art and science at play

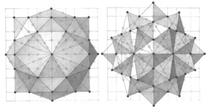
ZOMETOOL®

As is the case with all exceptional developments, Zometool is the result of many inspirational events and occurrences.

In the mid 1960's, "Drop City", a living environment conceived and created by art students and film makers in southern Colorado,

Drop City Panorama, Colorado, USA

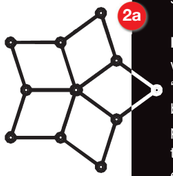
came into being. Inspired by Buckminster Fuller's architectural ideas, the "Droppers" designed their living quarters and studios on the basis of geometric solids, for example, triacontahedrons and other "zonohedrons". In 1967, Buckminster Fuller awarded Drop City the Dymaxion Prize for innovative und economical architecture. Steve Baer, an architect who often visited Drop City, developed a toy for children on the basis of these constructions: Zome Toy.



left: Paul Hildebrandt, above: „Cubespace avec Zometool" by Fabien Vienne, right: Zometool construction in Coimbra Portugal, "Bridges Conference 2011".

During the 1980's, inspired by Steve Baer's work, Paul Hildebrandt and Marc Pelletier began working together to revitalise and enhance Zometool. 10 years of exacting work were required, but the result was an ingenious design for a connecting ball, which, in combination with struts in specific shapes and colours, makes it easy for children and adults alike to build and play with Zometool. The very first Zometool ball was produced in April 1992 - and it was perfect.

The struts are produced in three different shapes, which fit into the respective openings of the ball, and in three lengths, which conform to the rules of the "Divine Proportion" (Golden Ratio). The strut forms, together with the precise arrangement of the openings, enable not only the portrayal of complex mathematical structures: Zometool links imaginative play with art, science and research. Complying with the rules of natural geometry, Zometool models are always well proportioned, harmonious structures - an inspirational medium for artistic expression.



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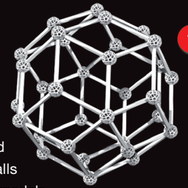
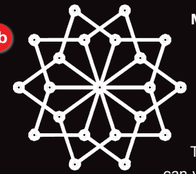
ZOMETOOL® design series



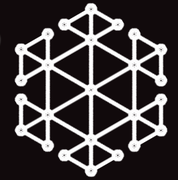
The symmetrical beauty of Zometool models is enhanced and accentuated by the black and white struts and balls of the **Design Series**. You can create a great variety of models and structures with **Design 5**.

Model 1. Coming back to the Divine Proportion: we can construct a **rhombic triacontahedron**, where the relationship of the diagonals within the 30 rhombic faces corresponds to the Divine Proportion. **Model 1** requires 60 medium 5-sided struts and 32 balls. With the completed Zometool model, we can depict a number of 3-D symmetries in a 2-Dimensional form.



Model 2 – 5-fold symmetry. In order to build this model **(2c)** we will have to bend the rules (and struts) a little; we are going to "weave" some struts. Take 15 B1 struts (in black) and 11 black balls; build 5 rhombic "petals" around a central ball with the pentagonal hole facing up **(2a)**. Now repeat the process for the next 5 petals and weave the new struts on top of the existing rosette at the point where they intersect **(2b)**. Now connect the existing tips to finish a rosette with 5-fold symmetry.

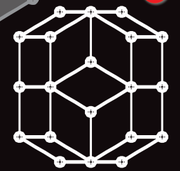
Tip: Zometool is particularly suitable for symmetric tessallations. Sir Roger Penrose employed Zometool whilst working on his "Penrose Tiling".



Model 3 - 3-fold symmetry. Make sure that each ball is positioned with a 3-sided opening facing upwards.

Model 4. Construct a 2-D Model with 2-fold symmetry. You will require: 20 balls, 10 short rectangular struts, 10 medium rectangular struts and 12 medium 5-sided struts. The uppermost opening of each ball should be a rectangle. The model which you have built is the **shadow** of the **rhombic triacontahedron** in 2-fold symmetry.

Take a closer look at this structure… can you identify further forms in "3-D"? You have constructed a pattern of cubes and oblongs…!



All of these 4 structures are actually one and the same model: a **rhombic triacontahedron**.

You can build many different models with this kit: for example, a **hypercube**... or simply follow your imagination and create!

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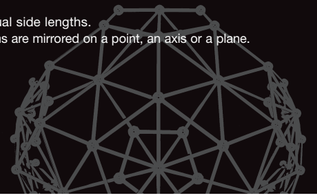
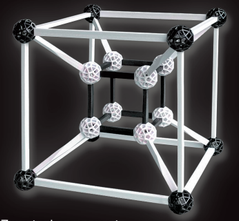
ZOMETOOL® glossary

Buckminster Fuller: *12.7.1895. † 1.7.1983 in USA; architect, visionary, philosopher and author. Particularly renowned for his “domes” and geodesic architecture.
Dimension: informally defined as the minimum number of coordinates needed to specify any point within a space or an object.
Drop City: artists’ community, founded in 1965 by Gene Bernofsky, JoAnn Bernofsky, Clark Richert and Richard Kallweit in Colorado.
Dymaxion: a definition created by Buckminster Fuller; abbr. of **dy**namic **max**imum tens**ion**. Used as a trade name for Fuller’s developments (cars, houses, etc).
Hypercube: cube in the 4th. dimension.
Tessellation: also known as tiling, mosaic; a method of filling a space with identical forms, without overlapping.
Penrose, Sir Roger: *8.8.1932 in Essex, England. Mathematician and theoretical physicist. Discovered and developed “Penrose Tiling”, forms with 5-fold symmetry, which fill a space (see “Tessellation”).
Projection: image of an object (also called “shadow”) on a 2-D surface, whereby the points of a 3-D object are shown in 2-D.
Rhombic icosidodecahedron: Polyhedron (multi-sided), born of the family of archimedean solids. Consists of 20 regular triangles, 30 squares and 12 regular pentagons.
Rhombus: every parallelogram with equal side lengths.
Symmetry: the effect achieved when forms are mirrored on a point, an axis or a plane.



To see a world in a grain of sand
And a heaven in a wild flower,
Hold infinity in the palm of your hand
and eternity in an hour.

William Blake



Hypercube

Zometool Rules

1. If it works, it works perfectly…
…and if it doesn’t work, it doesn’t work at all. Don’t force Zometool components. You can bend a strut to fit it into a tight spot, but struts in finished models are always straight, never under tension.

2. Don’t break it apart, take it apart!
Take models apart by grasping a strut with your fingers and pushing the ball straight off with your thumb. Twisting balls or pulling models apart or crushing them can cause parts to break!

Thanks to:
Photo “Drop City Panorama”, Clark Richert, USA; (Drop City was founded in 1965 by Gene Bernofsky, JoAnn Bernofsky, Clark Richert & Richard Kallweit.); “Cubespace” drawings (1999) with kind permission of Fabien Vienne; Photo P. Hildebrandt: Erwin Kotzab 2011; Photo of the construction in Coimbra: Jim Hausman. Software for model images: Dr. Scott Vorthman; Text and design: Erwin Kotzab and Lyn Taylor.

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The components of the Zometool Design Series are naturally compatible with all other Zometool kits.

“Kepler’s Kosmos” and “Creator 1”: just a small taste of the many possibilities in the extensive and versatile Zometool Universum.

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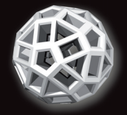

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