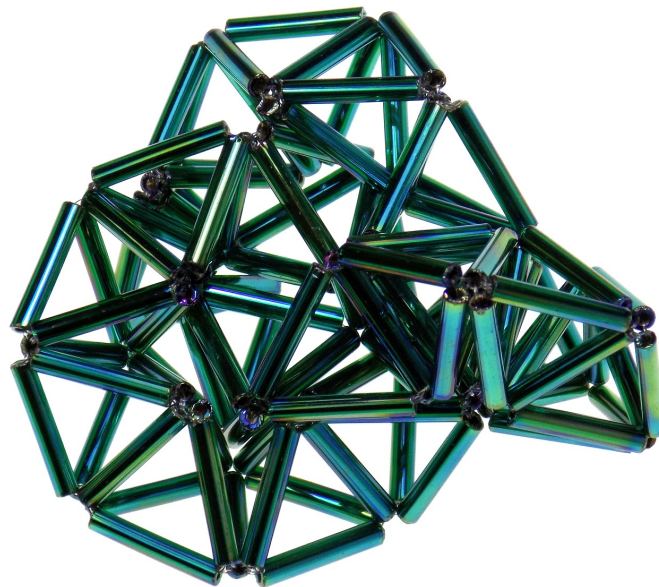


Trefoil Knot Kaleidocycle



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Bead Mechanics

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Acknowledgements

The idea for this beaded kaleidocycle came from the paper *Braided Rotating Rings* by Jean Pedersen, published in The Mathematical Gazette in 1978.

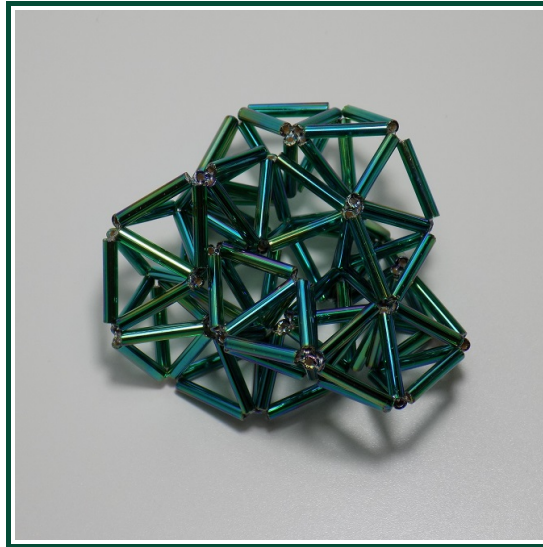
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Instructions

A while ago I found an interesting paper about rotating rings of tetrahedra (aka kaleidocycles) by Jean Pedersen (*Braided Rotating Rings*, The Mathematical Gazette, 1978), which mentioned that a kaleidocycle with at least 22 tetrahedra can be tied into a knot and still rotate. These instructions show how to make a kaleidocycle like this out of bugle beads!



Materials list

The kaleidocycle shown in these instructions is made with two colours of bugle beads – one for the hinges and one for the other sides of the tetrahedra. In the original version above I used only one colour, but it can be quite hard to see where the hinges are when you're making the first few tetrahedra!

- Matsuno 12mm bugle beads or Miyuki 12mm x 2.7mm twisted bugle beads:
 - 3g hinge colour, I used gold #634
 - 8g main colour, I used green #647
- Illusion cord, 0.25mm (0.01") diameter, clear
- (Optional) Long-nosed tweezers to help with threading the illusion cord through the beads

Overview

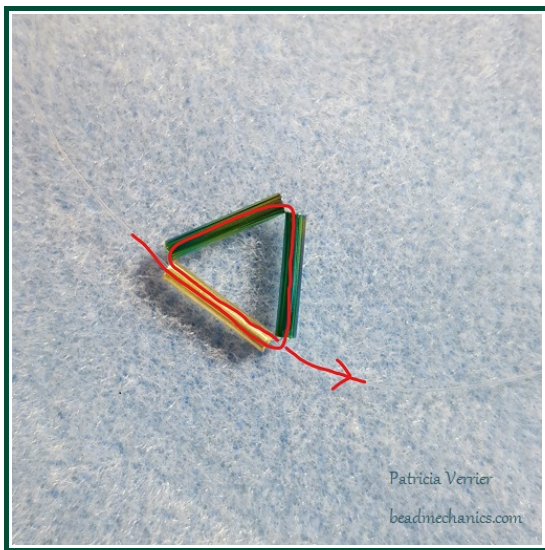
We're going to make a string of 21 tetrahedra, joined to each other on one bugle bead (which will act as the hinge). We'll then tie a knot with the string and join the ends together by making the last (22nd) tetrahedron.

The tetrahedra are all made from what I'm going to call *tetrahedral right-angle weave*, which is exactly like cubic right-angle weave and prismatic weave, except we're going to be making tetrahedra instead of cubes or prisms.

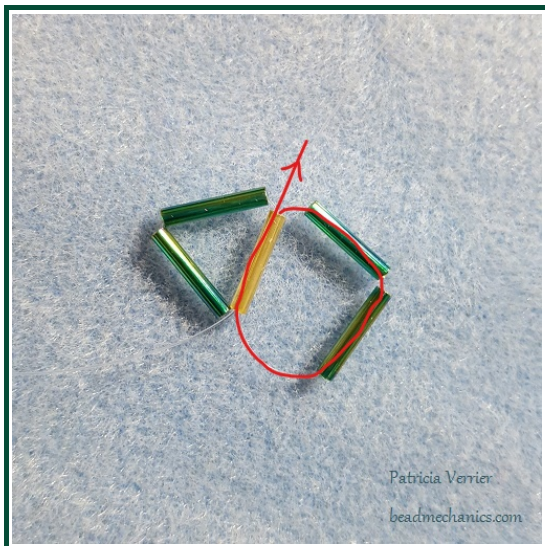
Step 1: Making the first tetrahedron

You need about 15' of thread to make the whole kaleidocycle (that's about 3 armspans). To make life easier I unreel about half that the spool and then work without cutting it off. When I run out of thread I then unreel the rest needed, cut it off and work from the other end.

Start by stringing 1 gold and 2 green bugles (leaving about a 10" tail if not working off the spool) then form them into a triangle by passing through the first gold bead again:



Then string 2 green bugles and pass through the gold bugle again to make a second triangle:



Then pass through the green bugle on the other triangle like this:



Now we add the final gold bugle to make the tetrahedra. String 1 gold and pass through the green bugles marked 1 and 2 on the image above, and then again through the gold bugle just added, like this:



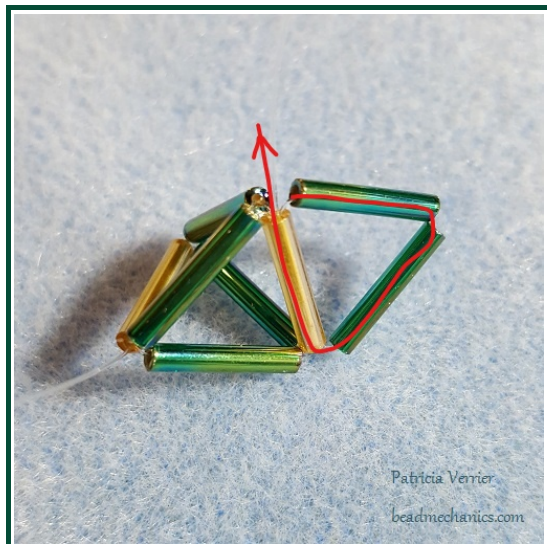
Finally, complete the last remaining face of the tetrahedra by passing through the 2 green bugles on the other side and then the gold again:



That's it for the first tetrahedron, now on to the second!

Step 2: Making the second tetrahedron

The gold bugles are the hinges of the kaleidocycle, and so the next tetrahedron is built from one of the gold bugles in the first. String 2 green bugles and pass back through the gold bugle on the first tetrahedron:

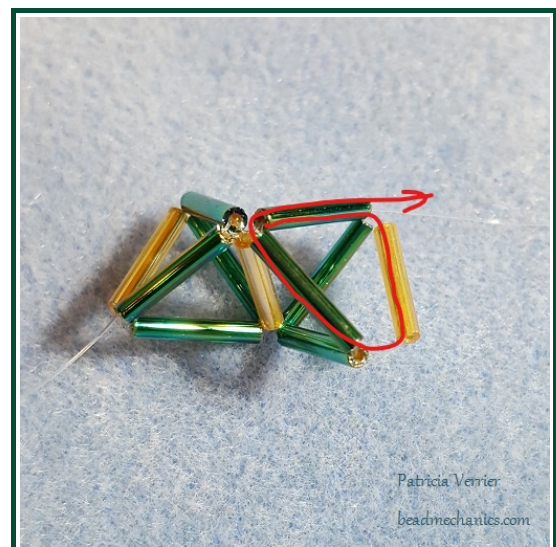


String 2 more green bugles and pass through the gold bugle once more:



(This last thread pass can get a bit tricky if the gold bugle is a bit narrower than normal – but if you hold the thread with a pair of tweezers that seems to make it easier.)

We now just have to add a gold bugle to the second tetrahedron. Pass through the first green bugle added, string 1 gold bugle, then pass through the top green bugle from the other triangle, like this:



Finally, complete the last face by passing through the gold bugle then the two other green bugles and then the gold bugle again, like so:



That's the second tetrahedron completed!



Step 3: Making tetrahedra 3 to 21

The next tetrahedra are all added in the exact same way as the second in Step 2 above:



Keep going until you have 21 complete tetrahedra. Then add the first two triangles of the last tetrahedra:



Don't add the last hinge gold bugle, it will be shared with the first tetrahedron.

You should now have a string of 21 and a half tetrahedra that looks like this:



Now pass the working end under and through the loop:



Now the fun part – tying the trefoil knot!

Step 4: Tying a trefoil knot

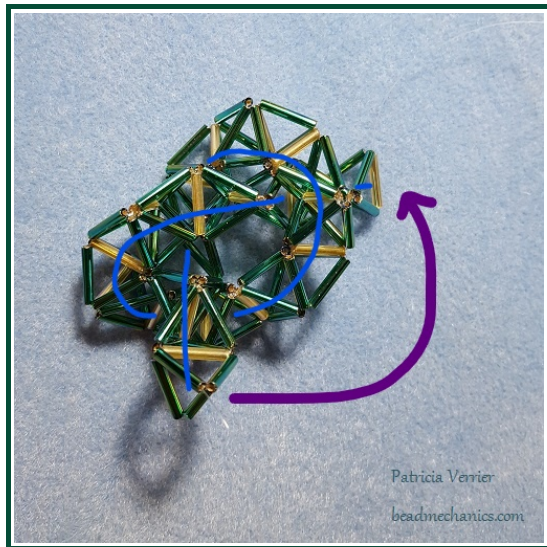
A trefoil knot is just a simple overhand knot. Start by laying the string out flat and then moving the working end (the one with the incomplete tetrahedron) over the other end:



You should now have something that looks like this:



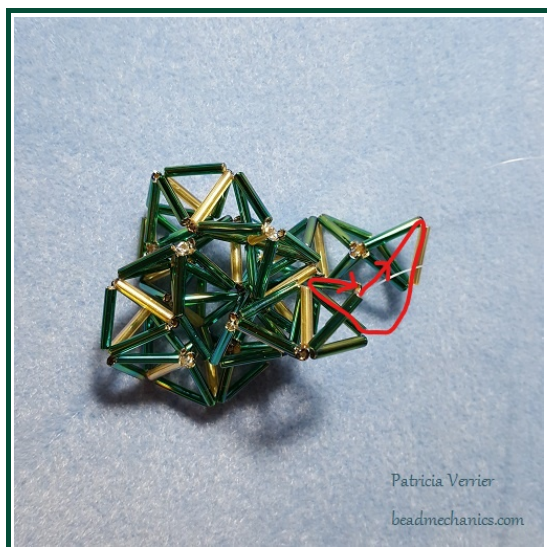
We now just need to bring the two ends together like this:



I've drawn the outline of the knot in blue on this photo. It looks a bit confusing, but don't worry it's actually pretty simple when you have the beads in front of you. (It's just hard to photograph!)

Step 5: Joining the ends together

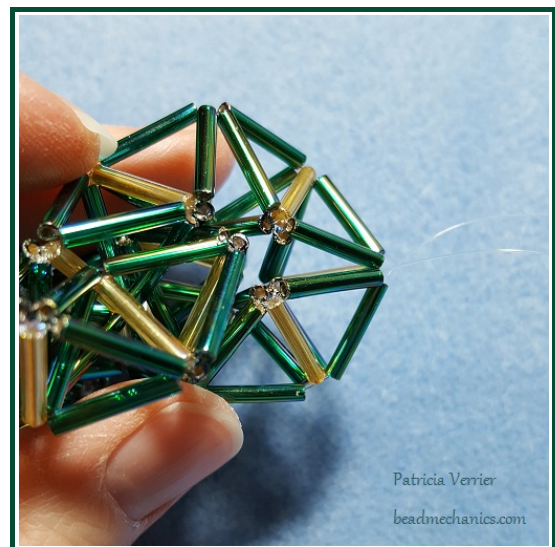
Now we just have to join the two ends together. This is done as before, except instead of adding a gold bugle you use the one from the first tetrahedron. Pass through this gold bugle and then remaining two green bugles on one incomplete face on the last tetrahedron:



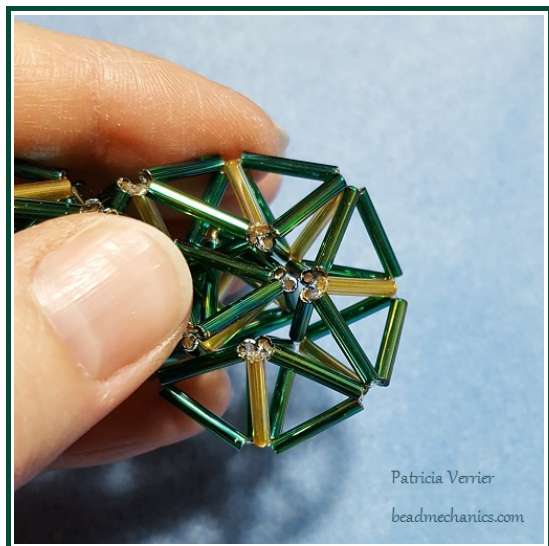
Then pass through the gold bugle again and then green bugles on the other incomplete face of the last tetrahedron:



When joined it should look like this:



The kaleidocycle doesn't have many degrees of freedom when the knot is tied so there isn't much risk of getting it twisted – there's only one way it wants to join up at this point! When it's joined right it should look like three inter-connected regular kaleidocycles:



Weave the ends in by passing back along the tetrahedra. I try and join the ends so the tail from the first tetrahedron is woven into the last one, and vice versa, to give a little bit more strength to the join.

You may find that you're not able to make any more passes through the gold bugles at this point – if so, just zig zag back and forth through the green bugles on one tetrahedron.

Finished!

That's it! The trefoil knot kaleidocycle is finished – now you just have to learn how to turn the three interlinked parts at the same time! Have fun!



Happy Beading!