

GEOMETRY AND ART

SYMMETRY, BALANCE, SCALE

WHAT DO MATH AND THE VISUAL ARTS HAVE IN COMMON? WHAT CONCEPTS DO they share? Why should we as learners have an understanding of these concepts? These are some of the guiding ideas that will be explored in this resource.

We know that line, shape, form, pattern, symmetry, scale, and proportion are the building blocks of both art and math. Geometry offers the most obvious connection between the two disciplines. Both art and math involve drawing and the use of shapes and forms, as well as an understanding of spatial concepts, two and three dimensions, measurement, estimation, and pattern. Many of these concepts are evident in an artwork's composition, how the artist uses the elements of art and applies the principles of design. Problem-solving skills such as visualization and spatial reasoning are also important for artists and professionals in math, science, and technology. By taking an interdisciplinary approach to art and geometry, students can identify and apply authentic connections between the two subjects and understand concepts that transcend the individual disciplines.

The parallels between geometry and art can be seen in many works of art in LACMA's collection. Some are functional, such as the table lamp composed of geometric shapes and intersecting lines designed by architect Frank Lloyd Wright. Complex and intricate patterns can also be found in quilts; the museum's 1930s-era quilt by artist Laura Long is an example. Geometric concepts are also evident in painting and sculpture, as in the cubist still life by the Mexican modernist Diego Rivera and in the works of American artist David Smith.

Language of the Visual Arts and Geometry

To see where geometry and art intersect, an understanding of some fundamental concepts is key. The visual arts and math share a vocabulary, though there are often multiple terms for the same concepts. For example, artists use the term *two-dimensional shape*, while mathematicians call the same thing a *plane figure*. What artists call a *three-dimensional form* is known as a *space* or *solid figure* in math.

Artists use basic components (often called the elements of art) to create a work of art: color, value, line, shape, form, texture, and space. The principles of design, such as perspective and proportion, are used by artists to arrange the elements of their artworks and to create certain effects. Artists "design" their works to varying degrees by controlling and ordering the elements of art. Look closely at each artwork to identify the elements of art and principles of design. Look for the lines, seek the shapes, find the patterns, and exercise your problem-solving skills!

Lines

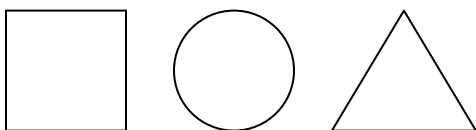
Lines can vary in width, length, curvature, color, or direction. What types of lines do you see? Are there horizontal, vertical, or diagonal lines? Are some of the lines parallel (do not cross each other) or are they perpendicular (intersecting at right angles)?

Repetition

Repetition is the recurrence of elements of art at regular intervals. When lines, shapes, and forms repeat in a predictable combination, they form a *pattern*. Identify the artist's use of repetition. What patterns do you see in these artworks?

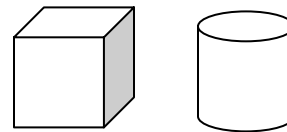
Shapes/Plane Figures

Shapes/Plane Figures are two-dimensional figures in which all points lie in the same plane. Shapes can be open or closed, free-form or geometric. What shapes or plane figures do you see in these artworks?



Forms/Space or Solid Figures

Forms/Space or Solid Figures are three-dimensional (having height, width, and depth), enclose volume (or mass), and help us to understand physical space. For example, a triangle, which is two-dimensional, is a *shape*. But a pyramid, which is three-dimensional, is a *form*. Cubes, spheres, pyramids, cones, and cylinders are examples of forms. They can be literally three-dimensional or they can have the illusion of three-dimensions. What forms or solid figures do you see in the artworks?



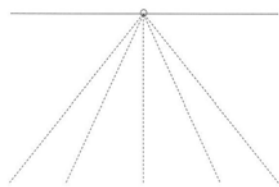
Balance

Balance is the arrangement of elements to create a sense of equilibrium and harmony. There are three types of balance—symmetry, asymmetry, or radial symmetry. Symmetry or symmetrical balance is fundamental to art, math, and science. Symmetry is a type of balance in which the shapes and patterns are identical on either side of a central boundary; the two halves of a work mirror each other. Asymmetry is an arrangement of parts in which the opposite sides, divided by a central line, are not identical. Radial symmetry is a form of symmetrical balance in which the elements of a composition radiate from a central point in a regular, repeating pattern. Radial symmetry can be found in nature in flowers, starfish, jellyfish, crystals, and snowflakes.

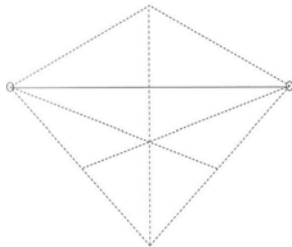
How would you describe the balance of each composition? What types of balance do you see? Inspired by the natural environment, artist Frank Lloyd Wright employed radial symmetry in his design for the *Table Lamp from the Susan Lawrence Dana House* (1902–4). See the view of the lamp shade from above. Laura Long's *Quilt* (1931) is also symmetrical. If you were to fold the quilt in half and in quarters, all parts, with exception of the colors, would look identical. The fold line is called the "line of symmetry." In the example of the quilt, the lines of symmetry are horizontal, vertical, and diagonal. Find the lines of symmetry in the artworks included in this resource or in your own artworks.

Perspective

Perspective is a system for representing three-dimensional objects, viewed in spatial recession, on a two-dimensional surface. The simplest form of perspective drawing is linear perspective, a system that allows artists to trick the eye into seeing depth on a flat surface. Linear perspective uses sets of implied lines called converging or orthogonal lines that move closer together in the apparent distance until they merge at an imaginary vanishing point in the horizon. One-point perspective uses lines that lead to a single vanishing point; two-point perspective uses lines that lead to two different vanishing points.



ONE-POINT PERSPECTIVE



TWO-POINT PERSPECTIVE

Look at an example of one-point perspective such as *Interior of Antwerp Cathedral* (1612) by Paul Vredeman de Vries (See the Discussion Questions PDF or lacma.org). With a pencil and ruler, find the vanishing point and trace the converging lines. For an example of two-point perspective, see Canaletto's *Piazza San Marco Looking South and West* (1763).

Many artists intentionally alter the perspective in their compositions. Rather than showing a scene from a single point of view, cubists depicted their subjects from multiple perspectives at the same time. Diego Rivera, who experimented with cubism in the early twentieth century, flattens the space in *Still Life with Bread and Fruit* (1917) and tips the composition toward the viewer. Rather than painting the table as though it recedes into space, Rivera presents the still life from multiple perspectives.

Proportion

In art, proportion is the principle of design concerned with the size relationships of parts of a composition to each other and to the whole. In math, proportion is the ratio or relation of one part or another to the whole with respect to size, quantity, and degree. Look carefully at each artwork and consider the artist's use of proportion.

David Smith's steel sculpture *Cubi XXIII* (1964) is approximately six feet tall and fourteen feet long, and stands directly on the gallery floor. Does the *scale* of the work—the relative size or proportion—affect your impression of it? How so?

Students can use these terms and the process of visual analysis to explore works of art from various cultures and eras. The four artworks highlighted in this printed resource are considered *modern*, an art-historical term defining art made from the late nineteenth century to the 1960s. This period of history was marked by significant changes in social and political structures and developments in technology and industry. Modernism evolved as artists sought new ways to respond to and represent their changing world. Much of the artwork produced in this period has little or no naturalistic images or subjects. A modern artist often takes what would have been one aspect of an image—like the geometry underlying its composition—and makes it the entire focus.

FRANK LLOYD WRIGHT (UNITED STATES, 1867–1959)

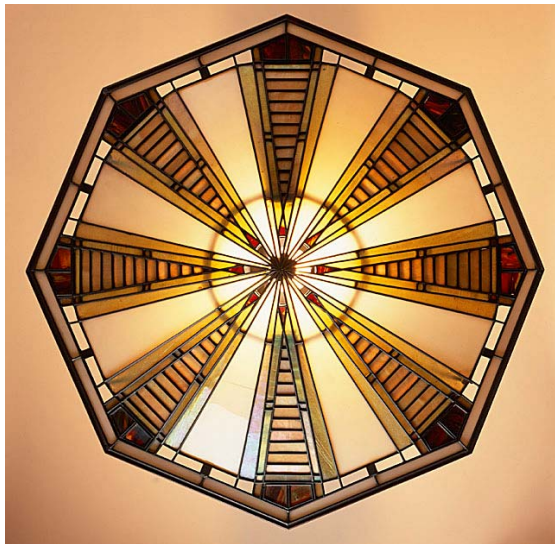
Table Lamp from the Susan Lawrence Dana House, Springfield, Illinois, 1902–4

The Grammar of Architecture and Design

In this table lamp created more than one hundred years ago, American architect Frank Lloyd Wright arranges lines and basic geometric shapes into an abstracted composition. The glass lamp shade is an octagon (eight-sided shape). The stained-glass design on the shade is composed of circles, squares, triangles, and rectangles. Rectangles and squares form the base of the lamp. Wright considered geometric shapes the "grammar" of architecture and design.

- What types of lines do you see? Draw some of the lines. The dark lines of the lamp shade are actually the zinc coming that hold the panels of glass together.

The lamp shade's pattern is an example of radial symmetry. The entire composition radiates from a central axis in a regular, repeating pattern. Wright used the geometric concepts of circumference, diameter, and radius to create this symmetrical design.



Playing with Shapes

Frank Lloyd Wright was born in 1867 in Richland Center, a small town in Wisconsin. When he was a child, his mother gave him a set of blocks that helped him discover how all buildings consist of

basic geometric shapes. Even late in his life, Wright remembered the simple wooden blocks that he had played with and how they had influenced his thinking. As an architect, Wright developed a system of rotating geometric forms that became one of his principal methods of design. "I used to love to sit down at the drawing board with a T-square and a triangle and concoct these patterns," Wright said in 1952. "I evolved a whole language of my own in connection with those things."

- With a ruler, compass, and protractor, make a drawing using lines, arcs, and geometric shapes.

The Built and Natural Environment

Wright was part of a group of midwestern artists and architects who were active in the Arts and Crafts movement. The ultimate aspiration of the Arts and Crafts movement was to incorporate art into every aspect of daily life. Designers and architects sought to create a total work of art that would include a building, its furnishings, and its settings as an environmental whole.

Susan Lawrence Dana, a wealthy and influential woman in Springfield, Illinois, commissioned Wright to design the lamp, the other furniture, textiles, and light fixtures, as well as the house itself and its landscaping. The Dana House is linked by geometry and colors inspired by the natural environment. The glass of the lamp, in earthy tones of amber, moss green, terracotta, and creamy white, mimics the colors of the midwestern prairie, which are also echoed throughout the house.

- Geometry is everywhere. We can train ourselves to find the geometry in everyday objects and in works of art. Look around at the buildings, roads, signage, foliage, and other features of your immediate environment. How many different shapes and forms can you find? What shapes are the windows, doors, and lighting fixtures? Make an inventory of the shapes and spaces that you see.



Frank Lloyd Wright (United States, 1867–1959)
Made by Linden Glass Company (Chicago, Illinois)
Table Lamp from the Susan Lawrence Dana House, Springfield, Illinois, 1902–4
Leaded glass, bronze, brass, and zinc; base: 20½ x 12 x 8⁷/₈ in., shade diameter: 29 in.
Los Angeles County Museum of Art, gift of Max Palevsky (M.2000.180.44a–b)
© Frank Lloyd Wright Estate/Artists Rights Society (ARS), New York

DIEGO RIVERA, (MEXICO, 1886–1957)

Still Life with Bread and Fruit ***(Naturaleza muerta con pan y fruta)***, 1917

Geometric Shapes and Forms

This still life, painted about ninety years ago by artist Diego Rivera, features a table laid with fruit, bread, a cutting knife, and various drinking and serving utensils. Rivera paints these everyday objects in a way that simplifies each thing to its elemental, geometric shape. The tablecloth that drapes over the left side of the table is composed of simple, triangular shapes. Look at the fruit in the middle of the painting. The pears and apples are spheres. The areas of light and shadow appear as shapes within shapes.

- How many different shapes do you see? Draw the shapes and forms, noting Rivera's use of light and dark colors to emphasize the volume of each form.
- The colors Rivera uses are primarily earthy brown and red tones, with some accents of orange, yellow, and bright green. Does the artist's limited color palette emphasize the shapes and forms? How so?

Flattening the Space

Rather than painting the table as though it recedes into space, Rivera flattens the space and tips everything toward the viewer: the things that are the farthest away from the viewer on the table appear higher in the composition. It almost appears as if everything is soon going to slide off this table. By flattening the space, though, Rivera gives a clear view of each individual object. Nothing is blocked by anything else in front of it, and each object in the painting is clearly viewable.

Cubism: Breaking the Rules

Rivera is best known for the large public murals he painted in Mexico in the 1920s and 1930s that celebrate the folk traditions of Mexican culture and the region's indigenous peoples, as well as the socialist ideals of postrevolutionary Mexico. At the beginning of his artistic career, starting in 1907, Rivera traveled to Europe and studied art, first in Spain and then in France. Rivera was in Paris when Pablo Picasso (1881–1973) and Georges Braque (1882–1963) began to experiment with cubism. The name cubism, in fact, comes from the fragments or "cubes" that they used as the basic structural unit of their compositions.

Since the Renaissance, Western artists have used linear perspective to create an illusion of space as it is seen from a single viewpoint at a particular moment in time. Rather than showing a scene from a single point of view, cubists depicted their subjects from multiple perspectives at the same time. Notice how the table is painted. We see it from the top and from two different sides at the same time. Rather than representing an object as it appeared, cubist artists showed its structure and placement in space, often layering several views of a scene on a single piece of paper or canvas.

Rivera's work fits into a long tradition of European and Mexican still-life painting. He also seems to pay homage to artists like Paul Cézanne (1839–1906), who painted many still lifes in the late nineteenth and early twentieth century. A strong influence on Picasso and Braque, as well as many other artists at that time, Cézanne believed that all things in nature could be reduced to their simplest geometric forms: the square, the circle, and the cone. In *Still Life with Bread and Fruit*, Rivera clearly puts that notion onto his canvas.

- View an example of Cézanne's still-life painting such as *Still Life With Cherries and Peaches* (1885–87) (See the Discussion Questions PDF or lacma.org). Compare and contrast Cézanne and Rivera's use of geometric forms.



Diego Rivera, (Mexico, 1886–1957)
Still Life with Bread and Fruit (Naturaleza muerta con pan y fruta), 1917
Oil on canvas, 45³/₁₆ x 35 in.
Los Angeles County Museum of Art, gift of Morton D. May (53.25.1)
© 2011 Banco de México Diego Rivera Frida Kahlo Museums Trust,
Mexico, D.F. / Artists Rights Society (ARS), NY

LAURA LONG (1870–1975)

Quilt, “Log Cabin” Pattern, 1931

Pattern and Repetition

This quilt looks like a huge pastel checkerboard. Layers of green, pink, orange, lavender, blue, and brown pieces of silk and velvet create diagonal stripes. This intricate pattern is called “log cabin,” a design characterized by the complicated series of concentric squares that overlap, hiding all of the seams. The design begins with a center shape, in this case a small square, and cut rectangular strips are sewn in sequence around the sides of the square. Once many of these fabric squares—called blocks—are assembled, they are then sewn together in a group, creating a repetitive design. Artist Laura Long chose this pattern about eighty years ago “because when I was a girl I saw one done in red and black wool and I never forgot how pretty it was.”

- See the Discussion Questions PDF or do an online search for the phrase “log cabin quilt pattern” to see a range of quilts made using this technique. Compare and contrast the designs.

The pattern of this quilt is a tessellation, a collection of shapes that fit together to cover a surface without overlapping or leaving gaps. In this quilt, there is a repeating geometric pattern made up of squares, rectangles, triangles, and diamonds. Tessellations can be seen in almost every brick wall, tiled floor or wall, quilt pattern, lace tablecloth, fabric, and wall-paper pattern.

- Create your own tessellation using shapes that are congruent, or exactly the same in size and outline. Make a simple tessellation using a regular polygon (a geometric shape in which all sides and angles look alike) such as a square, triangle, or rhombus (diamond) and trace the shape repeatedly, side by side.

Scale: Form and Function

Designed to fit over a bed, this quilt is approximately seven feet long and six feet wide. With its rectilinear design, all parts of the composition appear to be moving in or forming straight lines. The lines are not only seen in the diagonal stripes of color but also in the individual parts of each square.

- On a sheet of graph paper, measure a 2 x 2 inch square. Create a pattern in the square. What is the proportion of this square to the entire quilt? Using this ratio, estimate how many 2 x 2 inch squares you would need to create a bed-sized quilt.
- Create a collaborative quilt that is to scale with this quilt. Use paper or fabric squares cut to the same dimensions. Experiment with different materials and motifs to create a unique design.

A Quilting Tradition

Artist Laura Long grew up in Iowa. Like most of the women in rural nineteenth-century America, her mother was a quilter. Quilts were functional objects and making them taught girls important skills. Long said, “In my day, a girl had to make quilts to cover the beds in winter. And we learned to sew on quilts so we could make clothes to wear, too.” Quilting is also considered one of the traditional art forms of the United States. Long described her mother’s quilts as her “fancy work,” an opportunity for “a farm woman to express her artistic urges.”

Laura Long donated this quilt to LACMA in 1971, when she was 101 years old. She made the quilt in 1931 and stored it away in a closet because it was too fancy to spread on any bed. Long made only five or six quilts in her life; her lifetime hobby was painting.



Laura Long (1870–1975)
Quilt, "Log Cabin" Pattern, 1931
Silk, 86½ x 75½ in.

Los Angeles County Museum of Art, gift of Mr. and Mrs. Wilbur Long (M.71.103)
© Estate of Laura Long

DAVID SMITH (UNITED STATES, 1906–1965)

Cubi XXIII, 1964

Light and Mass

A tall cylinder and two giant angles sit directly on the gallery floor. This monumental stainless-steel sculpture is approximately six feet tall and fourteen feet long. Although it is constructed of steel, there is a weightless quality to the sculpture, emphasized by the artist's use of negative space. (Positive space is the area of an artwork filled with something; negative space is the empty space in and around the artwork.) The sculpture is also characterized by a burnished surface that captures and reflects light.

- Sketch the sculpture, noting the areas of positive and negative space.
- What types of angles do you see? Are they acute, obtuse, or right angles?
- Unlike the precise symmetry of Frank Lloyd Wright's table lamp, *Cubi XXIII* is defined by its asymmetrical balance. As a viewer, how might your impression of the sculpture change if it were symmetrical?

Experimenting with Structure and Surface

Cubi XXIII is part of a series of twenty-eight sculptures that the artist David Smith made in the early 1960s. Each *Cubi* has volumetric, geometric forms and burnished stainless-steel surfaces. Smith worked through his ideas for the series by using cardboard models (maquettes) that he constructed in three dimensions from old cardboard boxes and cartons. Once he settled on a configuration, the stainless-steel forms were ordered to his specifications from a factory. These hollow forms were then welded together to make the final sculpture. Once assembled, Smith used an electric-powered polishing disk to inscribe the surfaces with gestural marks that he likened to brushstrokes. The burnished surfaces both absorb and reflect light, so that the appearance of the sculptures changes according to the weather and time of day—or, if the sculptures are displayed inside, according to the viewer's vantage point.

- Collect a variety of boxes and tubes in different sizes and shapes. In small groups, work with other students to create a three-dimensional, standing sculpture. Experiment with different arrangements before using tape to connect the forms. You can also experiment with different surface textures.

Labor and Geometry

David Smith is widely heralded as one of the greatest American sculptors of the twentieth century. Raised in the Midwest, the son of an engineer-inventor and the great-grandson of a blacksmith, Smith had an early interest in all things industrial and mechanical. During the summer of 1925, he worked in a Studebaker automobile factory, where he connected the geometries of the factory environment (ovals, triangles, circles) with industrial labor itself (welding, milling), the same kind of labor he later would make use of as an artist to create sculpture of iron and steel. Throughout his life, Smith defined himself as a man of the people, a member of the working class. Even after he established himself as an artist, he occasionally sought factory work. In fact, he worked as a welder on army tanks at the American Locomotive Company in upstate New York during World War II.

In a 1964 interview with writer and critic Thomas B. Hess, Smith spoke of his use of found objects in his work and his fascination with what he called their "basic geometric form." This continuous interest in the purity of geometry can be seen throughout his body of work including paintings, drawings, and sculpture. See the Discussion Questions PDF or lacma.org for examples.



David Smith (United States, 1906–1965)

Cubi XXIII, 1964

Stainless steel, $76\frac{1}{4} \times 172\frac{7}{8} \times 35\frac{3}{8}$ in.


Los Angeles County Museum of Art, Modern and Contemporary Art Council Fund (M.67.26)

© The Estate of David Smith, VAGA, NY

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