Zome System

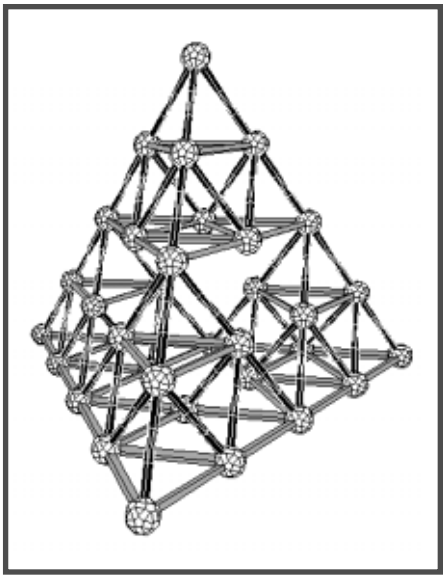
Builds Genius!

Tallest Tower in the World

Architecture / Physics
Intermediate Concept

Lesson Objective:
Students will start exploring structural stability in architecture. They will understand the importance of triangular reinforcements.

Prerequisite Skills:
Ability to identify names and shapes of regular polygons. Some background in the idea of gravity forces.



Time Needed:
Two or three class periods of 45 to 60 minutes

Materials Needed:
- One Zome System Creator Kit per 5-7 students
- Six or 7 telephone books or other heavy books
- Posters or books showing architectural elements such as trusses, buttresses, and space frames.

Procedure:
Start the class with a discussion of where we use geometry in our everyday life. Some students will be aware that knowledge of this subject is important to the engineers and architects who design and build houses, bridges, towers, etc. *How do these people know which structures to use in their work? Are some shapes more common than others? Is it important how attractive the shapes are? Are some shapes easier to manufacture than others? Are some shapes stronger than others?*

Divide the class into teams of 4-5 students. Their assignment is to build the tallest tower possible that is able to support a certain amount of weight, such as 3 phone books. Older students can be given additional requirements, such as having to work on a set budget (see the worksheet entitled "Construction Crew Wanted" that is part of the "Bridge Building Project" integrated unit).

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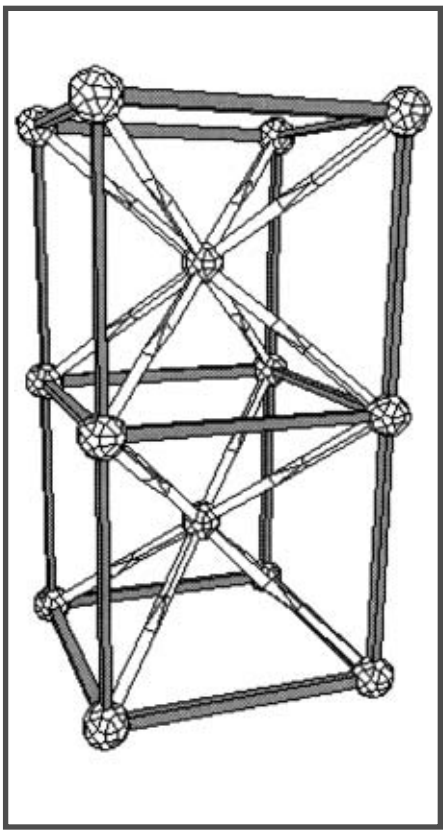
Discuss the planning and pre-building design process the teams need to engage in. Set a time limit for their first design.

Circulate and question the students as they work. *How can we test the strength of a shape before it is incorporated into the tower? Is it better to use longer struts as opposed to shorter ones? Where will the tower break, at the connection between the node and the strut, or will one of the elements actually break?* Students should take continuous notes of their observations during the construction phase. After the initial designs have been built each group should present their design to the class. Test the towers one by one, starting with the tallest one, until you have identified those that are able to carry the pre-determined weight. Discuss the appearance of the towers as the phone books are loaded on. *Is it wobbling side to side? Is it starting to twist? Where does it appear to be weak?* Finally, load on additional phone books on the surviving towers to determine the breaking point for each structure.



Lead a discussion of what shapes and reinforcing strategies worked well, and which ones did not. Students should write their own definitions of pattern, modularity, and stability. As a class, discuss these elements in the tower designs. *What shapes were most effective in reinforcing the structure? What were some things that the tallest towers had in common?... the sturdiest? ...the most efficient? How would you change the design in a second tower? What aspects would you leave the same?* The teams can then be allowed to build new towers to test their design changes.

The major concept that all students should find is that triangular reinforcements distribute weight most efficiently. *What is it about triangle that makes it stronger than, say, a rectangle or a square? How can we investigate this?*A good way of demonstrating the qualities of these shapes is to build a triangle and a rectangle and apply pressure on them with your hand. The angles of the rectangle will change while the lengths of its sides remain the same. It will thus fold over until it breaks apart. In the triangle the angles and side lengths are fixed to each other, it cannot

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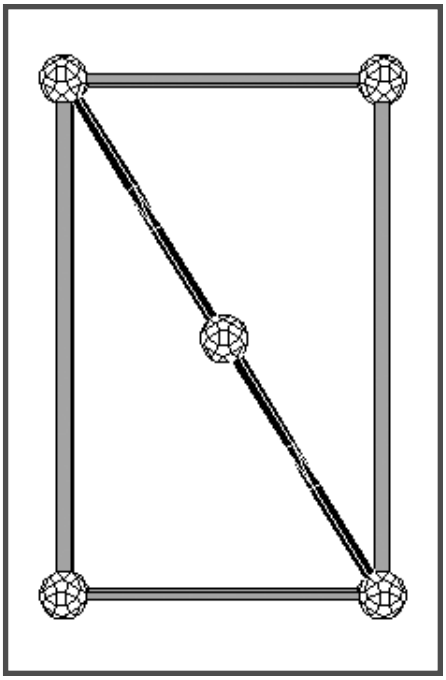
fold over. Increasingly large amounts of force can be distributed down along the sides, until the entire shape eventually snaps apart.
When they the teams are finished with their towers, they should write out a chart in three columns, labeled pattern, modularity, and stability, and list the properties of both towers. They should write a definition of triangular reinforcement.

Assessment:
Observe students as they build. Assign a short report where students describe their structures and discuss the effects of different designs. To meet the standard students must identify that triangular reinforcements improves the structural stability of their designs. To exceed the standard they must define in writing why the triangles is stronger.



Standards Addressed:
* Technology standards addressing structural stability.
* Physics standards addressing the effects gravity and stress on a structure.
* 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:
Further discussion and modeling of triangle patterns, gravity tension, and compression. The activity is also an excellent lead-in to units on architecture and engineering as well as civics discussions on city planning ("Livable City").