LOS ANGELES COUNTY MUSEUM OF ART
5905 WILSHIRE BOULEVARD
LOS ANGELES, CALIFORNIA 90036
EDUCATION DEPARTMENT

LACMA

Calder and Abstraction

THIS PROGRAM FOCUSES ON THE SPECIAL EXHIBITION *Calder and Abstraction: From Avant-Garde to Iconic* (on view through July 27, 2014). It provides the opportunity for educators and students to learn how American sculptor Alexander Calder (1898–1976) revolutionized sculpture—and modern art—by changing what had been a static and often monumental and figural art form into something radically new. He combined his deep understanding of materials and principles of balance and design with avant-garde notions of the use of abstract but organic forms to produce art that was wholly unprecedented: sculpture that incorporated space, movement, and time as essential components. Two types of his sculpture featured in the museum's exhibition (mobiles and large public sculptures) are so popular and familiar today that it is sometimes easy to forget the scope of Calder's achievement, along with his revolutionary contributions to modern art.

Classroom discussions of Calder's work can incorporate many different aspects of the sculptor's work. The materials he used are immediately noticeable. The son and grandson of successful sculptors, the artist was fascinated with materials, and how he could manipulate them, beginning in his childhood. As a young adult, Calder trained as a mechanical engineer but soon realized he would rather be an artist. After moving to Paris in 1926, he first made sculptures with wire and then with substances not often thought of as "fine art" materials, including industrial sheet metal and more common items such as plywood and string.

The basic elements of visual art—color, shape, and form—are particularly relevant in Calder's sculptures, and students can engage in lively discussions about them. Simply identifying those elements limits a full appreciation of his work, however. Calder's genius lay in his mastery of design and his understanding of balance, literally and figuratively. Looking closely at the sculptures reveals that he utilized color, shape, and form in multiple ways. "To me the most important thing in composition is disparity," Calder wrote in 1943. He used primary colors strategically: various component "parts" of each sculpture contrast with one another while also providing complementary counterbalance. The shapes of individual parts also both oppose and mirror each other, attracting the viewer's eye to individual "moments" but contributing to a coherent whole. The overall form of each work thus is balanced, as different sections harmonize visually, creating three-dimensional symmetry.

Calder's mobile sculptures subtly shift and change in wind currents, their movement introducing the dimensions of both time and space to the work. Viewers engage in multiple ways with the sculptures as they move and interact with the environment. Even the stabiles—sculptures that do not move—suggest motion, as their forms alternate material volume with empty space. One circles around, looking in, under, and through the sculpture, each movement revealing a different view of both the sculpture and its site.

Images of four Calder sculptures are provided here; each represents a key period in the artist's career. Two are part of the museum's permanent collection and are accessible to visitors virtually whenever the museum is open.

Alexander Calder
White Panel, 1936
Plywood, sheet metal, tubing, wire, string, and paint. 84 ½ x 47 x 51 inches
Calder Foundation, New York; Bequest of Mary Calder Rower, 2011

Photo: Calder Foundation, New York/Art Resource, NY

White Panel, 1936

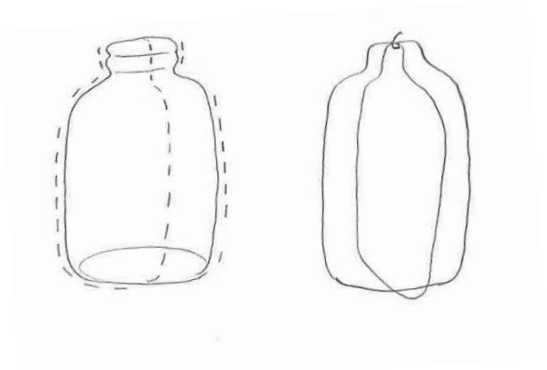
During the 1920s and early 1930s, Calder spent the majority of his time in France, then the epicenter of creative activity for an eclectic group of international artists, writers, poets, musicians, and choreographers. When Calder arrived in 1926, he was still in his twenties. Formed by his childhood fascination with materials, he also had a newly acquired engineering degree, training from New York's Art Students League, and experience as a magazine and newspaper illustrator. New friends and fellow artists, including Piet Mondrian, exposed him to modern notions of art, and he abandoned the representational style he had been working in (figural sculpture) and turned to abstraction.

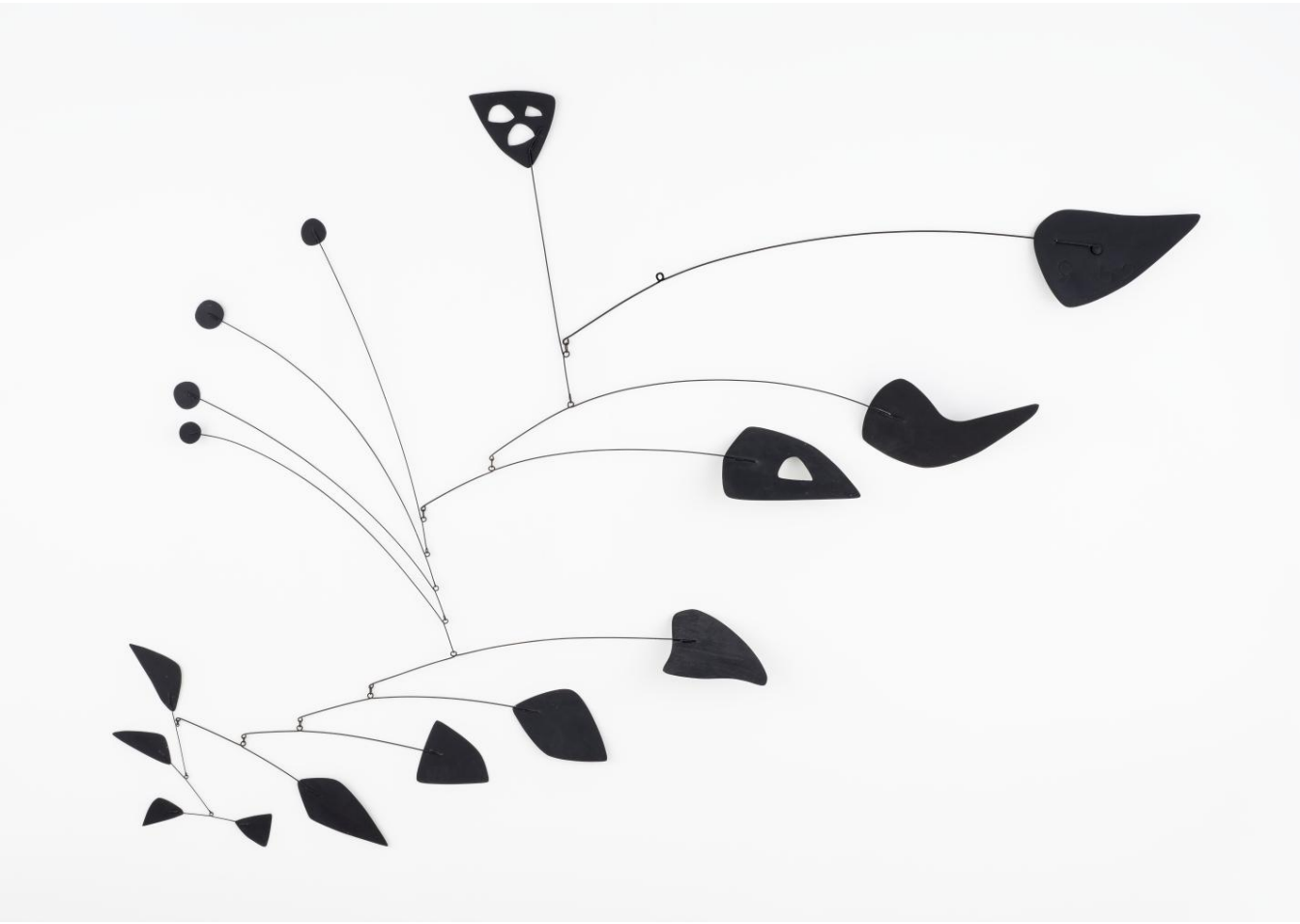
White Panel offers a key to the artist's vision. A visit to Mondrian's studio was a particular revelation. It was not the geometrically abstract paintings, but rather the studio environment that deeply impressed him. Calder said later, "I was particularly impressed by some rectangles of color he had tacked on his wall . . . I told him I would like to make them oscillate—he objected. I went home and tried to paint abstractly." Calder realized that he did not want to paint. He continued working with sculpture instead, and an idea took hold: "Why not plastic forms in motion? Not a simple translatory or rotary motion, but several motions of different types, speeds, and amplitudes composing to make a resultant whole. Just as one can compose colors and forms, so one can compose motions." Calder often used curvilinear and *biomorphic* forms (irregular abstract forms based on shapes found in nature); both Calder and his friend Joan Miró shared an affinity for that artistic vocabulary.

White Panel thus can be seen as a three-dimensional, kinetic abstract painting. The white plywood resembles a canvas, underscoring the sculpture's relationship to the medium of painting, yet the curving biomorphic forms are suspended in front, constantly turning, with kinetic energy supplied both by winding cords and cranks as well as by changing air currents. From these beginnings, Calder's mobiles—so named by artist Marcel Duchamp (see discussion for *Little Face*)—evolved. Calder stopped placing wood panels behind his sculptures; the cranks, pulleys, and other apparatus that provided motion were abandoned; and the mobiles instead were constructed with carefully balanced elements, either suspended in the air, perched on tabletops, or joined with stabiles.

Wire Drawings

Try drawing in two and three dimensions using paper, pencil, wire, and simple household objects. First, bring an assortment of small household items to the classroom, such as a screwdriver, a bucket, or a teapot. Ask each student to select an object and study its properties with their hands. What words might describe its form? Organic (curvy and amorphous but recalling plant or animal life) or geometric (straight and angular)? Next, draw the shape of the object in two dimensions on a piece of paper, using one continuous line to capture its outline or contour. Pay careful attention to the direction of the line and points of intersection. Then translate the pencil sketch into a wire drawing by drawing in space with a piece of Twisteez © wire (for the elementary grades) or 22-gauge aluminum wire (for the secondary grades). Shape the wire to mimic the object's contour; then expand it into three dimensions by adding and attaching additional wire. Experiment with ways to capture different contour lines, creating twists and turns to depict the object's three-dimensional form. Lastly, ask students to compare their pencil sketches and wire drawings. Which form best captures the essence of the object?





ALEXANDER CALDER
Little Face, 1962
Sheet metal, wire, and paint, 42 x 56 inches
Los Angeles County Museum of Art
Gift of the Joseph B. and Ann S. Koepfli Trust in honor of the museum's 40th anniversary, M.2011.139

Little Face, 1962

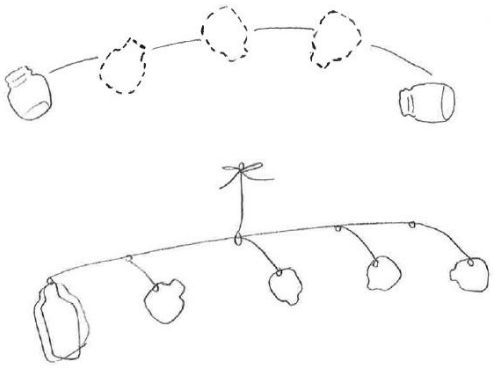
Little Face, a 1962 sculpture in LACMA's permanent collection, represents how Calder's mobiles evolved from their inception in the 1930s. From the perspective of the twenty-first century, when almost every infant in the United States is tucked into a crib with a mobile dangling above (Calder's work was the inspiration for this custom), it may be difficult to grasp just how groundbreaking Calder's art was, but no artist before him had created kinetic, suspended sculpture.

The term "mobile" was first used by the avant-garde French artist Marcel Duchamp, who visited Calder's studio in 1931, and, upon watching a sculpture move, promptly called it a "mobile." In French, this word refers to an object that moves but also means "motive." Perhaps this was Duchamp's sly way of both describing the artwork and suggesting the deliberate nature of the artist's invention.

Whereas Calder's earliest mobiles could be considered "moving paintings" (see *White Panel*), as he worked into the 1930s, his sculptures became less dependent on mass. Movement, rather than solid forms, began to delineate the sense of space. *Little Face* embodies many other characteristics of Calder's work: biomorphism; unexpected "holes" or "voids" in some of the component parts; shapes that alternate between smaller discs and larger paddles; and an all-important sense of balance, as one side visually and physically balances the other, with some wires outstretched horizontally while others soar vertically. Unlike some of Calder's other mobiles, however, this one is monochromatic (only one color). As it moves slowly in the air currents, it creates silhouettes, suggesting a second, ephemeral artwork made of light and shadow. The slowly turning sculpture moves unexpectedly, constantly changing shape, occupying and animating its space differently each time.

Wire Sculptures

For the upper elementary grades and above, ask students to transform their wire drawings into hanging wire sculptures. First, ask students to study how objects travel through space. Pair students and ask each team to select one of their inspiration objects. Each team should generate a hypothesis about how this household item, if thrown, might travel through the air. Students should record their hypotheses in writing and drawing, using one continuous line to describe the object's trajectory. Next, test the hypotheses in an open and safe space around campus. One student can throw the object, alternating different movements and heights, while the other student charts the object's path in a drawing or through a video. How does the object fill or deflect the air? How does the actual trajectory compare with the hypothesis? Revise the trajectory sketch as needed, then transform the sketch into a wire sculpture by adding onto and extending the original wire drawing. How will you capture the object's path through space? Try repeating or changing the wire drawing and attaching multiple drawings using single wire pieces as branches. Expand the branches into three dimensions to create volume but ensure that the drawings do not cross or collide. Once students have reached their desired compositions through trial and error, use string to hang the wire sculptures in the classroom.



Alexander Calder
Three Quintains (Hello Girls), 1964
Sheet metal and paint with motor, 275 x 288 inches
Los Angeles County Museum of Art, Art Museum Council Fund, M.65.10

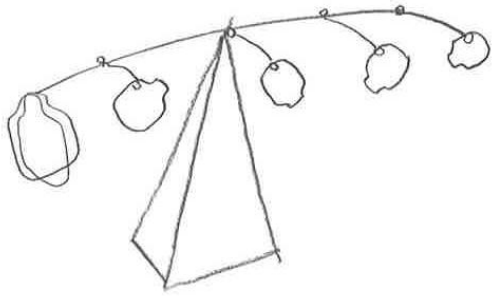
Three Quintains (Hello Girls), 1964

In the mid-1950s, Calder began working with quarter-inch steel (thicker than the aluminum he used during the 1940s during wartime shortages), which enabled him to construct larger, more durable, and more ambitious sculptures. This made him an ideal collaborator for architects hoping to enliven large public spaces, a popular goal for many communities in the 1960s and 1970s. *Three Quintains (Hello Girls)*, executed in 1964, was commissioned by LACMA's Art Museum Council for the 1965 opening of the museum in its present location on Wilshire Boulevard. Calder was by then an internationally famed artist, and it was considered an important moment in the museum's development when he agreed to the commission. As a LACMA official stated at the time, "To have a man of Alexander Calder's prominence be the first to design a sculpture specifically for the new museum would set the standards for future efforts, on the part of the artists and donors."

The sculpture, situated outdoors within a shallow pool at the museum's southeast corner, was specially designed to be a fountain. It was one of only a few of the artist's works to combine monumental size, kinetic movement, air currents, and water jets. The forms and design recall his earlier work, such as his 1930s "mobile paintings" (see *White Panel*), which included biomorphic and zigzag shapes. The colored paddles are painted in primary hues, while the supporting pylons are left unpainted, revealing the industrial nature of the material. The overall effect is of a very large sculpture that nonetheless moves with the grace of his much smaller mobiles.

Kinetic Sculptures

If your wire sculpture could walk, how would it move? Would it run and bounce through the air or slither slowly through space? For middle and high school grades, ask students to transform their wire sculptures into standing sculptures that utilizes a base and employ principles of balance. How will your sculpture's interaction with gravity change when the point of balance shifts from the hanging string to the floor? How will you keep the sculpture's sense of movement? Ask students to experiment with scraps of cardboard to serve as the standing sculpture's foundation. What shape will the foundation take and how will its shape ensure stability? Try pyramidal or rectangular bases and test different ways to attach the sculpture to its base.



Alexander Calder
Le Grande vitesse (intermediate maquette), 1969
Sheet metal, bolts, and paint
102 x 135 x 93 inches

Photo: Calder Foundation, New York/Art Resource, NY

La Grande vitesse (intermediate maquette), 1969

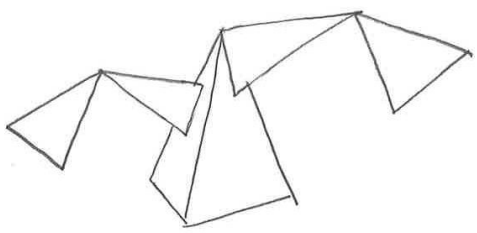
Calder's *maquette* (or model) was part of his planning process for a large sculpture commissioned by the city of Grand Rapids, Michigan. (The title translates as the "great swiftness," or, less literally, the "grand rapids.") Calder in the 1950s had begun a virtually nonstop output of public sculptures, a period that continued until his death in 1976. The elements he incorporated in the fully realized Grand Rapids work—monumental size (forty-three feet tall), bold color, and a robust shape designed to animate the outdoor space—are conveyed by the maquette, which itself is over eight feet tall.

Like many of Calder's public sculptures, this one—while suggesting motion—is stationary. Such works by the artist are known as "stabiles," a term, coined by artist Jean Arp in 1932, also applied to his smaller, nonmoving sculptures. Many of the artist's commis-sions share the brilliant orange-red color of *La Grande vitesse* and utilize similarly muscular, biomorphic forms. Often situated in prominent locations in major cities, such as courthouses and office complexes, the monumental sculptures have become quite familiar.

A closer look at the maquette reveals the artist's genius and his particular mastery of balance and proportion on a grand scale. The slender but massive sheet metal components echo or visually counterbalance each other. The open spaces, or voids, provide a changing glimpse of the sculpture's site as the viewer moves around it, and the sculpture seems to reveal itself anew from each vantage point. Some say that the biomorphic forms themselves suggest movement, resembling claws or even animals that are about to step across the landscape. The fully realized sculpture has become a source of enormous civic pride for Grand Rapids, which includes its image on the city's logo and flag.

Stabiles

If you could freeze the motion suggested by your wire sculpture, how would you translate this motion and its path into simple shapes and planes? For the high school grades, ask students to study the lines created by their standing sculptures, noting changes in direction and movement. What shapes emerge? Are there joints or points where the shapes touch? Ask students to translate these shapes into simple cardboard planes such as triangles or circles. Experiment with different ways to adhere the planes now that there are multiple points of balance throughout the sculpture. How will you ensure structural stability while still capturing the suggestion of movement and utilizing depth? When finished, display students' stabiles in the classroom alongside the inspiration objects and preparatory sketches that document the artistic process and the evolution of the project. In reflection, ask students to think about how and when they engaged in the stages of engineering: imagine, conceive, produce, revise, and refine. In culmination, students can summarize their understanding of engineering principles in writing, responding to such concepts as gravity, balance, and motion as they affected their sculptures. For a math connection, ask students to imagine taking their stabiles to monumental scale and to estimate the associated costs in different materials and sizes. Share the project-based learning experience with the rest of the school by curating and mounting a STEAM (science, technology, engineering, art, mathematics) exhibition.



Classroom Activity

Shaping Space

Essential Question

How do artists think in two and three dimensions?

Grades

K–2

Time

One to two class periods

Art Concepts

Line, shape, form, color, composition, visual plane, visual balance

Engineering Concepts

Identify a problem; convey possible solutions through visual and physical representations; compare, test, and evaluate solutions

Materials

Drawing paper, construction paper in various colors, pencils, scissors, glue sticks, hole punches, string, and chopsticks. Optional: wooden dowels.

Talking about Art

View and discuss the printed image of *White Panel* (1936).

What do you see? Take an inventory of the types of lines that you notice, using words and drawings to document your observations. How and where do these lines combine to create shapes? Describe the shapes that you see, using writing and drawing to support your interpretations.

If this artwork came to life in front of you, which lines and shapes would you find in the foreground of the artwork (the space closest to your eye)? Which lines and shapes would you find in the background (the space furthest from your eye)? Which lines and shapes might fall in between, in the middle ground? Discuss your predictions with a thinking partner.

Making Art

Divide students into groups of three. Assign each student to the background, middle ground, or foreground of the artwork. Ask them to use their bodies to describe the lines and shapes in the artwork and how these lines and shapes overlap in space. Have each group present a visual and physical tableau to the class, recreating *White Panel* in space.

Ask students to respond to their observations and interpretations by creating their own two- and three-dimensional artworks. First, students should cooperatively choose a color palette for their collaborative artwork, choosing three sheets of colored construction paper that complement each other (i.e., three warm or three cool colors). Next, students should cut a variety of shapes from the paper, such as geometric (angular) or organic (free-form) shapes, and label each shape with an identifying name.

How might students combine these shapes to create a two-dimensional composition? One student can sketch a proposed composition on behalf of the group. Together, they should discuss and edit the sketch until they have reached a balanced composition—visual balance in terms of the arrangement of shapes. Then, students should work together to execute the sketch by layering the shapes on top of each other on a separate sheet of paper. One student can start by laying the background shapes down first, working from background to foreground to create a collage.

How can students work together to translate this collage into three dimensions? Ask students to dissemble the collage, hole punch the top of each shape, and attach each shape to a long piece of string. They can practice layering these shapes by holding each shape from the top of the string and working together to recreate the original sketch in space. Students should try multiple solutions for executing the sketch, including shortening the string to move a shape's position within the composition or adhering additional shapes onto existing shapes to create dimensional forms. When they have reached a desired and agreed upon composition, they should tie the strings to a chopstick or a long wooden dowel.

Reflection

Display the printed image of *White Panel*, students' final artworks, and their original sketches in the classroom. Ask students to reflect on their discussion of the artwork and on the collaborative artmaking process by responding to the following questions as a group:

How did we get our ideas from the artwork *White Panel*?
How did we work together to make our own artwork?
What problems came up when we were making the artwork?
How did we work together to solve the problems?
How does our final artwork compare to our original sketch?
If we could make the final artwork again, what changes would we make?

Curriculum Connection

Integrate math concepts by discussing measurements and appropriate use of tools. Students can estimate lengths of different strings according to where the shapes should fall within the composition. They should use addition and subtraction to adjust their measurements and attend to precision using a ruler. For an extension to the upper grades, students can measure the perimeter and area of their shapes. Then, they can divide their composition into quadrants by establishing an X and Y axis and plot their shapes on the plane.

Classroom Activity

Contour Constructs

Essential Questions

How do artists draw inspiration from the world around them? How do they manipulate representational shapes to create new abstract forms?

Grades

K–5

Time

One class period

Art Concepts

Line, contour, shape, form, positive and negative space, visual and physical balance, representation, abstraction

Engineering Concepts

Identify a problem, specify criteria for developing a solution, explore multiple solutions, improve a solution based on simple test results

Materials

Poster board (cut to 8.5 x 11 in. sheets), tracing paper, pencils, scissors, glue sticks, hole punches, brass fasteners, and images sourced from magazines. Optional: cardboard bases.

Talking about Art

View and discuss the printed image of *Le Grande vitesse* (1969).

What do you notice about this sculpture? Use your finger to draw the outline, or contour, of this sculpture. Pay close attention to the direction of the contour and where it intersects with other lines. Did you use geometric (straight, angular) or organic (curvy) lines to describe the outline? Imagine you are sitting in front of this sculpture, but looking at it from a different perspective around the work. How might the outline change? Use a pencil and paper to predict what the contour might look like from another point of view.

Does the form (three-dimensional shape) of this sculpture remind you of something that you have seen in nature? Where in nature might the artist have drawn his inspiration? Share your observations, interpretations, and inferences with a thinking partner.

Making Art

Discover the artistic process of abstraction by creating your own sculpture inspired by natural forms. First, choose a large image from a magazine. Make sure the image is large enough to easily identify details and parts. Place a sheet of tracing paper on top of the magazine sheet and use a pencil to outline the contour of the image. Keep in mind that you are not trying to copy the image; you are using it as a guide to discover interesting lines and shapes. Draw the shapes as large as you can, simplifying the shapes if needed. Allow some lines to touch the edges of the tracing paper.

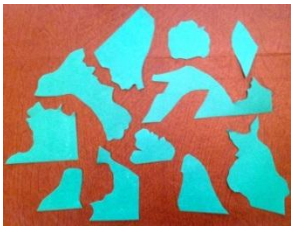
Next, carefully glue the tracing paper onto a sheet of poster board. Be sure to use just a little bit of glue, as you will eventually remove the tracing paper later. Cut the paper by following your contour lines with scissors. This should leave with you an assortment of shapes of different sizes, almost like puzzle pieces. As you look at the loose pieces, can you find evidence of your original image in these simplified shapes? This process is called abstraction—when an artist takes the essence of something representational and identifiable, like a plant or an animal, and turns it into something completely new that is much more difficult to recognize.

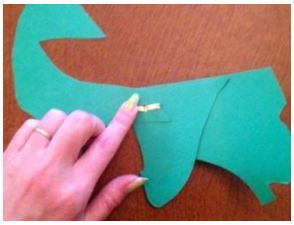
Next, brainstorm how you will arrange your pieces to create a sculpture. Will your sculpture incorporate organic lines or geometric lines? Remove the layer of tracing paper then manipulate your pieces using paper folding techniques, such as bending, curling, or rolling, to create organic or geometric contours.

How will you transform these two-dimensional pieces into a three-dimensional sculpture? Which pieces would make a good foundation and why? Which pieces are smaller, more nimble, and better suited for building up? Place the foundation pieces first then try arranging smaller pieces in space. Use your hands to think through possible arrangements that ensure structural stability and visual and physical balance.

After testing out multiple solutions, think about how you will adhere your pieces. Try layering two pieces on top of each other and hole punch where you intend to adhere them together. Use a fastener to link two pieces, then try moving the pieces in space to create different forms. Try linking two, three, or four pieces together to discover how a form can grow. Once you have secured your base, start building up and out. Adhere along the way.

As you build, consider the negative space created by joining positive pieces together. These windows of space will provide opportunities to see inside and through your sculpture from different angles. Remember to turn your sculpture 360 degrees as you go, so that you can view it and make needed changes from all sides. Try to use all of your pieces; leave no scrap behind. Continue to change the sculpture's form by bending, folding, and rolling the pieces. When finished, you may adhere your sculpture to a cardboard base.





Reflection

Display the sculptures in the classroom and facilitate a gallery walk. Ask students to reflect on the artmaking experience by responding to the following questions:

Does your sculpture resemble the original image?
What visual changes did you make along the way?
What structural changes did you make to ensure stability?
How does the final sculpture compare to your original idea?
If you could take this sculpture to scale and place the larger version in a natural site, where would you put it and why?

Curriculum Connection

Integrate concepts from science by choosing magazine images of plants, animals, and habitats. Compare scientific depictions of nature with those created by artists, including representational and abstract artworks.

Classroom Activity

Paper Sculptures

Essential Question	What is a sculpture?
Grades	SPED K–5
Time	One class period
Art Concepts	Line, shape, color, physical balance, composition
Engineering Concepts	Identify a problem, utilize multiple solutions, compare solutions
Materials	Tag board (3 x 5 in. pre-cut rectangles), colored construction paper (small pre-cut circles, squares, and rectangles), soft wire (such as Twisteez © wire), scissors, and hole punches. Optional: cardboard bases and hot glue guns.
Talking about Art	View and discuss the printed image of *Three Quintains* (*Hello Girls*) (1964). What do you see? What types of lines and shapes do you notice? Identify straight lines and shapes, then curvy lines and shapes. What colors did the artist use to paint these shapes? He used red, yellow, and blue, which are primary colors. You can mix primary colors to make many different colors. How did the artist put these lines and shapes together? Identify one detail that tells us how the artist made this artwork. Which parts of the artwork look heavy and difficult to attach? Which parts look light and much easier to attach? How are the heavy pieces and the light pieces of the artwork working together? Use your body to describe how this artwork stands on its own. If you could walk around this artwork, what more would you find? An artwork that you can walk around is called a sculpture. How are sculptures different from paintings or drawings? Paintings and drawings are two-dimensional, while sculptures are three-dimensional and, most of the time, they can stand on their own. When looking at a painting or a drawing, it is easy to see details if you look closely enough. When looking at a sculpture, it is important to walk around it so you can discover all of its sides. You will find new details the more ways you look.
Making Art	Create your own standing sculpture using paper shapes and folding techniques. First, what do you need to do in order to make a two-dimensional rectangular stand in three dimensions? Fold the rectangle in half to create a standing base. Your base can stand vertically or it can sit horizontally. Try both configurations and decide which one you like best.

Next, refold the rectangle and use scissors to cut a small slit. Then, place a shape, such as a small rectangle or triangle, into the cut. Does the shape balance with the base on its own? Try cutting two slits and attaching another shape, such as a circle. Is it more or less balanced? What would happen if you tried attaching a shape with three slits?

Now that you have tried folding shapes and attaching shapes without glue or tape, start with a horizontal or vertical base then continue to build up and out. After attaching shapes, you may hole punch the shapes to attach arms. Bend pieces of wire to create curvy lines. Twist pieces of wire around a pencil to create swirly and zigzag lines. Loop the wire into the hole punch to attach to your shapes and base. As you build, make sure that all of your pieces are working together and can stand on their own.

Reflection

Display students' sculptures in the classroom and facilitate a gallery walk. Discuss the problems that students faced while making their sculptures and how they utilized and compared different solutions.

Does your sculpture stand independently?

What folds and cuts did you make to make the sculpture stand on its own?

If you could create your sculpture again, what would you do differently and why?

Curriculum Connection

Incorporate math concepts into the lesson, using the human form and students' artworks as an opportunity to define and reinforce symmetry.

If your body were a sculpture, what parts would it have?

Which parts of the body are symmetrical, or almost the same on either side? Use your arms and legs to display symmetry.

What parts of your sculpture are symmetrical, too? Does it have arms or legs that look the same on either side?

If your composition is not symmetrical (asymmetrical), how could you change the individual parts of your sculpture to make it symmetrical?

Classroom Activity

Monumental Artworks

Three Quintains (*Hello Girls*) (maquette), 1964, sheet metal and paint, 10 ¼ x 17 ½ x 13 ½ inches, Los Angeles County Museum of Art, gift of Alexander Calder, M.66.93, © 2014 Calder Foundation, New York/Artists Rights Society (ARS), New York, photo © 2014 Museum Associates/LACMA

Essential Question	How do artists plan and build large-scale sculptures?
Grades	6—12
Time	One class period
Art Concepts	Shape, form, scale
Engineering Concepts	Attend to precision of criteria, consider constraints likely to limit possible solutions, combine parts of different solutions to create new solutions
Materials	Pencil, cardstock, and paper.
Talking about Art	View and discuss the printed image of *Three Quintains* (*Hello Girls*) (1964). What do you see? What materials do you think the artist might have used to create this sculpture? What clues can help you identify these materials?

Describe the scale or size of this sculpture. How might it compare to the size of a person or a building? How would you measure its individual parts, including the height of the triangular bases, the width of the metal arms, and the area of the circular shapes? Which mathematical formulas would you use to calculate these measurements?

How do you think the artist might have constructed this sculpture? What measurements might have helped him plan this work? What steps did he take to build the work? How did he revise or refine his plans along the way? What details do you see to support your inferences?

Compare and contrast the image of *Three Quintains* (*Hello Girls*) with the image of the maquette (or model) featured on the reverse. This is the model that Alexander Calder created to document his plans for the final work. What was his purpose in creating the maquette? Why was it important for Calder to plan his ideas first before creating the final work?

Discuss similarities and differences between the maquette and the final sculpture. What is the ratio between the scale of the maquette and the scale of the sculpture? What questions did Calder consider when taking the maquette to monumental scale? How might he have sourced his materials? How did he determine the quantity of materials needed?

Math Activity

Using the dimensions provided underneath the image of *Three Quintains* (*Hello Girls*), calculate the height and width of this sculpture. Assuming that the height represents the length from the bottom of one standing, triangular base to the top of one of the arms at its peak, use ratio and proportion to estimate the height of the bases and length of the arms. Estimate the area of the attached shapes.

Note the materials used to create this artwork and research the cost of a square foot of sheet metal. Estimate the area needed to produce one standing base with arms and shapes. What quantity of sheet metal would be required to execute the entire work?

Create your own small-scale maquette using cardstock, scissors, and paper-folding techniques. Determine the quantity of resources needed to take your maquette to monumental scale, considering the dimensions for each part of the sculpture. What materials will you use? What is the ratio of the maquette to the final sculpture? Identify the quantity of materials needed, using research to support your calculations. Then, research the cost of an alternative material. How would the total cost change if you were to choose a less or more expensive material? If you were to paint the entire surface area, how many gallons of paint would you need?

Reflection

Ask students to present their work to the class, detailing the dimensions of their maquettes and the cost of taking the maquettes to scale in various materials. They should describe their plans for the monumental work, including a site-specific location (i.e., a park, front yard, school, or garden). In culmination, students may evaluate each other's work according to cost and feasibility, then vote on a winning proposal.

Classroom Activity

Motion Machines

Essential Question	How do sculptors engage in artistic and engineering practices?
Grades	9–12
Time	One to two class periods
Art Concepts	Line, shape, texture, materiality, visual and physical balance, composition
Engineering Concepts	Attend to a range of considerations in criteria and constraints, break a major problem into smaller problems that can be solved separately, prioritize criteria and consider trade-offs as a solution is tested and refined
Materials	Paper, pencil, steel wire (22-gauge), string, scissors, and an assortment of two-dimensional materials of various weights, including cotton balls, cardboard, chipboard, cardstock, foam sheets, and foil sheets.
Talking about Art	View and discuss the printed image of *Little Face* (1962). What's going on in this artwork? Describe the artist's use of line and shape. How does the direction of the line change as your eye travels through the work? How do the shapes contract, expand, and transform? What material might the artist have used to create this sculpture? Describe the quality of the material, including its texture, weight, and density. If you were to hang this work, how would gravity act upon the material? What force could propel the arms and shapes through space? How would the composition, or arrangement of visual elements, change as the arms and shapes travel? Sketch a prediction of how this sculpture might move, from the multiple points of view.
Making Art	Create your own moving sculpture inspired by Alexander Calder's mastery of material. First, cut a piece of steel wire, hold it horizontally, and spin the wire 360 degrees. Take a quick sketch of the wire's pathway, or trajectory through space, comparing its horizontal and vertical movement. If you were to attach materials to either end of the wire, how would its trajectory change? Attach cotton balls to one end and a small piece of cardboard to the other then, with a partner, discuss how the wire's trajectory through space might change. Record your prediction in drawing, test your prediction, then revise the quantity of material needed in order to ensure equilibrium. Continue testing with different types of materials, such as cardstock against foam or chipboard against foil, creating a system of weighing a lighter material against a heavier material. Before each test, document your predictions. After each test, record your results.

How can you combine your experiments to create a larger wire sculpture that moves through space? First, think through ways to adhere two wire arms together, leaving the weighted materials (cotton balls, cardboard, etc.) intact, but still ensuring physical balance. Where is the point of balance? As you attach more arms together and as the sculpture begins to grow, how does its interaction with gravity change? Where are the new points of balance?

Continue adhering arms and weighted materials together until you have reached physical and visual balance. As long as there is physical balance between the weighted materials, you can ensure visual balance by creating an overall symmetrical or off-kilter composition.

Reflection

Ask students to install their sculptures in the classroom. They can hang their sculptures from the ceiling using string. Others can balance their sculptures on a tabletop. Facilitate a gallery walk then ask students to reflect on the artistic and engineering processes by answering the following questions with their partners:

What problem did you work through when creating your sculpture?
What constraints affected the development of a solution to this problem?
How did the results of your balance tests help you refine your solution?
What considerations did you make when ensuring both physical and visual balance?