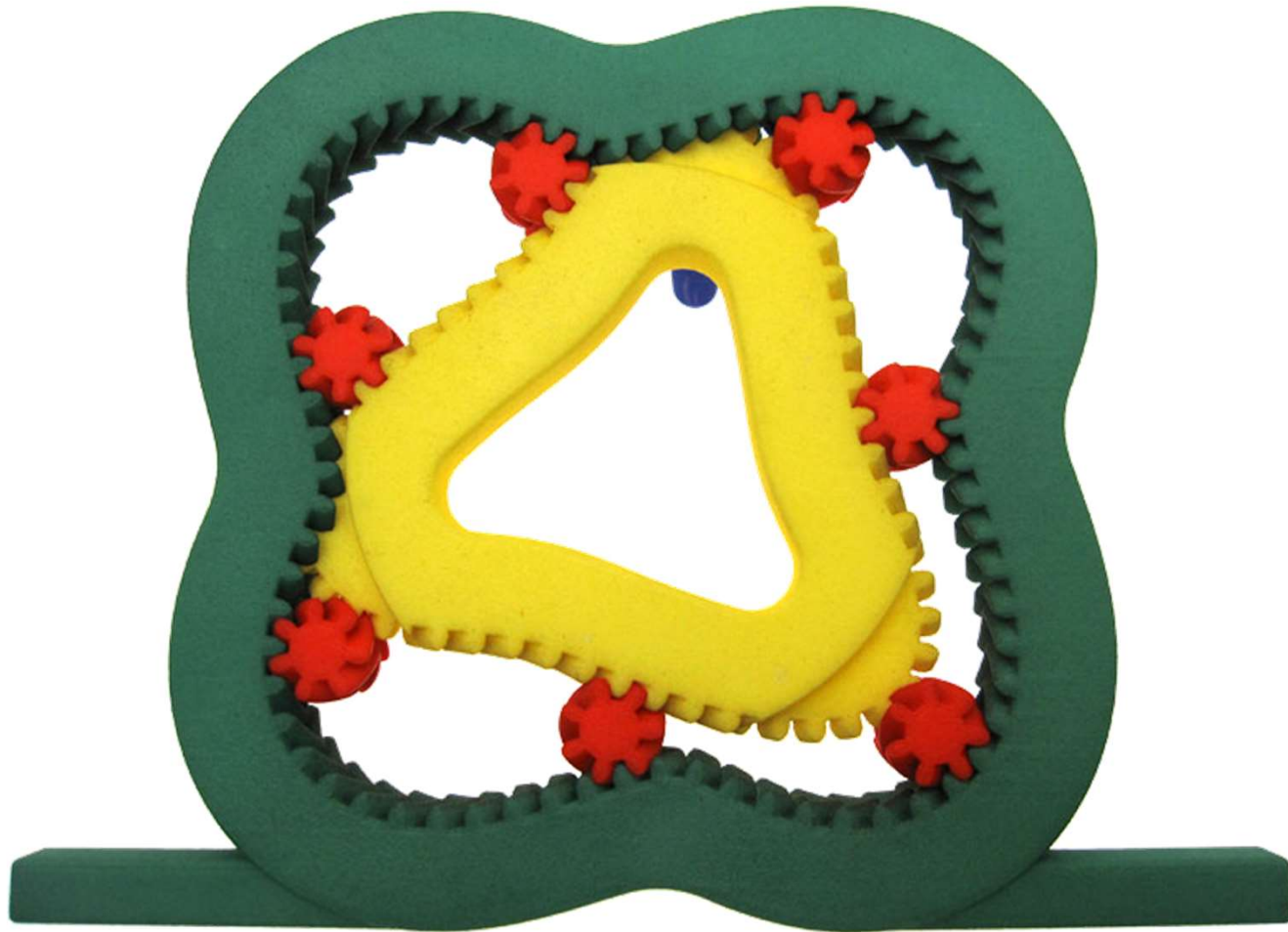
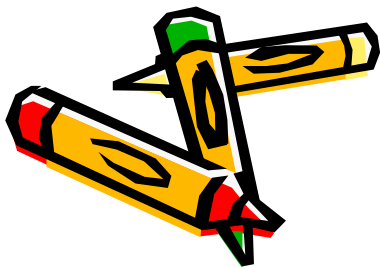
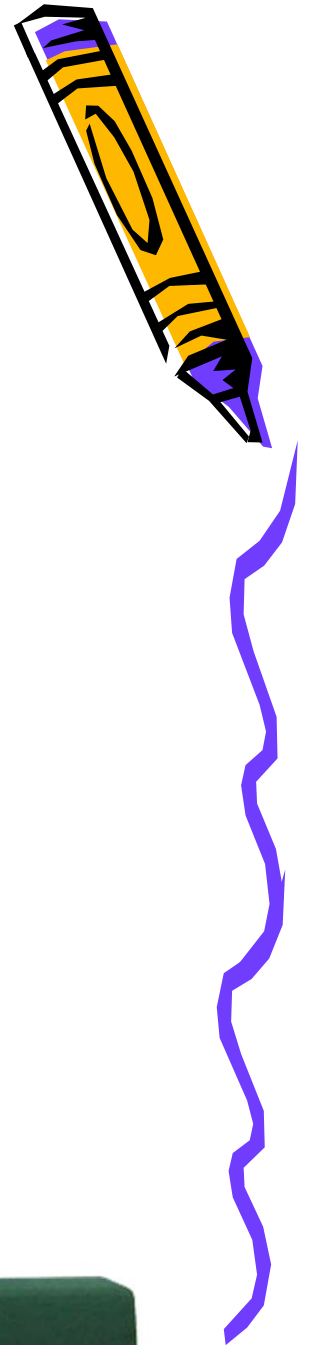


Gears

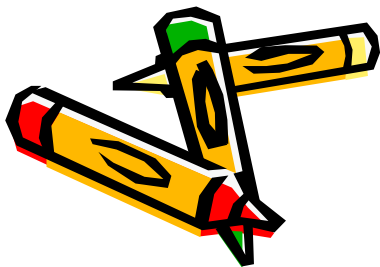
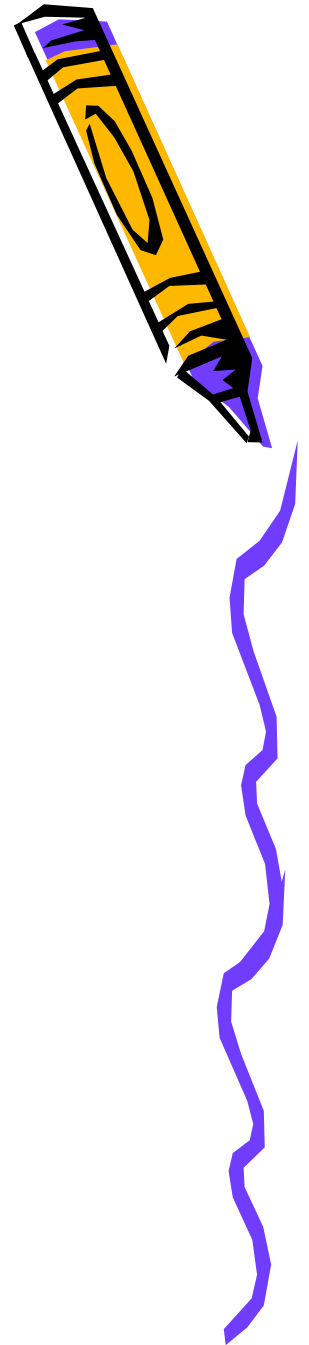
Variomatic Cube



Captured Gears

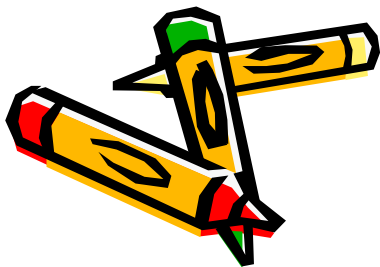
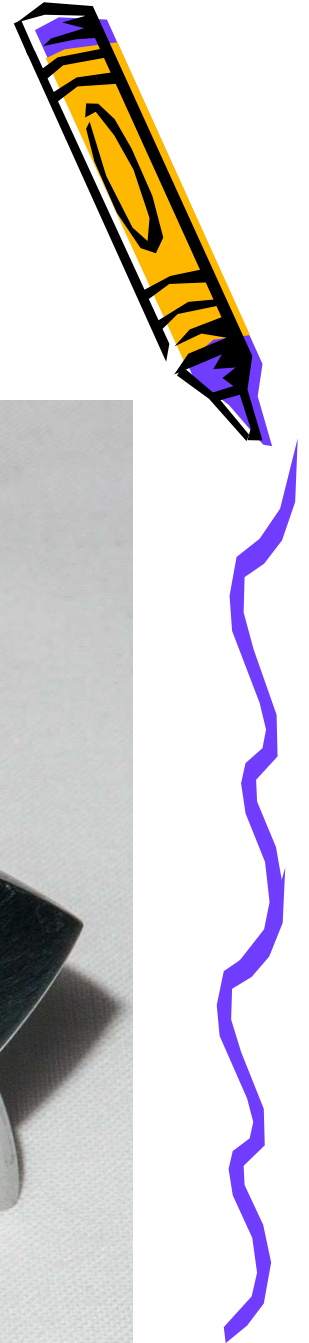


Valentine Gear Sphere



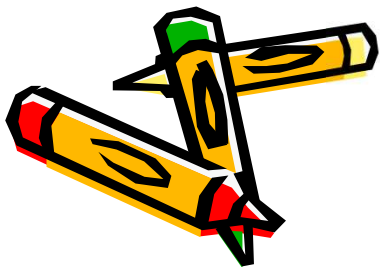
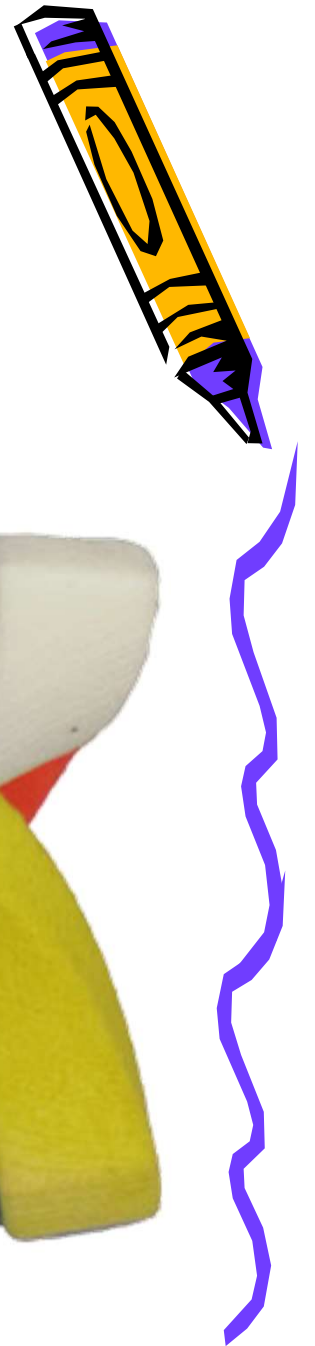
Interlocking

Arch burr



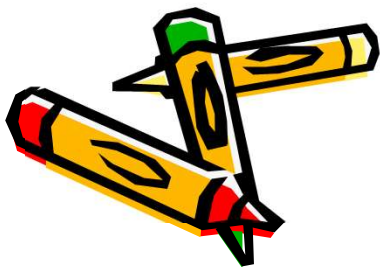
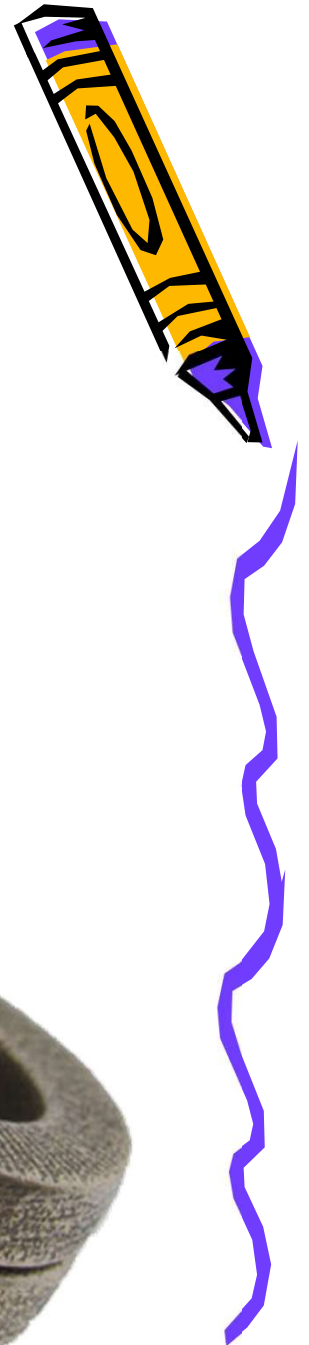
Interlocking

Candy Wrapper



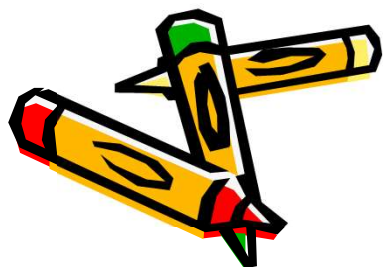
Interlocking

Cold Fusion



Interlocking

Hurly Burly



Thank you!

