A GEODESIC SPHERE MODEL

by **Thinkenstein** on June 24, 2009

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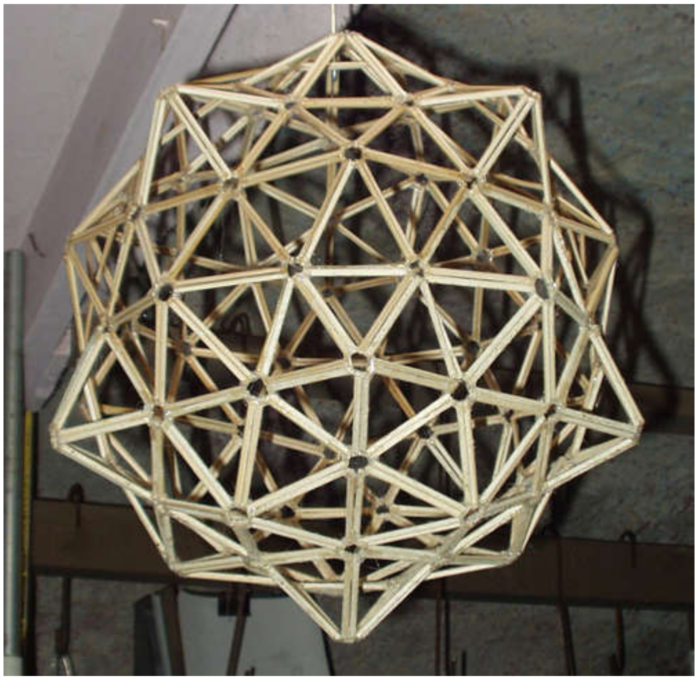
intro: A GEODESIC SPHERE MODEL

Geodesic dome construction has interested me since the 1960s, when I first became aware of that alternative to square box architecture. Buckminster "Bucky" Fuller popularized the idea, but as my quick research for this instructable finds, he was not the originator. That credit apparently goes to Dr. Walther Bauersfeld, who used the concept for the Zeiss Planetarium built some 20 years prior to Fuller's work. This is a Wikipedia link to Buckminster Fuller http://en.wikipedia.org/wiki/Buckminster_Fuller and to Walther Bauersfeld http://en.wikipedia.org/wiki/Walther_Bauersfeld .

Credits out of the way, geodesic domes are beautiful structures. Spheres give the greatest interior volume with the minimum of material. Their basic geometry can be broken up into hexagons and pentagons, or further broken up into triangles. See the rotating geogedisic spheres on the Buckminster Fuller page.

This model is made up of triangle units, which I then combined into hexagons and pentagons. Those units were then combined to make the sphere. I used bamboo shish-kabob skewers from the supermarket (called pincho sticks where I live), and hot melt glue.



step 1: GEOMETRY

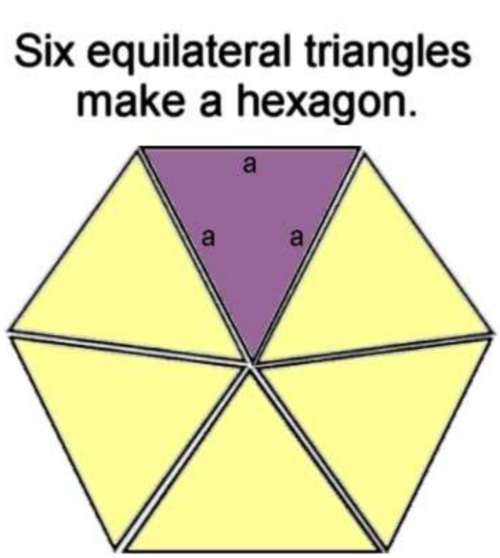
An equilateral triangle is a triangle composed of three sides of equal length. A flat hexagon (six sides) can be constructed out of six equilateral triangles. To more closely approximate spherical curvature, you want to raise the center of the hexagon a little. You do this by increasing the length two sides of each triangles, the sides that radiate out from the center of the hexagon. The longer you stretch the two sides, the more exaggerated will be the peak in the center of the hexagon.

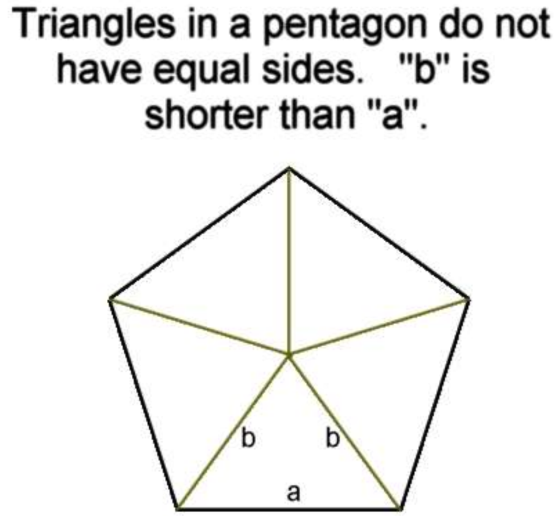
In a flat pentagon (5 sides) the two sides of the triangles that radiate from the center will be shorter than the third side. To more closely approximate a sphere, you have to lengthen them also. As with the hexagon, the amount that those sides are lengthened will determine the height of the peak in the center.

I don't know the math for making triangles that result in a near-perfect sphere, but I find the idea of lumpy domes and peaky geodesic spheres more interesting anyway. Just playing it by feel, this is the design I came up with.

I used the same triangles for making the hexagons and the pentagons. The dimensions I used for the triangles are: 2 inches for the short side, 2 1/4 inches for the long sides. Whatever variations you do with sides that radiate from the center, the outer sides have to be the same so that the hexagons and pentagons will join correctly.

(I have plans for making a next-generation model with the hexagon peaks going inward and the pentagon peaks going outward, to make a pollen grain-like structure.)





step 2: TOOLS AND MATERIALS

Tools: Cutting pliers to cut the sticks
Hot melt glue gun

Materials: Flat working surface
Non-stick work surface cover (Teflon cloth)
Vinyl (or cardboard) to make a holding jig for the sticks while gluing them
Bamboo shis-kebab ("pincho") sticks from the supermarket.
Hot melt glue

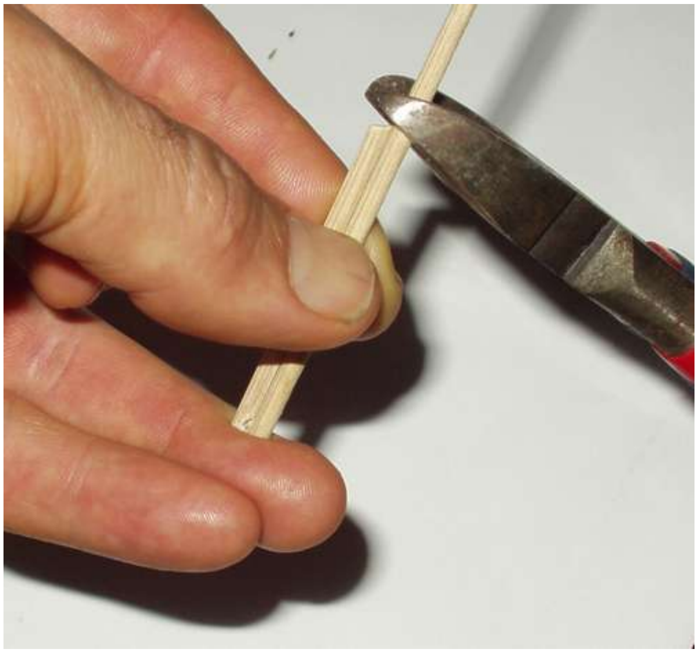
step 3: CUT STICKS TO LENGTH

Remember that the outside edges of the hexagons and pentagons have to all be the same length. How much you tinker with the inside lengths of the triangle sides determines the amount of peak in the middle of each hexagon and pentagon.

Unless you are really enamored by the way mine turned out using 2 inch and 2 1/4 inch pieces, have fun and create your own variations.

When I decided on the dimensions I was going to use, I cut a sample stick of the two sizes and used those sticks as guides for cutting all the other sticks of the same length. That way, all I had to do was match up stick ends, butt the cutters up against the other end of the guide stick and snip.

If you use different lengths for the radiating triangle sides of the hexagons and pentagons, you will have to cut three different lengths, not two.

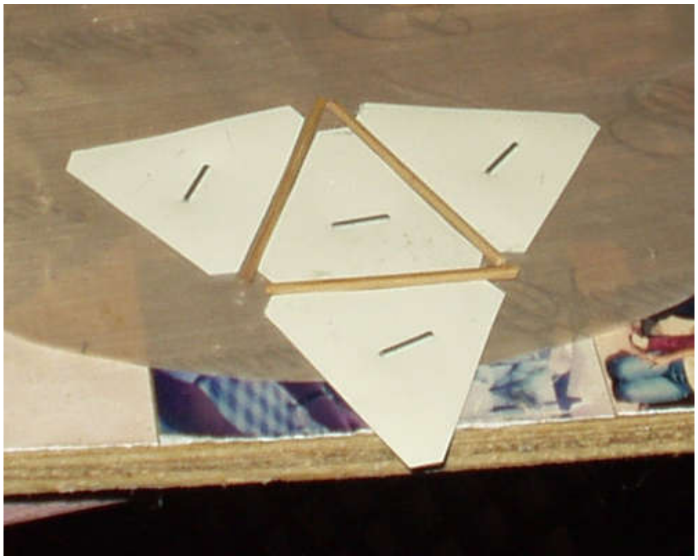


step 4: MAKE A HOLDING JIG

My work surface is a piece of plywood (a photo collage covers it) with a layer of non-stick Teflon cloth stapled to it. The Teflon is to keep the hot melt glue from sticking to the plywood. Teflon cloth may be available in kitchen supply centers. (Silicone rubber is another good non-stick material, but you would probably have to make your own non-stick sheet by spreading it out on cloth, paper, or some other base material. I use an artist's palette knife to do the spreading.)

Over the Teflon cloth, I stapled down some vinyl material as guides to hold the bamboo stick sections. You could probably use cardboard, or maybe ice cream sticks. Leave the corner areas open, since that is where you will be using the glue and you don't want to gum up your holding jig.

Once I got the sticks positioned in the jig, I set a weight on them to hold them in place. (I used a big round washer with some magnets stuck to it as the weight.) The sticks are so light that any pressure from the glue gun can dislodge them if they are not held in place.



step 5: ASSEMBLE THE HEXAGON AND PENTAGON UNITS

I assembled the hexagon and pentagon units by hand, without using a holding jig for positioning the triangles. There is a hole at the center of the hexagons and pentagons. Adjust the triangles to leave a nicely round hole and the rest of the shape will fall into place by itself.

Putting in the last triangle of each unit is the trickiest part, since you have to fold the assembled polygons some as you raise the center peak. Fortunately, the hot melt glue is flexible, so joints hinge nicely. The glue also cools and solidifies quickly, so you can hold it by hand until the last glue job hardens up. As you hold it, keep the base of the hexagon or pentagon unit pressed against the flat base of the work surface so that the base of the hexagon or pentagon will be in a flat plane.

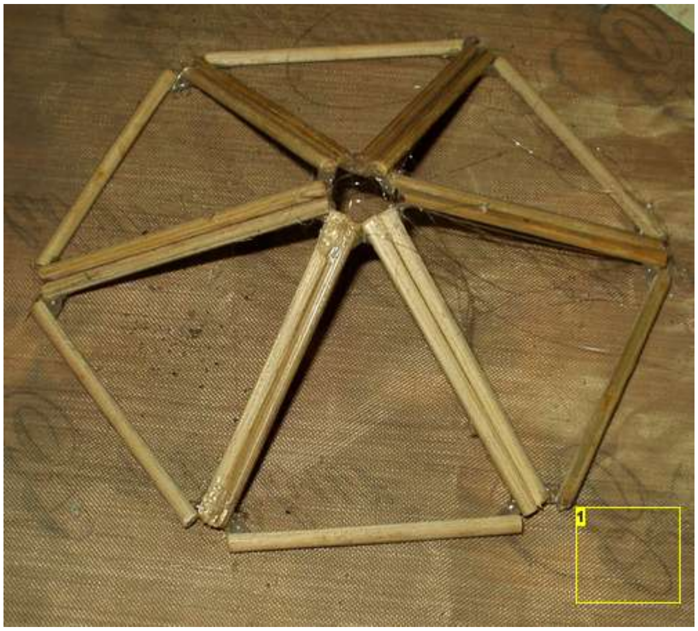


Image Notes
1. Hexagon unit completed, with raised peak.

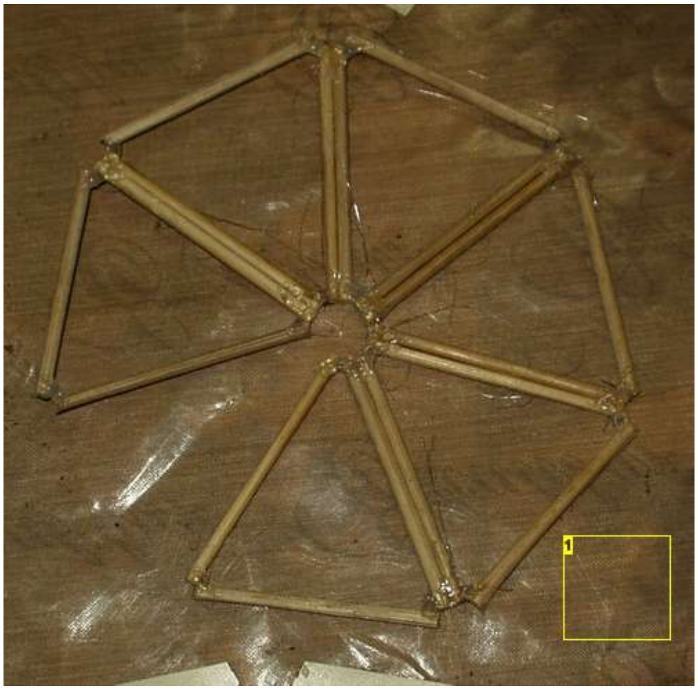


Image Notes
1. Hexagon unit flat, before raising the peak.

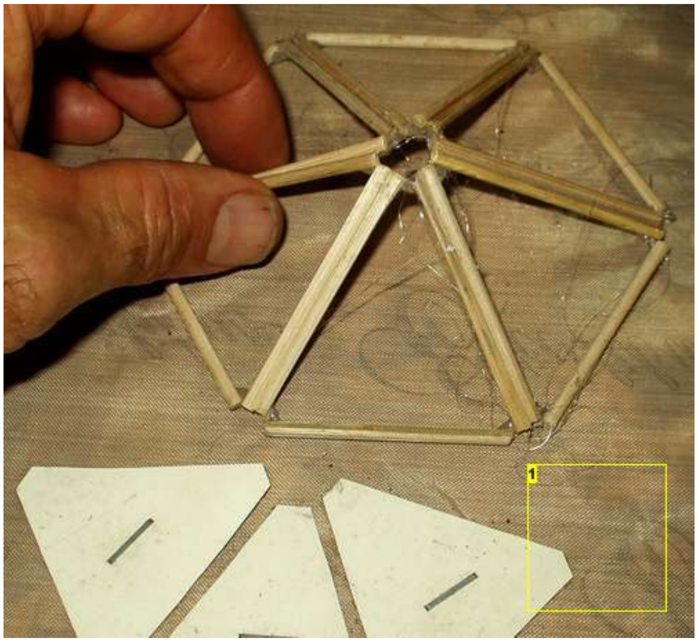


Image Notes
1. Folding the flat hexagon unit to make the peak.

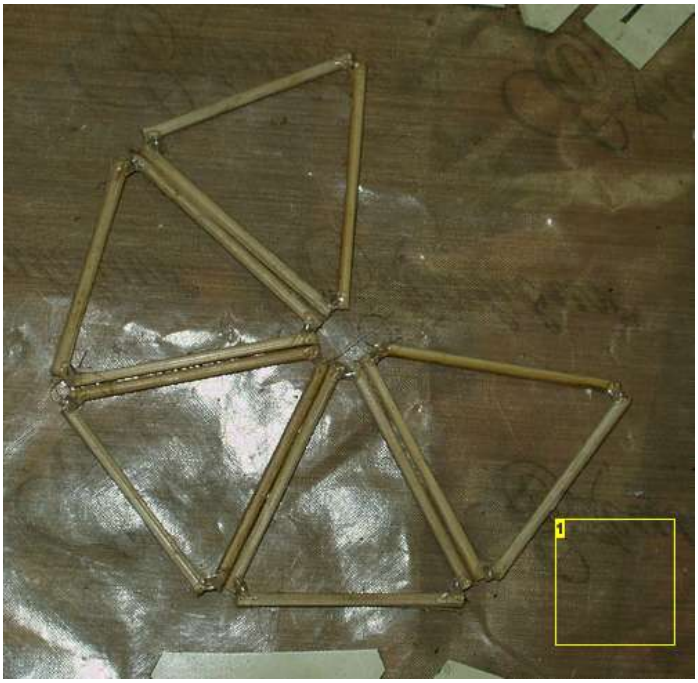


Image Notes
1. Flat pentagon unit. The same as the flat hexagon unit, but with one less triangle.

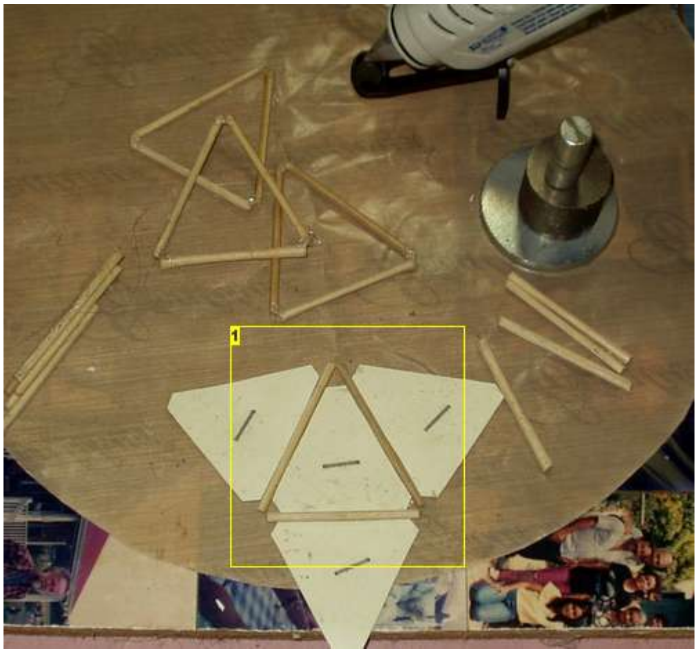


Image Notes
1. The holding jig with three sticks ready for gluing.

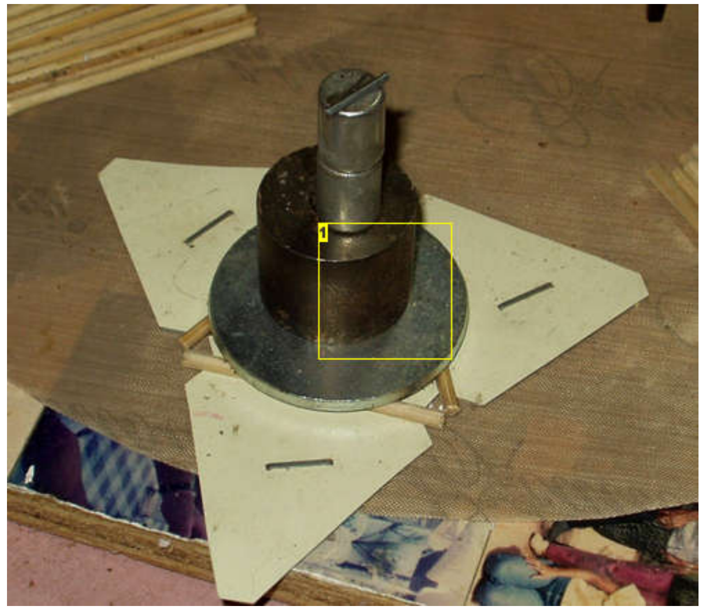


Image Notes
1. Magnets and washer used to weight down the sticks while gluing the triangles.

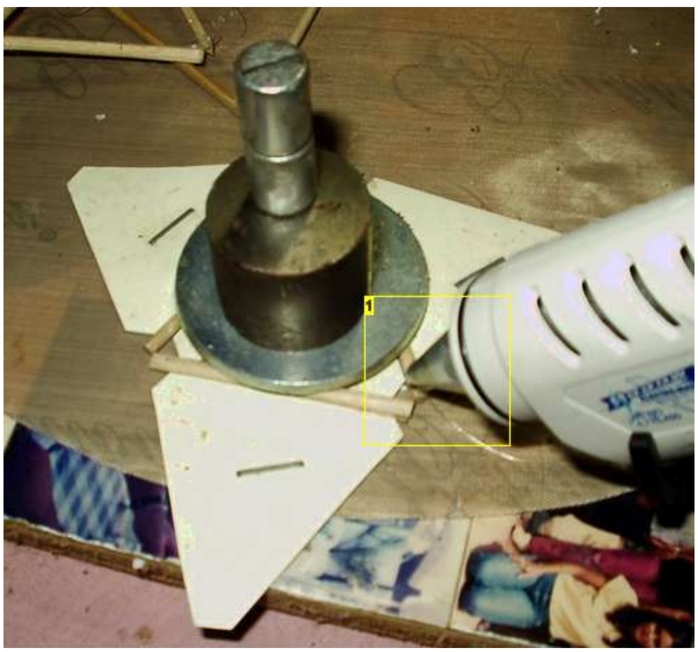


Image Notes
1. Gluing the corners.

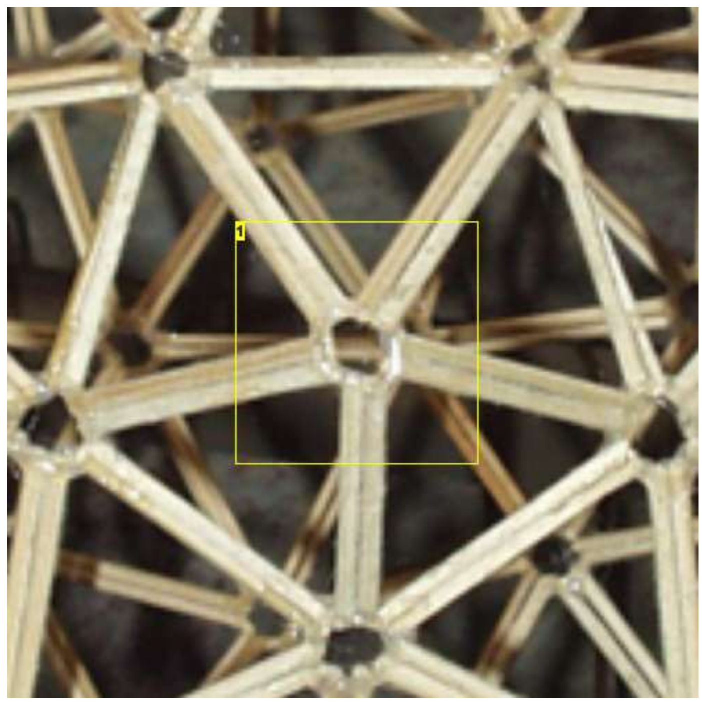
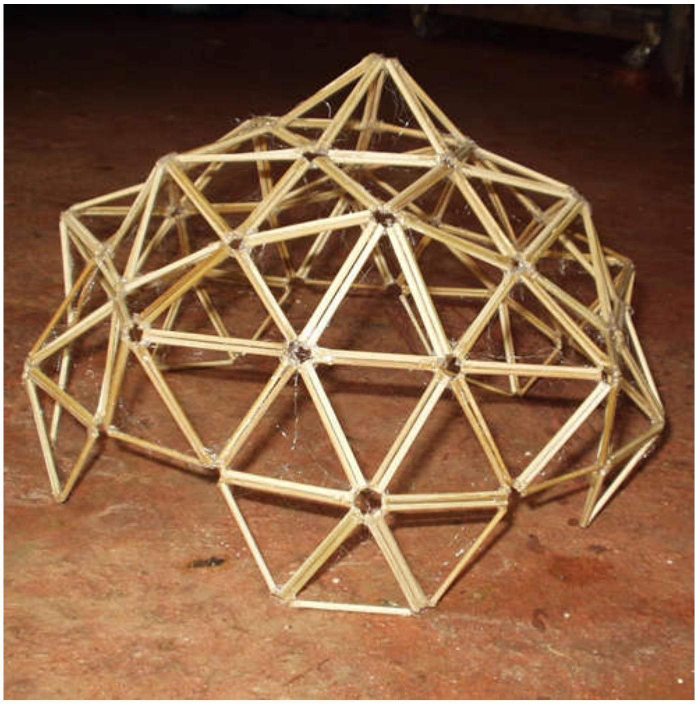


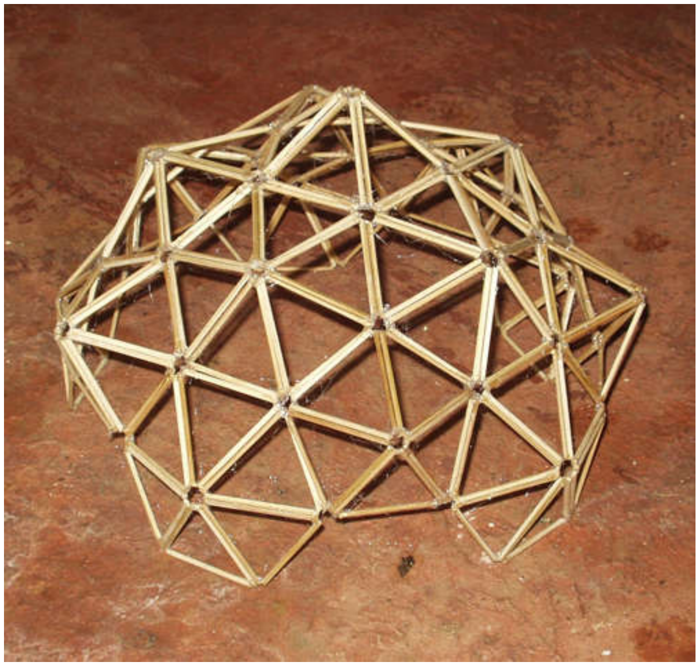
Image Notes
1. A hole forms at the center of each intersection.

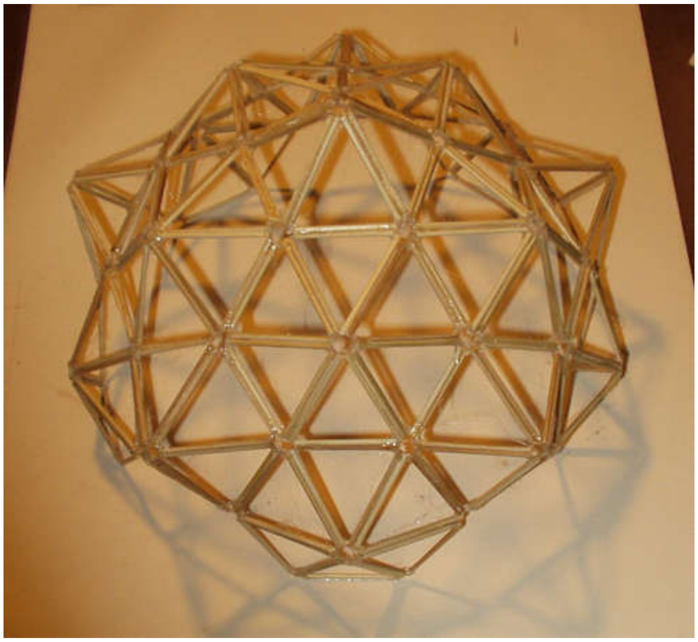
step 6: ASSEMBLING THE SPHERE

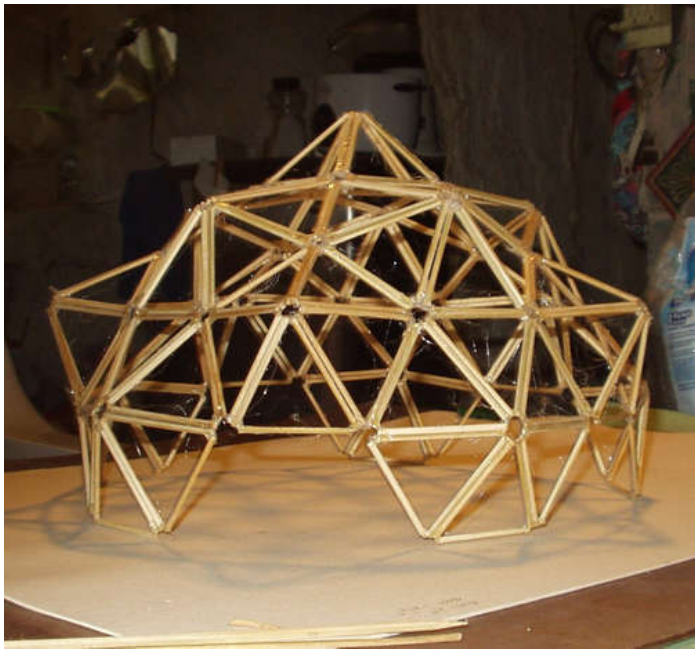
Each pentagon is surrounded by five hexagons. Each hexagon is surrounded by three hexagons and three pentagons.

As the sphere grows, it passes through stages that can be used as architectural models for dome structures.



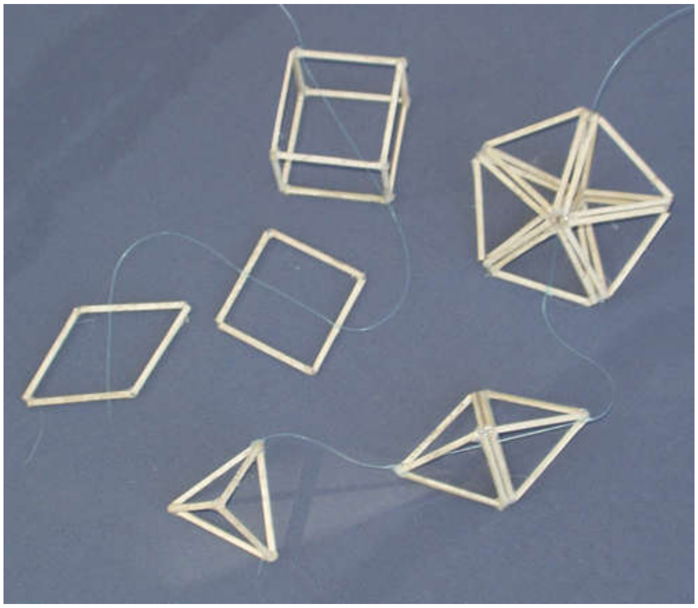






step 7: RELATED 3-D MODELS

This technique using bamboo sticks and hot melt glue can be used for making other geometry models, which might be of use in classrooms. These are a few other shapes I have made with this technique.



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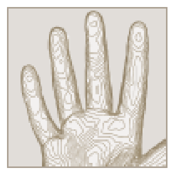

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