Zome System

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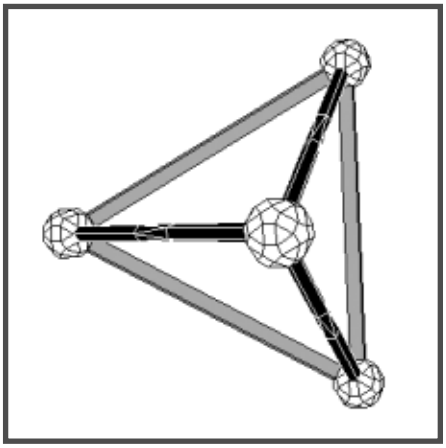
Plato's Solids - II

Mathematics / Philosophy
Intermediate Concept

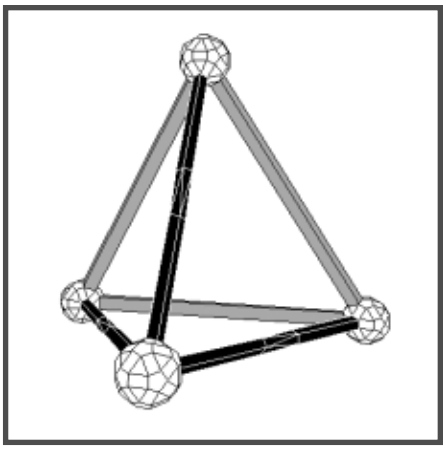
Lesson Objective:
Students will build the five regular Platonic solids with Zome System. They will learn about the solids' history and their occurrence in nature, the man-made world, and philosophy.



Prerequisite Skills:
Knowledge of basic polygons ("Geometric Shapes"), and ability to define a two-dimensional versus a three-dimensional figure ("2-D and 3-D Shapes"). Completion of "Plato's Solids - 1".

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

Materials Needed:
- Two Zome System Creator Kits for 25-30 students
- Three or four packs of supplementary green Zome System struts, if available
- Cardstock and Zome System vertices built during the "Plato's Solids -1" lesson
- Examples or images of crystals, virus and radiolarians,if available (can be found on the Internet)



Procedure:
Group the students into their teams from the previous lesson, and return to them the cardstock and Zome System vertices built then.

How should we go about building complete solids from the vertices we built before? How many solids can be made based on the five vertices? What would be the best way to proceed? Define for the students regular polyhedra if they are not familiar with the definition. Direct the students to build the complete solids, based on their suggestions of how to meet the challenge.

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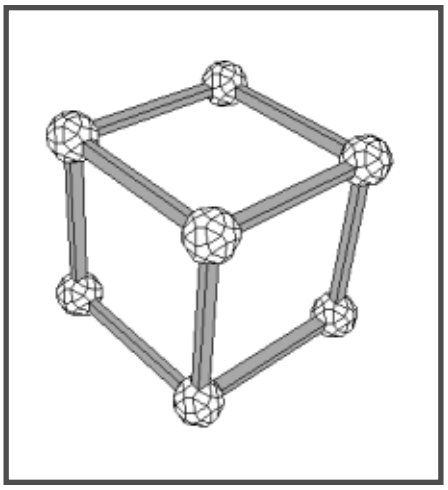
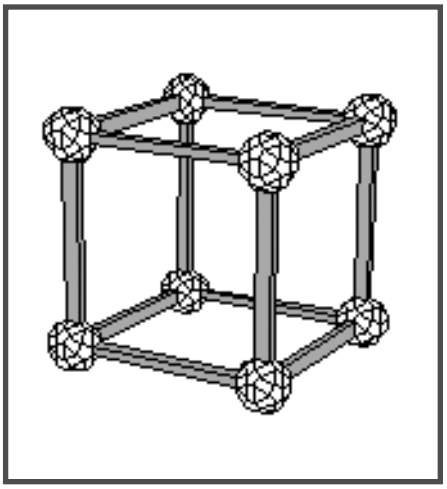
Students who do not have access to the supplementary green Zome System struts may encounter some problems building the tetrahedron or octahedron. A slightly irregular tetrahedron can be made using a blue equilateral triangle and built upward using red struts. A slightly irregular octahedron is made by creating a rectangle using blue and red struts, and then building upward and downward using red and blue struts. Both solids can be built regulat using the green struts.

Categorize the shapes by the shapes of the faces they have, and name the shapes. *How do we name geometric shapes? How many faces do the five solids have?*



Name of Solid	Number of Faces	Shape of Each Face
Tetrahedron	4	triangle
Hexahedron (cube)	6	square
Octahedron	8	triangle
Dodecahedron	12	pentagon
Icosahedron	20	triangle



History of Plato's Solids

No one knows who first discovered these shapes, but excavations in Europe have unearthed carved dodecahedral toys, which are at least 2500 years old. Images of the solids were also made by civilizations in both Africa and South America. The first person to describe all of them together was the Greek philosopher Plato, about 400 BC. He believed that the solids have mystical properties associated with the four elements of alchemy: earth, air, fire, and water. Plato assigned each element to a solid.

Fire — Tetrahedron	Earth — Cube
Air — Octahedron	Water — Icosahedron

This leaves the dodecahedron, which Plato associated with the shape of the whole universe, and the property of ether. *What do the solids have in common with their element?*

The 16th century German astronomer Johannes Kepler was fascinated by the Platonic solids, and came to believe

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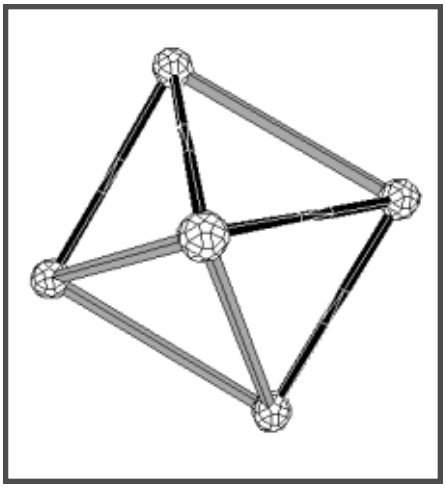
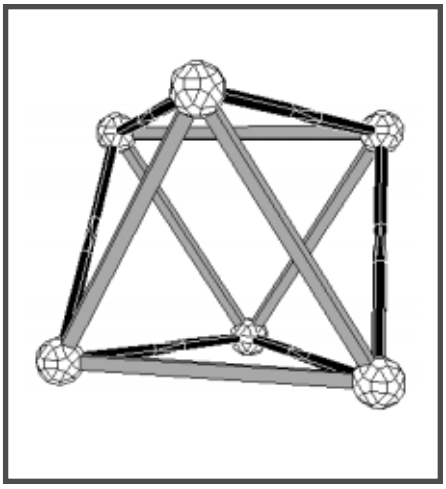
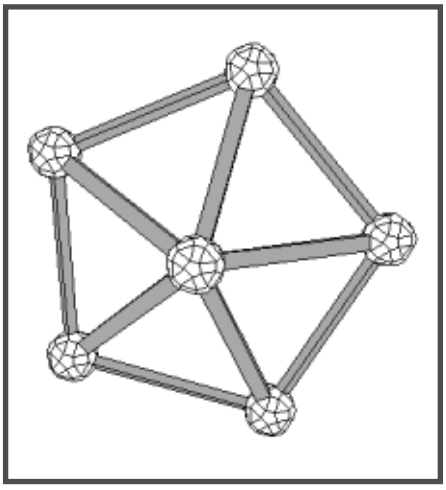
that they must be related to the structure of the universe. He created a model of the solar system based on the solids nested inside one another to explain the relative sizes of the planetary orbits. Kepler eventually abandoned this scheme as it never fit the real orbit sizes well enough. If time allows, the teams can attempt to nest the solids inside each other following Kepler's theory.

The five regular solids also occur in nature. For instance, many mineral crystals grow into the shape of an octahedron or a cube. Fluorite crystals exist in cubic and octahedron shapes. These are relatively inexpensive, and may be brought in for the class to examine. The external skeletons of microscopic sea creatures called radiolarian are shaped as tetrahedra. Most viruses, including those causing measles, AIDS, and the common cold are shaped as the icosahedron. The only molecule shaped like a dodecahedron, (Dodecahedrane $C_{20}H_{20}$) is make of carbon and hydrogen, the basic elements of life.

The solids continue to fascinate modern thinkers. The famous architect Buckminster Fuller based the design of his geodesic dome on the icosahedron. *Why does nature and man use such symmetrical shapes?* Ask the students to write down their theories of how the Platonic solids are connected to natural forms.







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Assessment:
Observe and students as they build their structures, and take notes of their findings. Review notes in math journals. To meet the standard, students must complete their Platonic solids in Zome System. To exceed the standard they must make written connections between the solids and naturally occurring forms.

Standards Addressed:
* 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 exploration of Polyhedra shapes ("Archimedian Solids", and constructions 4, 5, 6, and 8 in Zome System Manual). More work on three-dimensional tessellations ("3-D Triangle Tiles" and "Beehive City").