



### Age Level:

Third grade and up

### Subjects:

Math  
Science  
Social Studies  
Language Arts  
Visual Arts

### Time:

One 45-minute session

### Learning Objectives:

- To gain an understanding of mathematical principles through sensory perception
- To relate mathematics to real-life observations

### Design Professional:

As you do each exercise with the students, reinforce what they are doing by showing pictures of buildings that demonstrate the same structural principles the students are acting out. Work with the teacher to make sure the students are experiencing the concepts appropriate for their age group.

This activity is so much in the province of the architect that it will be difficult to prevent it from becoming a lecture. Plan with the teacher to keep the experiential quality paramount and to be sure it is appropriate for the grade level.

### Teacher:

This is a great activity for the students to get up and move around the classroom. Work with the design professional to make sure there is enough wall space for students to reach and open floor space for groups to demonstrate larger structural components.

You may feel uneasy about this activity and hope the design professional will take it over. However, the design professional needs you to aid in keeping the presentation appropriate to the grade level and to have the students experience the concepts, so they are understanding them by actually feeling and visualizing them.

Don't hesitate to add comments and suggestions as you see how the students are responding.

### Rationale:

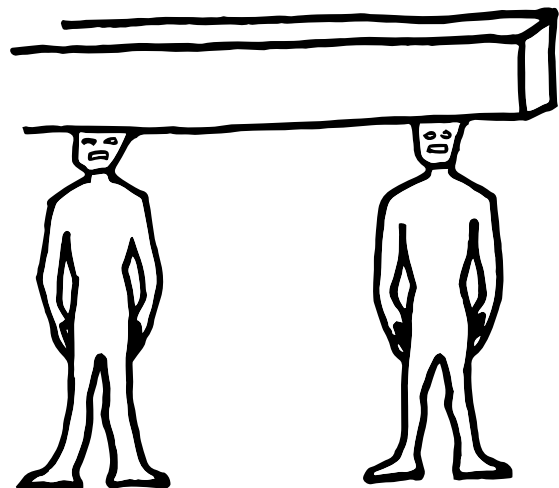
Concepts concerning the structural properties of various geometric shapes and how this knowledge relates to the buildings they experience every day are very difficult for students to grasp.

However, the human body is a wonderful structural example. When students are involved in activities that use their bodies to actually "feel" how it is to be a beam, a column, a truss, etc., and that is related to the buildings they live in, or other architectural examples, they quickly become excited about how structures work.

### Presenting the Activity:

Initiate a discussion about the relationship between the human body and architectural structures. Use the following pages and diagrams as a guide.

Note: An excellent supplement to this lesson is the book, *"What it Feels Like to be a Building."* by Forrest Wilson (Preservation Press, National Trust for Historic Preservation, 1735 Massachusetts Ave., NW., Washington, DC., 20036.)





### Position

### Where do you feel it?

#### Sitting down:

- |  |   |
|--|---|
| 1. Press fingers together with lower arms against each other.                              | Hands and upper arms                      |
| 2. Make a fist with thumbs up and press hands together with lower arms against each other. | Stronger pressure in hands and upper arms |
| 3. Press fingers and thumbs together with hands spread out and lower arms together.        | Stronger in fingers and upper arms        |
| 4. Press fingers and thumbs together with arms spread out forming triangles.               | Stronger pressure in hands and arms       |



#### Standing up:

5. Do the same exercises, one after the other, while standing up. Note the differences in the feelings in the hands and arms and what other parts of the body are experiencing. Structures work together!
6. Stand up straight, with arms at sides and make yourself feel HEAVY on the floor.
7. Stand with legs apart. Where do you feel the pressure now? How do you feel in relation to the floor?
8. Stand with legs apart and put hands on hips. How has the pressure changed? How many triangles has your body formed? (Three)
9. If a 150 pound dog was excited to see you and was about to jump on you, what position would you take? Why?





The pressure you have been feeling, that tightening up of various parts of your body, is called tension, when applied to a structure.

The most basic structural system is the post (or column) and lintel (or beam). Almost every building will use this system somewhere in its structure.

10. Stand in pairs, side-by-side, with your arms outstretched to the side. Each person is the same as a post (column). Your arms are similar to a lintel (beam) that is supported by the post (column). When posts (columns) are joined together in a row, they help support each other. If your fingers are just touching, you won't be able to hold much of a load on your hands, and your arms will get tired quickly (Position A).

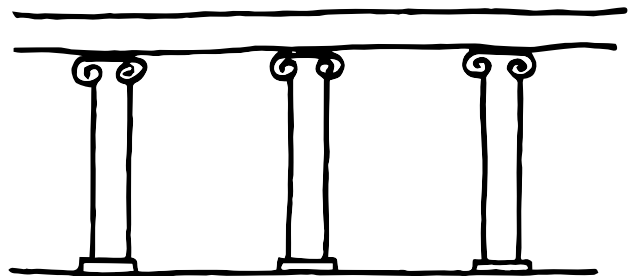
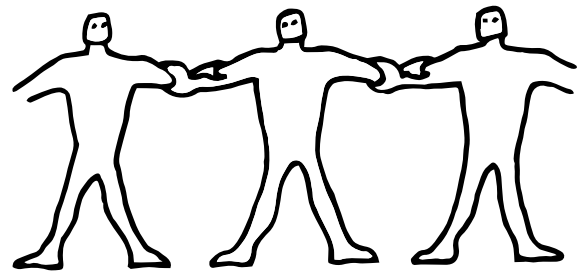
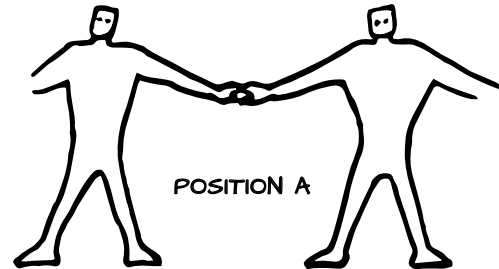
Now lock your fingers together and pull against each other (Position B). See how much stronger you feel?

Now interlock your hands and arms up to your elbows and pull against each other (Position C). Does that feel different? Much stronger? Your arms are reinforcing each other.

11. Have groups of three or four students stand in a row with arms outstretched. With only the fingers touching, the columns and beams do not affect each other at all. Try each of the two interlocking positions, B and C. Which seems the strongest? Where do you think the beams will be the weakest? (At the center)

Each person is the same as a post or column. Your arms are the lintels or beams that are supported by the posts (columns). When these structural members are joined together, they help support each other.

When a series of posts and lintels (columns and beams) are put together in a row, it is called a colonnade.



COLONNADE



Another structural form is the arch.

12. Have each pair of students stand facing each other a little way apart, with arms raised above the head, and fingers touching each other. Have them do steps A, B, and C in this position.

Suggested dialogue:

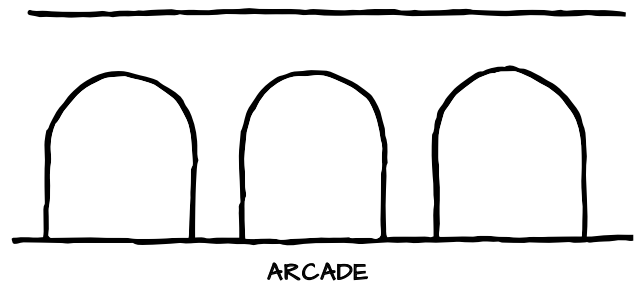
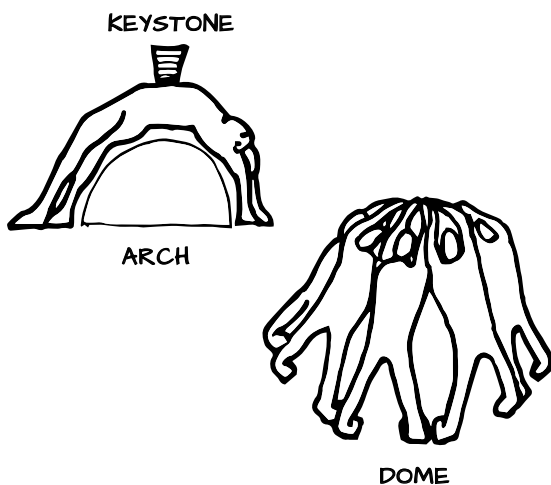
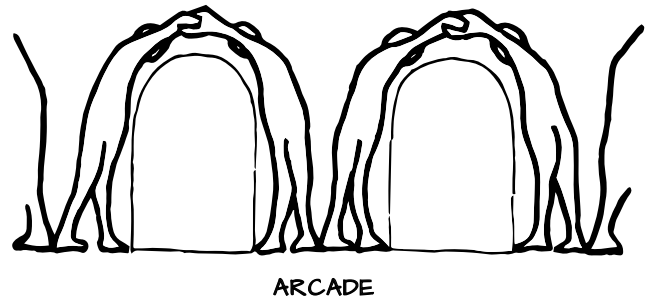
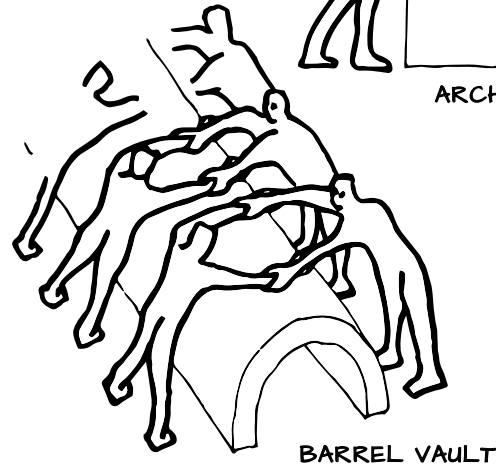
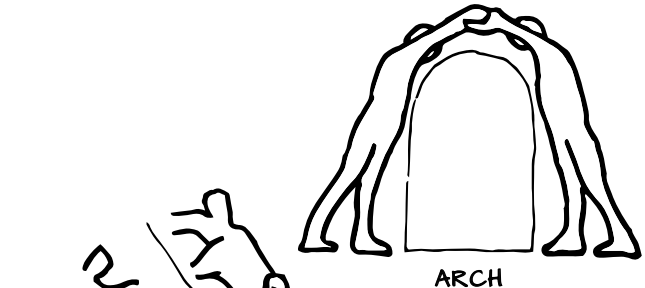
*“How did your body feel different than when you were posts and lintels? Where do you think the weakest point of the arch is? (At the top, where the hands join) However, the top can become the strongest point, when a wedge shaped stone called a keystone is fitted in at the top.”*

Have the pairs stand in a row with their feet touching the next pair. When you have a series of arches in a row, it is called an arcade.

13. Have the pairs stand side-by-side, while they face each other. When a series of arches are put together this way, they form a barrel vault.

Have groups of about eight students form a circle and join hands in the center, with their feet touching the feet of the people on either side of them. When a series of arches meet in the center, they form a dome.

14. Another rather energetic way to experience an arch is to do a back bend. When books are loaded on the center of this arch, you will know how it feels to be a keystone!





The strongest structural form is a triangle.

*“Remember the first thing we did when you put your fingers together with lower arms against each other? Do that again and press your fingers and thumbs together with your arms out at the sides. That feels much stronger, doesn’t it? Look at the triangles your fingers and arms have formed—they are what makes it feel so much stronger.”*

15. Have pairs of students place their feet together and join hands, trying both the B and C inter-locking positions.

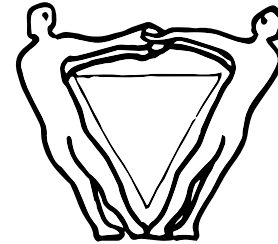
*“How does that feel? Can you lean back much farther than you could if your arms were not interlocked?”*

*“A triangle is a very strong shape.*

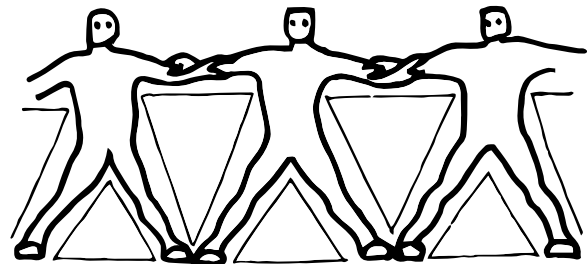
*“What you have just formed is a segment or part of a truss. A truss is a series of triangles.”*

16. Now have a row of students interlock arms with their feet spread apart, so they are touching the feet of the persons on either side. Each student’s body has formed a triangle and the space between their bodies and their out-stretched arms has formed another triangle.

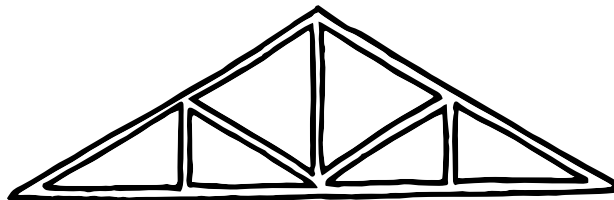
They are simulating a truss, which is a very strong structural form that can support heavy loads and span wide spaces.



TRUSS SEGMENT



TRIANGULAR TRUSS



TRIANGULAR TRUSS



“Probably many of you have roofs on your homes that look like a triangle. They are gable roofs. It is a good shape to let the rain run off, but it is also strong. If your roof isn’t very wide, it may have just one brace up near the ridge. If your house is wider and needs a bigger roof, there may be more braces, and they most likely will be placed so they form triangles or a truss. If it is possible, try to take a look up in your attic.

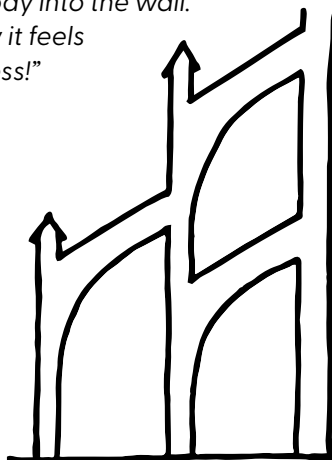
“There is one more structural form we are going to talk about. Of course, there are many more, but this will be enough for now!

“If you have a very high wall, or one that has a heavy load on it, it may need some help to keep it standing up.”

17. “Stand up straight against a wall in the room with the side of your body touching the wall as closely as you can from your feet to your shoulder. This would be the way another wall at right angles to the one you’re leaning against would help to reinforce or buttress a wall.

“You might also be a pilaster—that is, an extra square or rectangle added to a wall to make it stronger. Stand with your back to a wall and press against it. That is how it feels to be a pilaster.

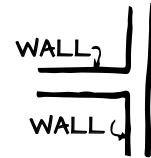
“If the wall needs a lot of help, a flying buttress might be added. Face the wall and stand out from it a little ways. Put your hands over your head and press the palms against the wall. Lean your whole body into the wall. Now you know how it feels to be a flying buttress!”



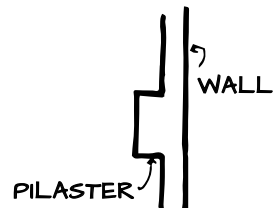
FLYING BUTTRESS



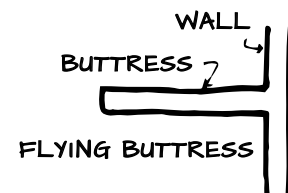
WALL



PILASTER



FLYING BUTTRESS



## HOW IT FEELS TO BE A STRUCTURE

Application of Architectural Concepts



"Let's look around this classroom and see if we can find any of these structural shapes. You will have to use your X-ray vision to see through the walls and ceiling!"

"Look at the door. It would have something like posts at the sides and a lintel over the top. What about the window? Yes, that would be similar.

"Inside the walls of the room there is probably a series of posts (strips of wood called studs) about two feet apart, that go from the floor to the ceiling.

"Across the ceiling there may be beams, but this is a pretty wide room, and it may have some trusses in the ceiling.

"Try to imagine what structures may be in the walls and ceilings all around the school. There may be a big truss that is visible in the gym or cafeteria.

"When you go home tonight, look around your house to see what structural forms you have there. Tell your family what you have been doing and have them help you.

"You should be able to find most all of the structural forms, although it would be unusual to find a dome! They are usually on towers, churches or sports arenas.

"Write some notes, or better yet, make some sketches and compare them at school tomorrow."

