Zome System
Builds Genius!

Mathematics / Physics / Art
Basic Concept

Lesson Objective:
Students will deepen their understanding of the relationship between 3 dimensions and 2 dimensions by working with shadows of the cube and other models.

Prerequisite skills:
Ability to define the difference between 2-D and 3-D objects ("2-D and 3-D Shapes," "3-D Triangles," and "Speed Lines!). Ability to build, describe the properties of, and create permanent shadows of, the cube ("Cubes - I," "Cubes - II," and "Cubes - III").

Time Needed:
One class period of 45-60 minutes

Materials Needed:
- Two Zome System Creator Kits for class of 25-30 students
- Blueprint cube "shadow" for each team, as created in the "Cubes 3" exploration
- One piece of 12"x15" cardboard for each team of 3 students, to cast shadows on
- Overhead projector(s), or lots of sun
- Books, posters, slides or other materials on perspective drawing and optical illusions. Artwork by M.C. Escher is recommended.

Preparation:
Organize the classroom so several teams of students project shadows simultaneously. Set up a single overhead projector on the far side of the room to light up an entire wall, or use several overhead projectors. Alternatively students can work in a sunny area of the classroom or outside. Regroup the class into the same teams of 3 from the
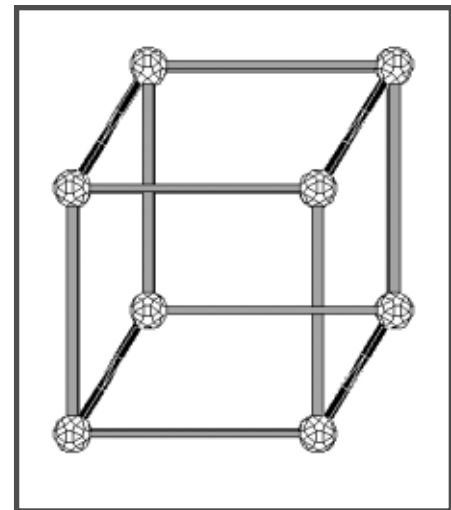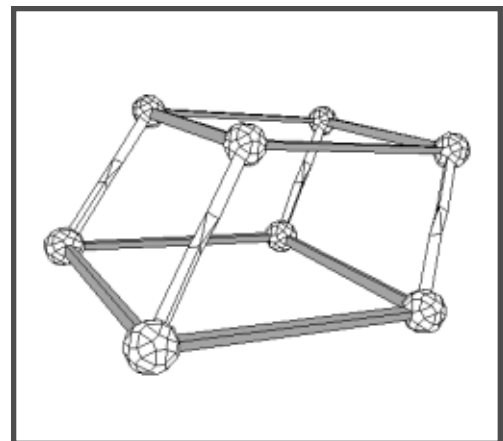
Zome System

"Cubes 3" lesson. The challenge for the teams is to build a Zome System model <u>other than a cube</u> which casts the same shadow as they captured on blueprint paper in the previous class. Each team member should build one model which s/he thinks will answer the challenge. Team member should rotate through the roles as Scribe, Holder, and Shadow.

The Scribe directs the trial of her own model and records the results in his math journal, The Holder holds the Scribes' model in various positions between the light source and the shadow casting surface, and the Shadow holds the shadow casting surface (with the blueprint cube shadow taped to it) in various positions. The Holder and the Shadow cooperate to cast the shadow of the 3-dimensional model directly on top of the blueprint cube shadow. The Scribe directs by suggesting changes in the position of the model or the shadow casting surface until the 2 shadows match up. If no match can be found after five minutes, teams should rotate roles and try the next Scribe's model. When all teams have finished their three rotations, each team selects one successful shadow match to present to the class.

Discuss of student discoveries during and after the presentations. *Were all the cube shadows from the previous exploration the same? Why, or why not? Is it possible to make a model other than a cube which casts the same shadow as a cube? More than one? How many? Do the new models have in anything in common with the cube models? How many struts does each successful new model have? How many nodes? Could you make a flat model which casts the same shadow as your blueprint cube shadow? Is it easier or harder? Why? What happens to shadows when you rotate the shadow casting surface away from the light? Why? What happens to shadows when the sun moves through the sky? Could two people look at the same drawing and see two different things? Why?*

Continue the exploration of perception, perspective, dimensions, and optical illusion, using artwork by M.C. Escher and others. Drawing and perception are all related to the jump from 3 dimensions (an object) to 2 dimensions (an image) and back to 3(+) dimensions (the object as it exists in the mind). Students can discuss both practical application of these concepts, and more abstract philosophical aspects.

Assessment:
Take notes during discussions and while the students experiment, Review the created "shadow models" and notes taken by the teams. To meet the standard, students must build Zome System models which cast shadows identical to those they created earlier using cubes.

Standards Addressed:
* Mathematics standards addressing **mathematical connections** (NCTM Standard 4)
* Mathematics standards addressing **geometry and spatial sense** (NCTM Standard 9)
* Fine Art standards addressing **perspective and projection drawing**

Transfer Possibilities:
More work on shadows and perspective drawing.