

## Mathematics / Art Basic Concept

### Lesson Objective:

Students will learn how to build distorted versions of regular polygons by working with shadows of Zome System models.

### Prerequisite skills:

Ability to recognize various polygons and connect them to numbers and symmetries (“Shape and Number,” “What is Reflection Symmetry?” “2-D and 3-D Shapes,”).

### Time Needed:

One class period of 45-60 minutes.

### Materials Needed:

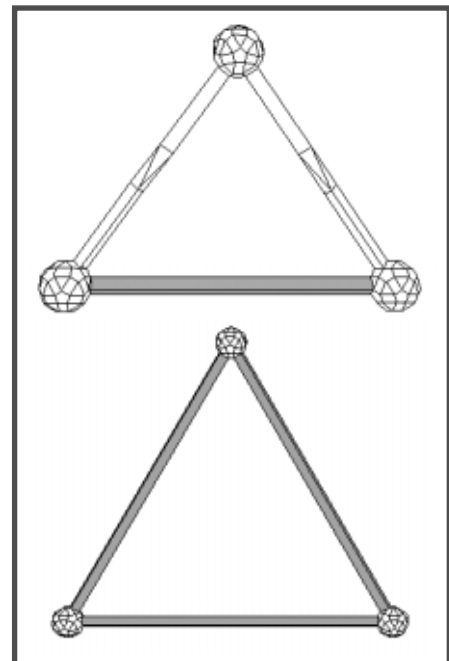
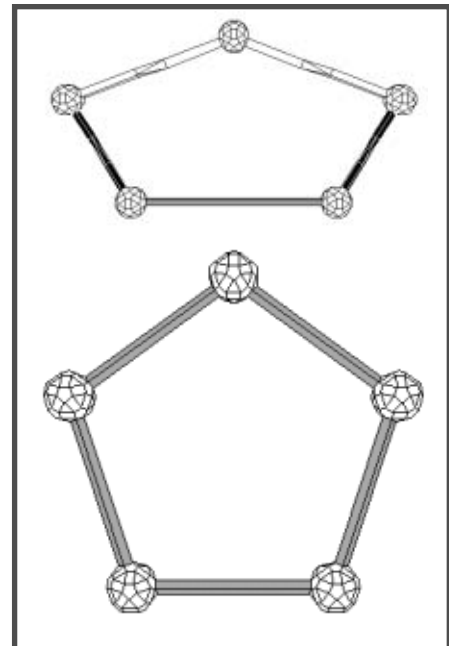
- One or two Zome System Creator Kits for class of 25-30 students
- One or more overhead projectors
- Large sheets of paper in case shadows do not fit in student’s math journals (optional)

### Procedure:

Prepare for the class by setting up overhead projectors so many students are able to cast shadows simultaneously. If the class can be held on a sunny day, it is best to hold part of the lesson outdoors; sunlight produces the crispest shadows.

Divide the class into teams of 2 students, and distribute the Zome System pieces evenly. The challenge for the teams is to build squashed or distorted versions of polygons they have worked with in previous lessons. The distorted shapes must be identical to shadows of the polygons they already know.

The teams should first build the regular shapes they learned in the “Shape and Numbers” exploration. One team member should then use the overhead projector to

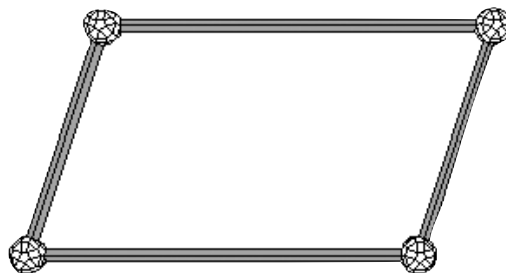


# Squashing Shapes

## Zome System

*Builds Genius!*

cast a squashed shadow of the polygon model, while her/his partner traces the shape of the shadow on paper. The partners then switch roles. Both team members should build Zome System models which matches the shadow drawings as closely as possible. When both team members are satisfied with their new shapes, they should return to the light source. One should hold a squashed shape flat against the screen or wall, while the other manipulates her/his regular model, trying to exactly line up its shadow with the squashed model. Switch roles so both members get to understand the necessary manipulation of the model in the light.



When all teams have finished work, ask each team to select one successful shadow match to demonstrate in front of the class. Lead a class discussion of student discoveries. *What makes the shadows squashed? Under what conditions are the shadows not squashed? How can you be sure? Was everyone able to match regular and squashed models exactly? Why, or why not? What is the “most squashed” shadow you can get? Why? What is the same about the regular models and their squashes (number of sides, combined angles)? What is different about the regular models and their squashes? How many different squashes could you build of the same regular model? Is it possible to cast stretched shadows? Is it possible to build stretched models? Is it a stretched model just a squashed model turned sideways?* The class can be extended to include the study of distortions in patterns and pictures in other media. Examples can include pictures of railroad crossing warnings painted on a highways, or very stretched writing from puzzle books. *What do we actually see when we view a TV screen from an angle instead of straight on.*

### Assessment:

Circulate and question the teams while they are working. Review their drawings, models, and notes in journals. To meet the standard students must complete at least two squashed models of regular polygons. To exceed the standard they must verbalize how the squashed and regular shapes relate to each other (what is the same, and what is different). They must also develop a theory why the movement of the model in the light produces a distorted shadow.

### Standards Addressed:

- \* Mathematics standards addressing **mathematical connections** (NCTM Standard 4).
- \* Mathematics standards addressing **geometry and spatial sense** (NCTM Standard 9).
- \* Fine Arts standards that **identify and apply the elements of art in a variety of media.**

### Transfer Possibilities:

This lesson is appropriate as a starting point for work on shadows and perspective drawing (“3-D Triangles,” “Speed Lines!,” “Cubes - I,” “Cubes - II,” “Cubes - III,” and “Cubes - IV”).