Adventures in Sphereland

by Vaclav Obsivac

I often wonder what happens to a puzzle if I change the building units, will I create a new puzzle? And more important, is it an interesting puzzle that works!
Sphere puzzles made of wood are very beautifull, I like them for the final look of the wooden structure.
Once I was wondering what happens to my puzzles if I use spheres instead of my triangular prisms. So I made several drawings by hand on paper. After several tries in my scetchbook symmetrical configurations of the spheres formed - pentagons. I became excited and at once I started to make a model. This model showed it all: every sphere was on vertex of an icosahedron. From that moment I finally and completely understood the structure of the icosahedron. I then knew how build it – and how easy that is. This was a very usefull excercise for me, because I do not like to study theory. I rather prefer discovering the relations in geometry by looking at models.

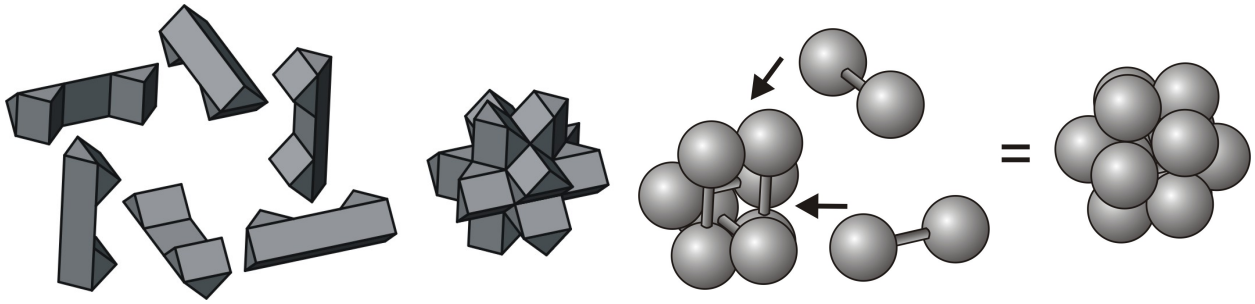

Figure 1. change from prism cross to sphere puzzle

You can see what happens then ..... in Figure 1 above. I use six simple pieces similar to the common six piece burr. The distance between centers of two spheres which are not touching is golden ratio. Unfortunatelly these six pieces was not able successfuly to hold the puzzle together. Only small move of pices or some small fault during making and the puzzle do not work well.

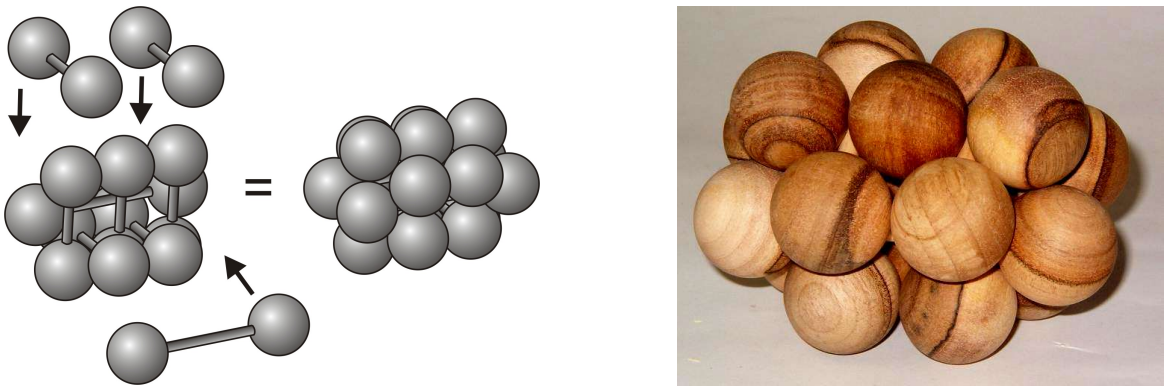

Figure 2. 18 spheres and 9pieces

I then investigated other possibilities. I started adding an extra piece in each orthogonal direction, step by step. So here the next versions appeared (see Figures 2,3 and 4). Maybe the most interesting of them is the **36 sphere puzzle** (see Figure 4).

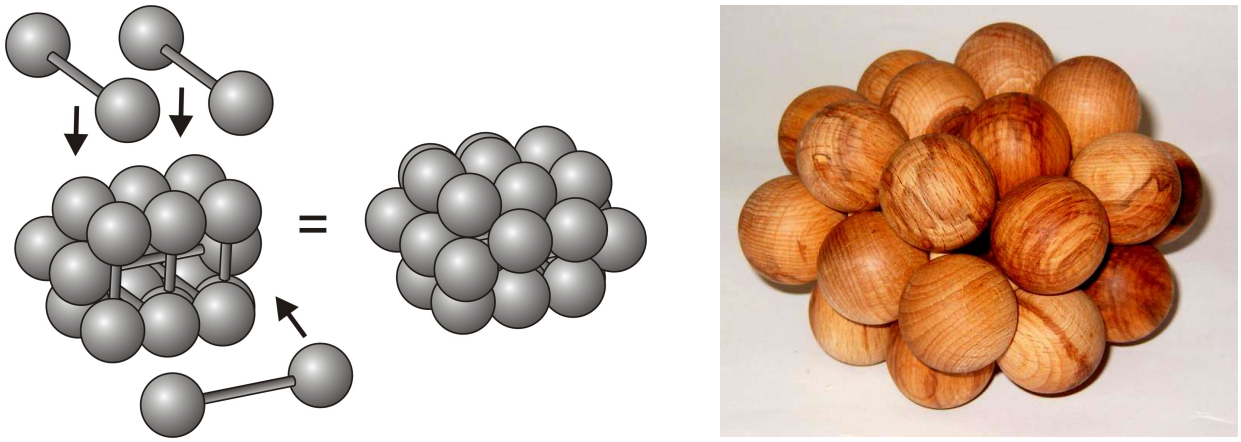

Figure 3. 26 spheres and 13 pieces

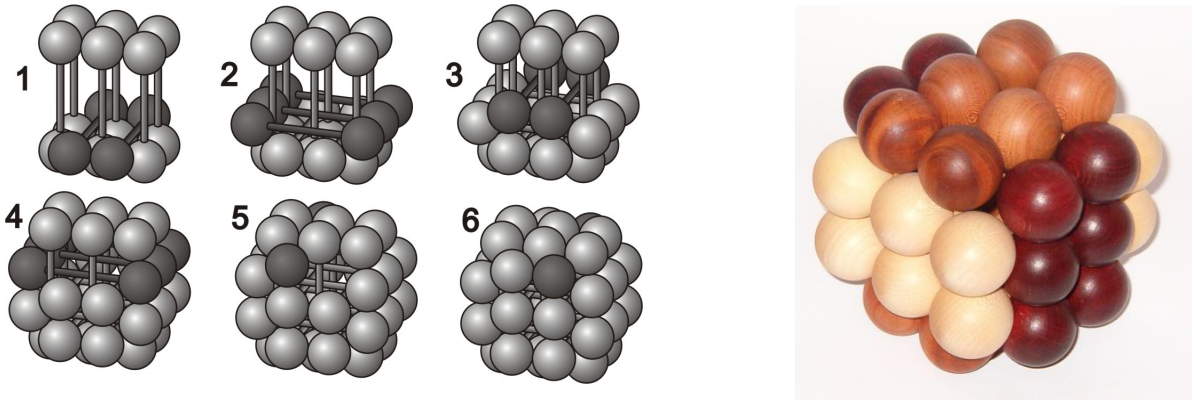

Figure 4. 36 sphere puzzle (18 pieces)

But back to the six piece sphere puzzle with 12 spheres. The icosahedral form of the cluster of spheres is very attrative, and I was searching for a method to make the puzzle more interlocking. To do so, I made the connecting rod in one piece longer. This piece is orientated as an axis of the icosahedron, so the piece goes through the centre of the icosahedron. Then I took the remaining five original pieces (golden ratio size) and I placed them around the longer piece. A bit of dexterity is needed for assemblage of this puzzle, but with some perseverance everybody is able to assemble the puzzle. I named this puzzle **Kiss** (see Figure 5.),after the kissing number: a formation of 12 spheres. In fact a fitting name.

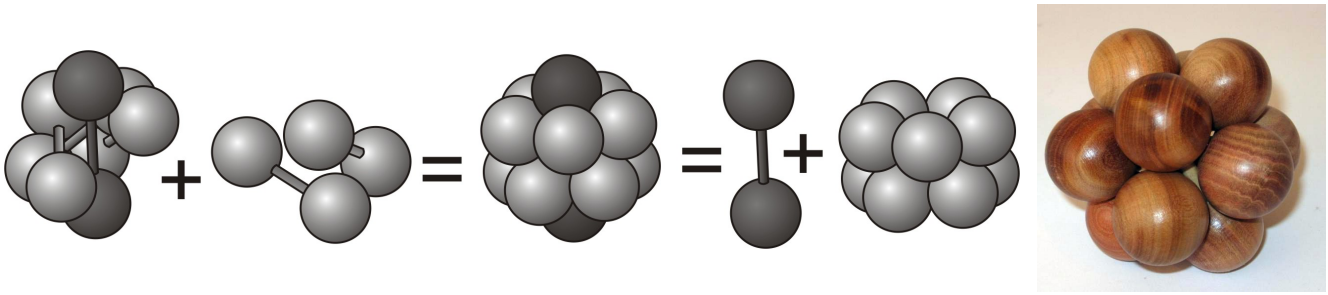

Figure 5. Kiss (6pieces)

At the same time I tryed another possibility. I noticed that I can also lock the six identical sphere pieces by using one special piece. If you imagine the six piece puzzle as a cube - the space diagonal is the position for the seventh piece. The assemblage of this puzzle requires a little dexterity too. I called it **VINCOXIV.**

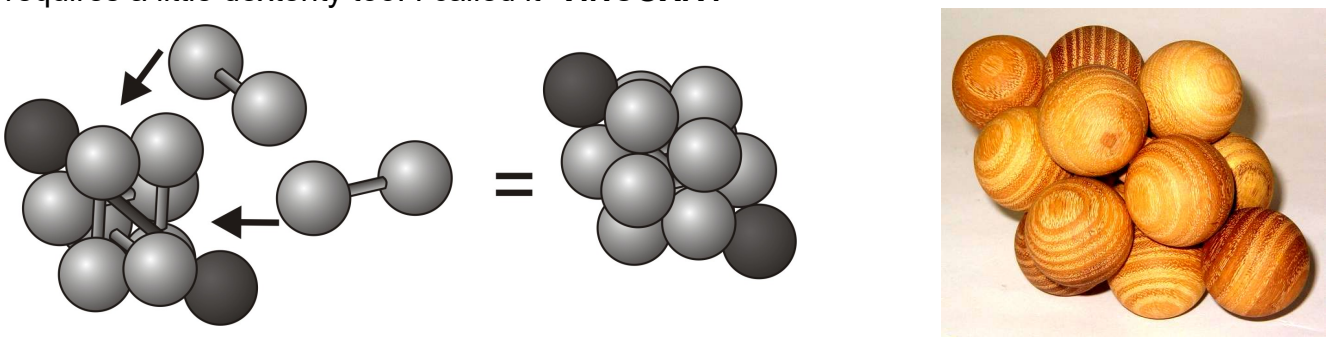

Figure 6. VINCOXIV (7pieces)

A further challenge was to create a icosahedral cluster of spheres with an edgelength of more than two spheres. The first icosahedral spherepuzzle (Kiss, see Figure5.) has two spheres on an edge. Now I was thinking about Icosahedron with three spheres on each edge. My idea was to make another six pieces puzzle, so looking at the icosahedral cluster of 42 spheres I designed six identical pieces from 7 spheres each. This puzzle is the same type as a six piece puzzle with coordinated motion. I can see the same moves here. I called it **Icosahedron 42** (the puzzle is from 42 spheres).

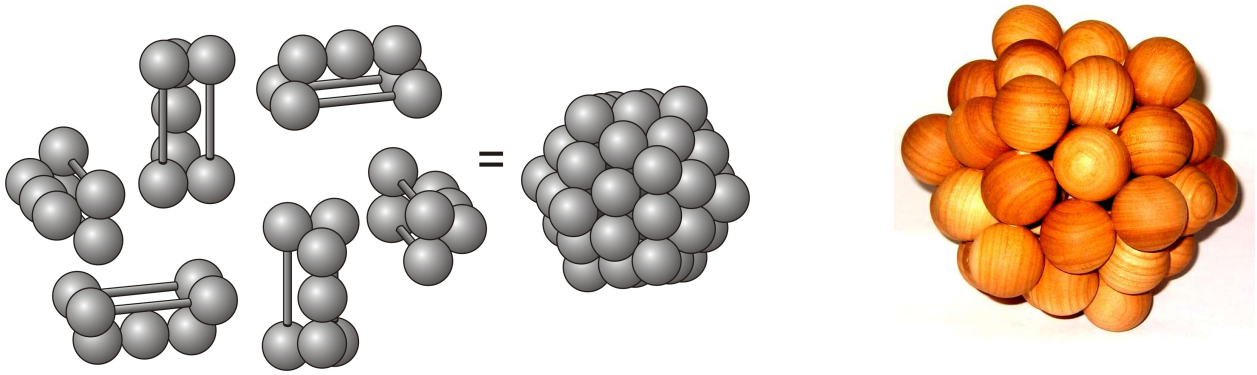

Figure 6. Icosahedron 42

The next goal was an icosahedral cluster with four spheres on an edge, in total 92 spheres. To create this formation I was not able to use identical six pieces. These are

many spheres and the number 92 is no multiple of 6. I have tried several combinations of pieces but was always left with eight extra spheres. Then it hit me: eight spheres – the cube has eight vertexes! So the cubical piece appeared as a result. It was not too difficult to create the other pieces to complete this icosahedral puzzle. To the cube piece I added three different types of pieces - 43 pieces all together. Each piece has two spheres connected by wooden pin. The spacing of spheres in pieces are always defined by the Golden Number. I named this puzzle **Icosahedron 92** (92 - number of spheres).

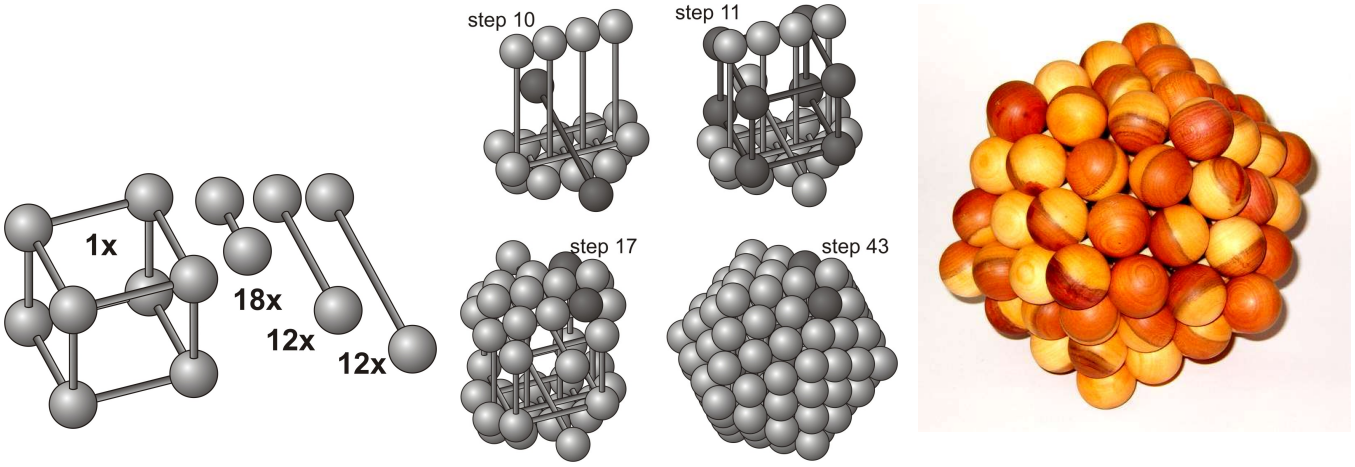

Figure 7. Icosahedron 92, assemblage and model

After the creation of this puzzles I wanted to make it without the cube piece. I tried to create all pieces with two spheres only, but it was without success - the puzzle was not able to hold the icosahedral form by itselve. The cluster needed some skeleton so that the pieces can not slide in parallel layers.

The next bigger puzzles are icosahedral forms with 5, 6, and 7 spheres on an edge, needing 162, 252, 362 spheres respectively. In these bigger icosahedral puzzles I used rectangular pieces (in general with a sphere on each vertex of the rectangle). These regtangular pieces make the cluster rigid– like the cube piece did in **Icosahedron 92**. I tried to make another, bigger icosahedral form (8 spheres on an edge, a total of 492 spheres), but this cluster is not rigid too so it is not very suitable for a puzzle. In Figures 8 to 12 you can see what kind of pieces were used for these big icosahedral puzzles.

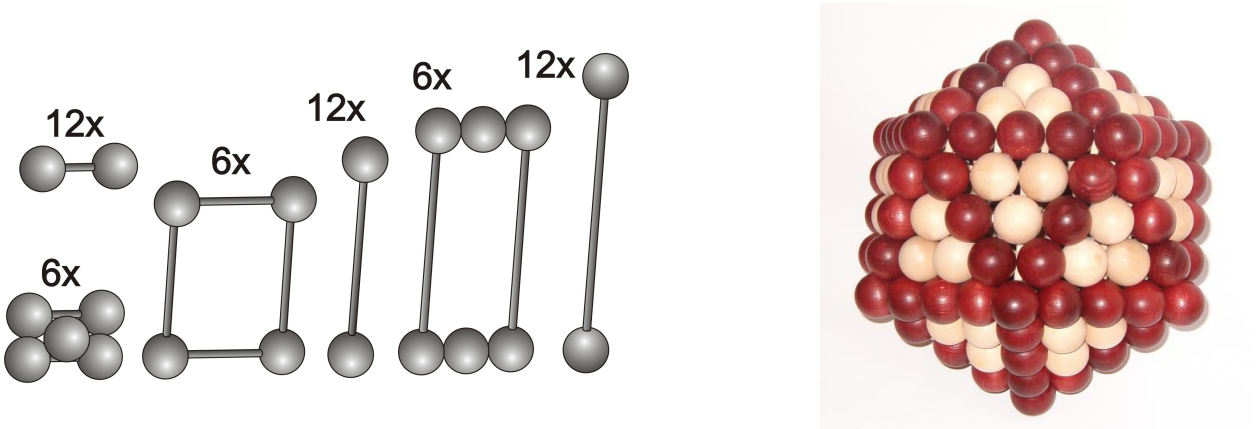

Figure 8. Icosahedron 162, pieces and model

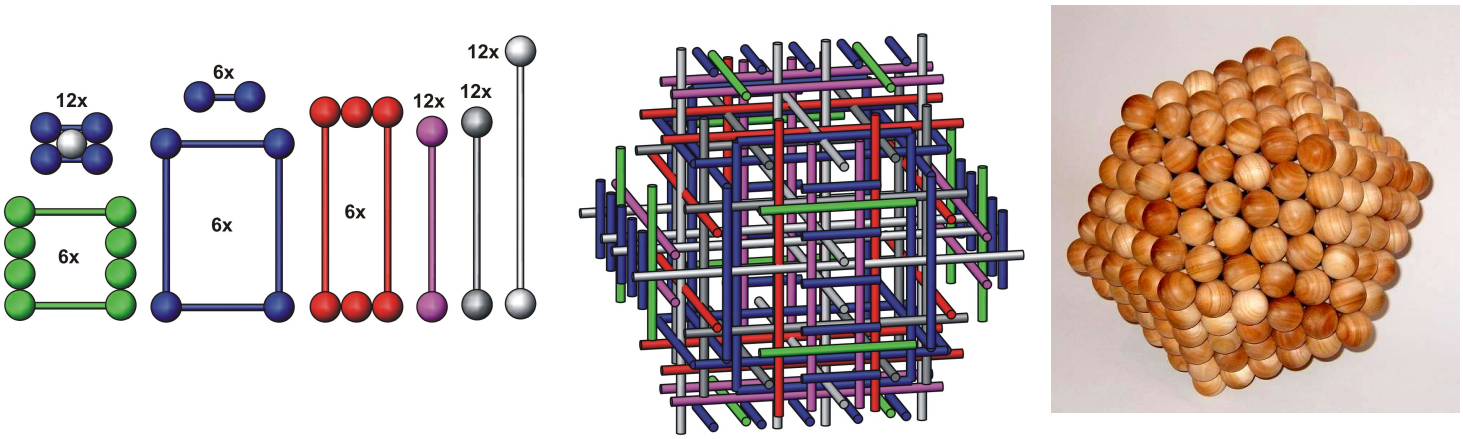

Figure 9. Icosahedron 252, pieces, assemblage and model

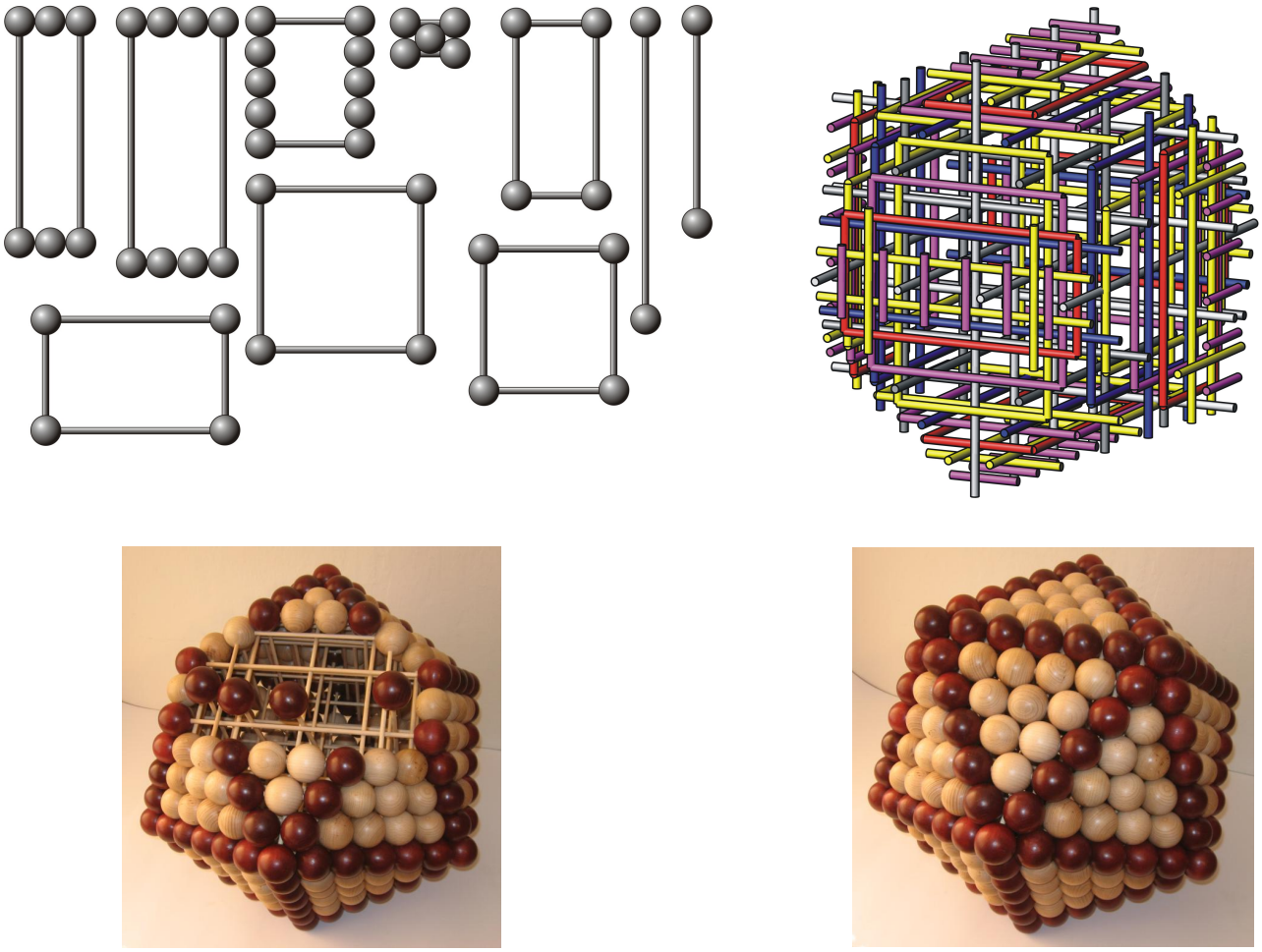

Figure 10. Icosahedron 362, pieces, assemblage and models

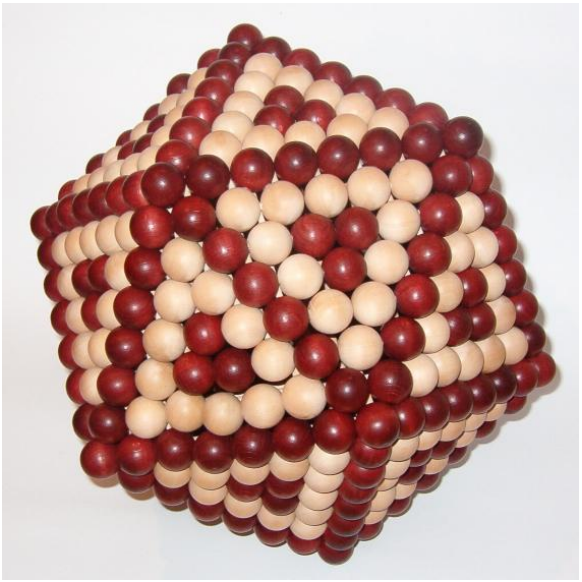

Figure 12. Icosahedron 492

Figure 13. Spherical model

Objects on strings

During this period of puzzle-creation I wanted to build other, non-icosahedral, forms. I found out that these spheres pieces lead to icosahedral clusters only - simply put: the spheres are taking the hexagonal positions in the plane and icosahedral positions in space. So I discovered America after Columbus :-). Other geometrical forms inspired me to design splendid objects, where I use beads (spheres with a hole) and an elastic string. To make an object I always put all the beads on only one string. Below you can see one sample of how you can make an object with 30 spherical beads on one string. The number of beads commands the form: it will be a dodecahedron which has 30 edges. So on each edge there will be one sphere.

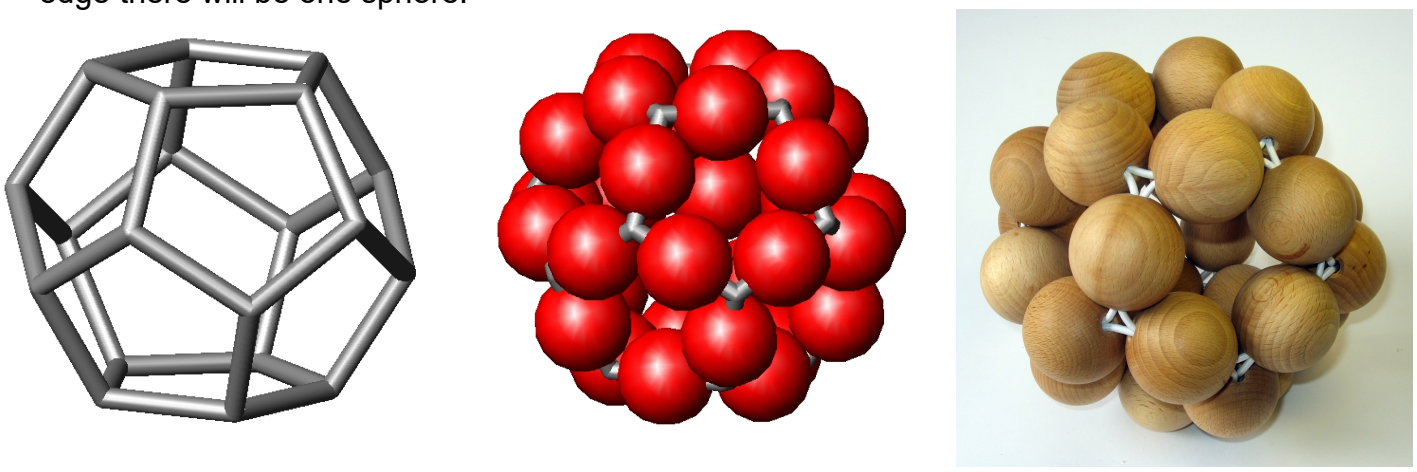

Figure 14. Dodecahedral cluster of beads, structure and model

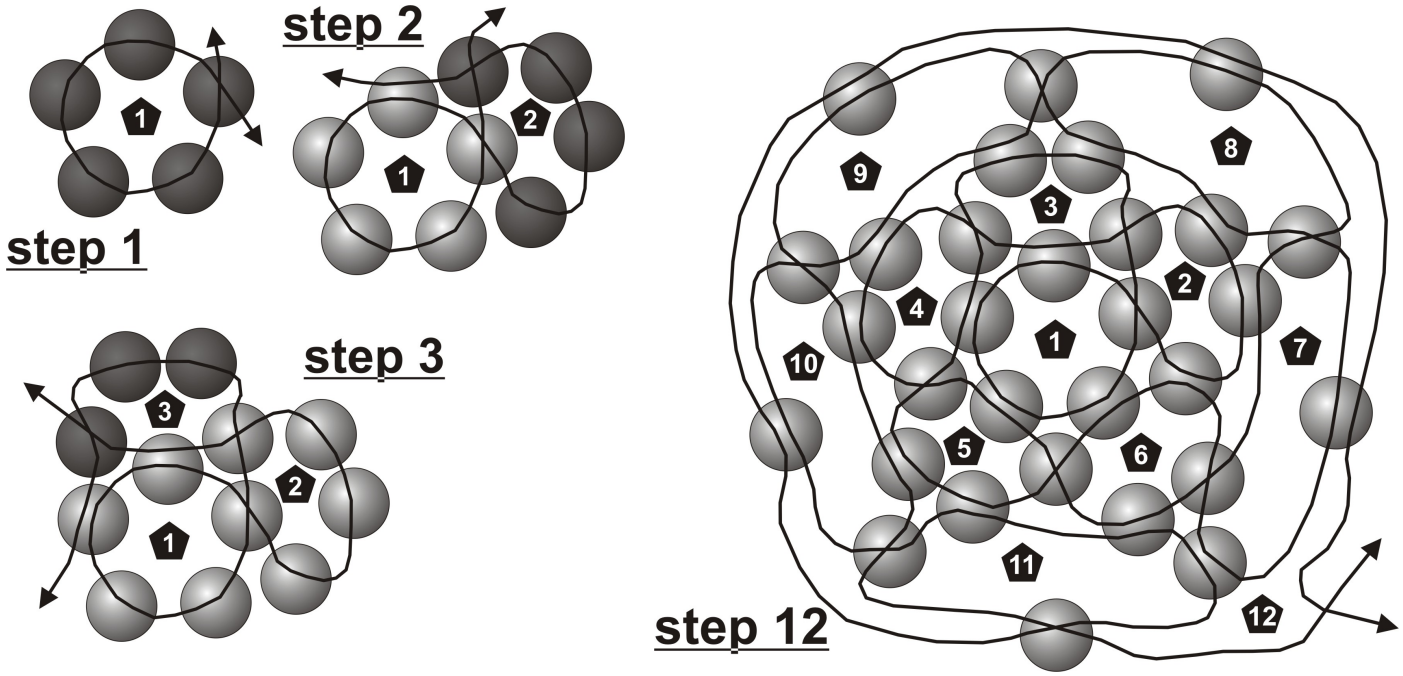

Figure 15. How to do it

Figure 16. Different objects with spheres or bicones.

Icomuts

At last I was wondering what will happen with these puzzles if I use cubes instead of spheres. So I started again with the six piece burr. As always I enjoyed these

investigations, creations, changes, finding or discovering of new possibilities. What, will you ask , is my favourite of this sphere puzzles? I remember the last one was always the best one .... or maybe I like every one of them.

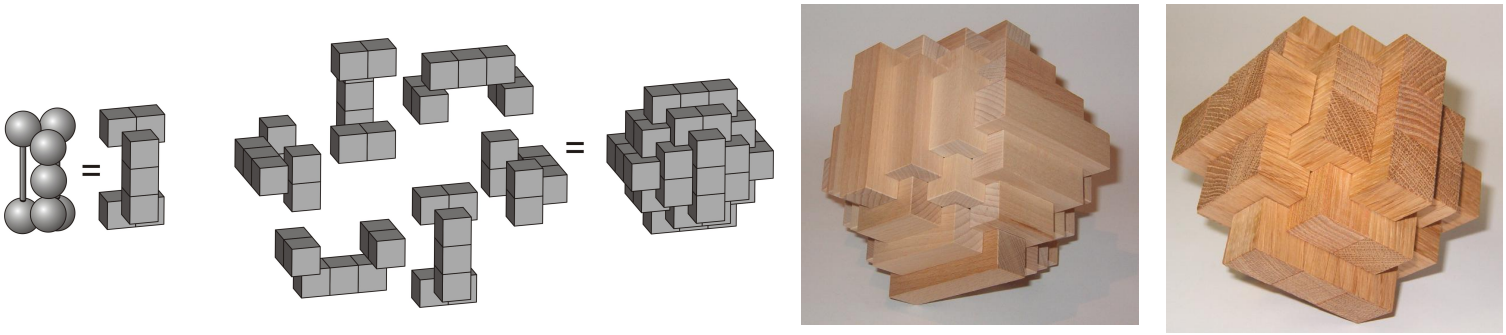

Figure 17. Icomuts