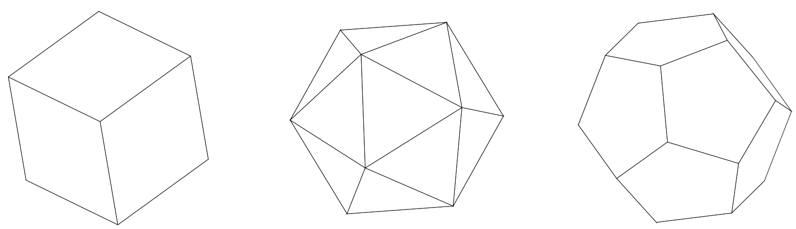
Zome Patterns Worksheet

Directions:

Important: When you finish with this exercise, please take any structures you have built completely apart and sort the pieces into the appropriate containers.

As a warm-up, use zome parts to build each of the following structures: a cube, an icosahedron and a dodecahedron. For each of these structures, you will need only blue struts, all having the same length. The struts are tough, but it is possible to break them. Push them straight into and pull them straight out of the Zome balls to make and break connections. The figure below shows models of the three structures you are trying to build.



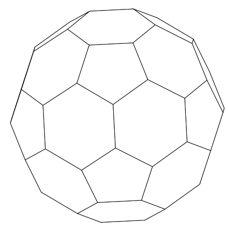
For each of the objects, count the number of vertices (Zome balls), edges (Zome struts) and faces (flat regions surrounded by balls and struts). We will use V, E and F to indicate the number of vertices, edges and faces, respectively of our structures. Try to figure out different ways to count them by dividing them into classes, or by whatever other means you can think of. These structures are relatively easy to count, but other examples will be more complex.

Whenever you build a structure and count V, E and F, enter that information into the table at the end of this worksheet.

Today we are interested in objects that do not contain "holes" in the sense that if you blow up a very flexible balloon inside the object, it would touch all the struts and balls without having to touch itself. (For example, a doughnut-shaped figure would not count, since if you inflated a balloon inside, two sections of the balloon's outer surface would eventually come in contact.) Another way to think of your objects is that if they were completely flexible, they could be distorted, without cutting, to the form of a sphere. A mathematician would say that they are topologically equivalent to a sphere.

Now build some more models that are "topologically equivalent to a sphere". Do not neglect simple models like tetrahedrons and octahedrons (which will require different-length and different-color struts). Other ideas include "cones", Egyptian pyramids, and so on. One easy way to make new models is to add faces to an existing model. For example, imagine adding a sort of Egyptian pyramid on top of a cube to make something that looks a bit like a house with a roof. For each of the models that you build, carefully count V, E and F, and record your results in the table at the end of the worksheet.

More challenging objects (both to build and to count the V, E and F features for include the "soccer ball" as illustrated below, and you can even make a large model of the Zome ball itself. The soccer ball will require only blue and yellow struts where all the blue struts are the same as are all the yellow ones, and the yellow strut size is as close as possible to the blue strut size. A model of the Zome ball itself will require two different lengths of blue struts. Again, count and record the V, E and F data for each structure.



After you have collected your data, try to find patterns in it. **Hint:** There is a simple algebraic expression relating V, E and F. Once you find the expression, try to come up with reasons why it might be true.

An advanced topic you can experiment with is to see if you can do a similar analysis of objects with a hole in them (objects that are topologically equivalent to a doughnut, or torus).

The cube and octahedron are said to be dual. So are the dodecahedron and icosahedron. The tetrahedron is said to be self-dual. What might this mean? **Hint:** Look at the values for V, E and F for these pairs of objects. Do other objects have duals in this sense?

Object	Vertices (V)	Edges (E)	Faces (F)	