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STEAM Education for Teaching Professionalism

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Visual illusions and impossible figures

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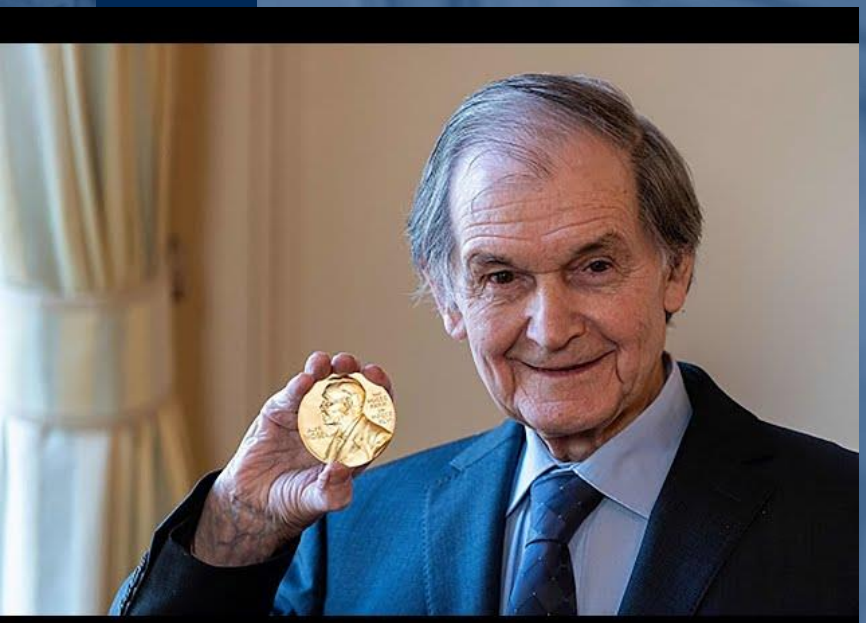
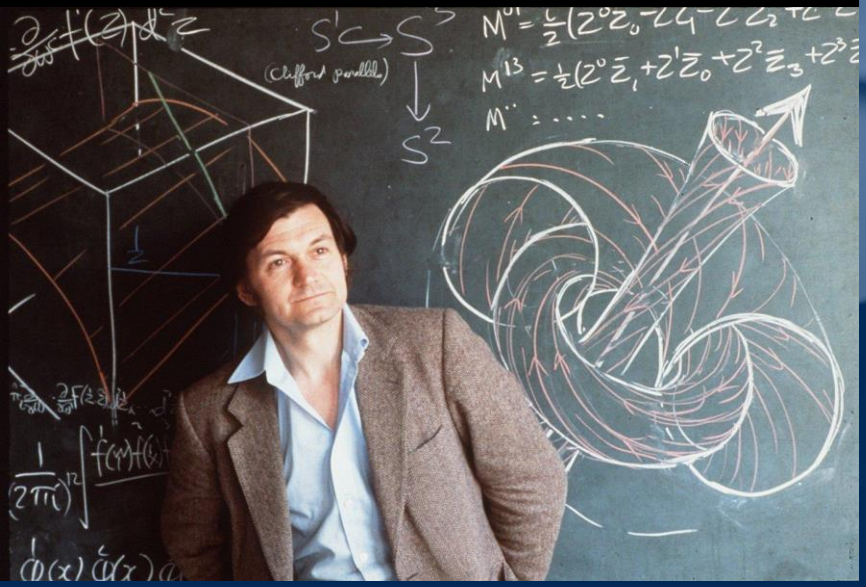
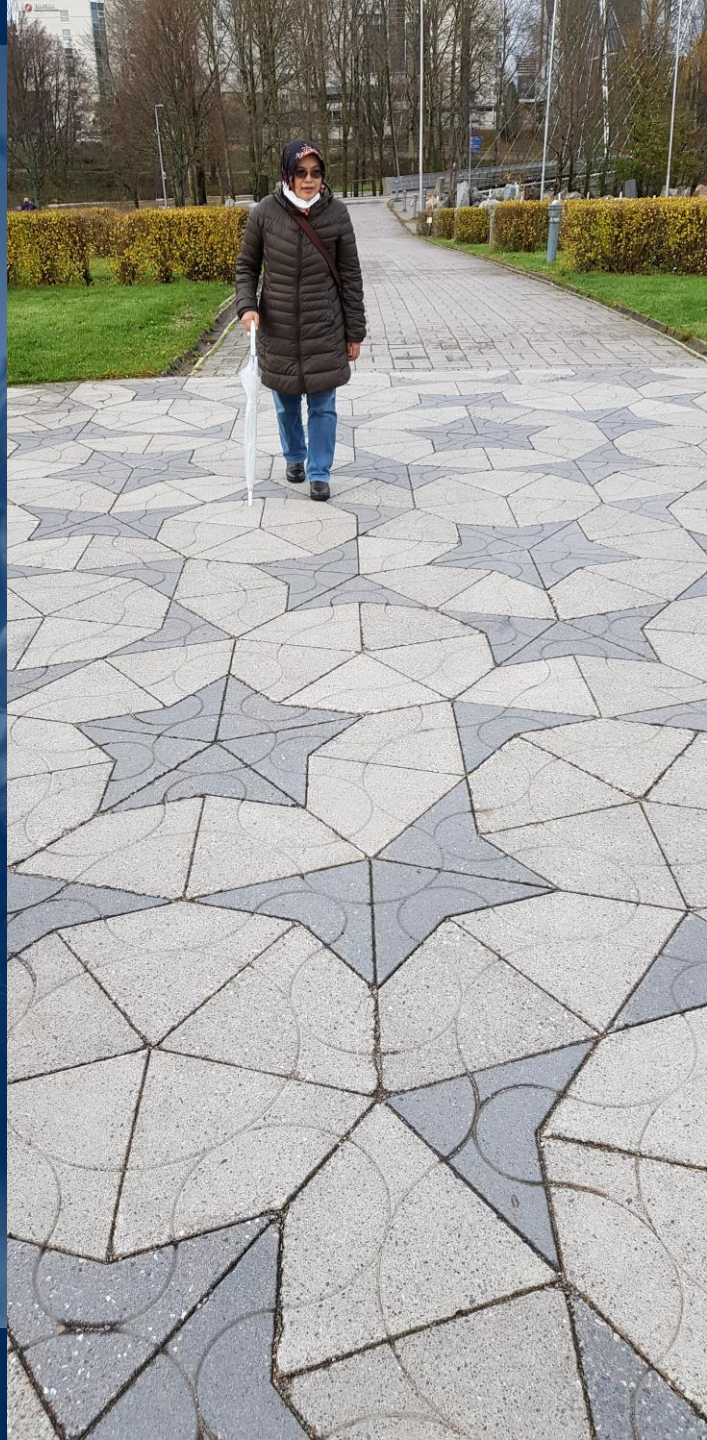
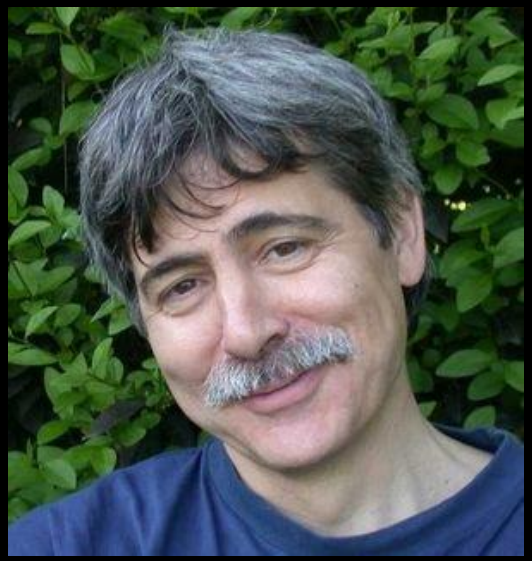
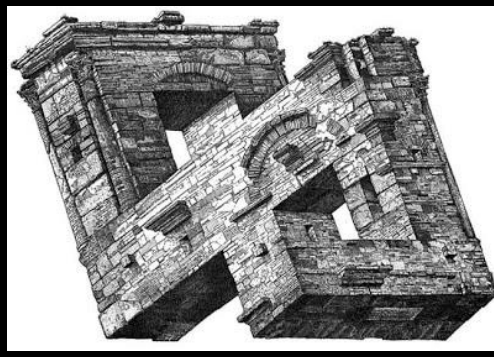




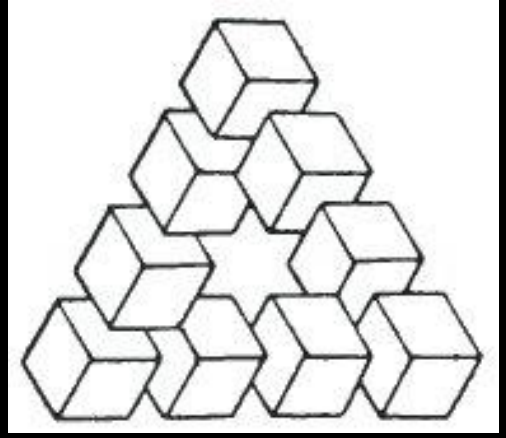
Sir Roger Penrose Nobel Award in Physics in 2020



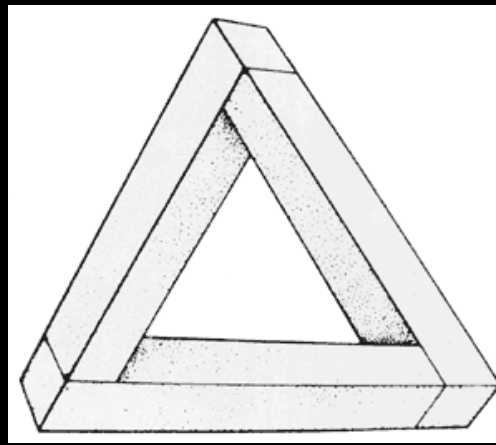


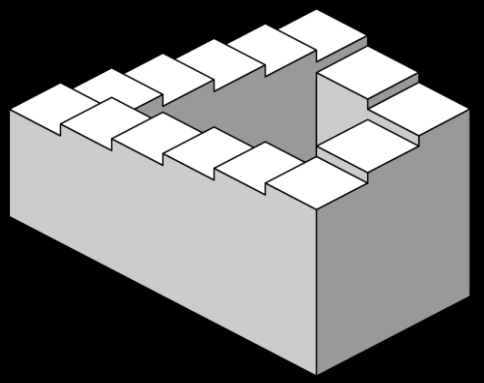


Tamás F. Farkas and István Orosz artists, who create impossible objects; Ildikó Szabó mathematics teacher, who has built a math-art education program on Farkas' and Orosz' artworks; and the mathematician László Vörös, who builds a geometrical research on Farkas' and Orosz' art pieces.

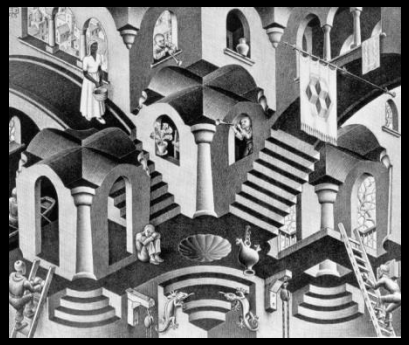


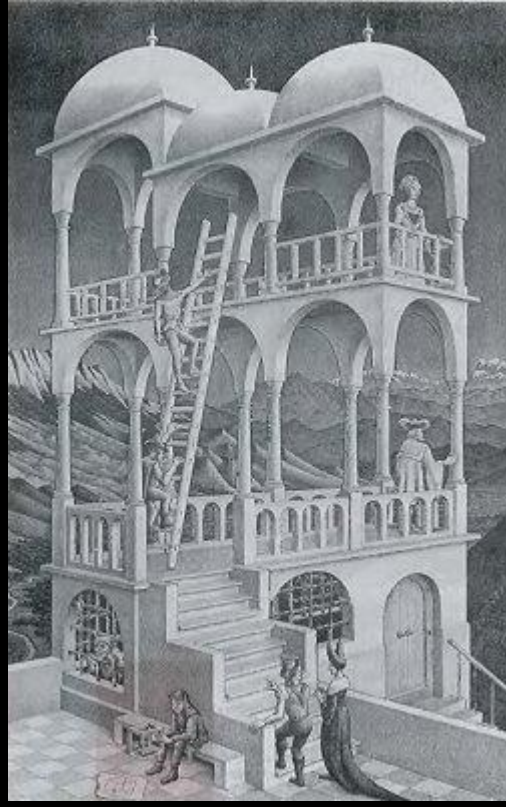
In the year 1934 the Swedish artist **Oscar Reutersvärd** drew a special arrangement of nine cubes and the first impossible tri-bar had been created. He continued to experiment in this new field and made many hundreds of drawings. In 1958 **L.S. & R. Penrose** published an article in the **British Journal of Psychology**: ***'Impossible objects,a special kind of visual illusion'.*** In this article they described the **impossible tri-bar** and the idea of **endless stairs.**

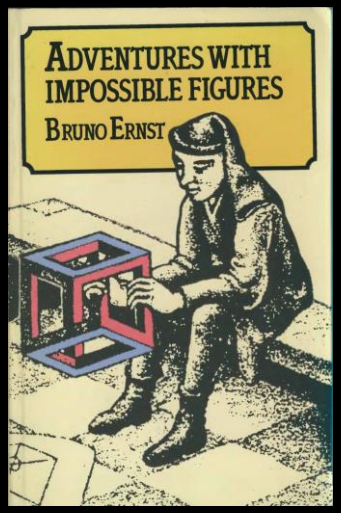




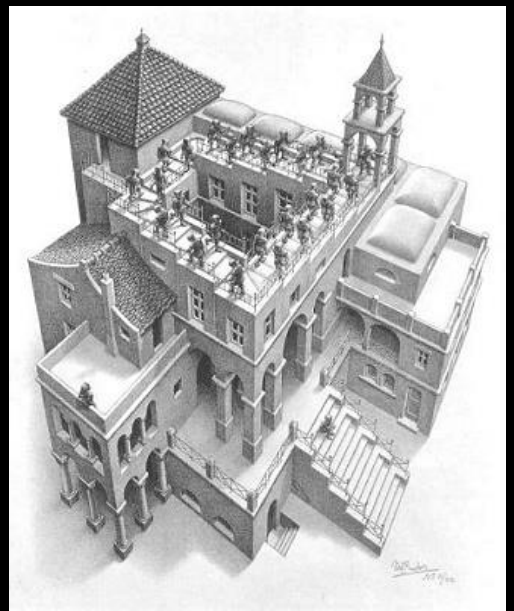
Now, we have learnt, that **WHO** are the **impossible figures. L**et's examine then **WHAT** makes a figure **impossible?**

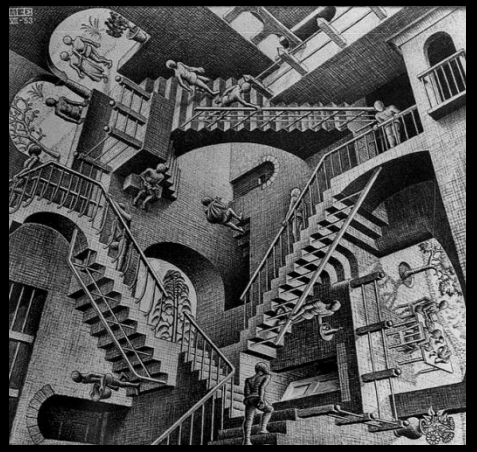






These ideas were taken up by artists, especially **M. C. Escher**… Bruno Ernst has met with Escher 2 years prior the Penroses' article publication and followed up the design and creation of Escher's most famous impossible figures' based artworks: ***Belvedere (1958), Ascending and Descending (1960), and Waterfall (1961).***





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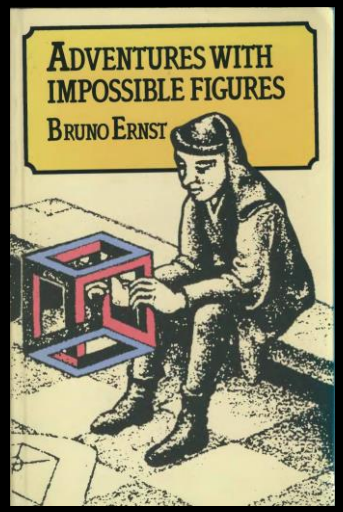
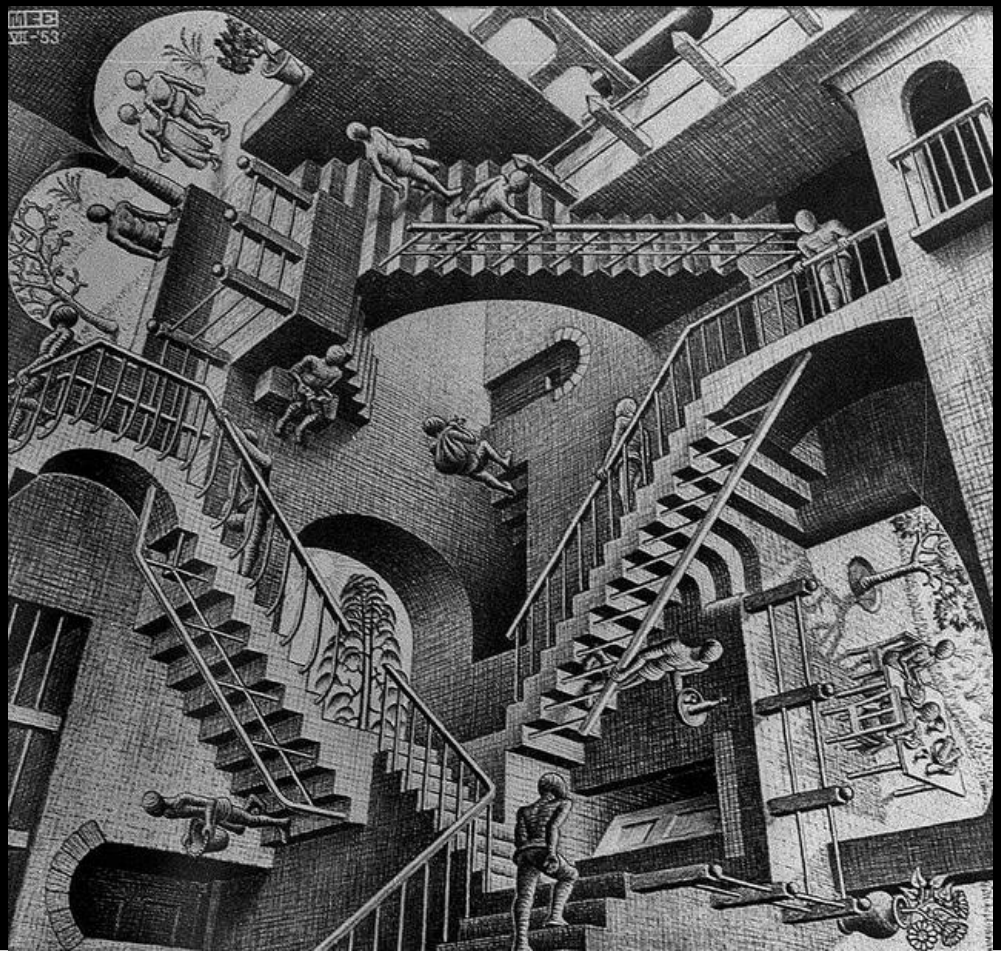
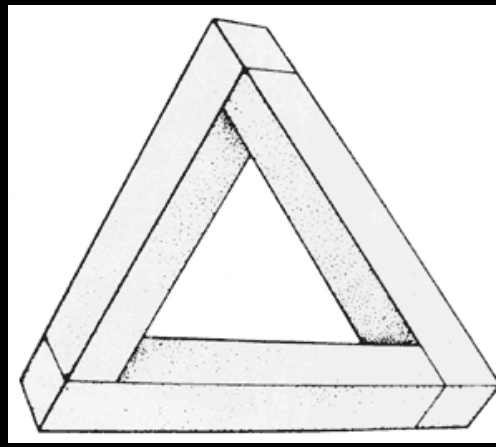
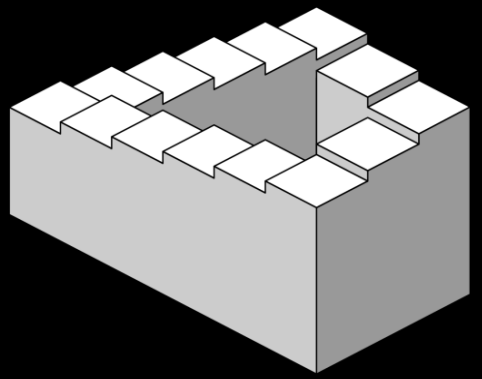
Impossible Figures: figures which can be imagined or drawn, but which cannot be made in any concrete form. Their effect is based on (at least) **two separate layers of illusion**. **(1) Illusion of spatiality:** all we are really looking at is **a set of lines** printed on a piece of paper (flat), yet we appear to see a solid object. **(2)** The bars which make up the impossible tri-bar **cannot meet in real space (different perspectives united in an isometric drawing), but we still try to assign a meaning. Strange consequences…**





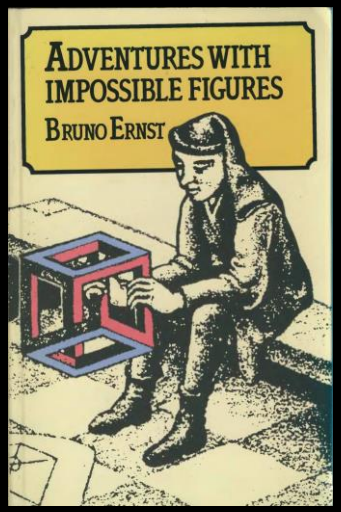


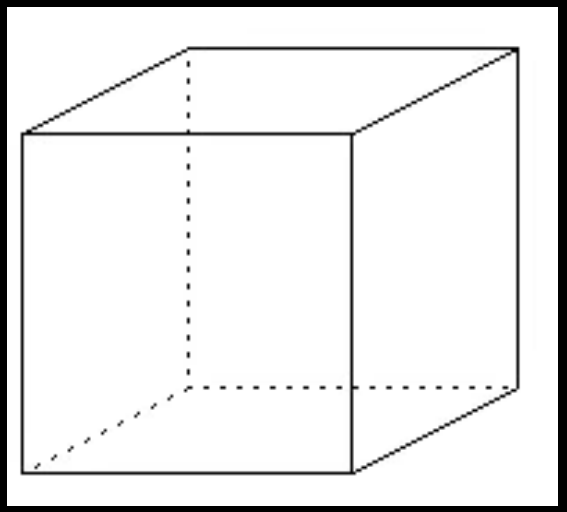


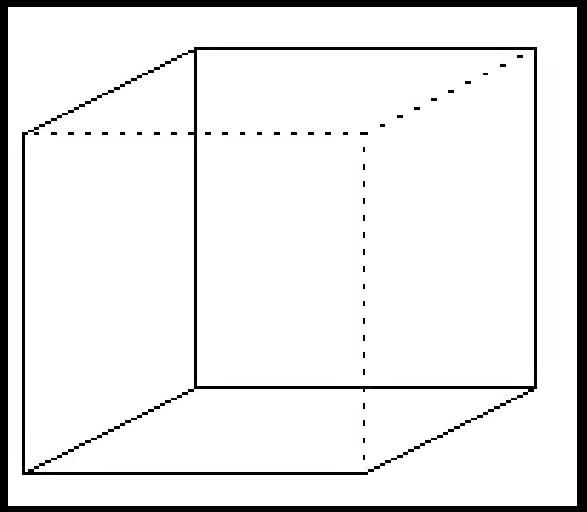
Illusion of Spatiality:

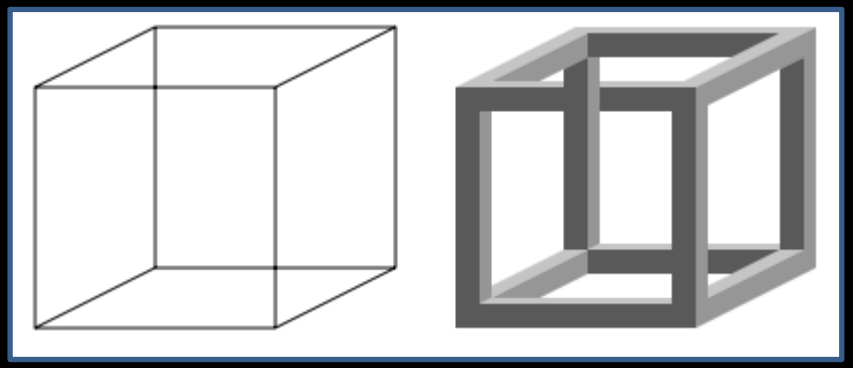
- The **Necker cube** is an optical illusion first published as a rhomboid in 1832 by Swiss crystallographer Louis Albert Necker.

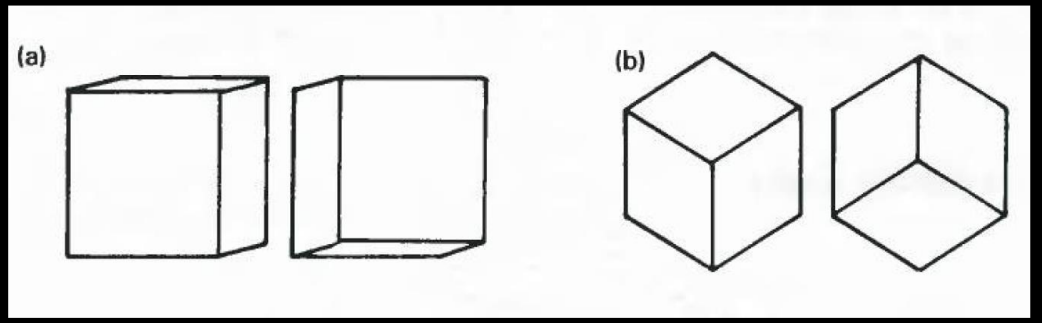
Inside or Outside? Above or Below? Convex or Concave?











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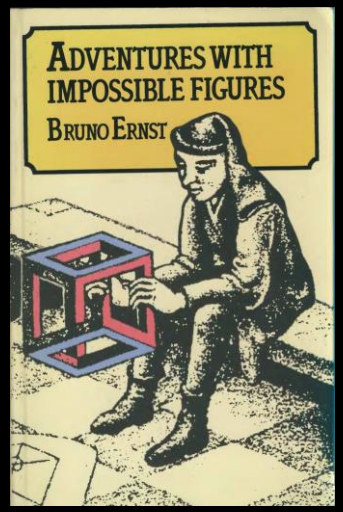
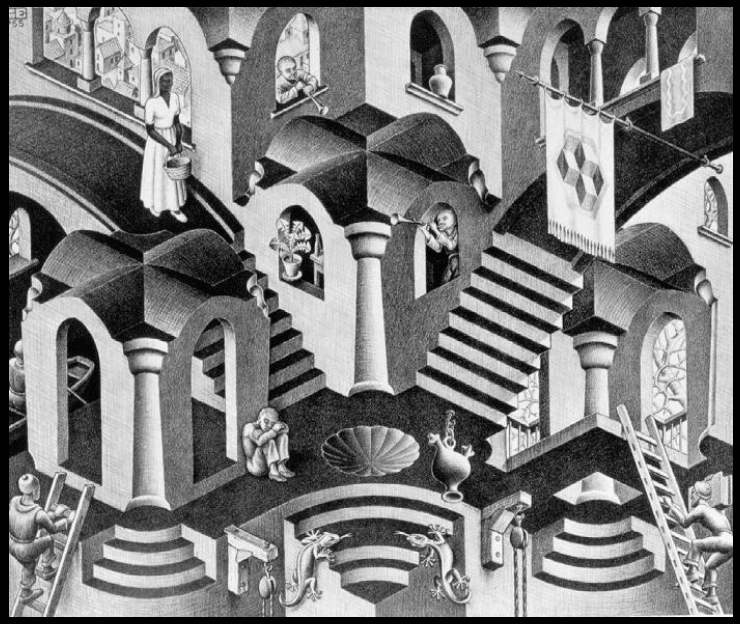
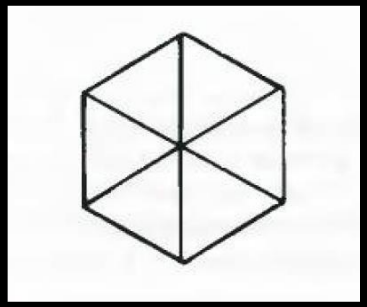




The phenomenon of switching between the two interpretations: ***perceptual inversion.***

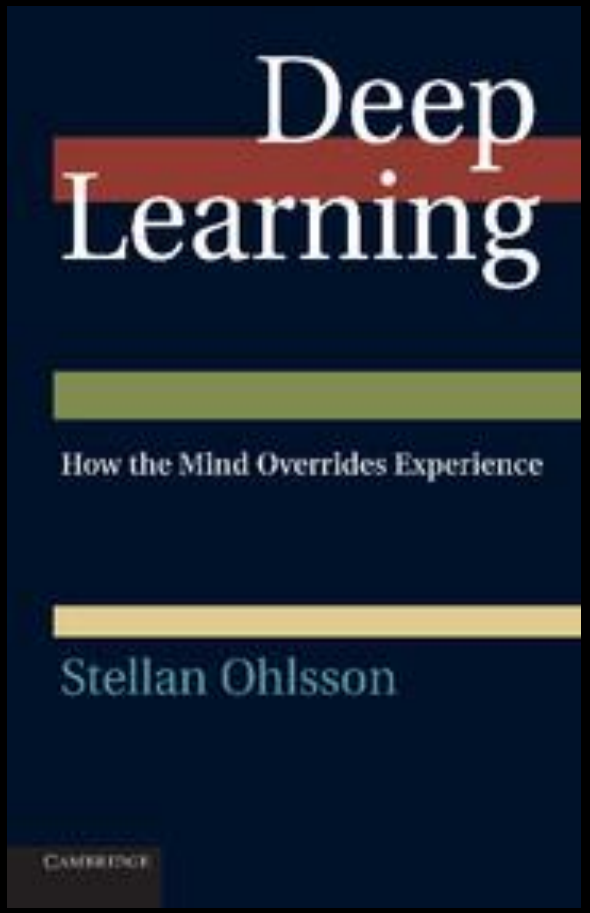
The Necker Cube with the greatest angle of change gives a hexagon. THIS HEXAGON, AS A MODULE, BECOMES VERY IMPORTANT IN THE DESIGN OF IMPOSSIBLE FIGURES!

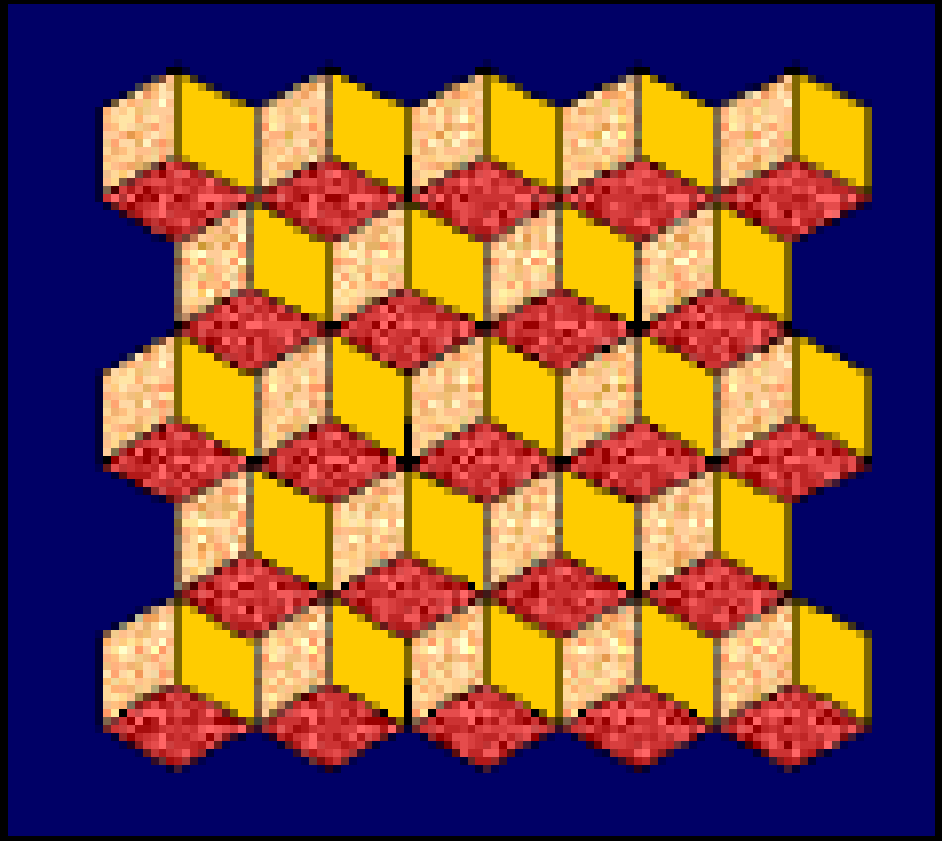


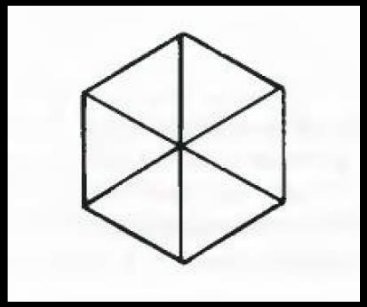
Illusion of Spatiality:

Kurt Koffka - German psychologist. One of the founder of Gestalt psychology. Experiments on problem-solving and creativity. Re-discovery of **reversible figures** like **Necker Cube.**

Crystallography ➡ ***Gestalt Theory*** ➡ ***Visual Mathematics***



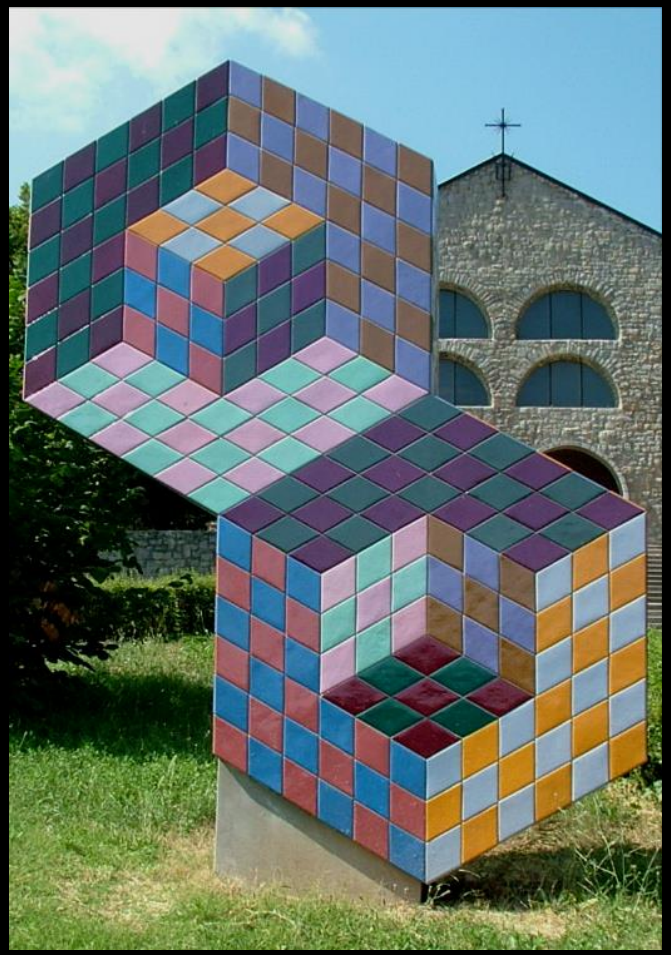


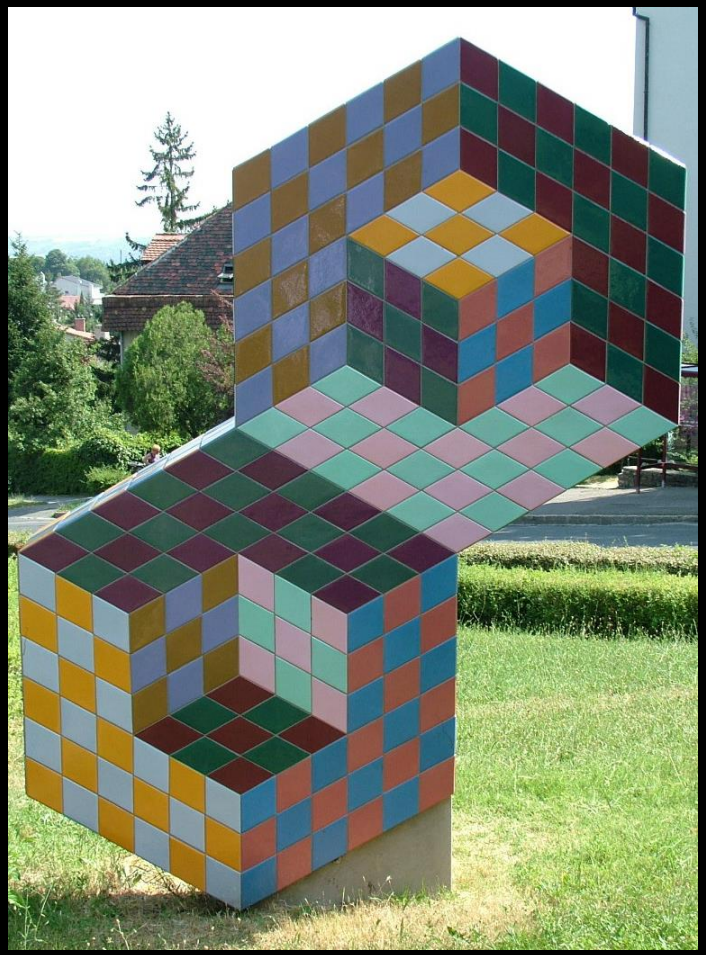


Victor Vasarely: JEL, Pécs city, 1977.

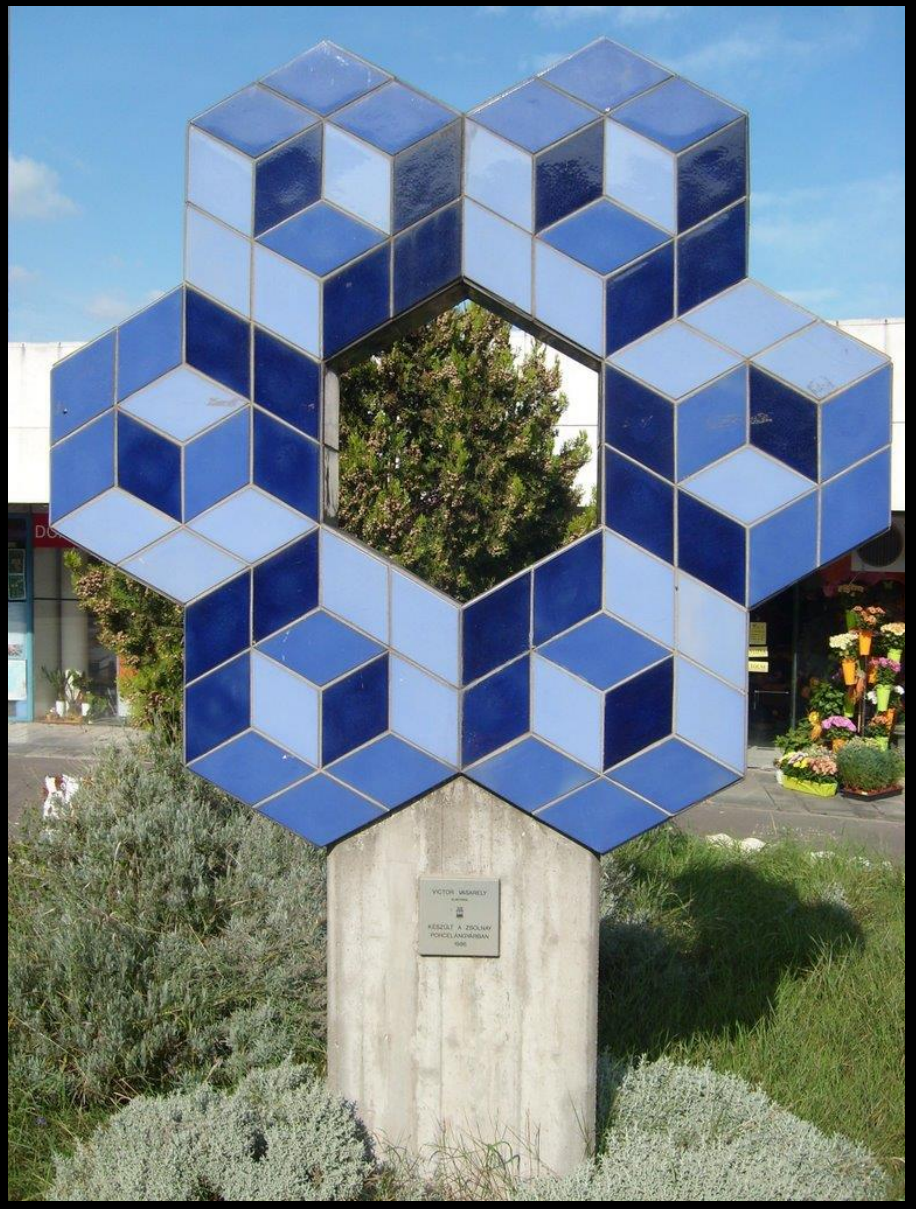
"Koffka-art"

How many aspects, how many views are possible?





Victor Vasarely's "visual mathematics"



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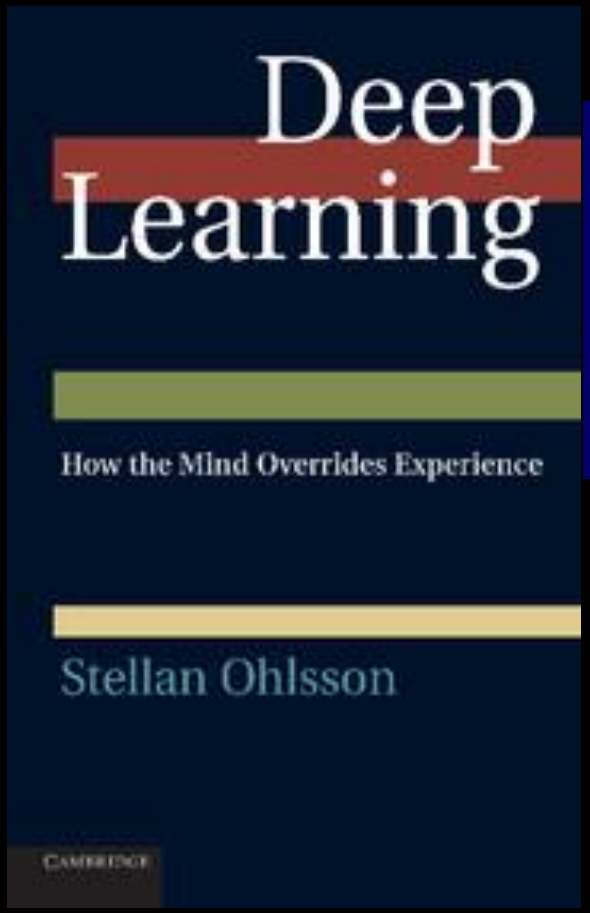
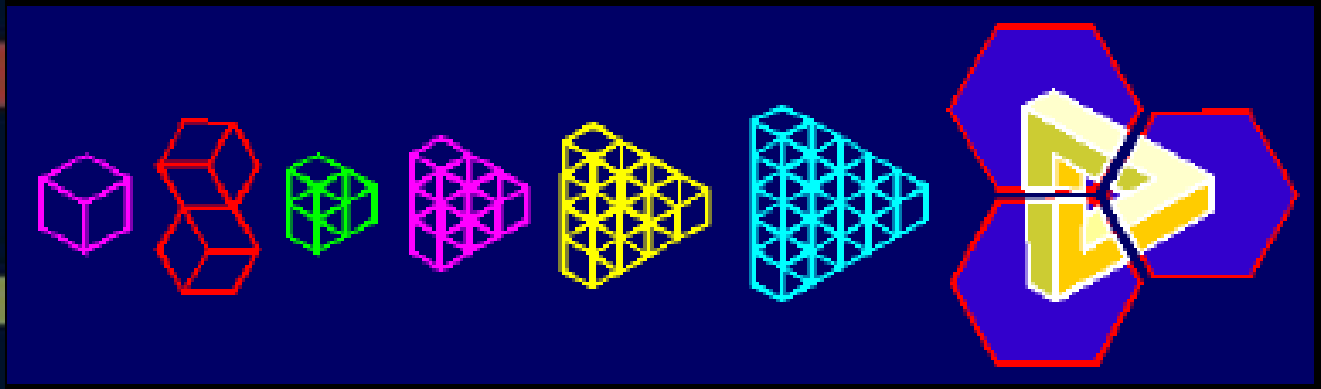
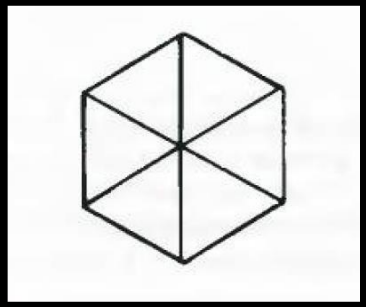
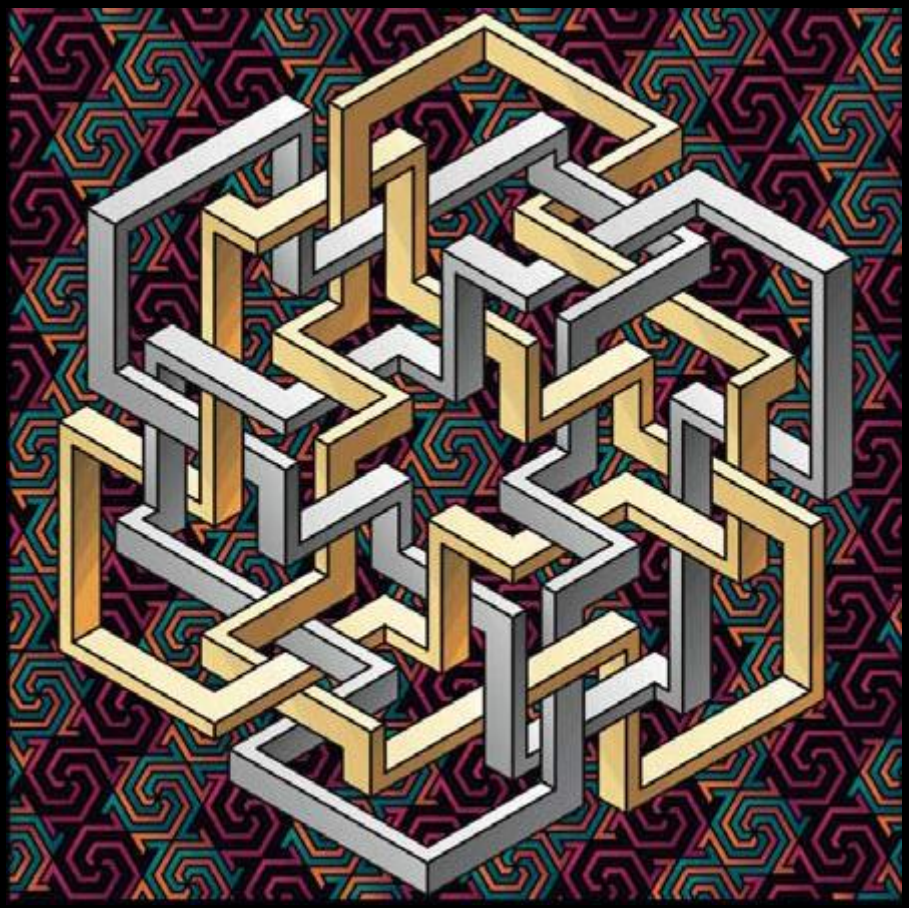




Development from Koffka cube to Penrose Tribar.



Tamás F. Farkas's Impossible Art:



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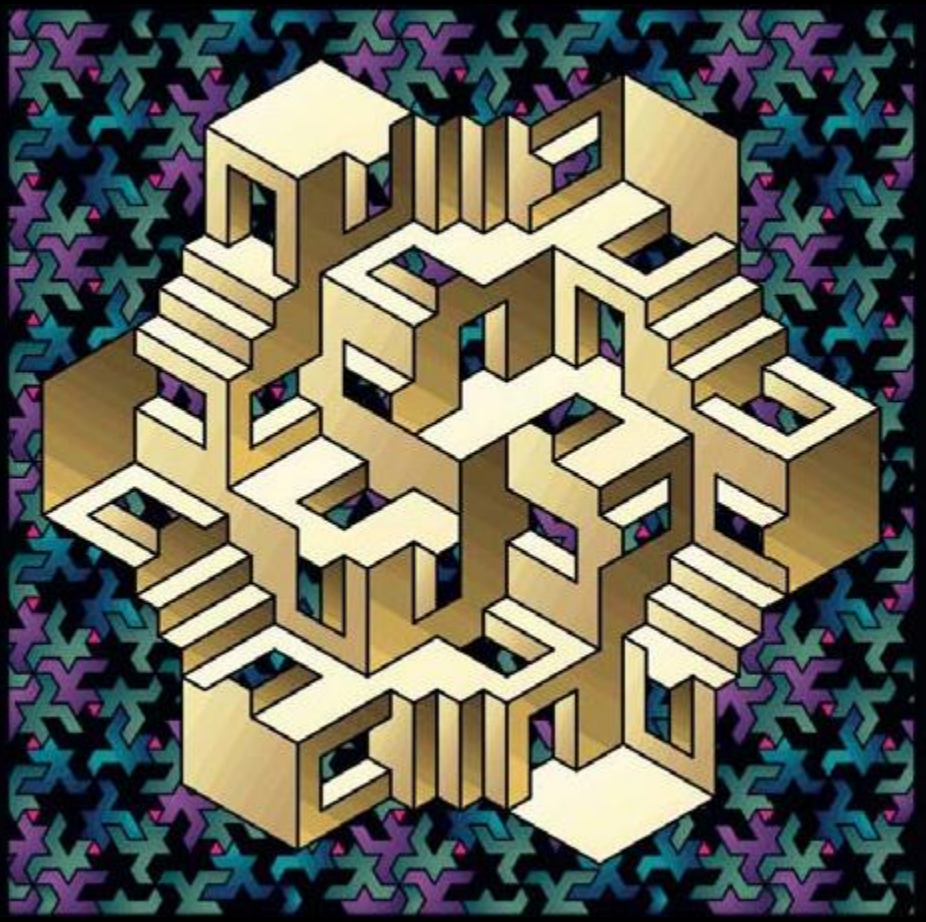

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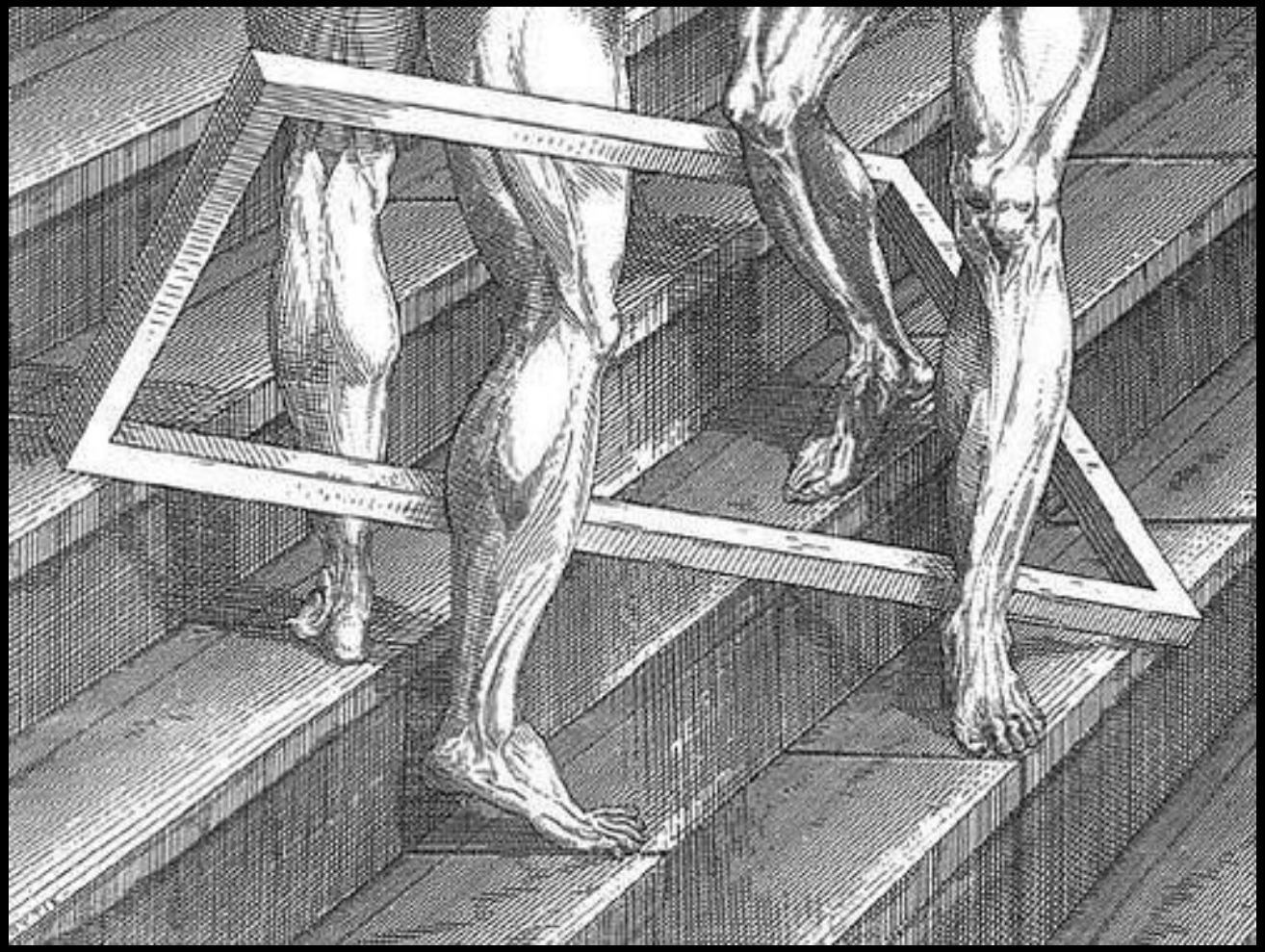
Tamás F. Farkas's Impossible Art:

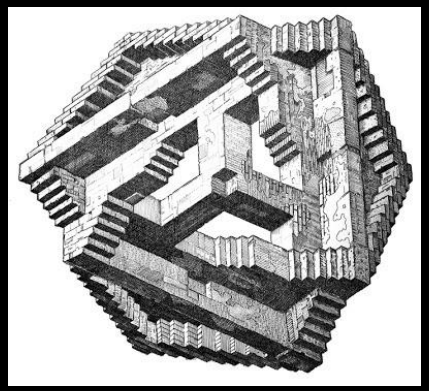
"Farkas's work defies categorization. If we want to label it (…) perhaps we could proceed from M. C. Escher's activity, that is, geometry is always at the root of his works. However, while Escher's geometry is always connected in some way to figurative representations (strange buildings, animal and human figures), **Farkas's work eschews any link to the 'real'. His art is built on clear-cut, geometric figures.** (…) **his pictures is about governing the space or the structure of the space** (…) Tamás F. Farkas's career is considerable, not only from the point of view of art but also science; **he looks at geometry not with the eye of a scientist nor that of an artist but both**, thus achieving results that can be utilised in unique ways, ways that would never have been possible with traditional geometry. So his works can, for example, be used to illustrate phenomena of other sciences based on mathematics (such as crystallography, quantum physics etc.), allowing us to better understand abstract-rational results incomprehensible by sensory organs."

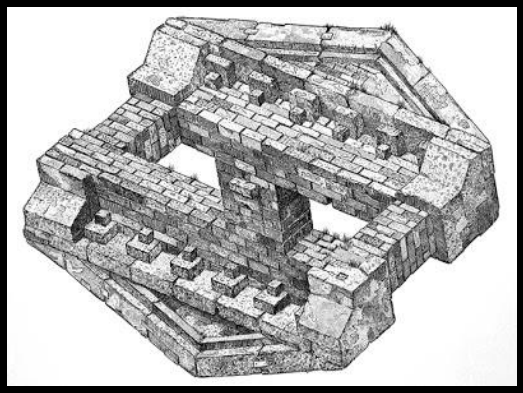
Dr. György Darvas, symmetrologist

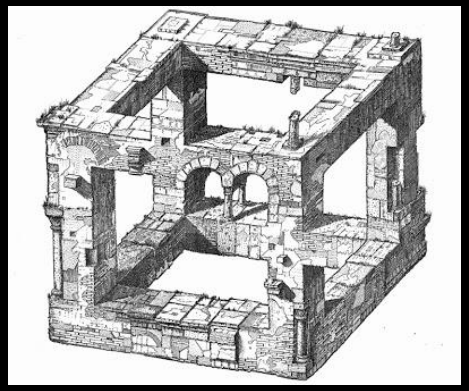
István Orosz's Impossible Staircase – a nonetheless philosophical reminiscence of Escher's Ascending and Descending:

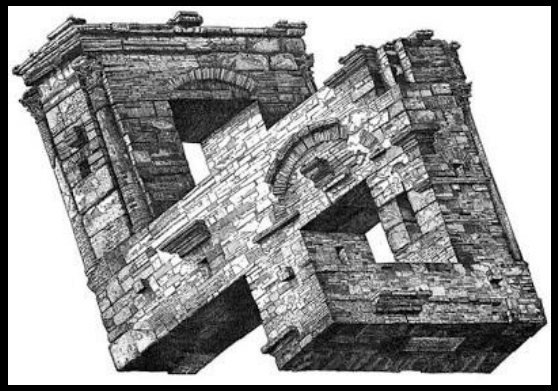


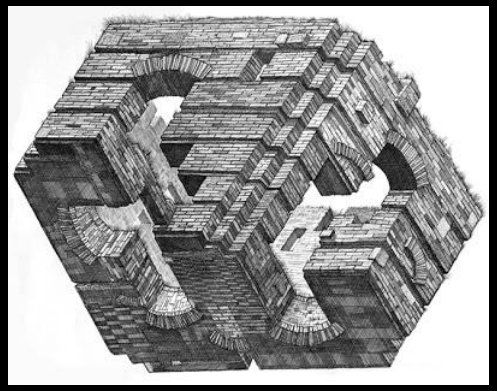
István Orosz's Impossible Buildings:

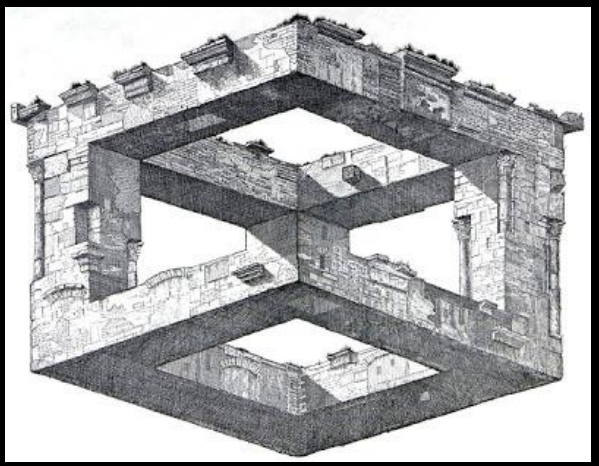


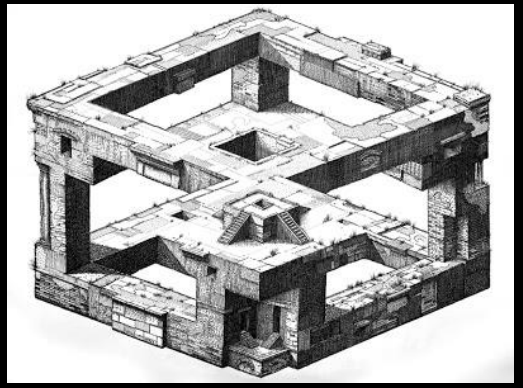


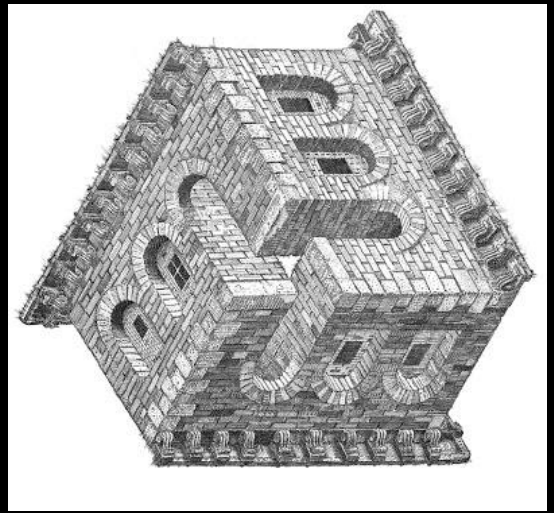




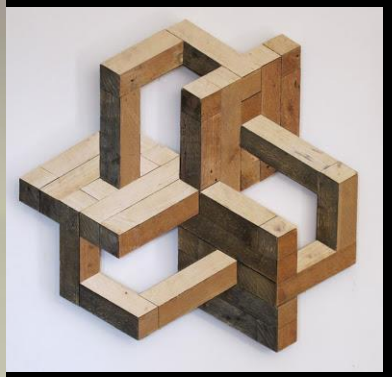


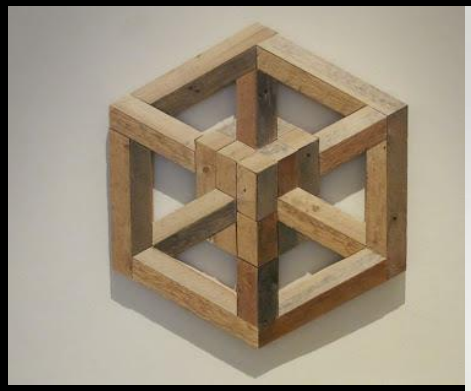
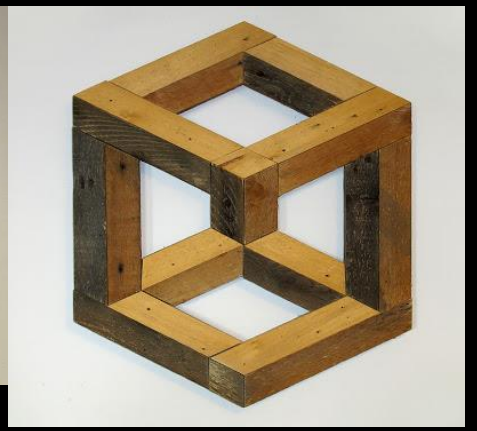
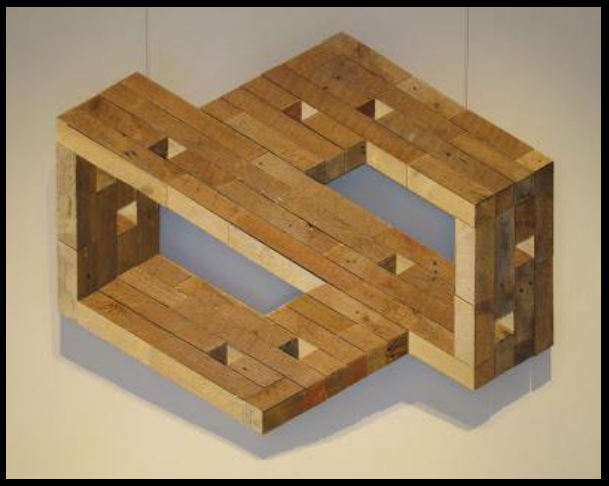
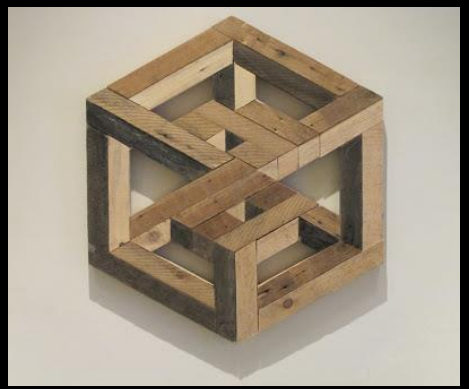
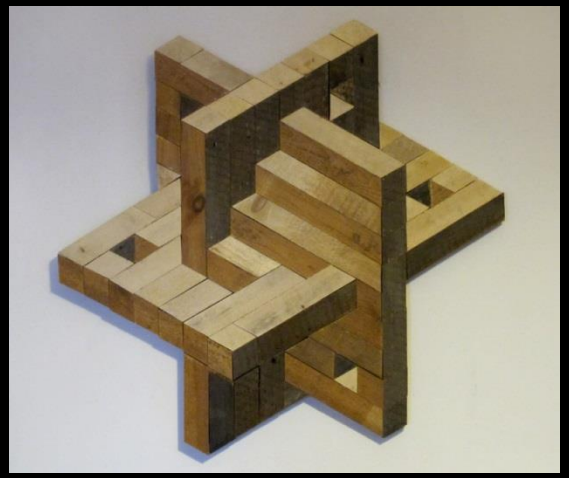




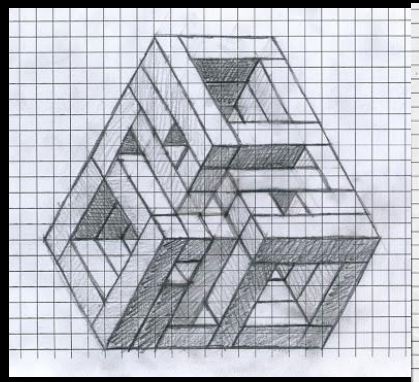


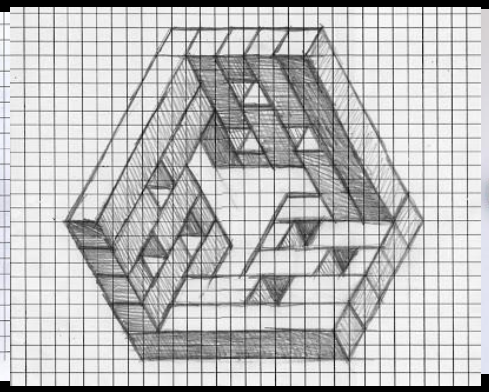
István Orosz's Impossible Planks:

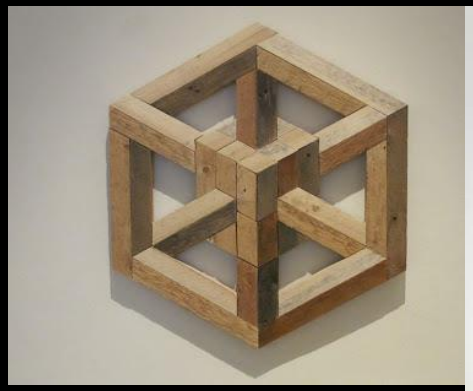


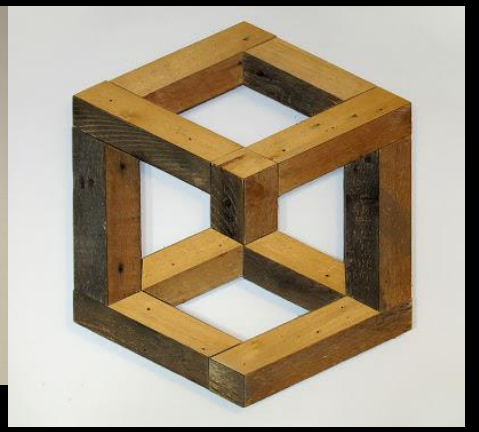






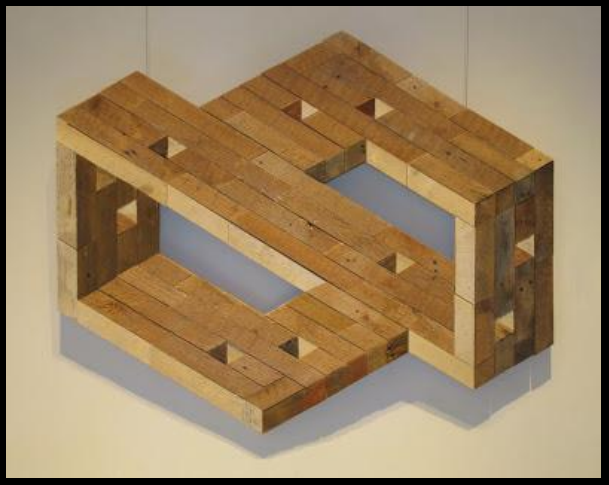
István Orosz's Impossible Designs:

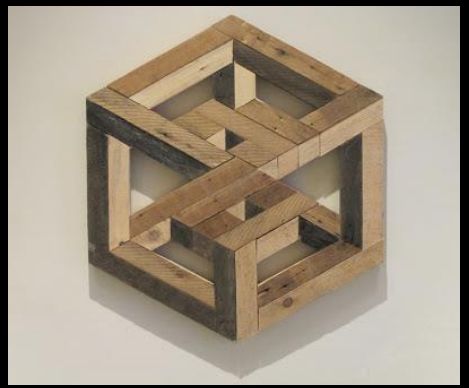


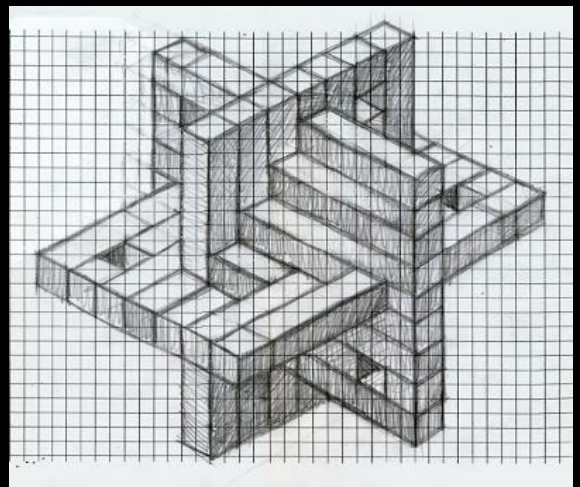






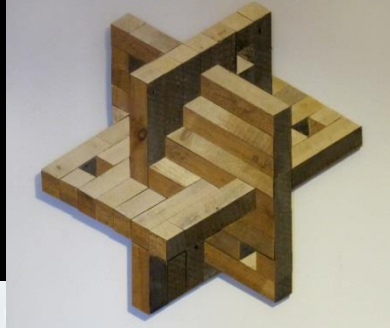


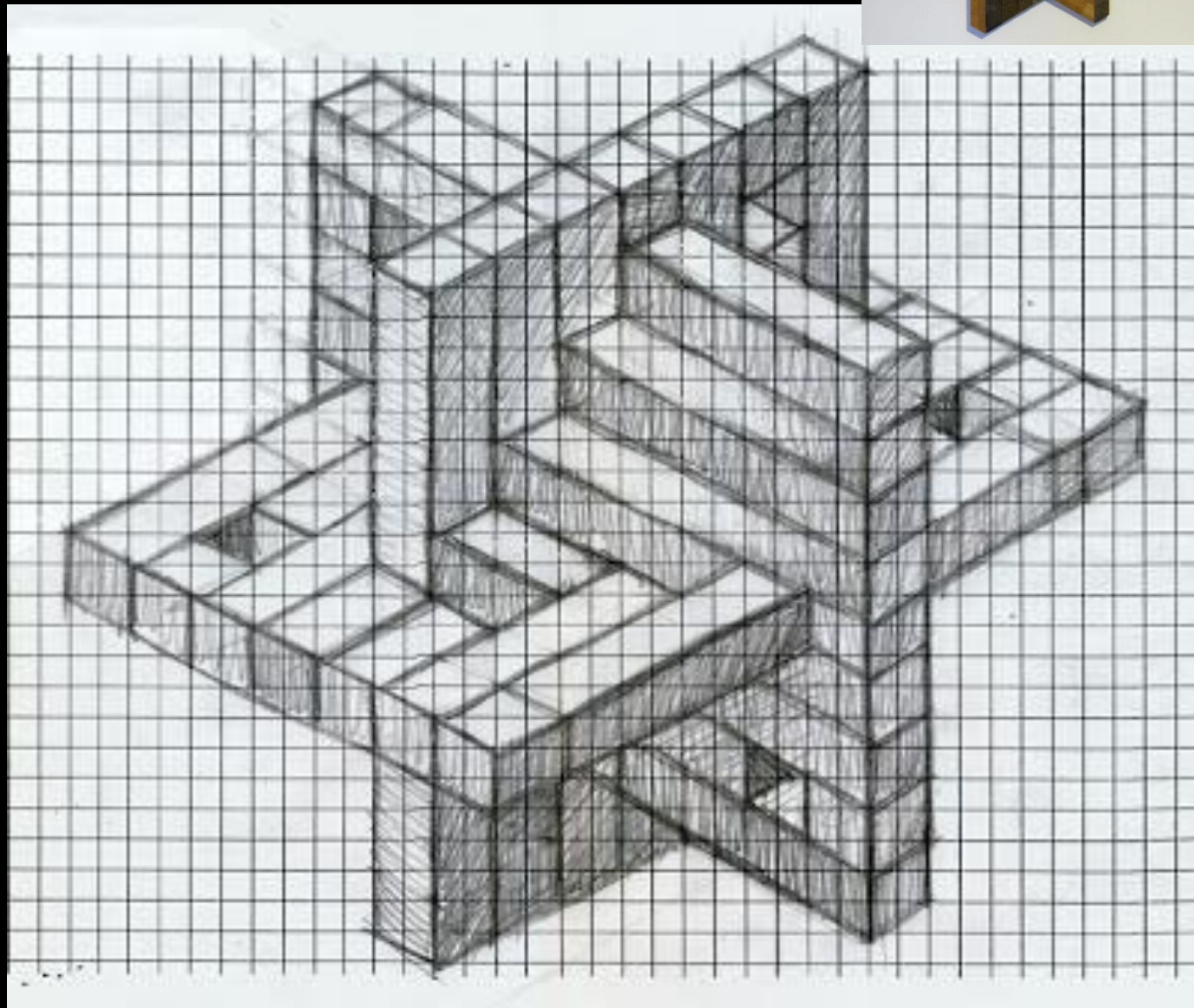




István Orosz's Impossible Designs:

Video: ***http://utisz-utisz.blogspot.hu/p/mertan.html***



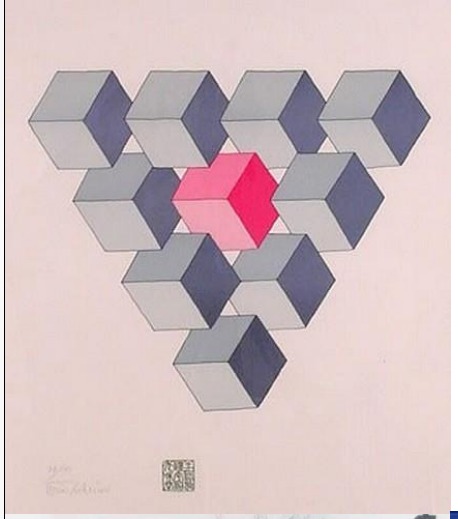


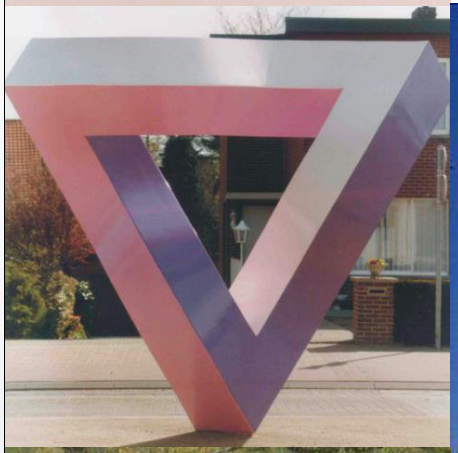
"The procedure is a piece of cake: nailing. But the precedent is maybe more interesting. After changing the roof some planks had left in the garden and they became black. Some other planks we stored in the attic, and those became brown. Then I bought some new planks too, which were white."

István Orosz in personal communication

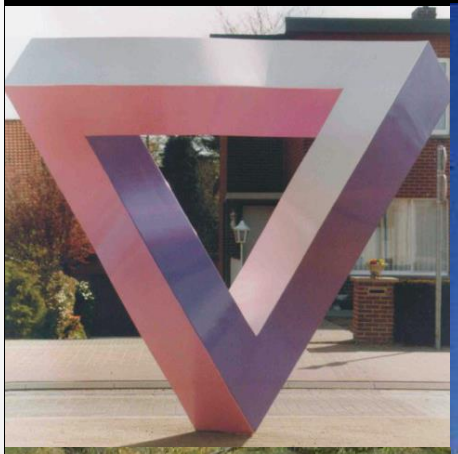
Hyllning till

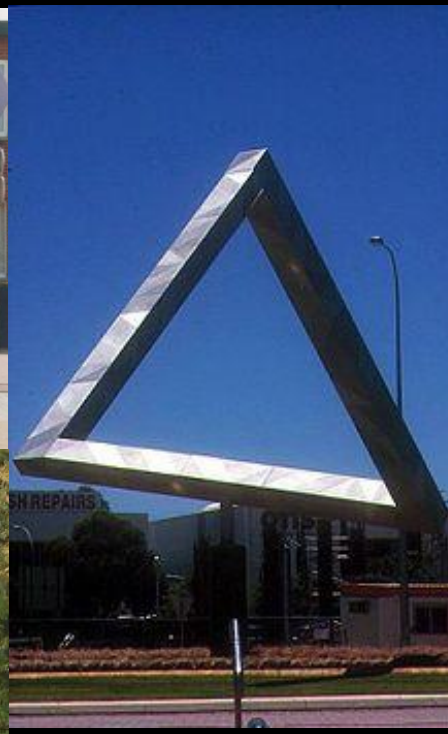
OSCAR REUTERSVÄRD





Impossible Triangle





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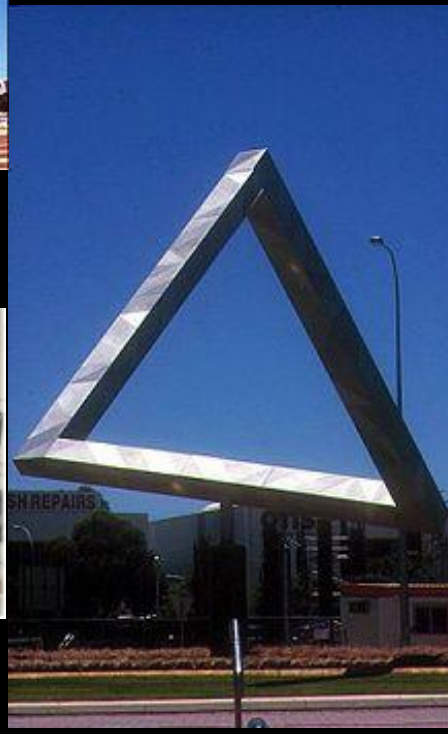
Artist, Brian McKay (left) and architect Ahmad Abas



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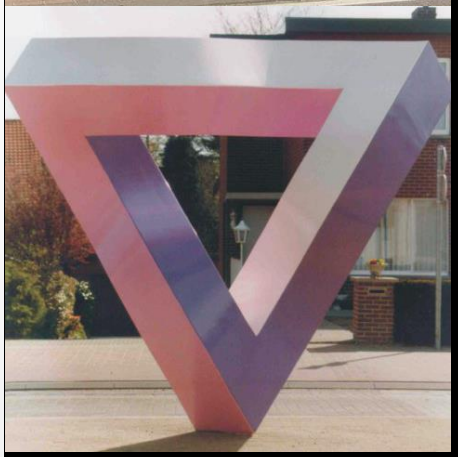

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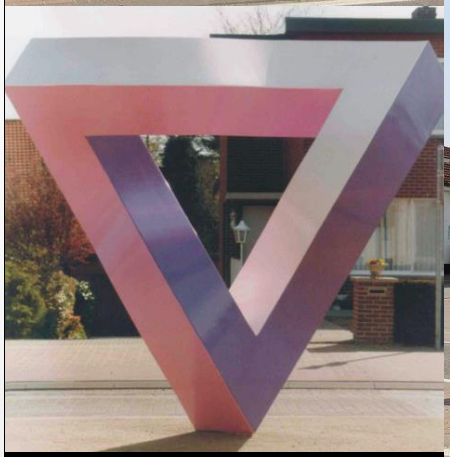

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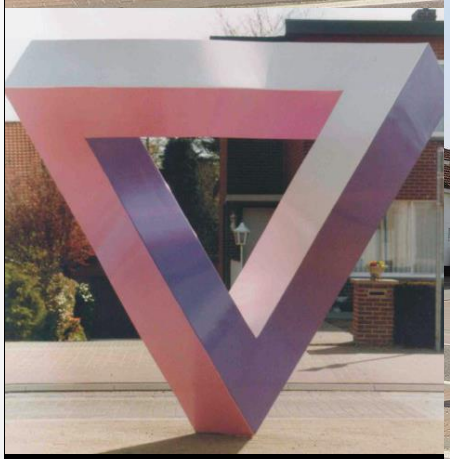

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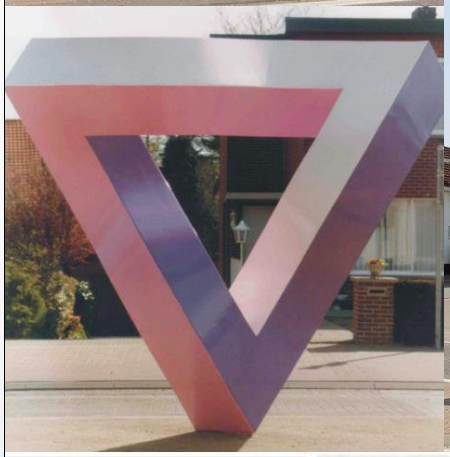

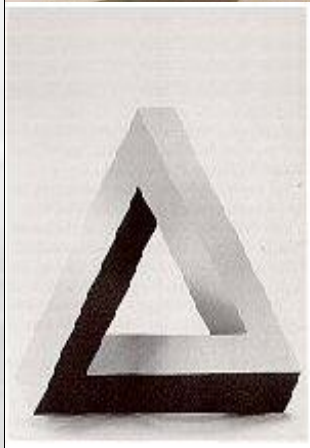

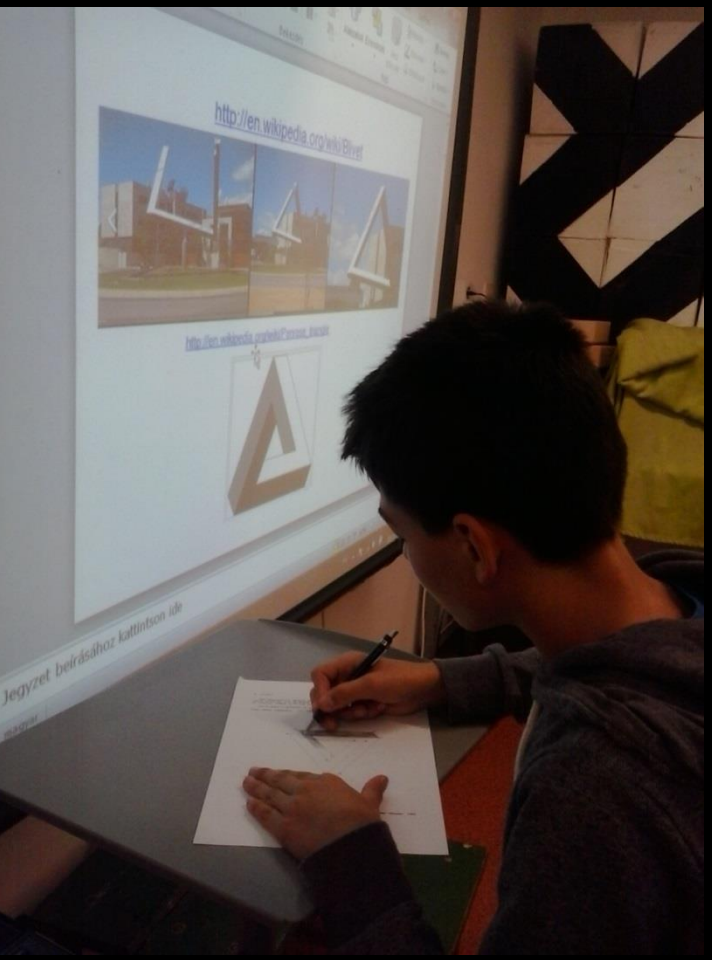

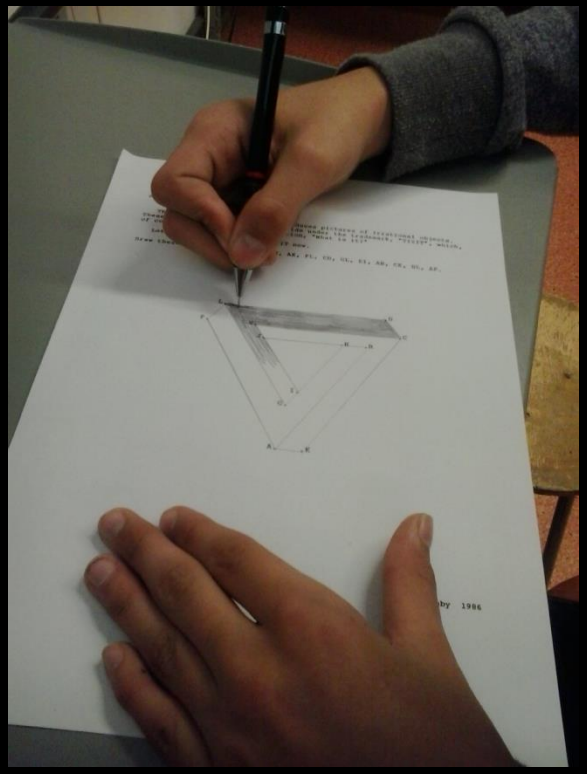

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The Westminster Whimsy Works produces pictures of irrational objects
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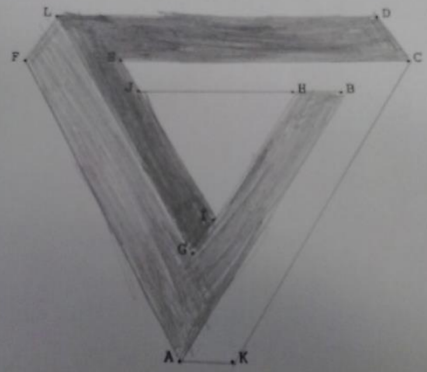
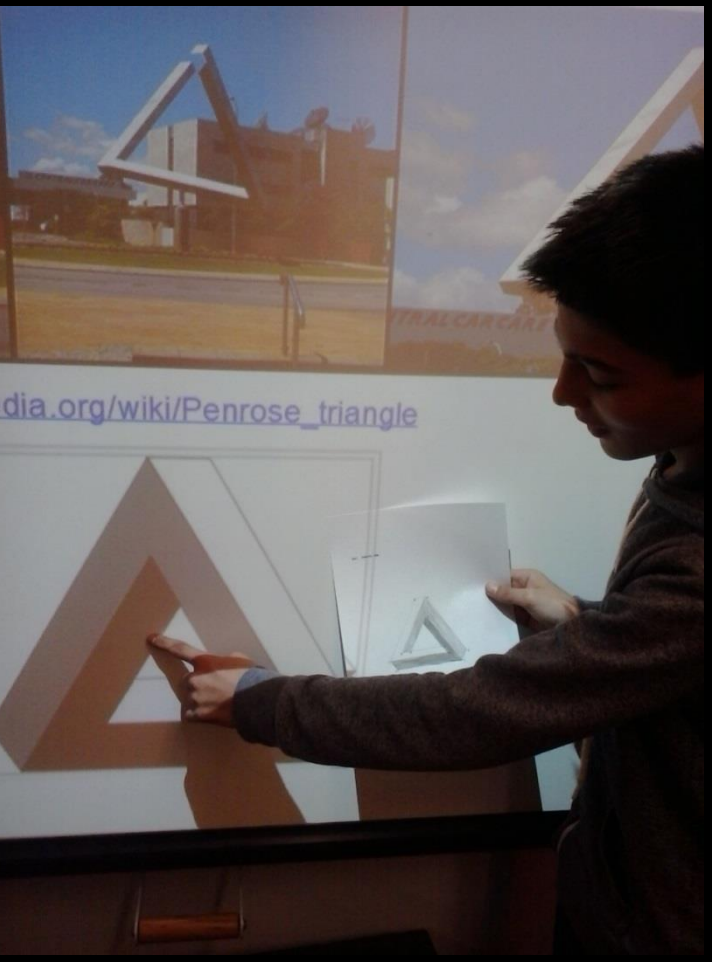
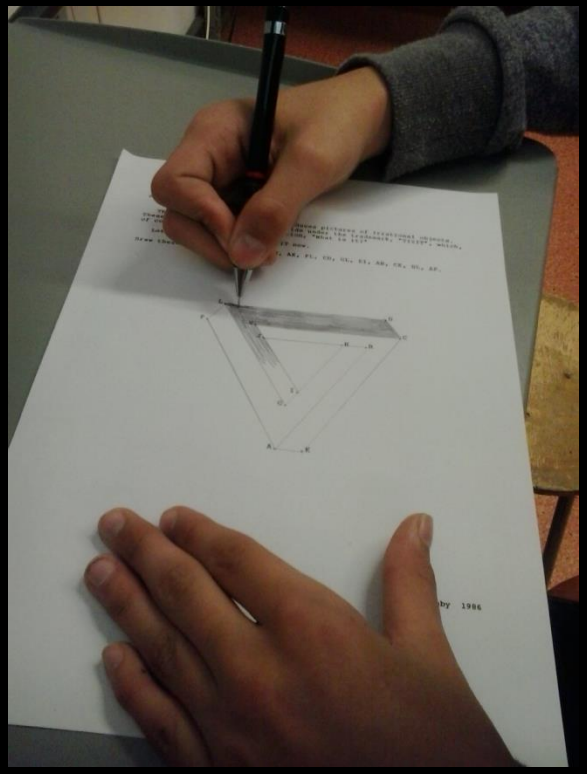
course, comes from the exclamation, "What is it?"

Let's make a picture of a TIZIT now.

w these segments: BJ, CE, GH, AK, FL, CD, GL, EI, AB, CK, DL, AF.







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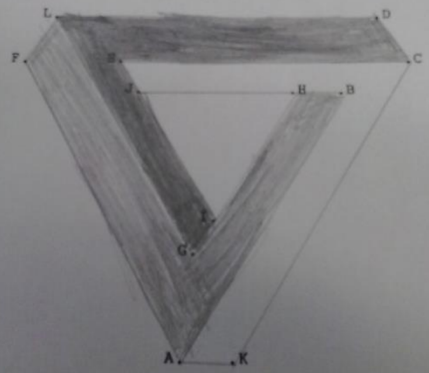

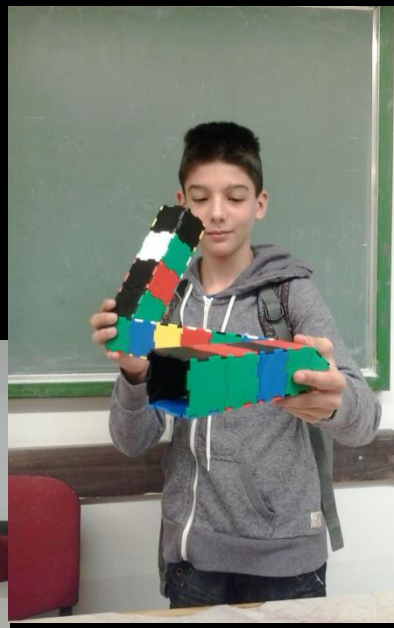

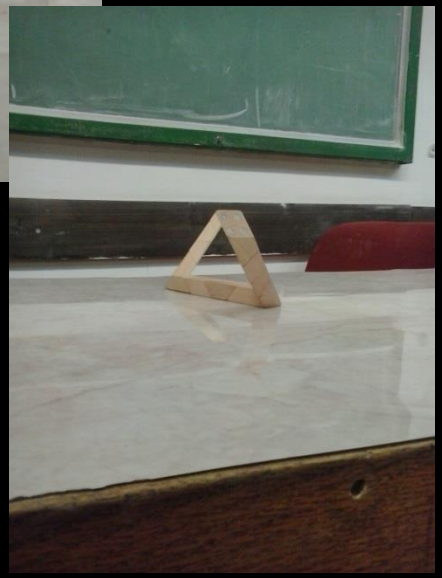

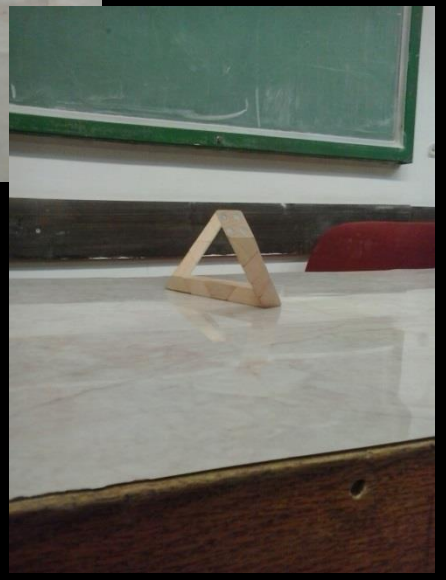

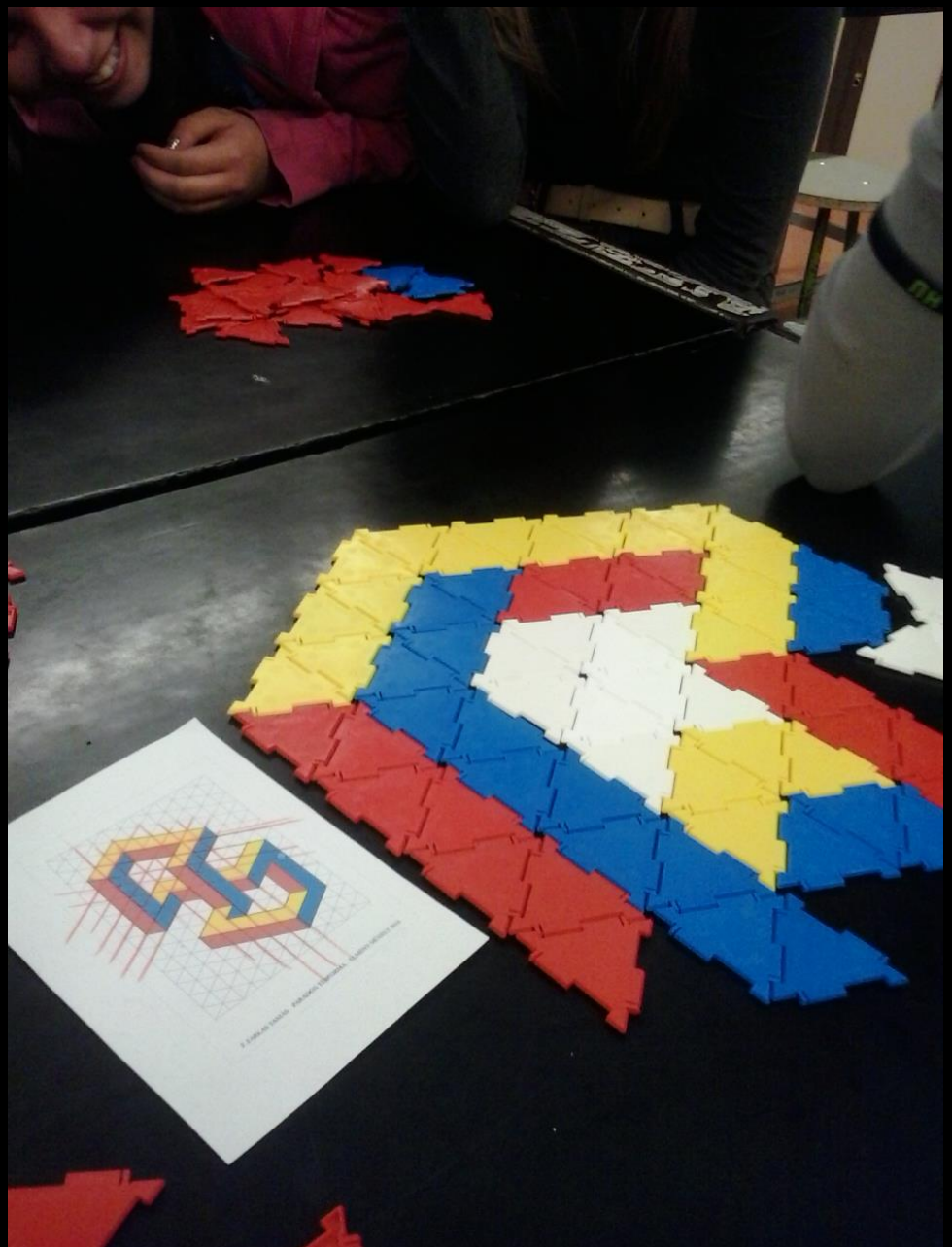

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László Vörös's Impossible Research and Experience Workshop based on F. Farkas's, Victor Vasarely's, Escher's Impossible Figures:

Vörös builds **spatial reconstructions of impossible figure's pictures with help of 3-dimensional models of the 6-dimensional cube and of derived lower dimensional parts of those. The isometric, isogonal axonometric projection of these joins a net of regular triangles.** Vörös shows and tells how to transform these spatial shapes to get the same pictures by oblique parallel or central projections.

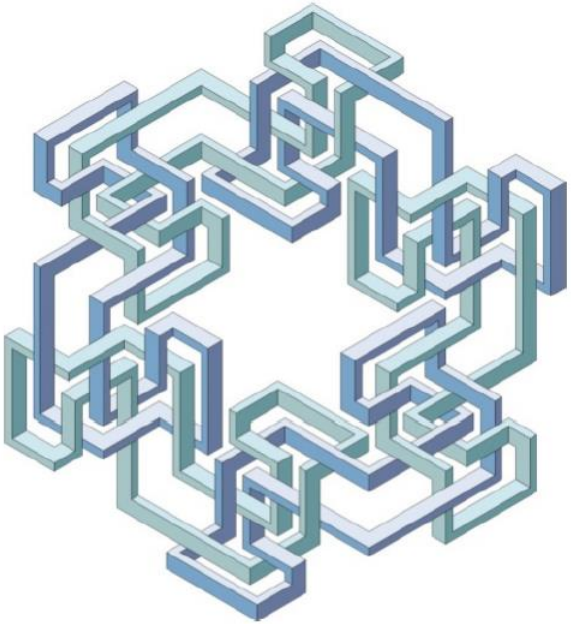


Fig. 1: *Picture plan of T. F. Farkas*

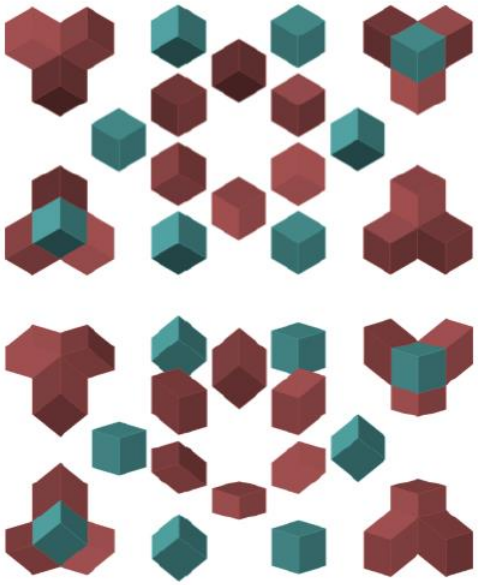


Fig. 2: *Applied 3D elements*

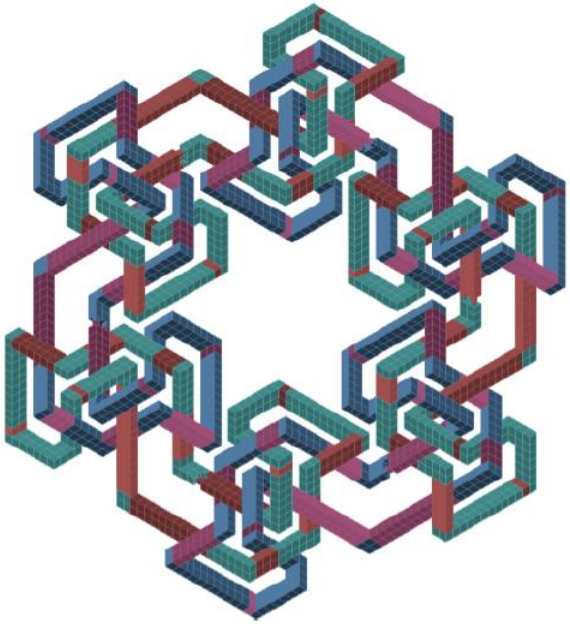


Fig. 3: *Modified 3D reconstruction*

László Vörös's Impossible Research and Experience Workshop based on F. Farkas's, Victor Vasarely's, Escher's Impossible Figures:

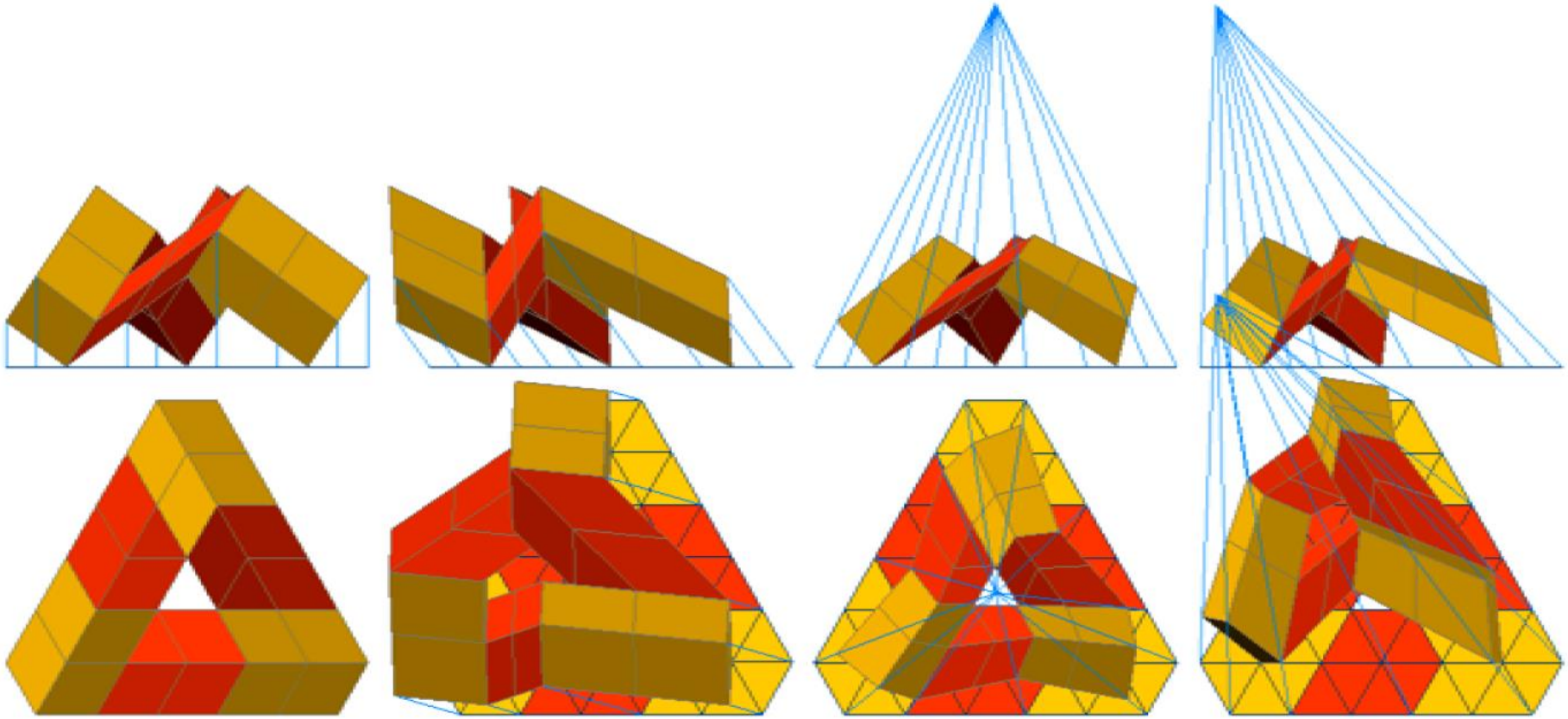
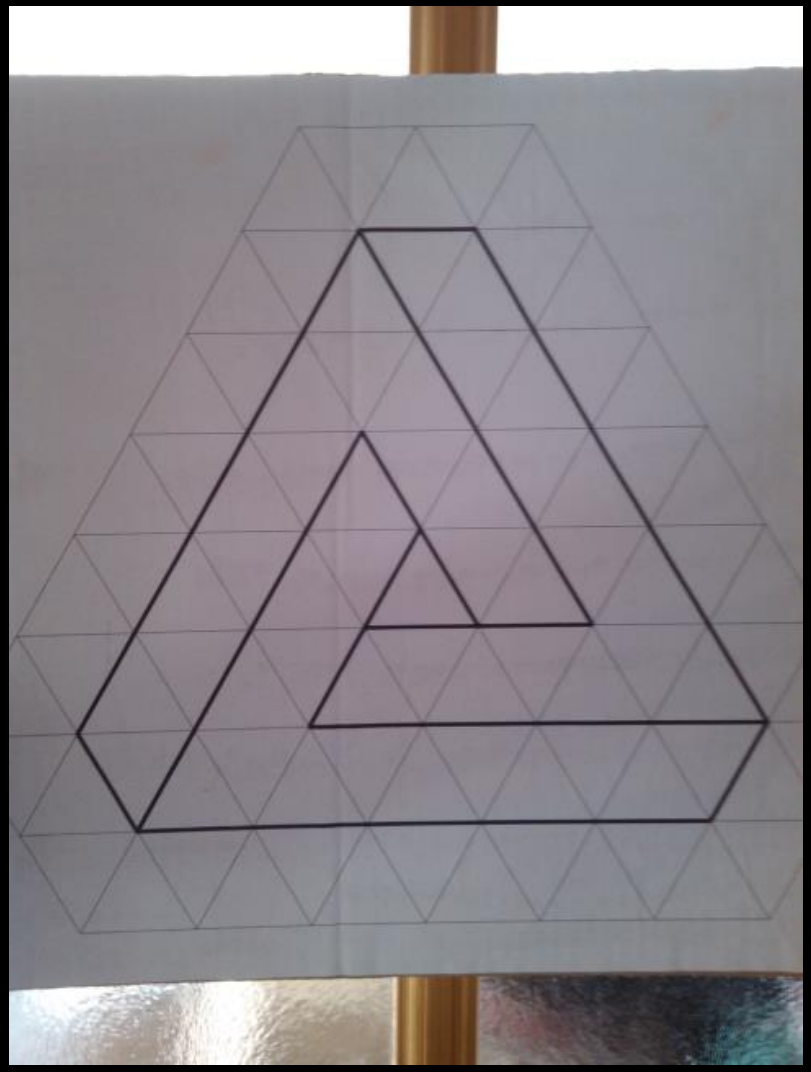
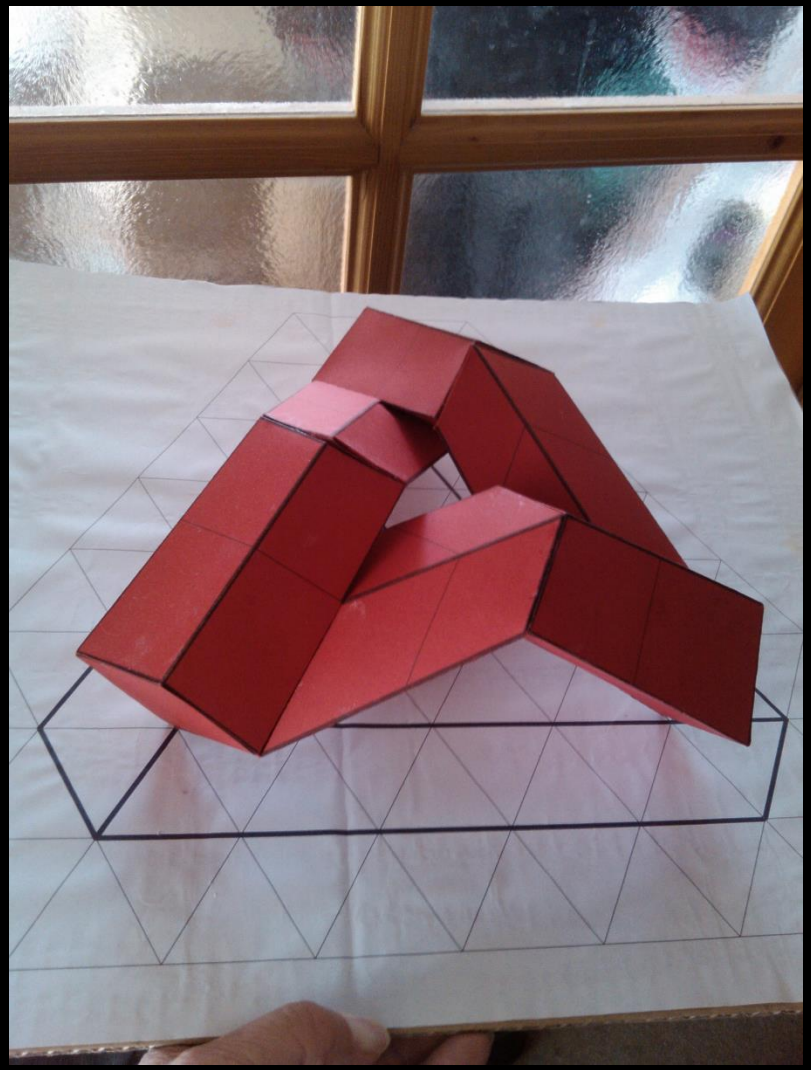


Fig. 5a-d: *Modified shapes and different kinds of projections creating the image of the Penrose triangle*

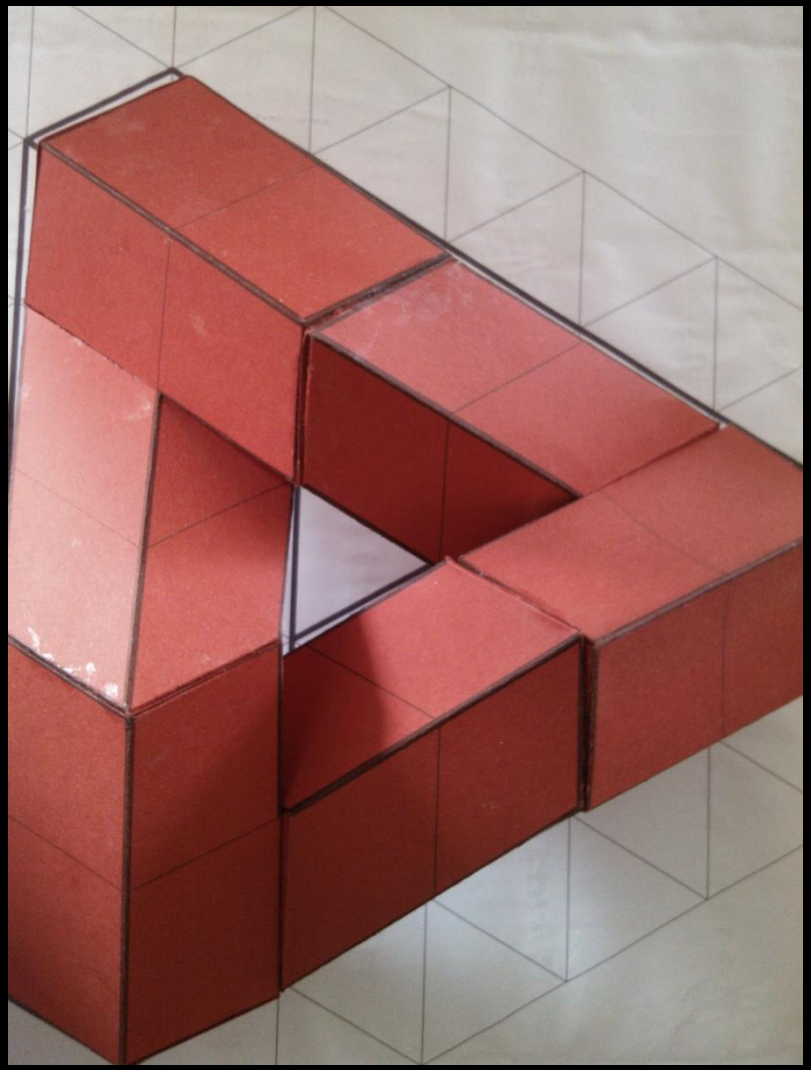
László Vörös's Impossible Research and Experience Workshop based on F. Farkas's, Victor Vasarely's, Escher's Impossible Figures:



László Vörös's Impossible Research and Experience Workshop based on F. Farkas's, Victor Vasarely's, Escher's Impossible Figures:



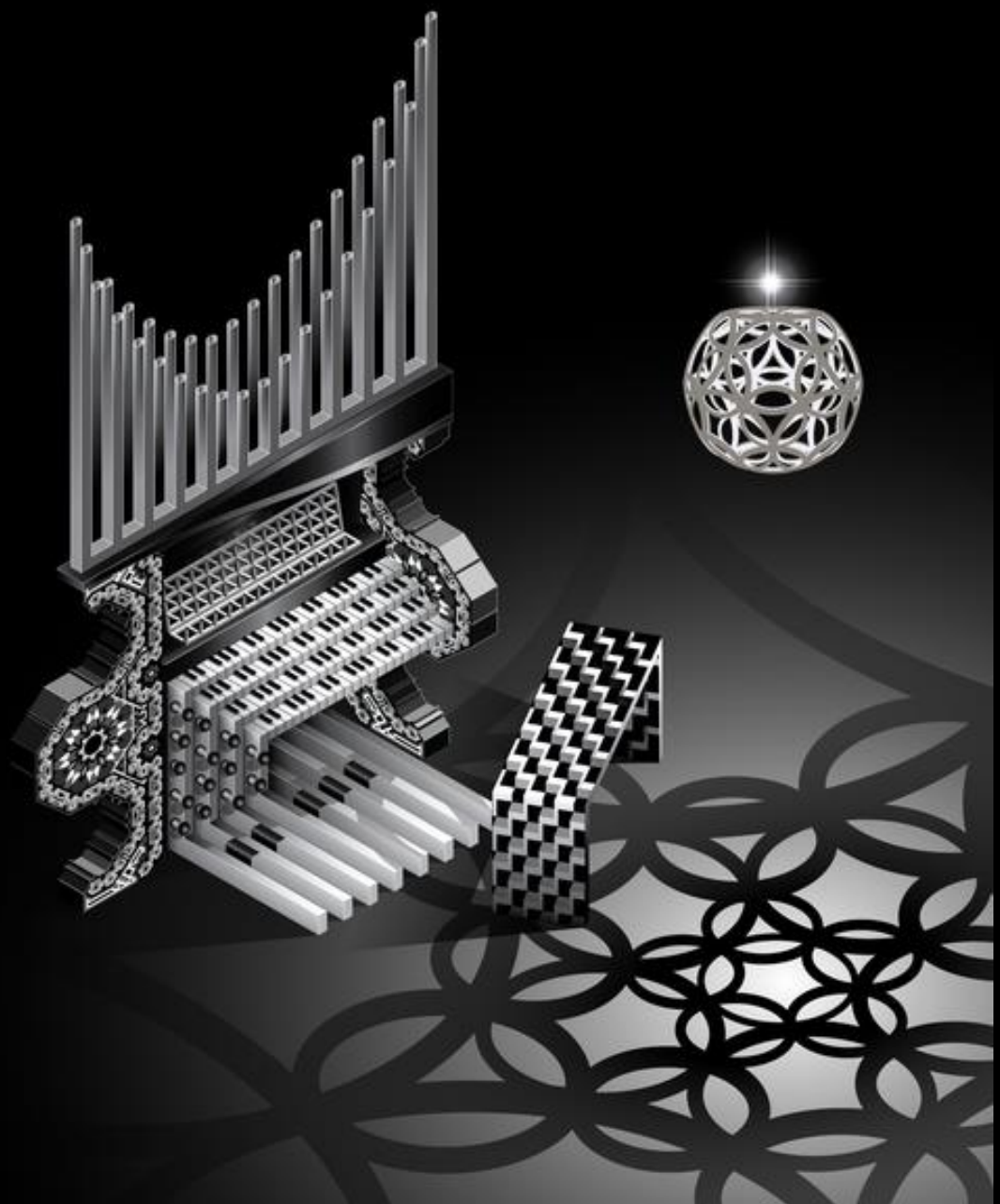
László Vörös's Impossible Research and Experience Workshop based on F. Farkas's, Victor Vasarely's, Escher's Impossible Figures:



László Vörös's Impossible Research and Experience Workshop based on F. Farkas's, Victor Vasarely's, Escher's Impossible Figures:

Tiffany Inglis' Impossible Research and Impossible Art:

As we have seen, there are various techniques for constructing impossible figures both in 2D and 3D, but most **involve tricks that are not easily generalizable.** Inglis describes a simple framework that uses axonometric blocks for construction and permits pseudo-3D manipulations even though the figure may not have a real 3D counterpart.



Koji Miyazaki's Impossible Research on Multidimensional Impossible Polycubes:

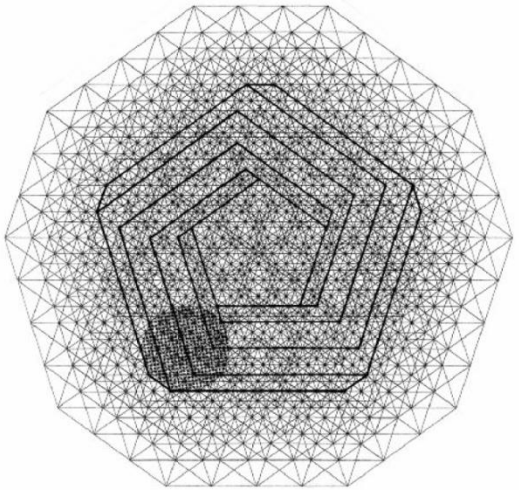


Figure 13 : *An impossible 5-bar embedded in an impossible 5-polycube. The shaded decagon highlights a 5-cube as a base of a 6-cubic prism. CG: M. Ishii.*

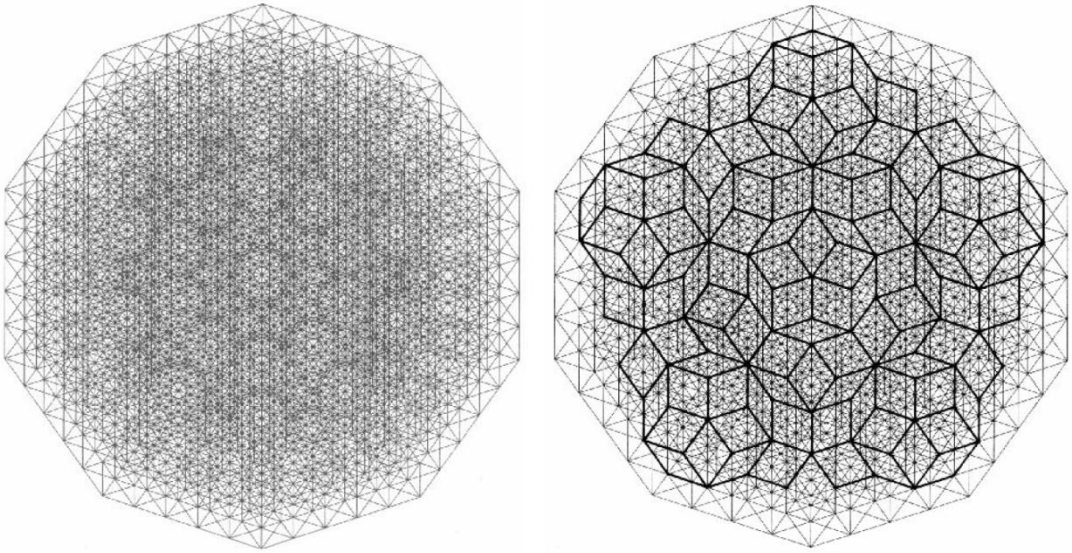
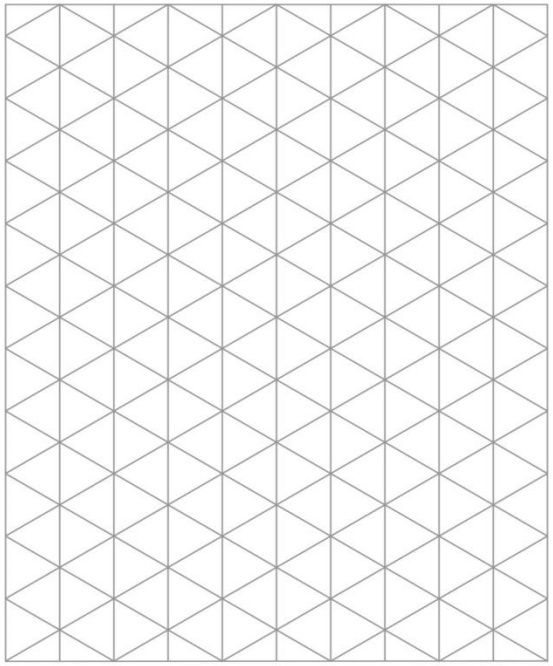
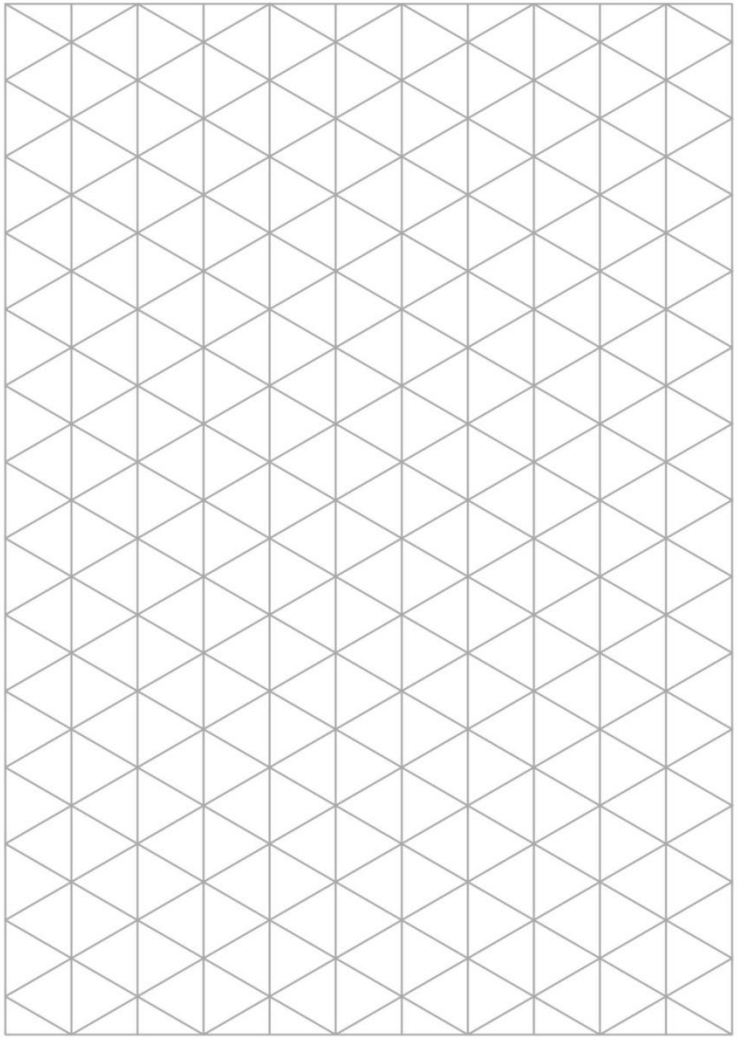
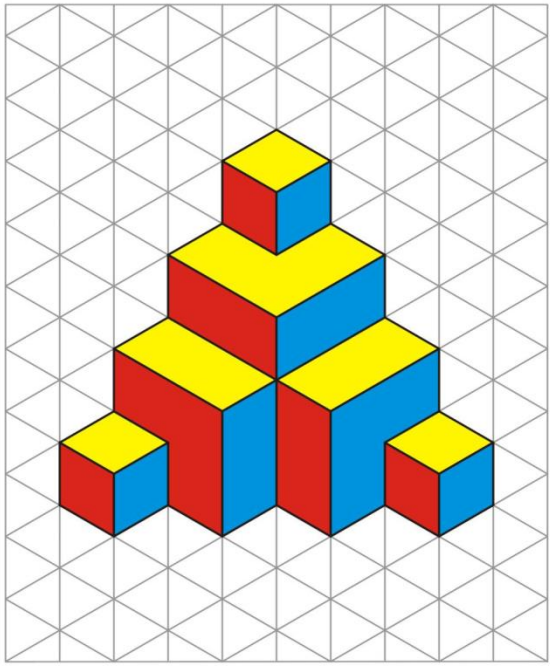
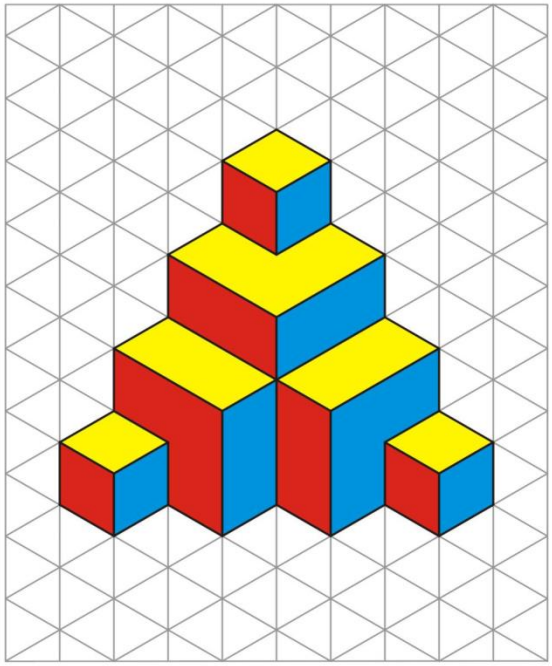


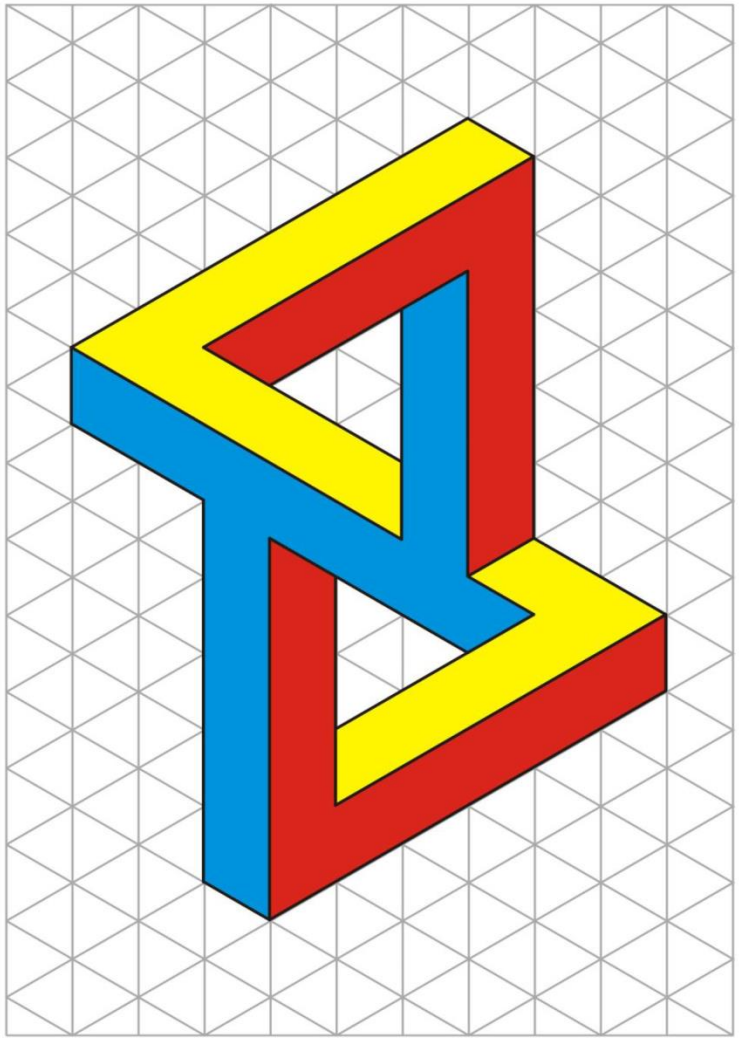
Figure 14 : *The transparent representation of the projection onto 2-space of a 5-polycube (left) and a radial quasi-periodic pattern appearing in it (right). CG: M. Ishii.*

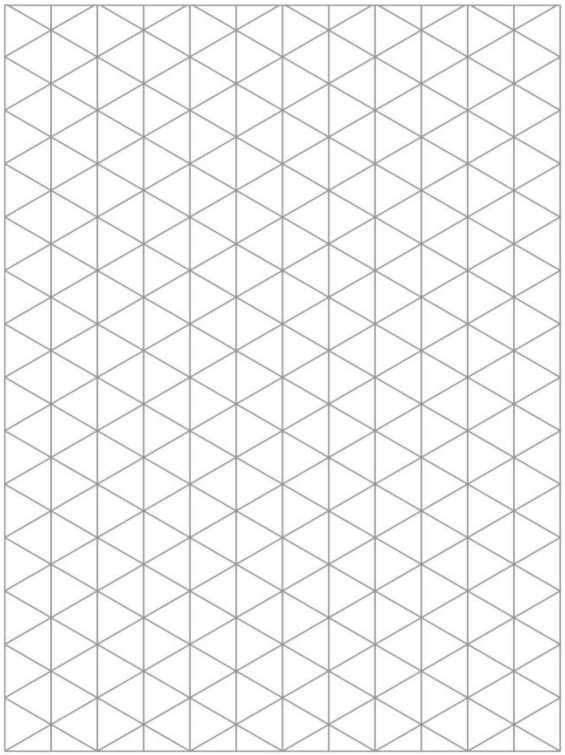


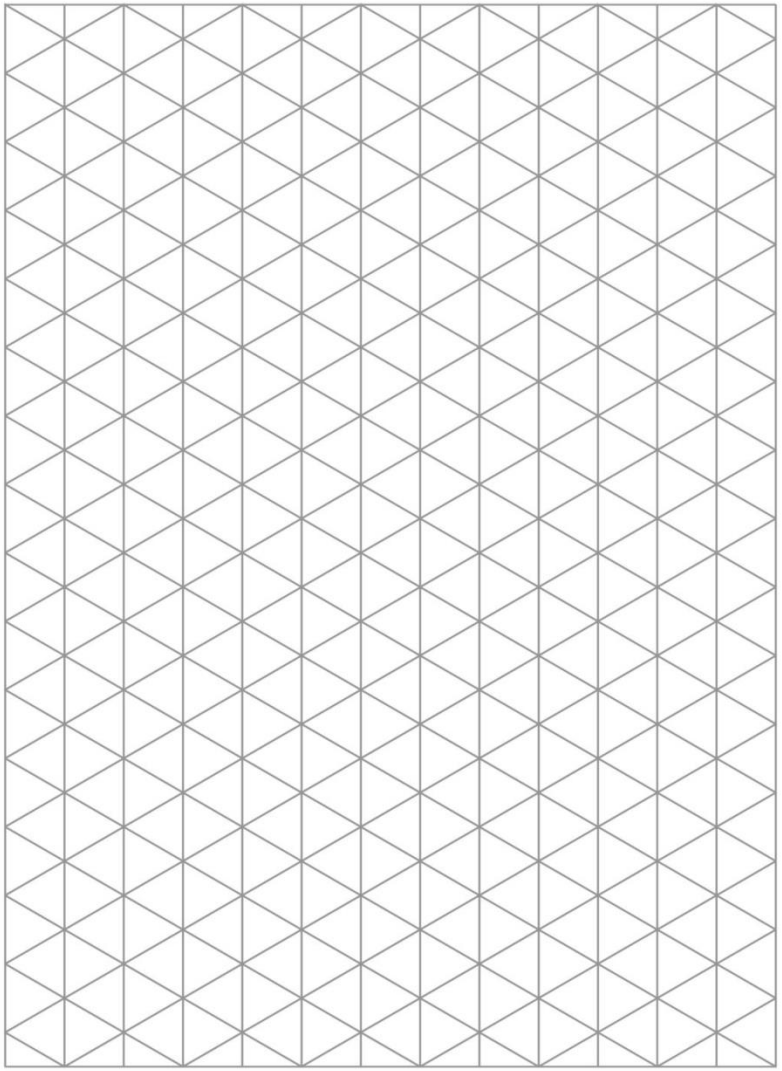


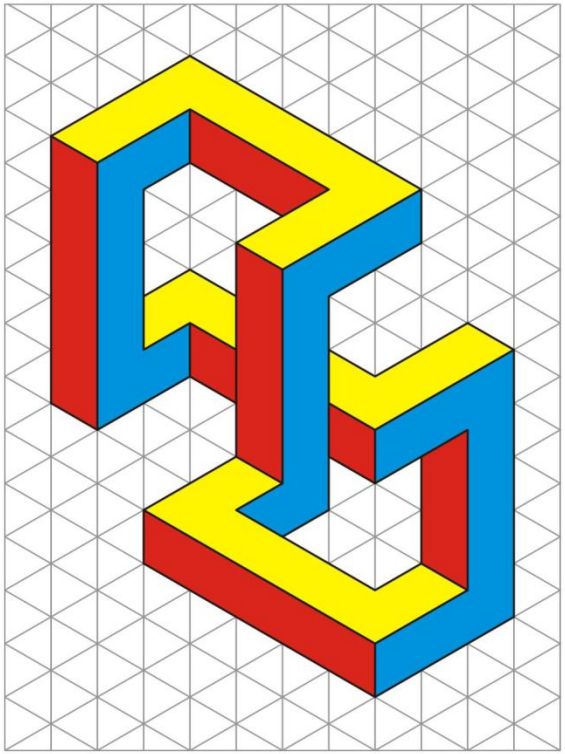


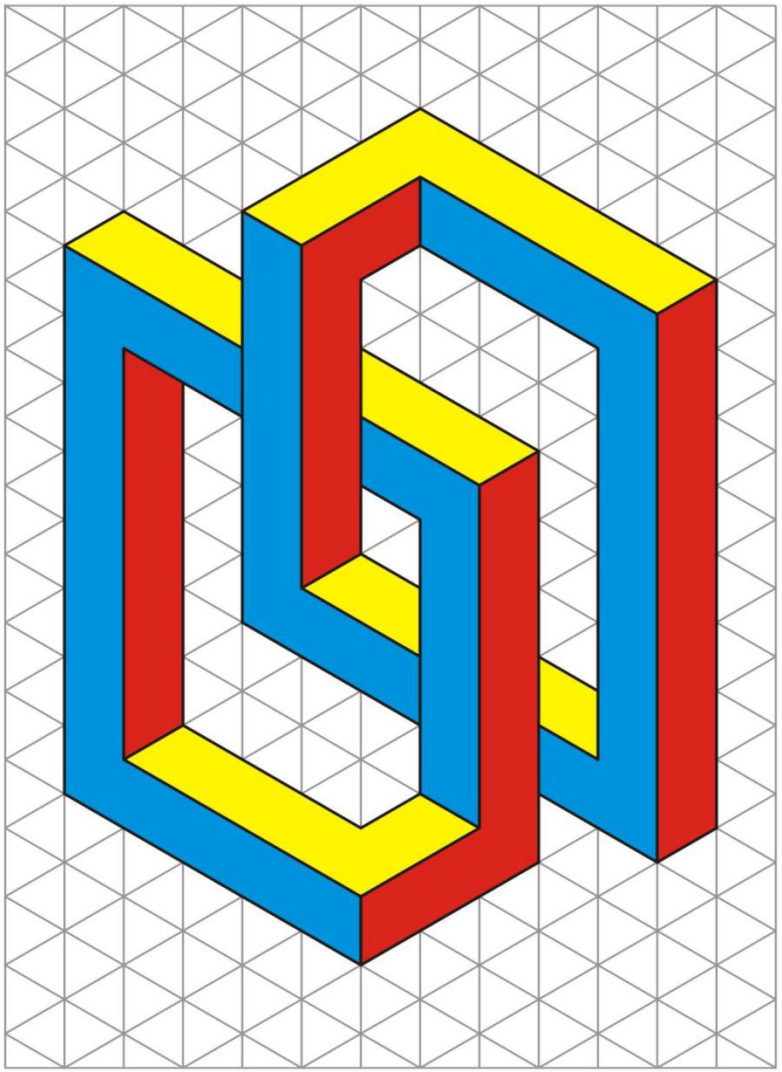


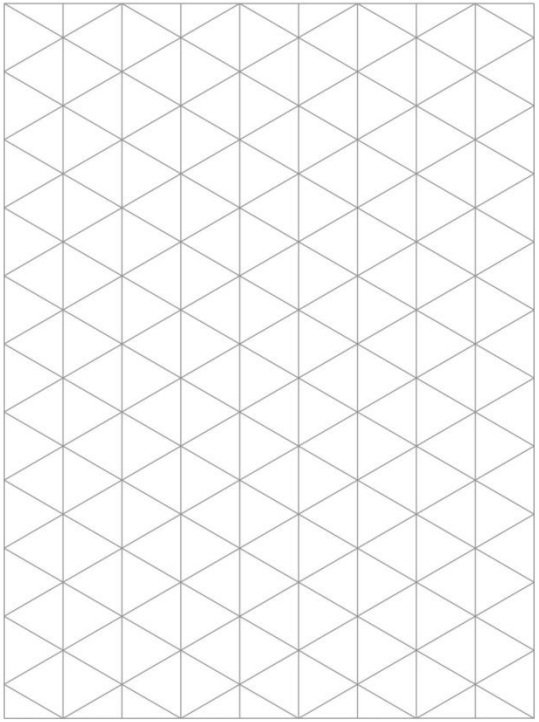












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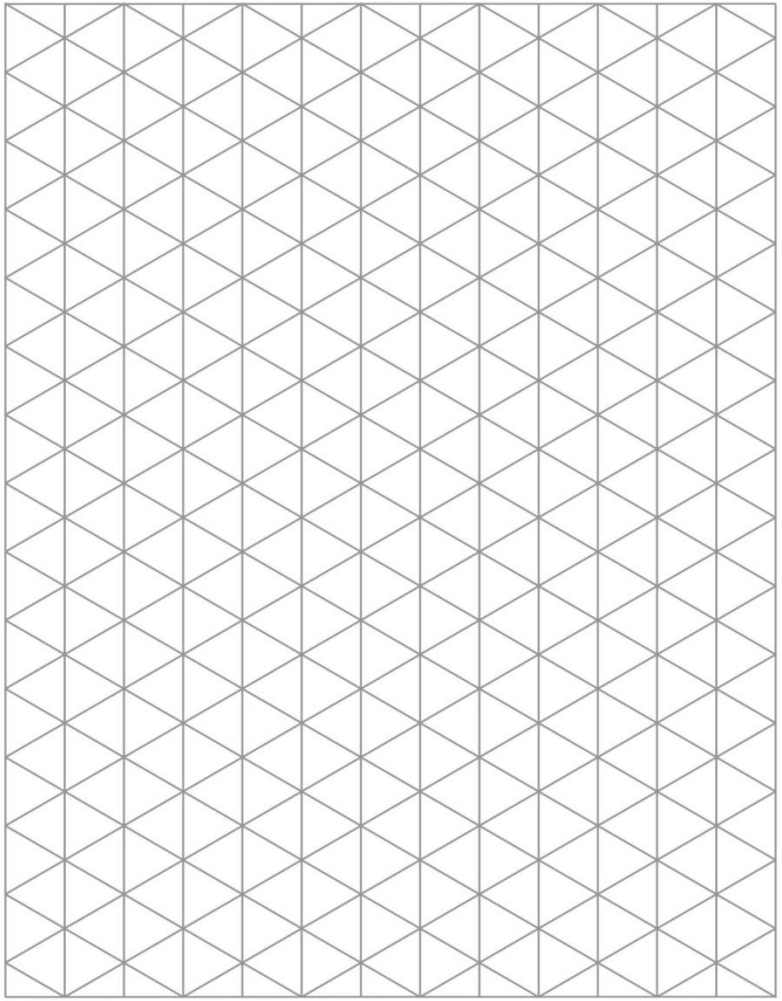
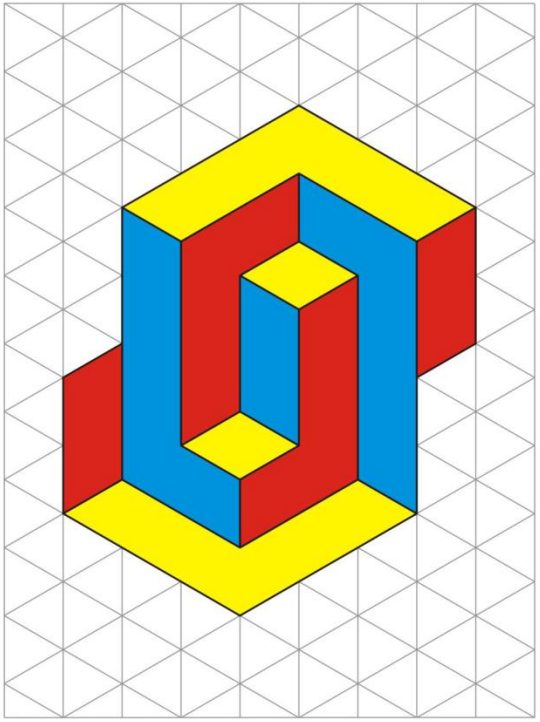
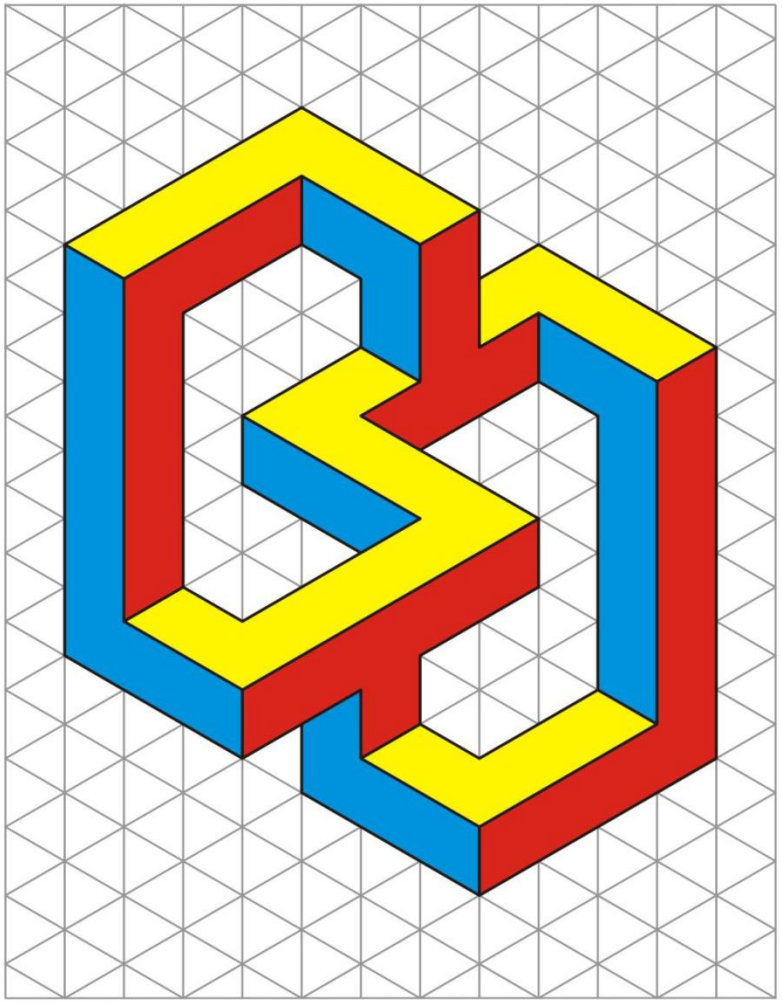
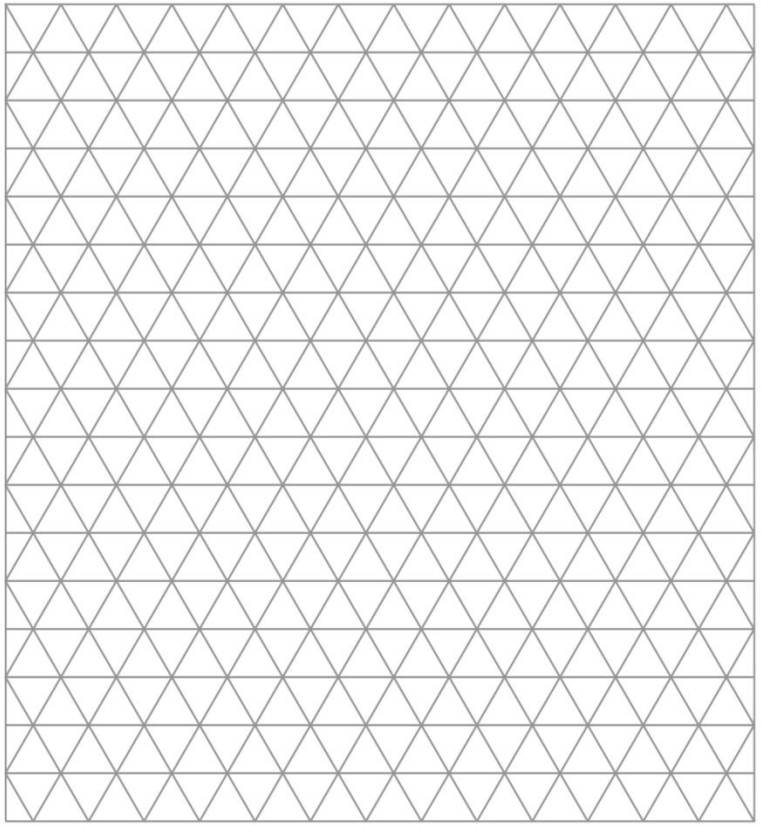


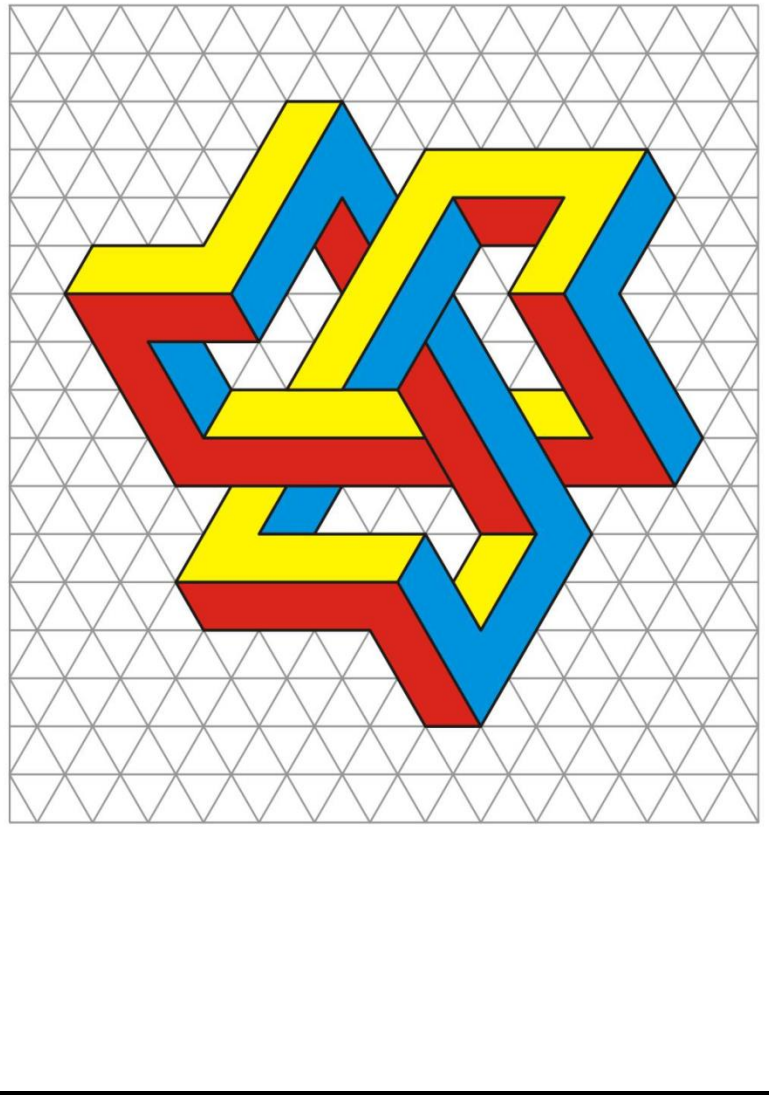
F. FARKAS TAMÁS PARADOX FORMAKAPCSOLAT II. ÉLMÉNY MŰHELY 2014







F. FARKAS TAMÁS PARADOX ALAKZAT ÉLMÉNY MŰHELY 2014



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