



Designing Twisty Puzzles

By M. Oskar van Deventer
IPP Berlin, August 7th, 2011



Twisty Puzzle dictionary

References

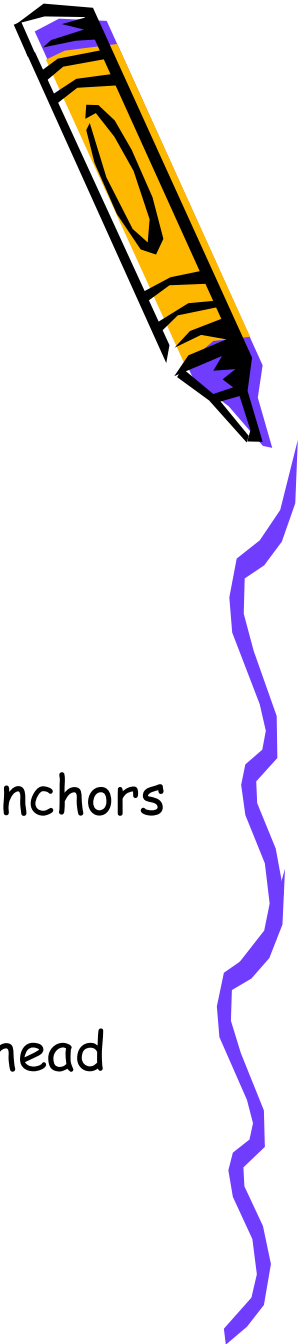
- Twisty Puzzle
- The Twisty Puzzles Forum
- Jaap's Sphere
- Gelatinbrain
- Shapeways

Basic design

- Cut curve
- Shells
- Clearance
- Fillet/hollow/mesh

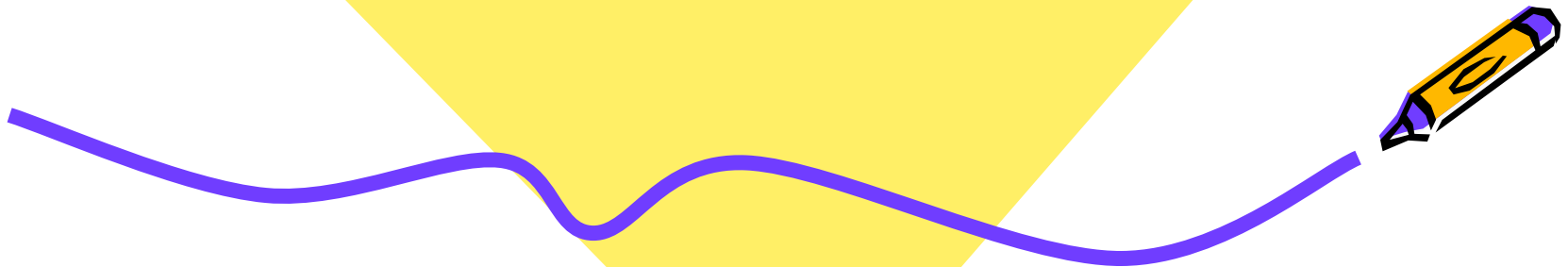
Specials

- Shape-modding
- Bandaging
- Void/Hollow
- Circle/Crazy
- Pull & Turn
- High-order/Floating anchors
- Gears
- Jumbling
- Fudging
- Deep cutting/Knucklehead
- Hybrids
- Boublesizing
- Multi-core



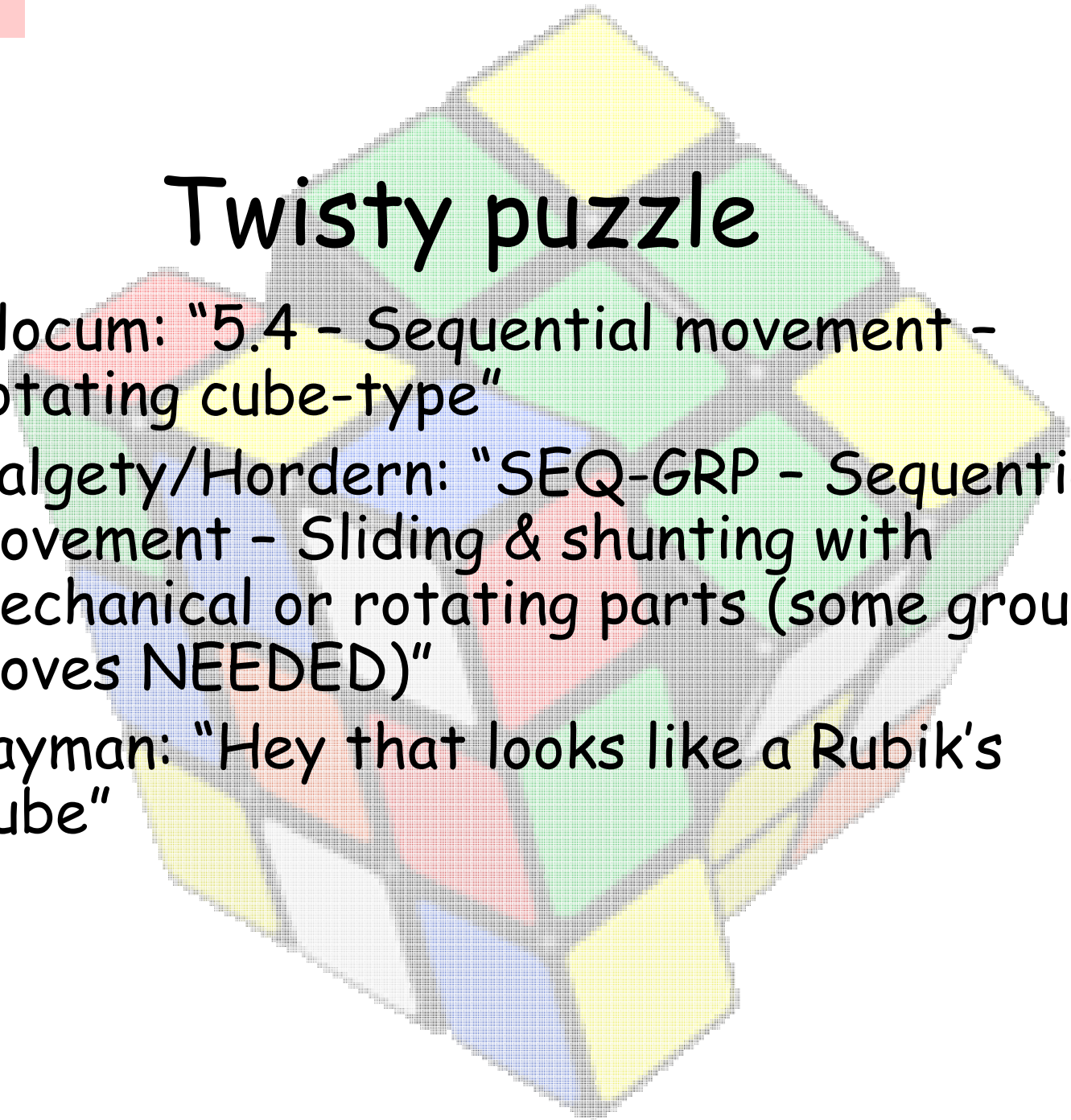


References



Twisty puzzle

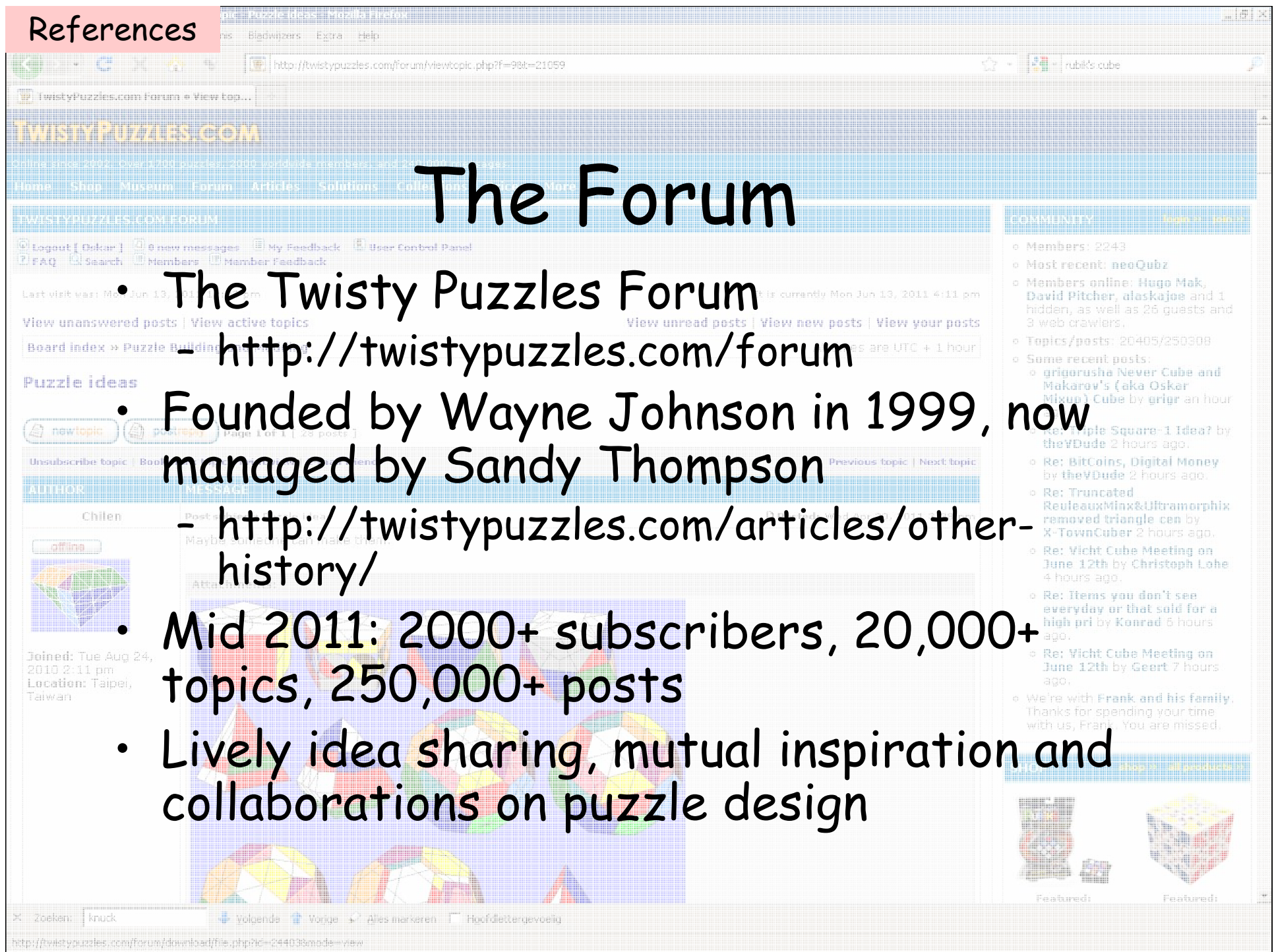
- Slocum: "5.4 - Sequential movement - rotating cube-type"
- Dalgety/Hordern: "SEQ-GRP - Sequential movement - Sliding & shunting with mechanical or rotating parts (some group moves NEEDED)"
- Layman: "Hey that looks like a Rubik's Cube"



References

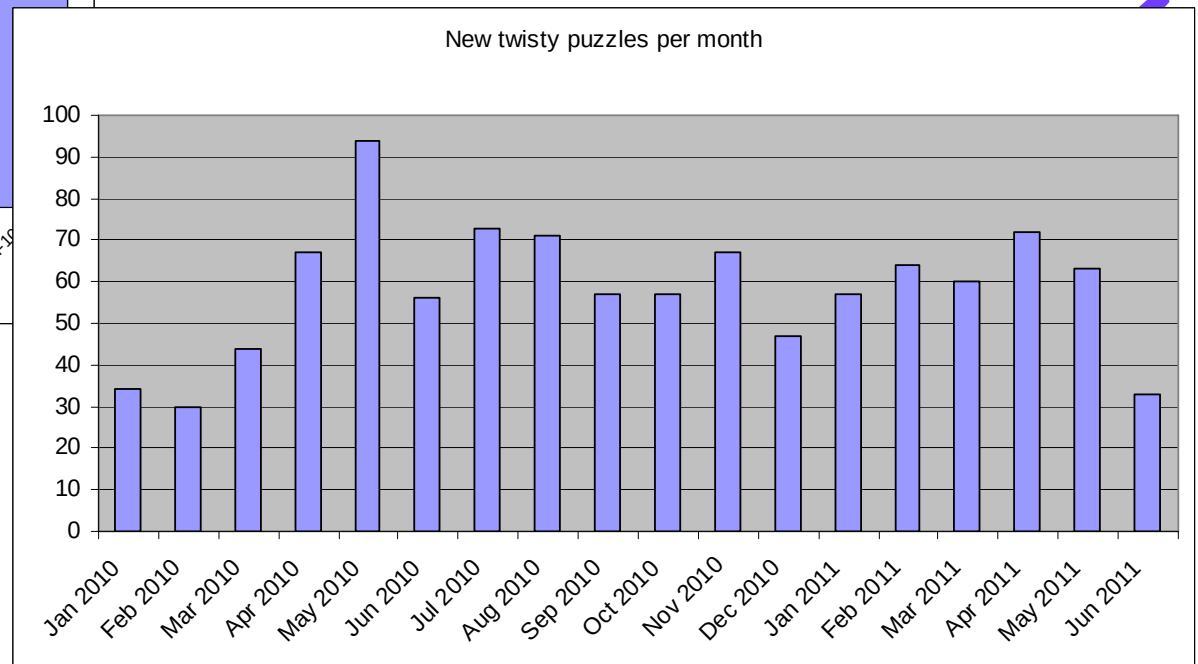
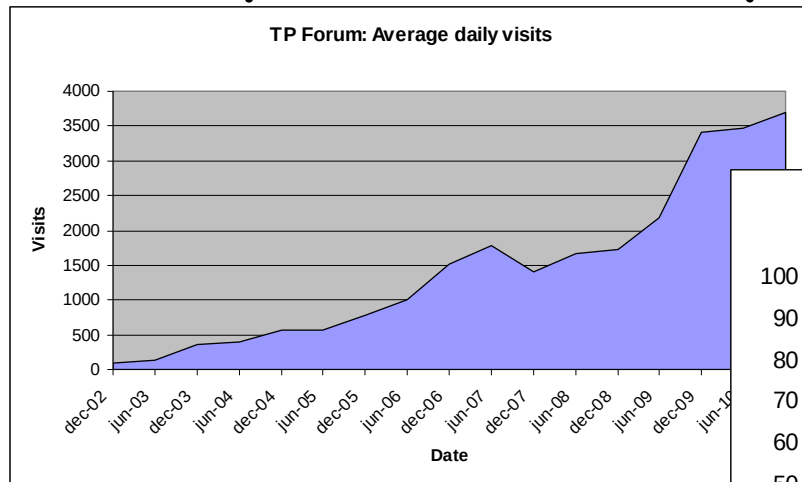
The Forum

- The Twisty Puzzles Forum
 - <http://twistypuzzles.com/forum>
- Founded by Wayne Johnson in 1999, now managed by Sandy Thompson
 - <http://twistypuzzles.com/articles/other-history/>
- Mid 2011: 2000+ subscribers, 20,000+ topics, 250,000+ posts
- Lively idea sharing, mutual inspiration and collaborations on puzzle design



The Forum

- Year 2010 "golden year": 697 new puzzles, many unique



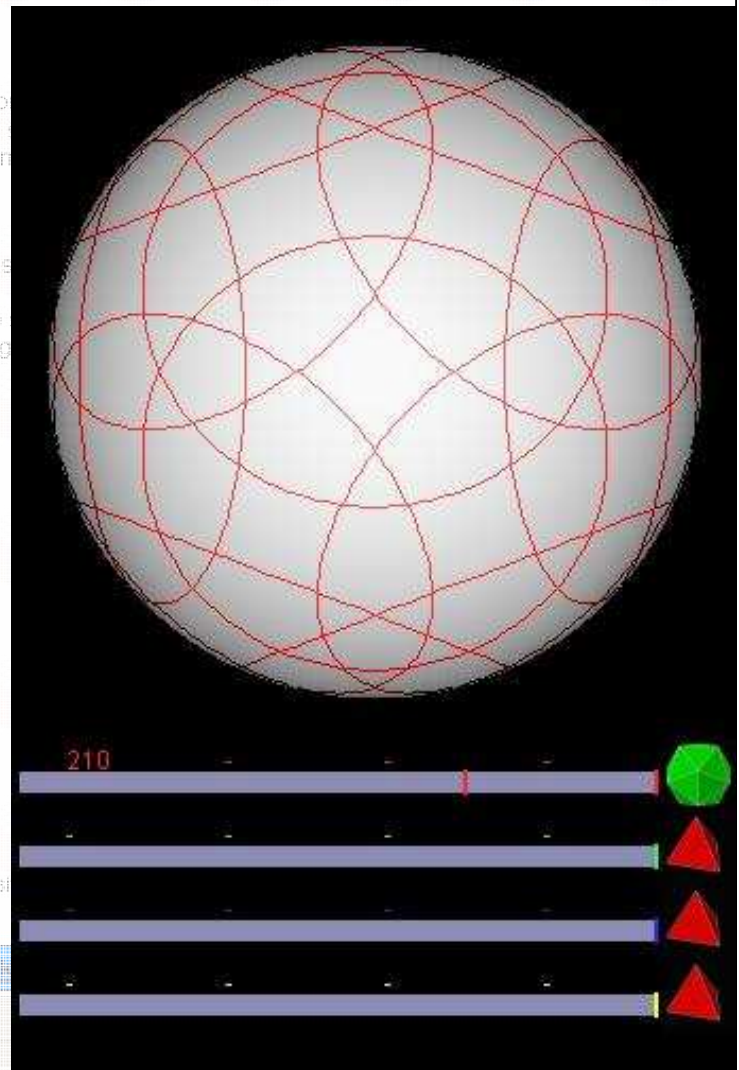
References

Jaap's Sphere

- <http://www.jaapsch.net/puzzles/sphere.htm>
- Applet by Jaap Scherphuis, since 2003
- Visualising twisty puzzle geometries
- Analysis and inspiration

Written by Jaap Scherphuis © 2003/2004.

Download the [source and class files](#). The program may be freely used or adapted for use on any other non-commercial website to [Jaap's Puzzle Page](#). The program may not be sold or used in any commercial manner without prior permission.

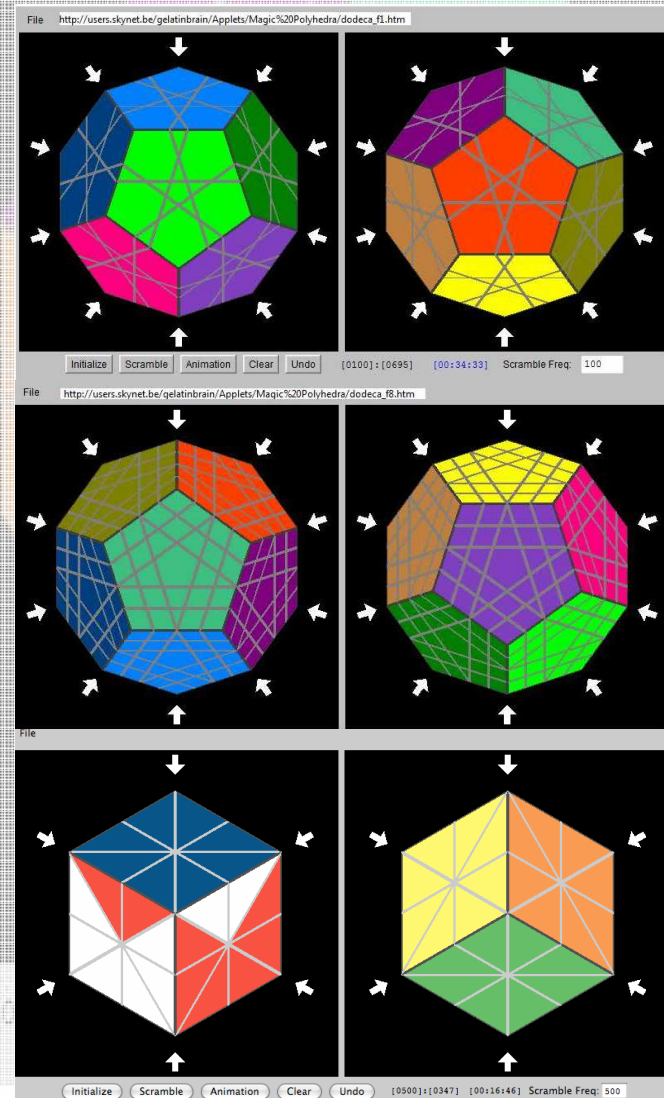


References

http://users.skynet.be/gelatinbrain/Applets/Magic%20Polyhedra/dodeca_f1.htm

Gelatinbrain

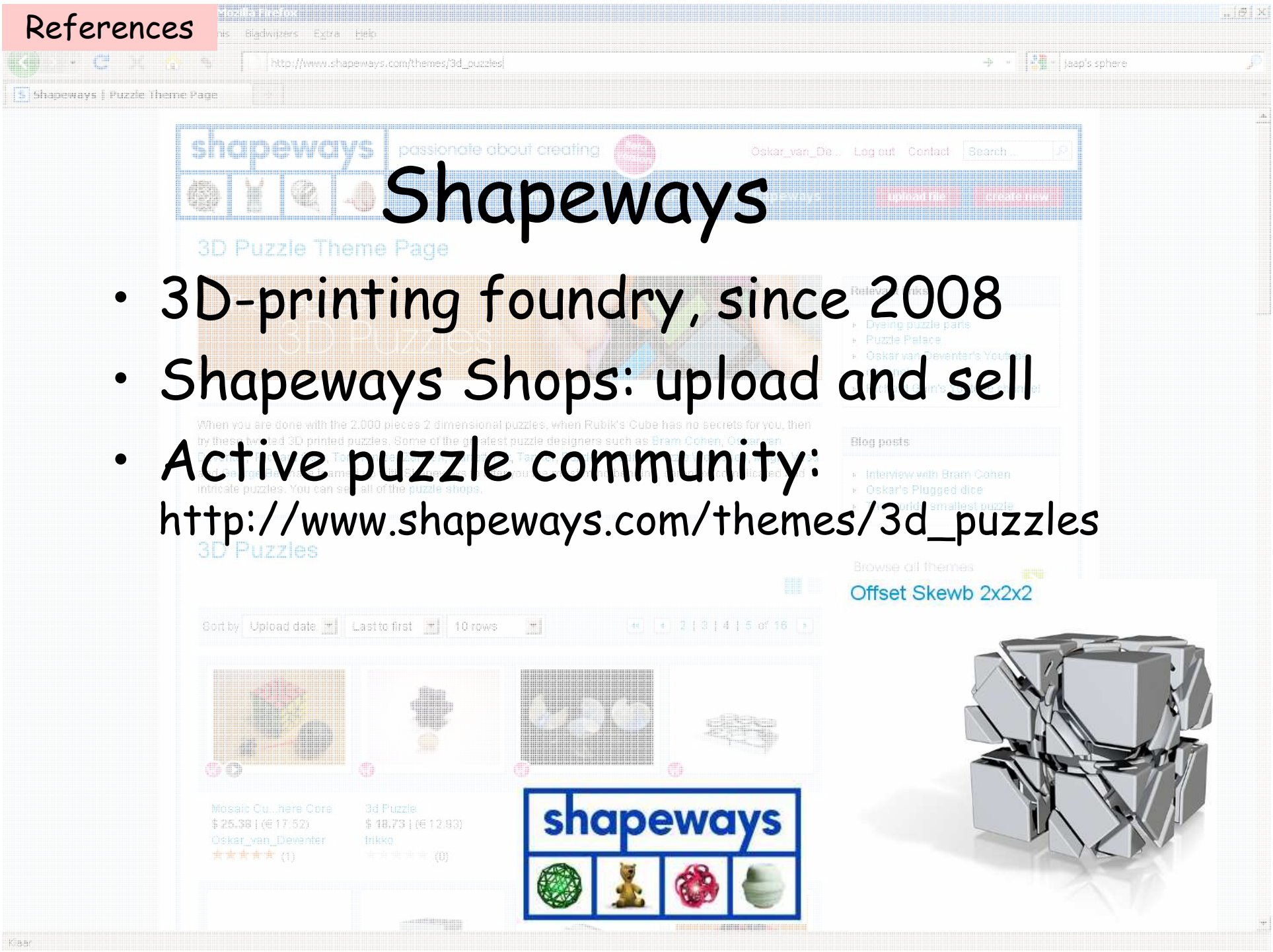
- <http://users.skynet.be/gelatinbrain/Applets/Magic%20Polyhedra/>
- Page and applets by Paul Smet
- Simulations of over 370 twisty puzzles, most never built
- Competitative solving
- Analysis and inspiration



References

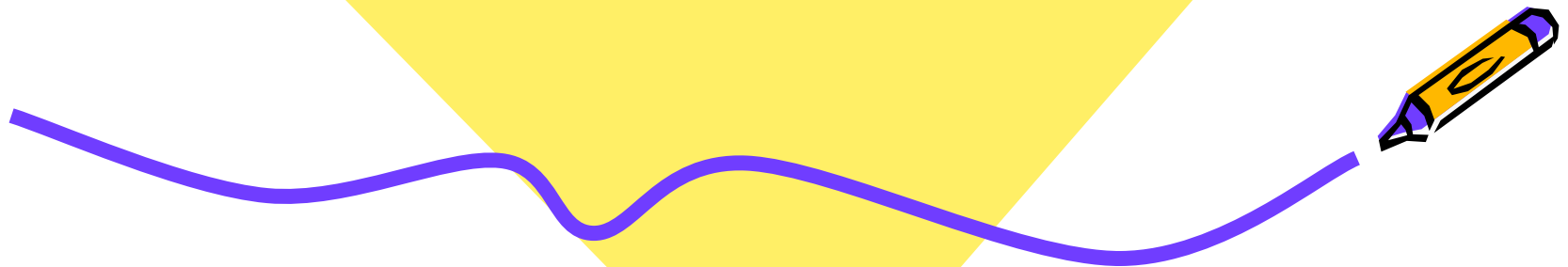
Shapeways

- 3D-printing foundry, since 2008
- Shapeways Shops: upload and sell
- Active puzzle community:
http://www.shapeways.com/themes/3d_puzzles



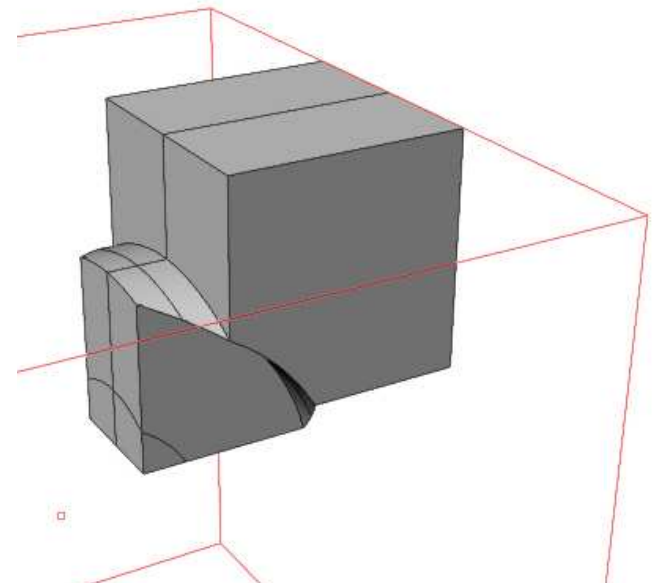
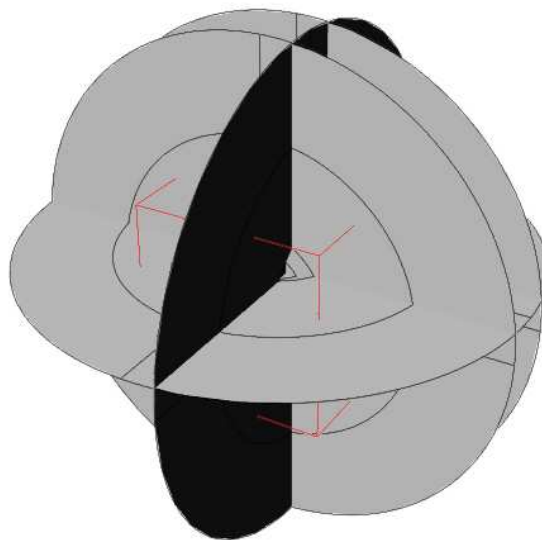
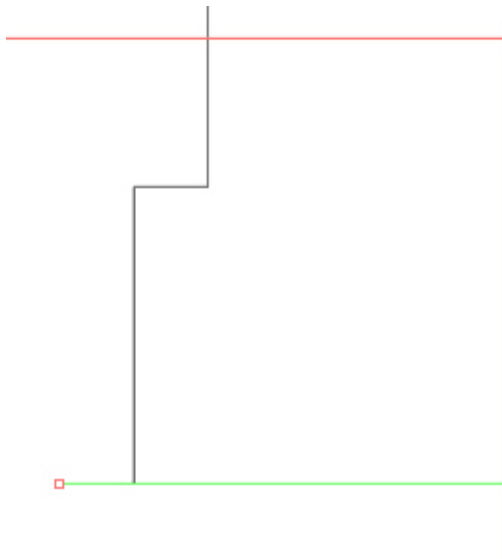


Basic Design



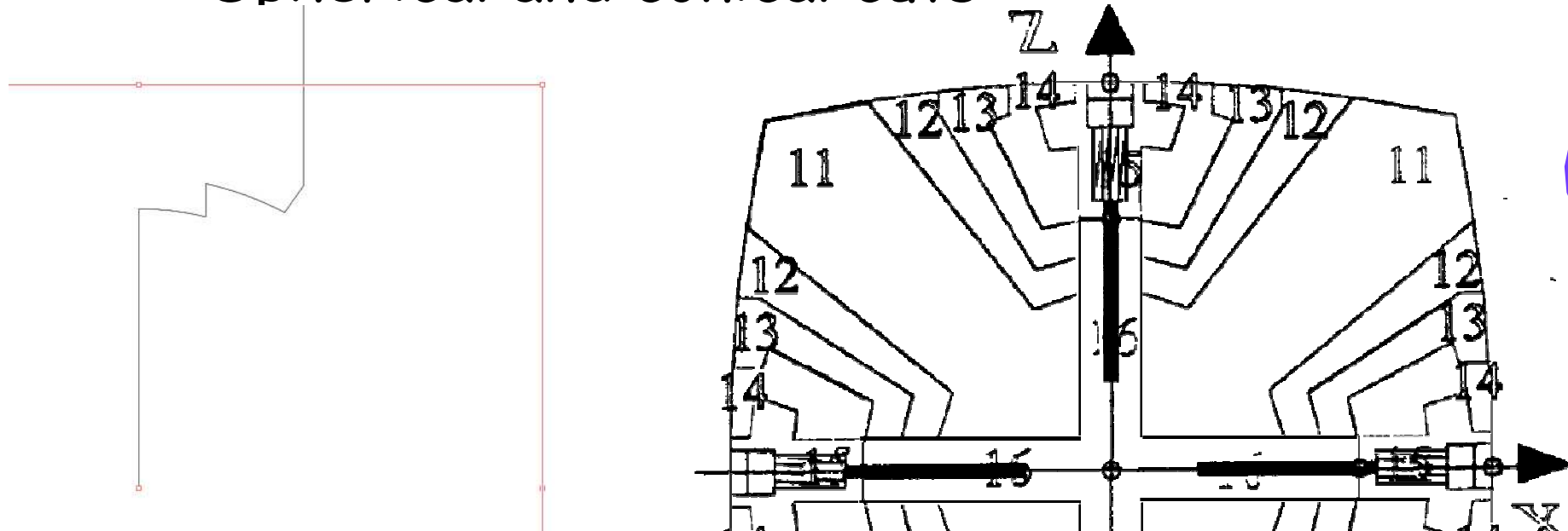
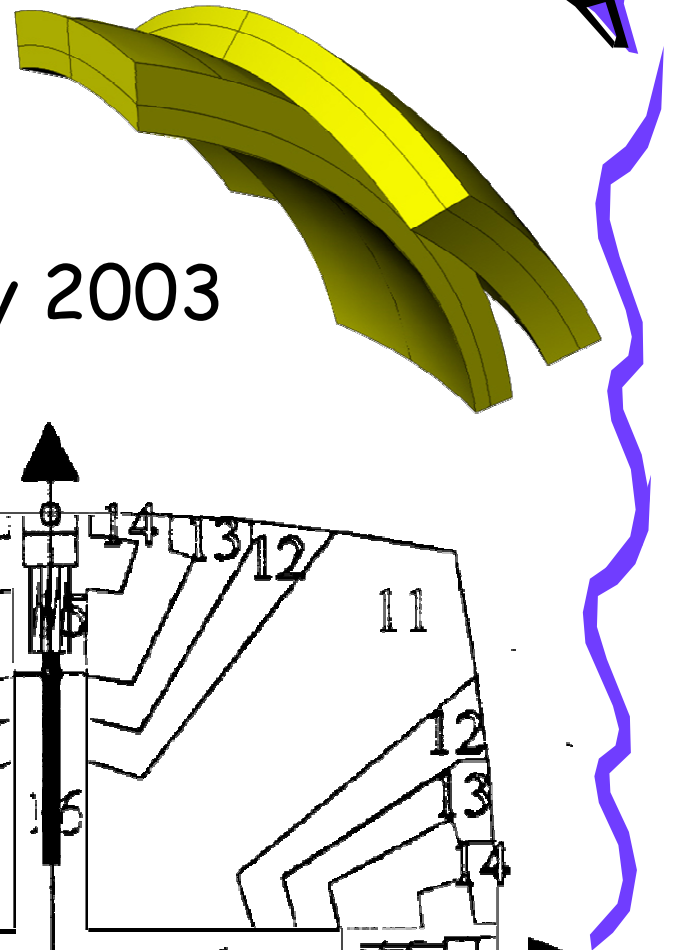
Designing twisty puzzles

- 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



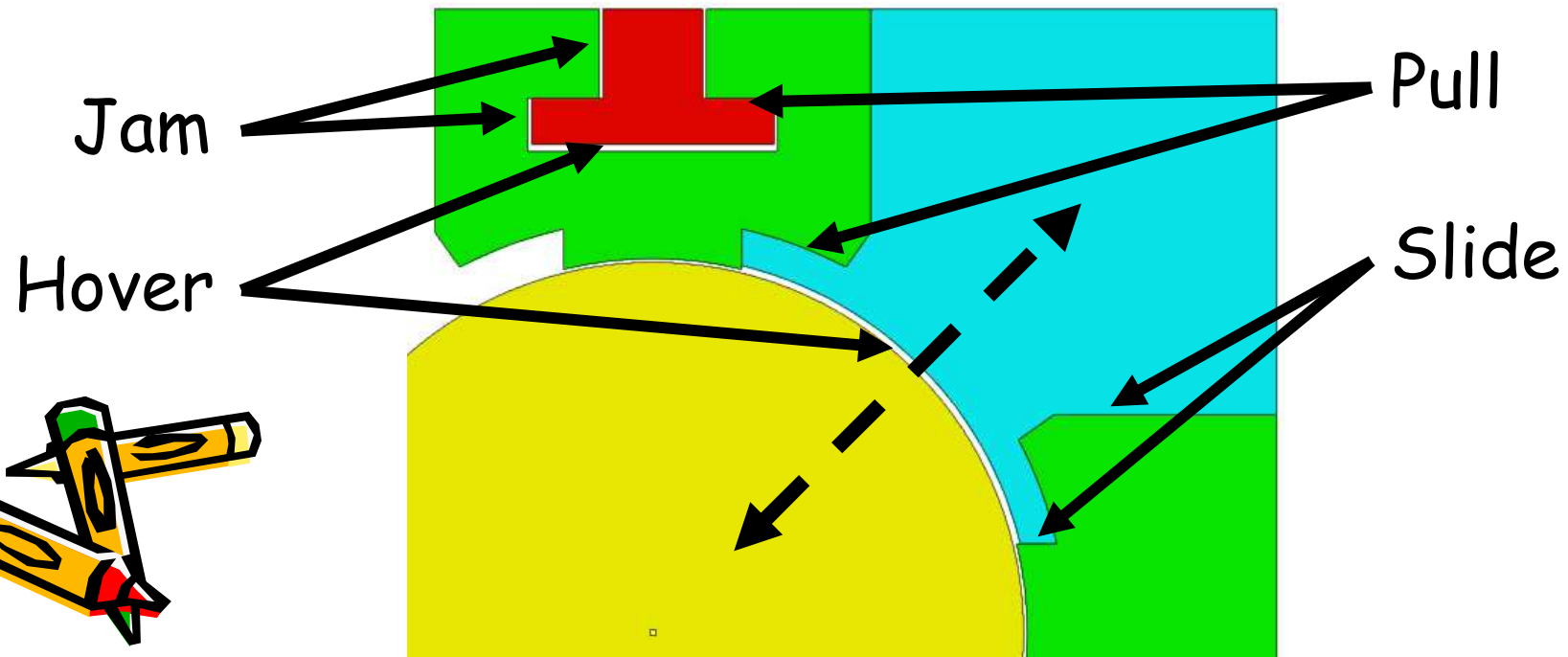
Shells: stable and robust

- Introduced by Bram Cohen, TP Forum, April 2004
- Used by Panagiotos Verdes for his "V" cubes patent, May 2003
- Spherical and conical cuts



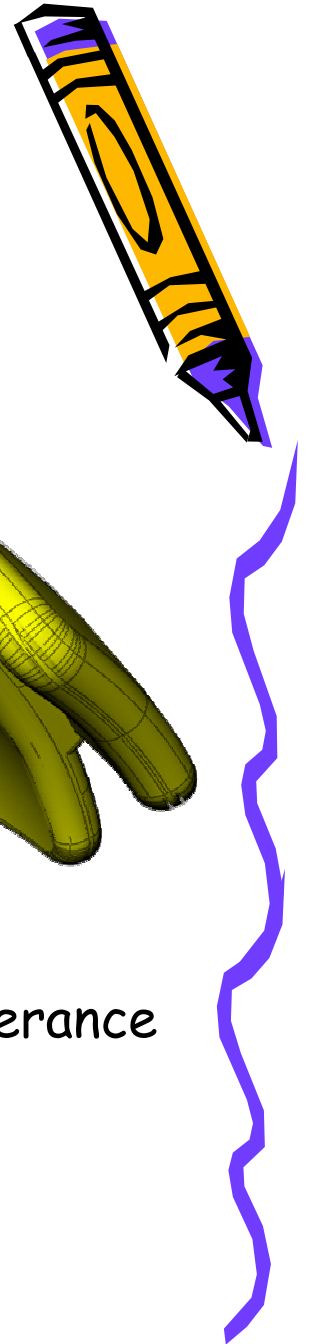
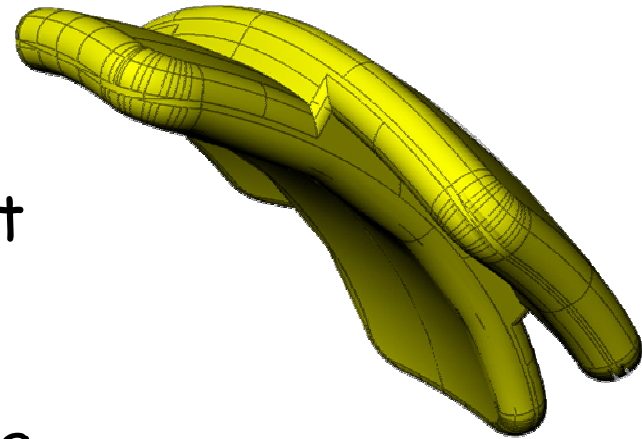
Clearance: pulling together

- 0 mm: where pieces pull or slide
- E.g. 0.4 mm: where pieces hover
- E.g. 0.2+0.2 mm: where pieces jam



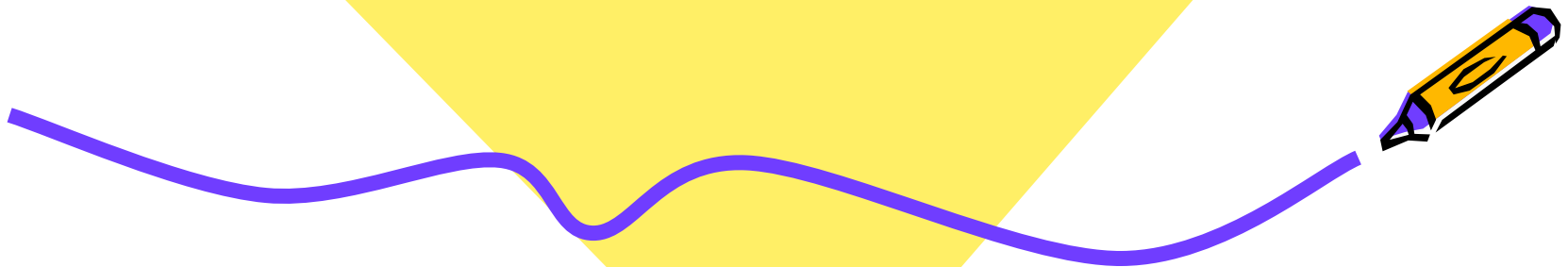
Fillet-hollow-mesh

- Filleting: smooth turning
 - E.g. 2 mm where corners meet
 - E.g. 1 mm at rims
- Hollowing: save 3D printing cost
 - E.g. 0.7 mm wall thickness
 - E.g. 0.1 mm diameter "air hole"
- Meshing: render for 3D printing
 - E.g. 0.05 mm min. edge length
 - E.g. 0.05 mm max. dist. edge to surface, or max. tolerance
 - E.g. 20 deg max. angle deviation



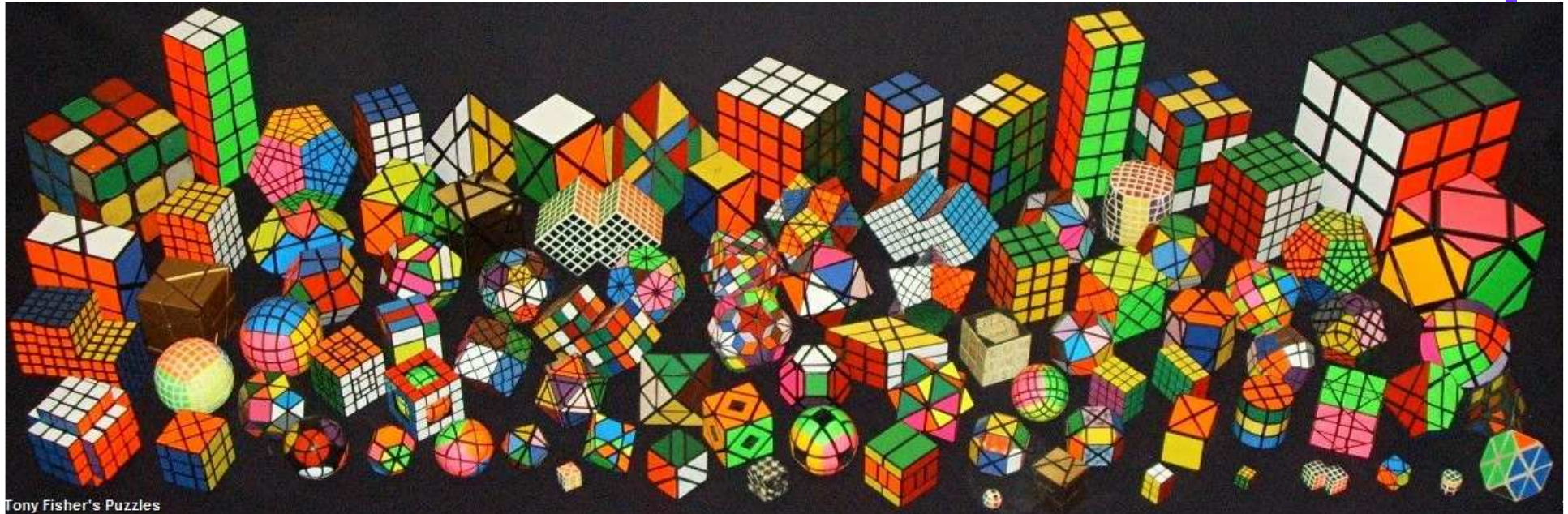


Specials



Shape-modding

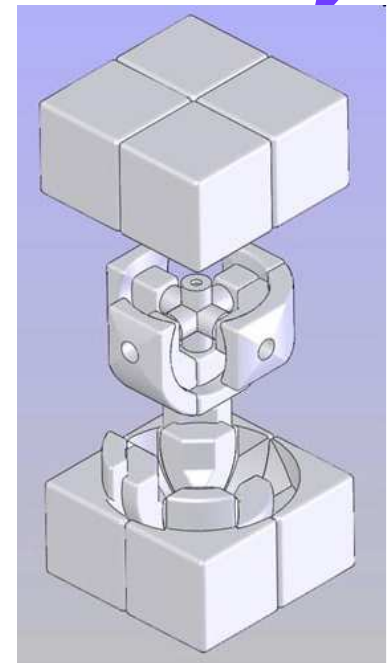
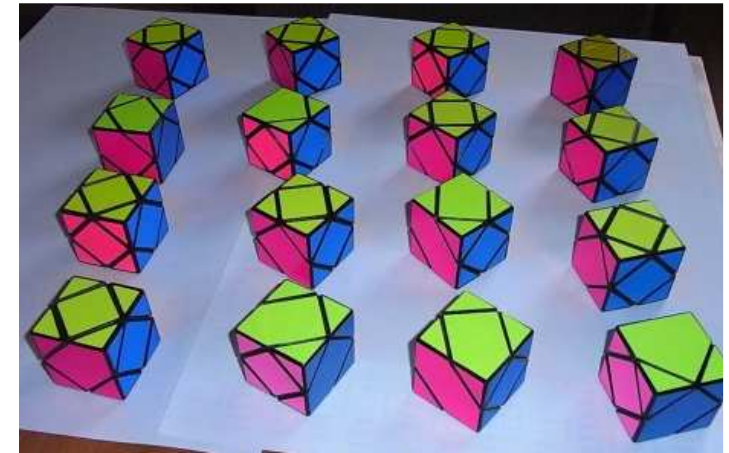
- Changing shapes, adding pieces, joining puzzles
- Tony Fisher, the "mod god"
 - <http://tonyfisherpuzzles.net/>
- Claus Wenicker, Andreas Nortmann, many others



Bandaging

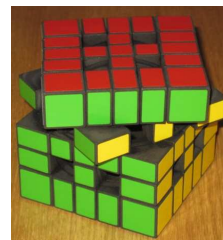
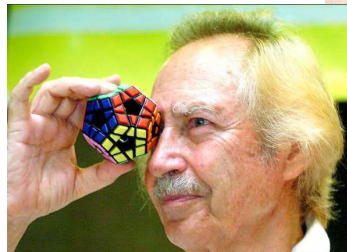
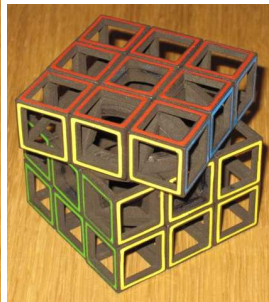
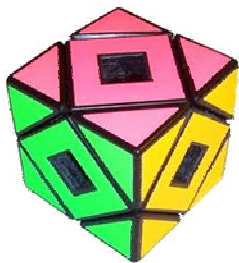
"Glueing" some pieces together

- Noah, Adam Cowan: Nightmare Cube, hidden bandaging
- Adam Cowan: Handlebar Cube, non-adjacent pieces
- Oskar: Get Stuck Cube, sliding bandages
- Andreas Nortmann: All bandaged Cubes & Skewbs
- Many 100's variations



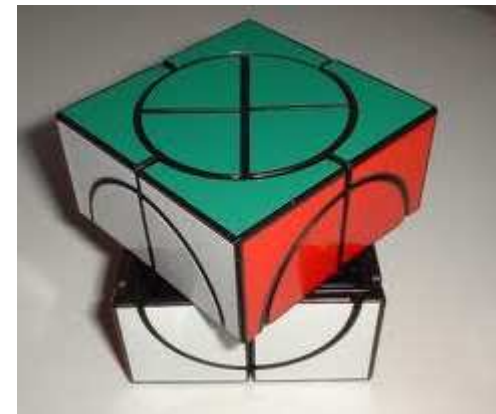
Void/Hollow

- Katsuhiko Okamoto
 - Award-winning Void Cube, 2007
- Several variations
- Gift Cube: marriage proposals



Circle/Crazy

- Aleh Hladzilin:
 - Adding turning circles



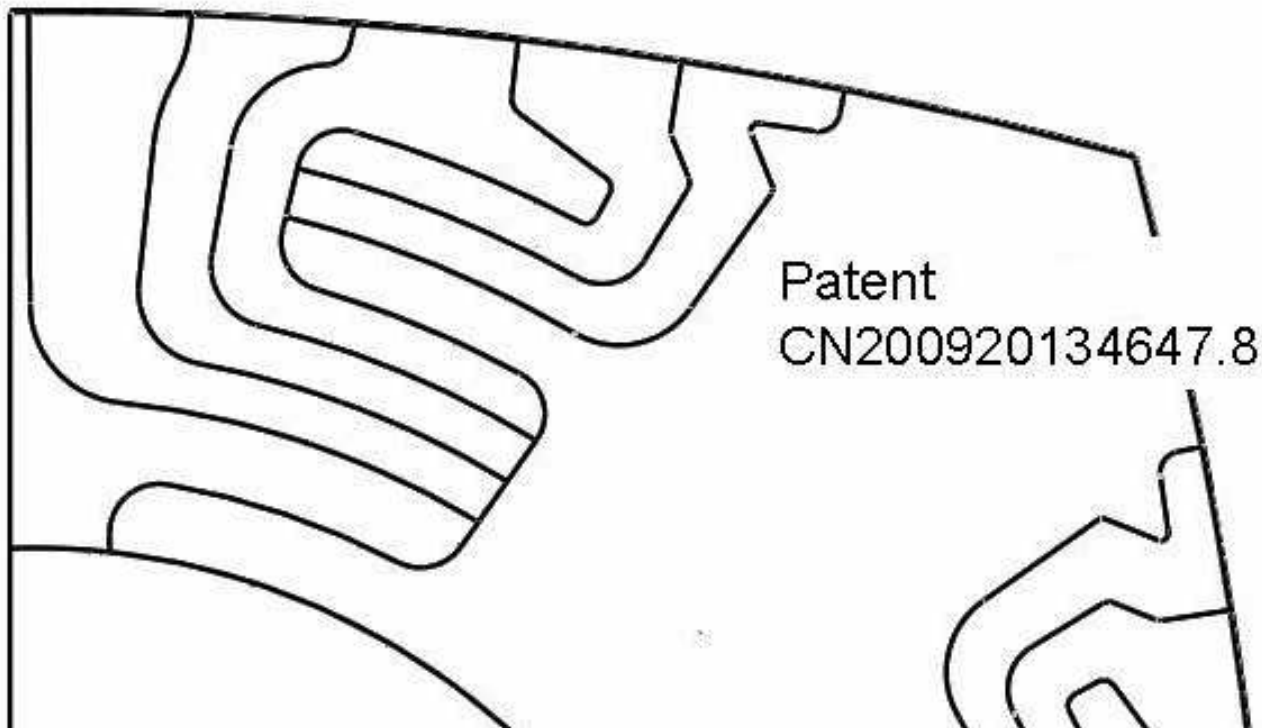
Pull-and-turn

- Daqing Bao: Magical Ball



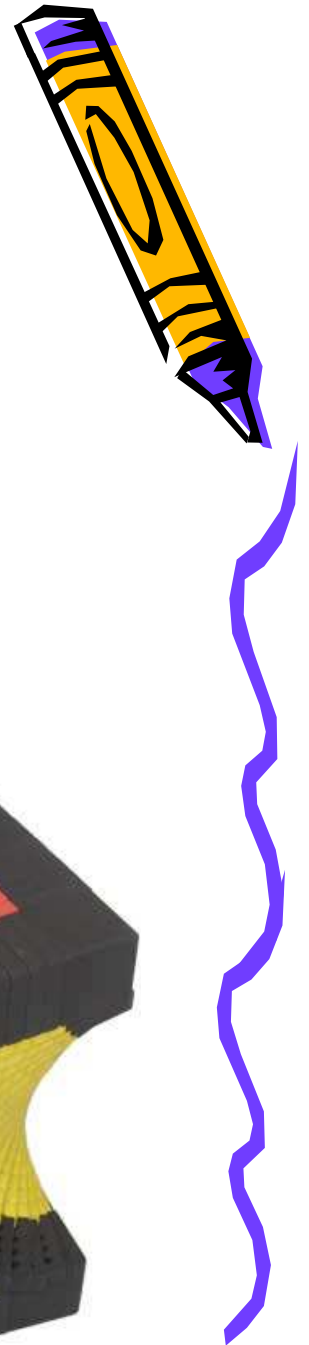
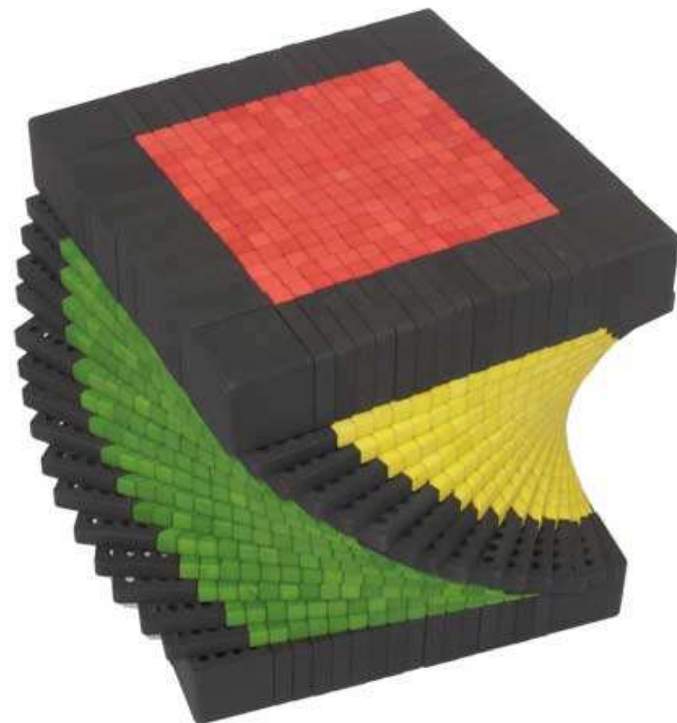
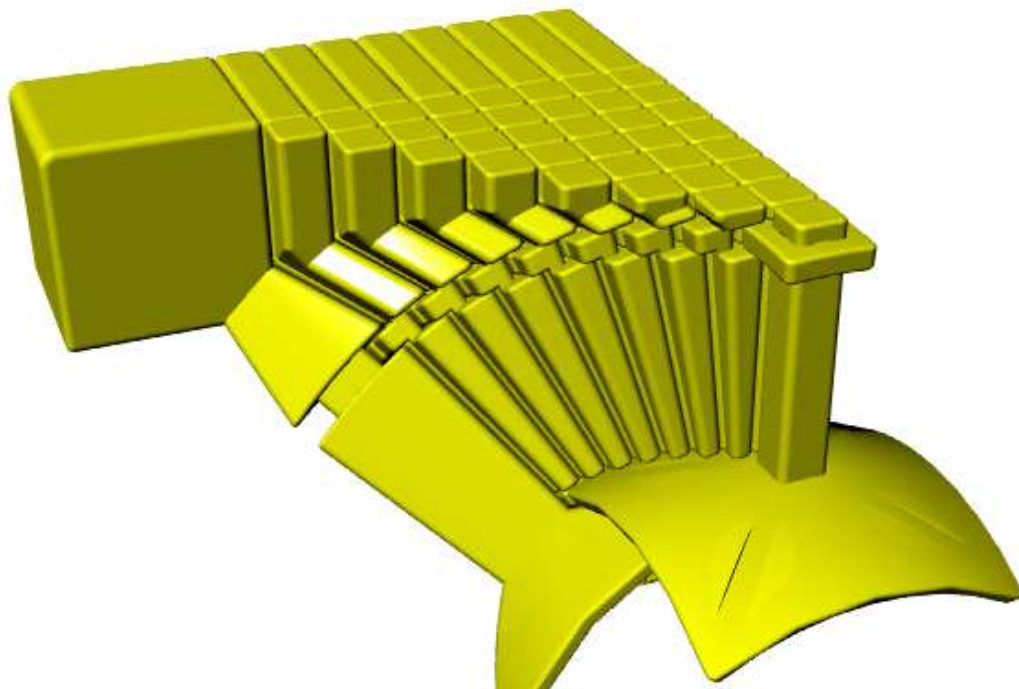
High-order

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



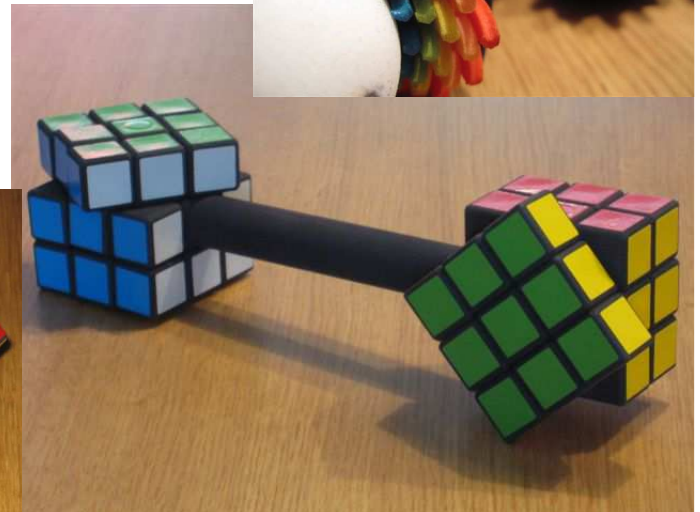
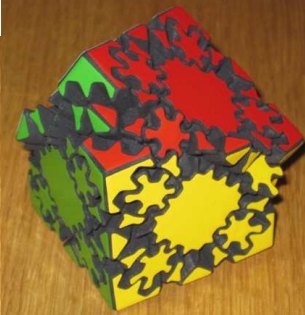
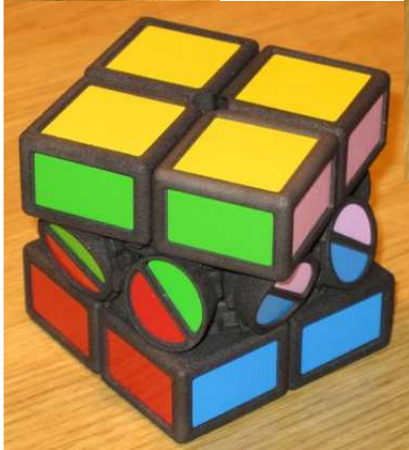
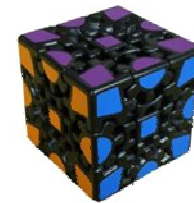
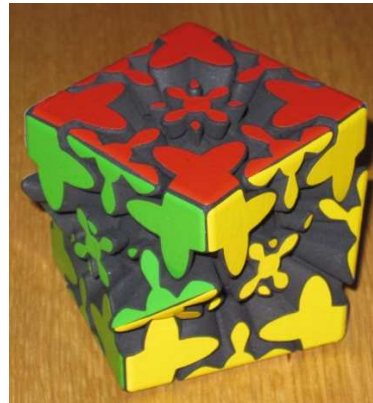
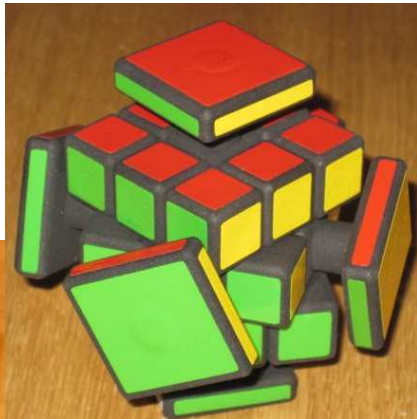
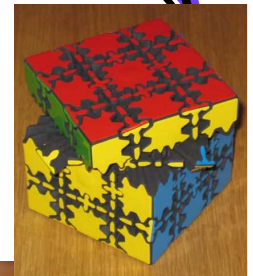
Floating anchors

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



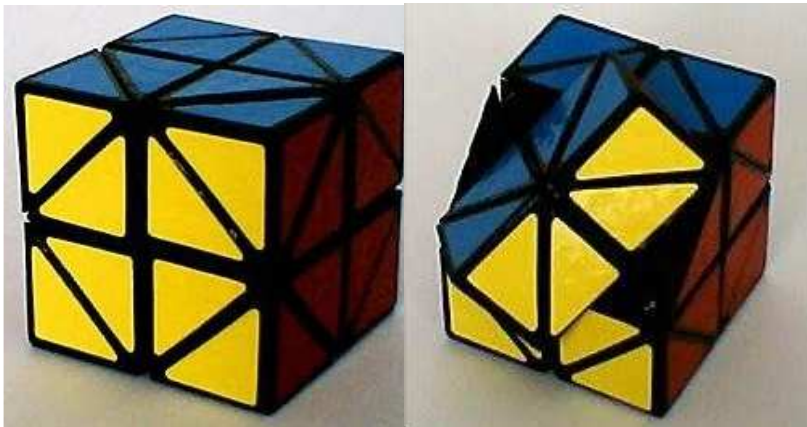
Gears

- Bram & Oskar: Bram's Cube, Gear Shift
- Oskar: Gear Cube, Dumbbell Cube, ...
- Alex Polonsky: Polo Cube



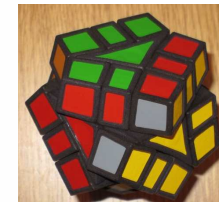
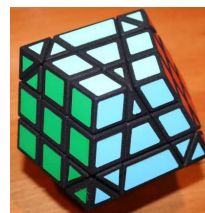
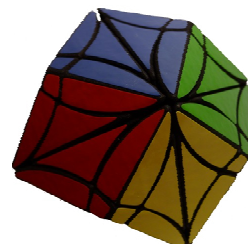
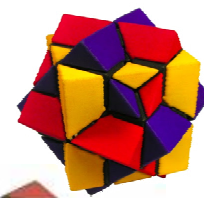
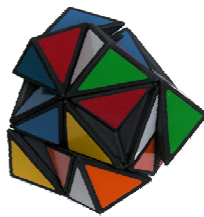
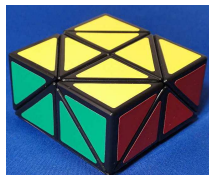
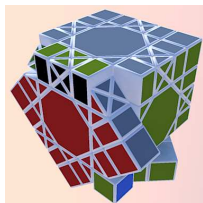
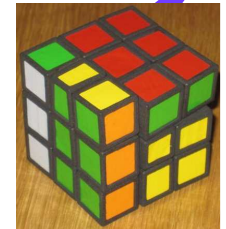
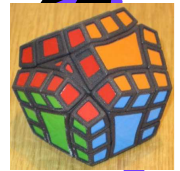
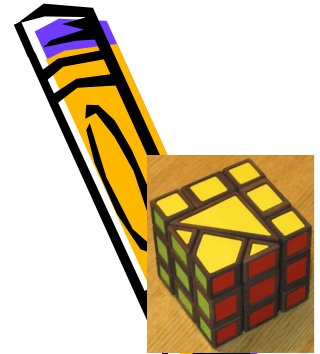
Jumbling

- Katsuhiko Okamoto / Adam Cowan
 - Bevel Cube / Helicopter Cube, 2007
- Bram Cohen:
 - "A twisty puzzle 'jumbles' when it cannot be unbandaged into a doctrinaire puzzle."
- David Pitcher:
 - Rhombic Dodec, 2003, not published



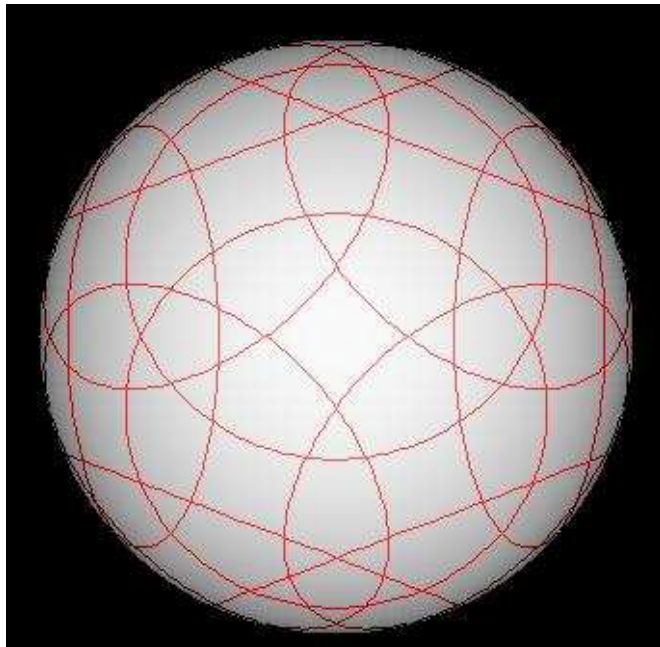
Jumbling

- 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, Dave Lithwin, Paul Smet, Chilen Chen, Martin Ming, Krystian Wilisowski, Vladimir Iaroslavski, Scott Elliott, Bob Hearn, and many others ...
- Enough material to do a PhD!



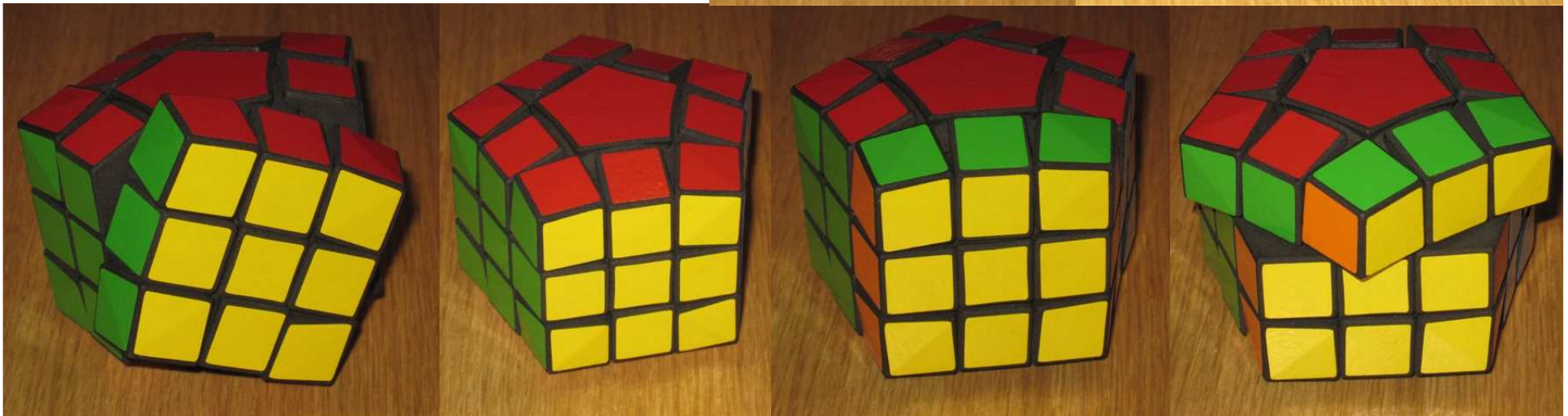
Jumbling

- A face-turning icosahedron jumbles!
- Discovered by Matt Galla
- Confirmed by Bob Hearn, Jason Smith and Oskar



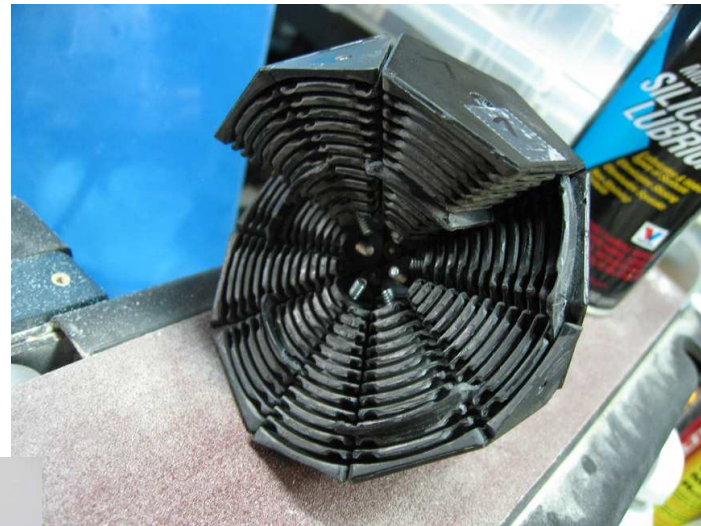
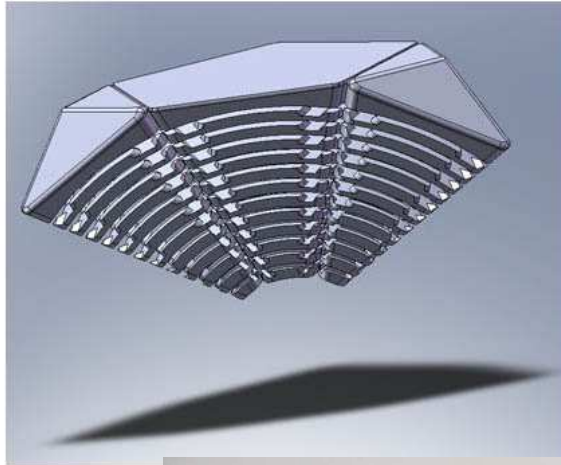
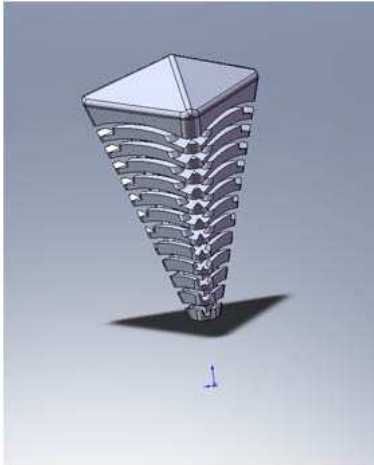
Fudging

- Oskar's
 - Futtminx
 - Illegal Cube
- Term coined by Bram Cohen



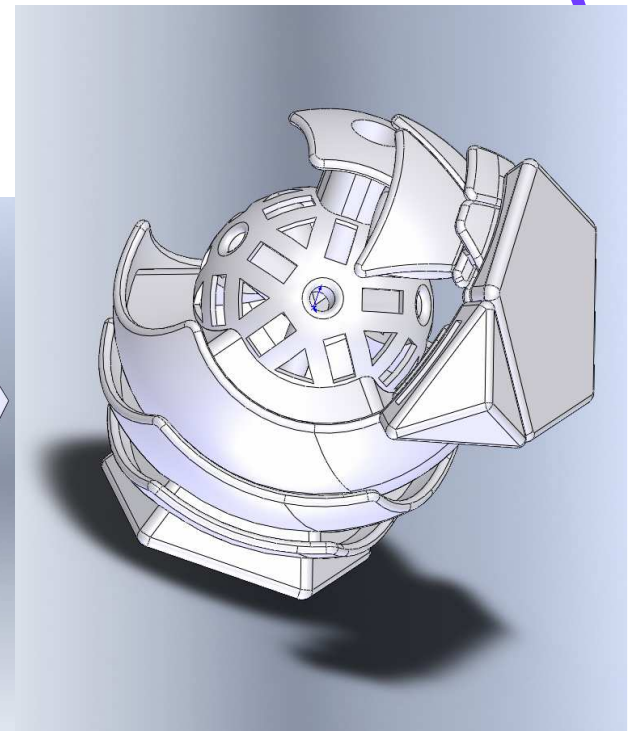
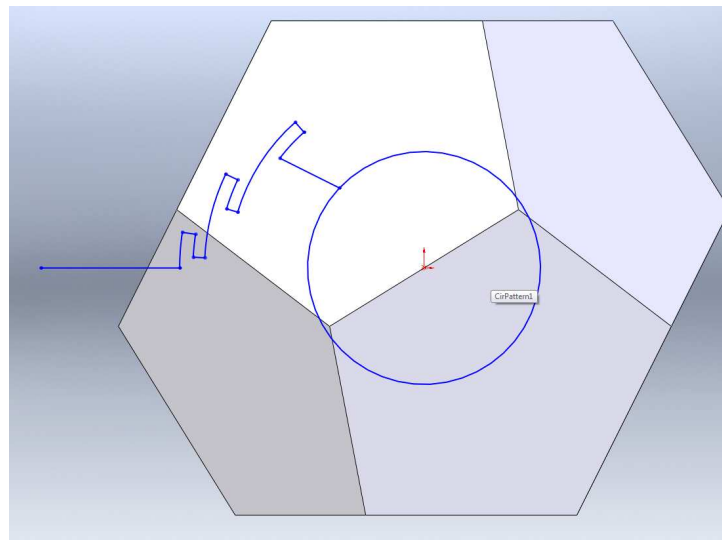
Deep cutting: Knucklehead

- Jason Smith's Pentultimate



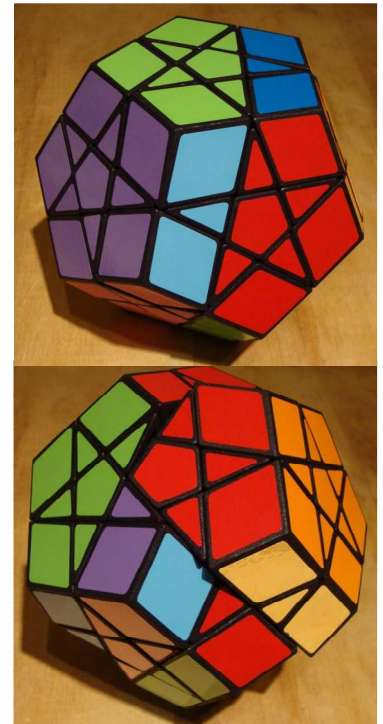
Deep cutting: Shells

- Tom van der Zanden's Mini Pentultimate
 - Inner shell: bandaged Megaminx
 - Middle shell: Pyraminx Crystal
 - Outer shell: Pentultimate



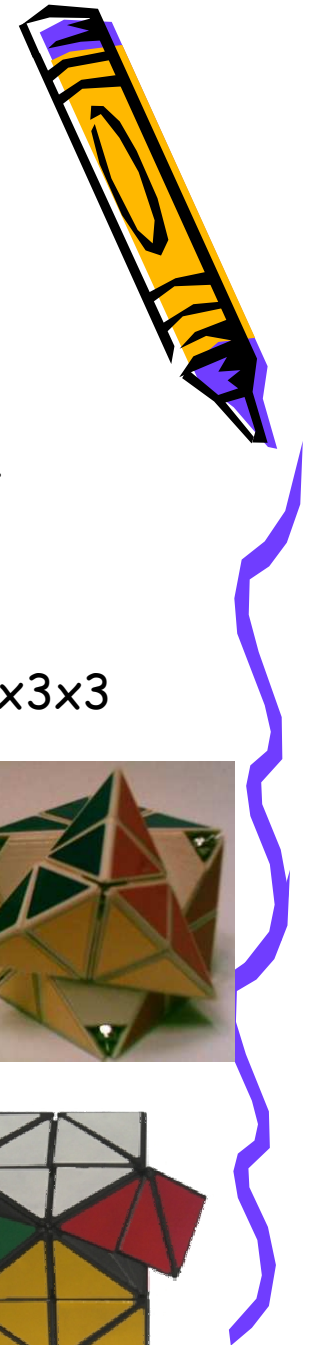
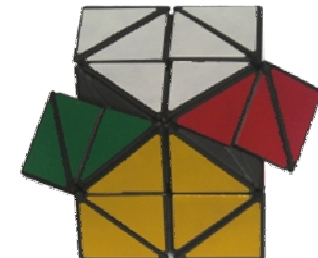
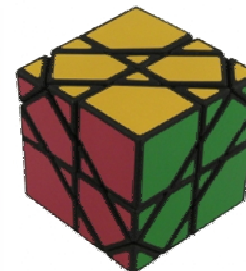
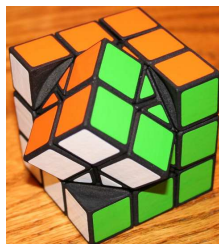
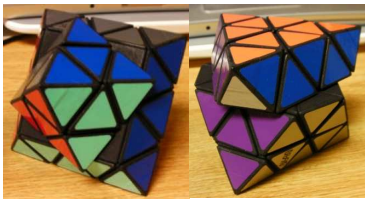
Deep cutting: Shells

- Andrew Cormier's Chopasaurus
 - 4 shells, 919 pieces, most inside
 - Voted best twisty puzzle of 2010



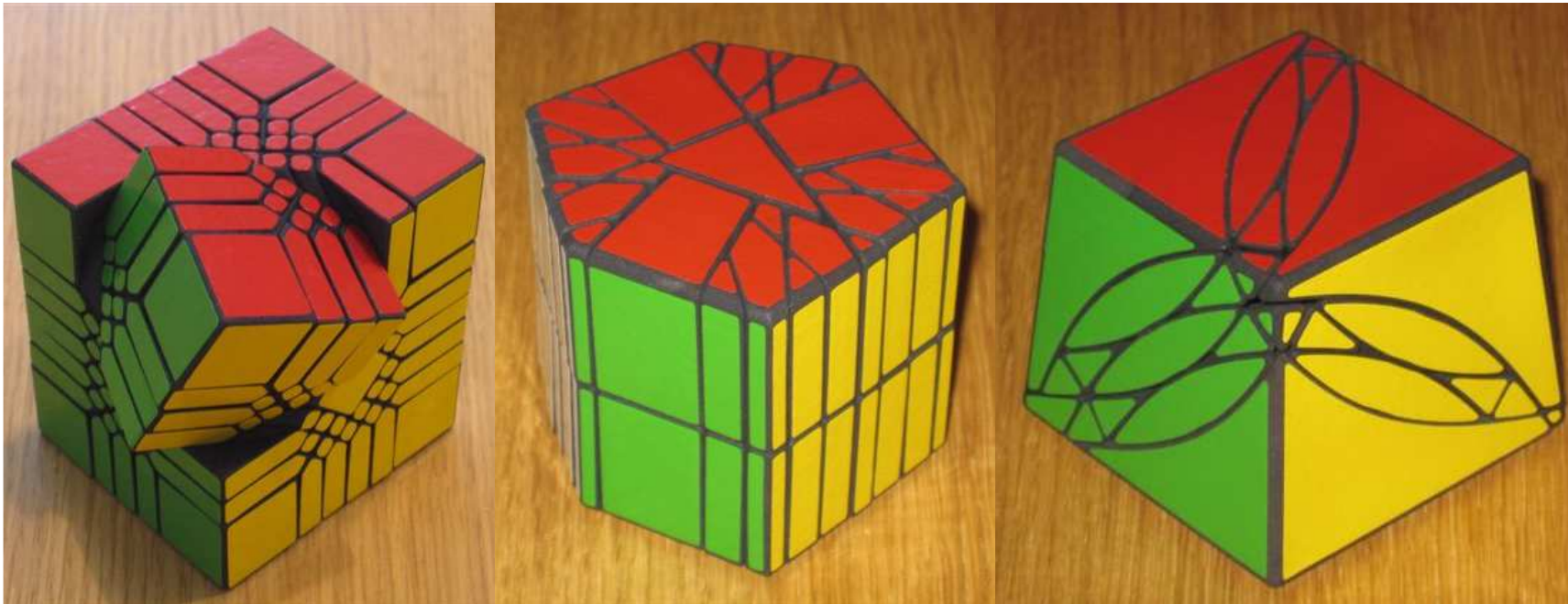
Hybrids

- Combining different geometries
 - Tom van der Zanden: Offset Skewb + 2x2x2; Dino Cube + 3x3x3; Helicopter Cube + Skewb
 - Adam Cowan & Jason Smith: Skewb + 2x2x2
 - Wayne Johnson & Adam Cowan: SuperX (=Dino + 2x2x2)
 - Eric Vergo: Unbandaged Helicopter Cube + 2x2x2; Redi 3x3x3
 - Eitan Cher: Comboctahedron
 - Sharon Avidor & Matthew Ray: Copterminx
 - Ola Jansson: Lattice X



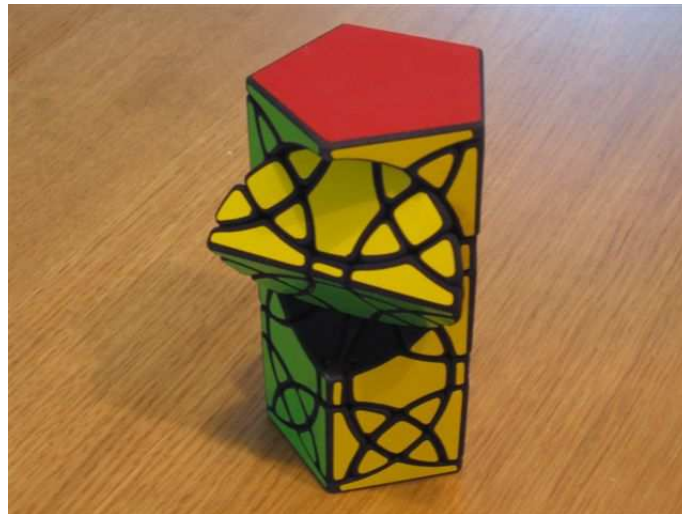
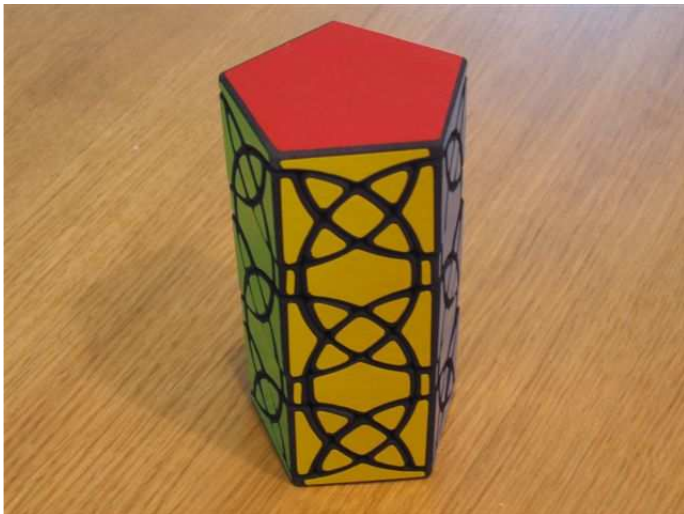
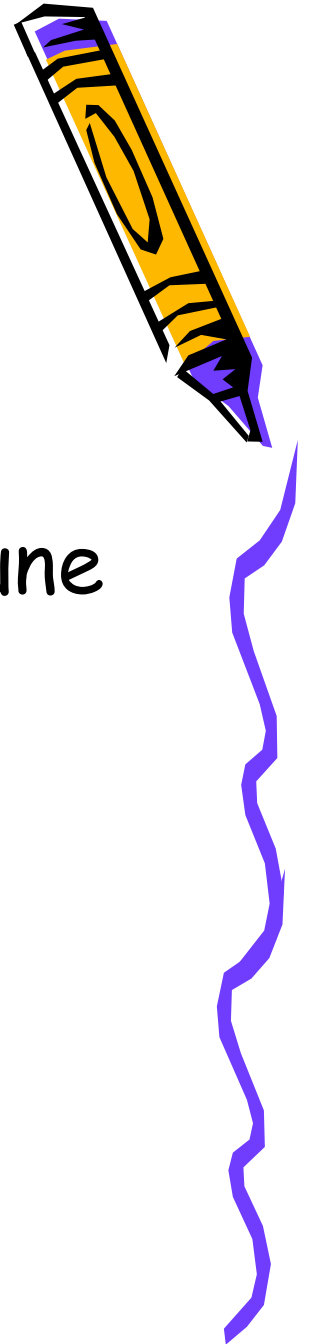
Boublesizing

- Discovery: Anthony "Boublez" Villaveiran, March 2011
- First puzzles: Mosaic Block, Hexagonish Block, Bubble Block, Oskar, May-June 2011



Multi-core

- Proposal: David Pitcher, April 2011
- First puzzle: Pentastick, Oskar, June 2011



Acknowledgement ...

- ... to the many excellent and creative designers from the Twisty Puzzles Forum, who inspired and designed so many creative and innovative twisty puzzles. I am sorry that I could not mention all ...



Orkan

Petaminx, Royal Pentultimate, Olzing, Pillowing, Floppy,