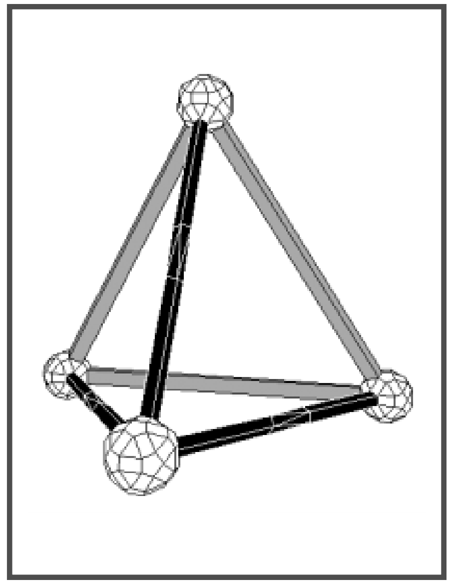
3-D Triangle Tiles

Zome System

Builds Genius!

Mathematics
Intermediate Concept

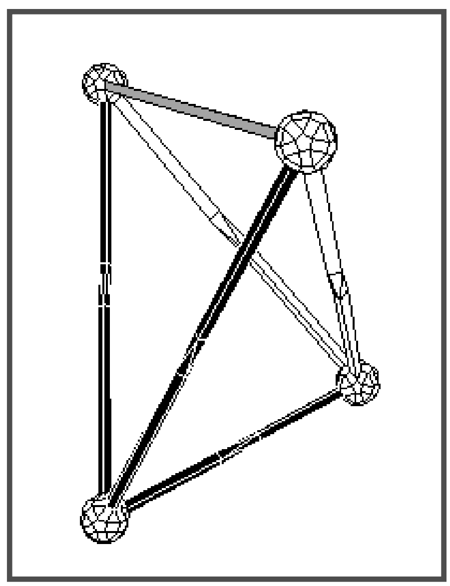


Lesson Objective:
Students will apply concepts learned in the "Triangle Tiles" exploration to build a 3-dimensional triangular pattern called a space-frame structure.

Prerequisite skills:
Ability to define the properties of triangles and 2-, and 3-dimensional triangular patterns ("Shape and Number", "Similar Triangles", "3-Dimensional Triangles", "Plane Patterns" and "Triangle Patterns").

Time Needed:
One class period of 45-60 minutes.

Materials Needed:
- Two Zome System Creator Kits for 25-30 students
- Images of natural and man-made space-frame structures (These are useful for discussion purposes, and can include cross-sections of bone, cell structures of plants, bridges, high-voltage wire towers, architectural space frame structures, etc.)



Procedure:
Divide your class into teams of 4 students each and distribute Zome System components evenly among the teams. As in the "Triangle Tiles" exploration, it's important that each team starts with the same number of each Zome System component. Set aside any remainders.

Based on their experience in the "3-D Triangles" and "Triangle Tiles" exploration, challenge each team to build a 3-dimensional triangular pattern; i.e. a 3-D pattern based on one unique 3-D triangle repeated many times. Again, the ultimate challenge will be to build the structure containing the most 3-D triangles. Inter-team trading of parts is allowed.

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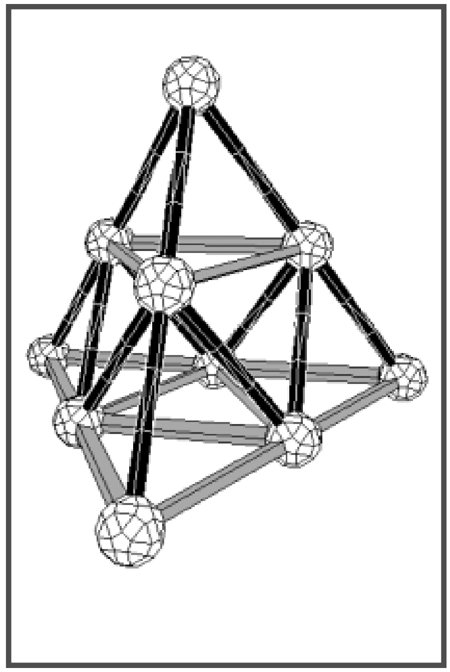
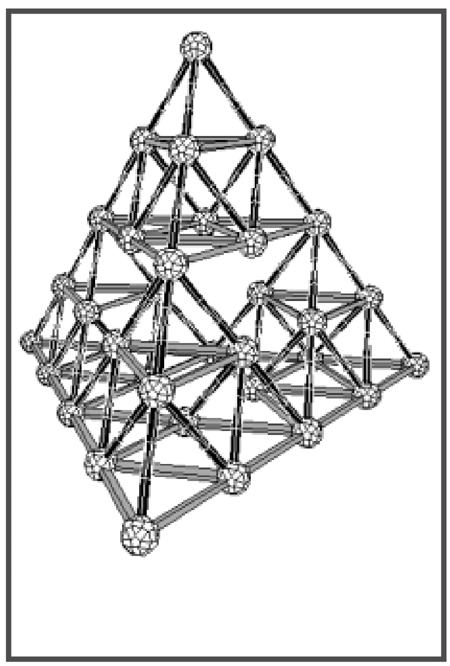
Allow 10-15 minutes for this exploration, during which time you can offer guidance to teams an individual basis. Teams can adapt the procedure used to build triangle patterns to the 3-D triangle tiles. Team members should first agree on a 3-D triangular "seed" which will be used as the basis for all cells in the pattern. Following this, each team member should make an exact copy of the seed triangle (for at least 4 total.) Teams may have to trade parts to build 4 units. The team must now figure out how to fit their 3-D triangles together to form a repeating pattern. This may be done by removing one or more nodes and/or struts from a given 3-D triangle, attaching it to the 3-D seed triangle and repeating the process until finding a pattern that works. Hint: one way to fit the 4 3-D triangles together is to build one larger 3-D triangle in which each edge is twice as long as the seed 3-D triangle. Finally, team members may expand their 3-dimensional tiling by copying the pattern and adding to the faces of the structure.

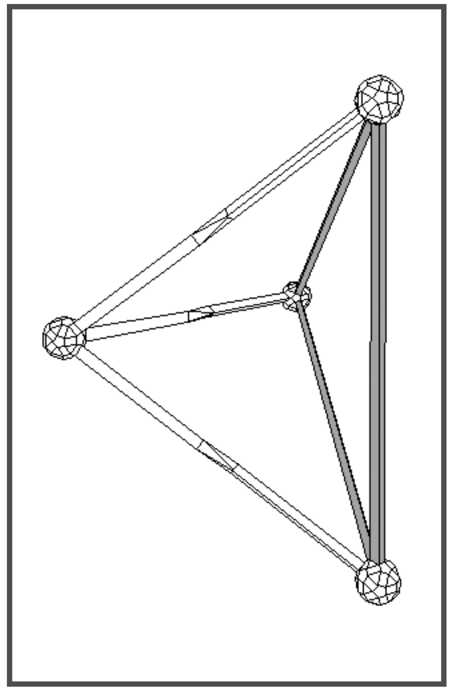


At the end of the building time have teams bring their models to the front of the class and discuss the strategy they used to maximize the number of 3-D triangles. Questions can include: *What factors affect the number of 3-D triangles you can build? The color of the struts? The number of identical struts in each one? The types of 3-D triangles used by other teams? How is the outcome affected if one team "copies" the structure built by another team? Should you make more long struts by adding together a short and a medium with a node in the middle? How does that affect the node supply?*



Follow up with a class discussion of the structures themselves: *How are the 3-D triangle patterns similar to the flat triangle tiles? How are they different? Are the 3-D triangular patterns made up only of 3-D triangles? If not, can anyone find a shape in the pattern which is not a 3-D triangle? How many sides does it have? Do 3-D triangular patterns have translational symmetry similar to 2-D triangle tile patterns? In how many directions? What structures in nature and the built environment have a similar pattern? Why?*

Ask teams to discuss their findings and write conclusions in their math journals. You may wish to introduce new vocabulary: a 3-D triangle is usually called a tetrahedron (meaning 4-faces). The 8-sided figure in between the tetrahedra is called an octahedron (meaning 8-faces). Geodesic dome inventor R. Buckminster Fuller coined the term oct-tet truss for these 3-D patterns, but in general they are referred to as space-frame structures.



Assessment:
Review written work in math journals. Question students in group discussion using questions similar to those suggested in the procedure section. To meet the standard, students will be able to translate 2-D triangles tiles into 3-D triangle tiles. To exceed the standard, students will be able to identify the 3-D structures by name.

Standards Addressed:
* Mathematics standards addressing mathematical problem solving as a method of inquiry and application (NCTM Standard 1).
* Mathematics standards addressing mathematics as a means of communications (NCTM Standard 2).
* Mathematics standards addressing investigation of mathematical connections (NCTM Standard 4).
* Mathematics standards addressing the study of the geometry of one, two, and three dimensions in a variety of situations (NCTM Standard 12).

Transfer Possibilities:
Continued work on the use of geometry in architecture and structural engineering (“Livable City” and “Bridge Building Unit”.)