Symmetry in Form and Function

We immediately notice a structure’s shape and size when we look at it. The shape of an object helps us identify it. The shape also helps us distinguish it from other objects. One aspect of shape is symmetry. A structure displays symmetry (is symmetrical) if it can be divided in half, creating two pieces that are mirror images of each other.

A line of symmetry is an imaginary line that divides a symmetrical object into two mirror image halves (Figure 1).

**Figure 1** The CN Tower (a), jet aircraft (b), table lamp (c), and butterfly (d) all display symmetry.

**symmetry:** an exact reflection on opposite sides of a line dividing an object in half

**line of symmetry:** a line that divides an object into two mirror image halves; helps display symmetry
Symmetry in Nature
Symmetry is an important principle in nature. Look at yourself in the mirror. Pretend that there is a line going down from your forehead, over the tip of your nose, through the middle of your chin, and then straight down the centre of your body. You will notice that the two halves of your body on each side of this imaginary line are nearly mirror images of each other. (No one is perfectly symmetrical.) The entire human body is nearly symmetrical when a line of symmetry is drawn in this way (Figure 2). Humans usually have two kidneys, two lungs, two symmetrical rib cages—even the human brain is divided into two symmetrical lobes. Is the human body symmetrical if viewed above and below the waistline?

Humans exhibit symmetry. Dogs, cats, butterflies, flowers, leaves, and sea stars all exhibit symmetry. Symmetrical structures are all around us.

Figure 2 In 1492, Leonardo da Vinci illustrated the symmetry in the human body in one of his most famous drawings, the Vitruvian Man.
The Role of Symmetry

Symmetry is an important idea when considering the aesthetics of a structure. **Aesthetics** determine how visually appealing something is. Many people consider objects that are symmetrical to be more appealing than objects that are asymmetrical (not symmetrical) (Figure 3).

Asymmetrical Design

Would you like to live in a building where the walls were not straight, the floor was uneven, and none of the windows were the same size? These designs were all used in structures designed by Austrian artist Friedensreich Hundertwasser (1928–2000). Hundertwasser is famous among modern artists for rejecting symmetry as a design principle. Most of Hundertwasser’s structures (Figure 4) and designs are controversial. Today, people find Hundertwasser’s designs to be interesting because they are unique. It remains to be seen whether his structures will still be appreciated years from now.

**Figure 3** The Taj Mahal was designed to highlight the visual appeal of symmetry.

**Figure 4** Hundertwasser rejects symmetry in his designs, but do they still have aesthetic appeal?

**TRY THIS:** Choosing an Apartment

**SKILLS MENU:** performing, evaluating, communicating

In this activity, you will role-play a real estate agent and an apartment hunter, and explore the benefits of symmetry and asymmetry in an apartment.

1. Work with a partner for this activity. Choose one of you to role-play the real estate agent and one the apartment hunter.

2. The real estate agent will prepare a convincing argument on why an asymmetrical apartment is better than an apartment in a more symmetric building.

3. The apartment hunter will evaluate the argument and decide whether it would convince him or her to live there.

4. Now, switch roles. This time, have the new real estate agent prepare a persuasive argument on the benefits of a symmetric apartment. The new client will evaluate the argument.

A. Were your partner’s arguments convincing? Why or why not?

B. Now that you have completed this activity, which apartment would you prefer? Explain.
Symmetry, Centre of Gravity, and Stability

Symmetry is usually considered attractive. It is also useful in the design of stable structures. The dead load of a symmetrical structure is usually spread more evenly along the length of the structure. This makes the structure more stable.

A designer constructs a more stable structure by considering the location of the centre of gravity in a structure’s design. The location of the line of symmetry can sometimes help to locate a structure’s centre of gravity. In Figure 5, the pyramid is completely symmetrical. A line of symmetry could be drawn through any of the four triangular faces of the pyramid. In this case, the centre of gravity is located directly below where the lines of symmetry would meet, deep in the very centre of the pyramid. Pyramids like this are very stable.

While lines of symmetry sometimes help to locate a structure’s centre of gravity, this is not always true. A structure’s centre of gravity is only located on its line of symmetry when the mass of the structure is evenly spread out. A line of symmetry is only visual. It does not account for the mass of a structure and how that mass is arranged. Consider Figure 6. The pyramid is still symmetrical. However, the centre of gravity is no longer on any line of symmetry because the mass of the pyramid is no longer evenly spread out. One side has more mass than the other side.

Figure 5  El Castillo, located in Chichen Itza, Yucatan, Mexico, was built by the Mayans between the eleventh and thirteenth centuries CE.

Figure 6  The left side of this pyramid has been built out of wood. The centre of gravity is no longer on the line of symmetry.

Unit Task
How can you apply your understanding of symmetry to the Unit Task?

CHECK YOUR LEARNING

1. Draw three symmetrical geometrical figures. Clearly mark the line of symmetry on each figure.
2. Why is symmetry considered to be an important principle in the design of structures? Give two reasons in your explanation.
3. (a) Give two examples of symmetrical objects from nature, and two that have been built by humans.
   (b) Find an example of an asymmetric structure, either human-made or from nature. Evaluate the structure in terms of stability and aesthetics.