

#MATHFINDER



talkSTEM
Share. Engage. Inspire.™



SMU

PARTNERS



Visit talkstem.org/mathfinder
to learn more!

MATHFINDER FESTIVAL 2022

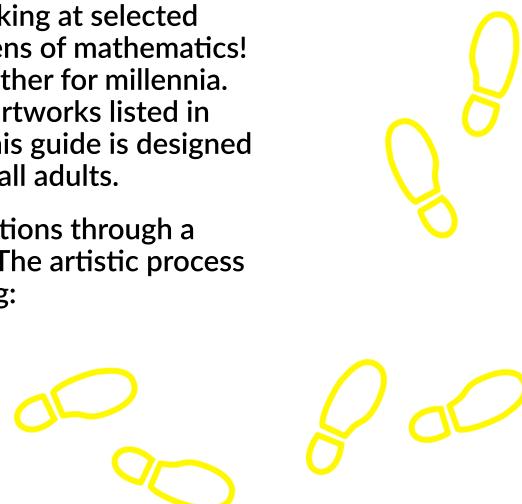
AT THE
DMA
DALLAS MUSEUM OF ART

SEEING THE
WORLD
through
MATHEMATICAL LENS
A Place-Based Mobile App for Creating Math Walks

Welcome to a new way of looking at selected artworks in the museum - through the lens of mathematics! Art, science, and math have walked together for millennia. We encourage you to explore the seven artworks listed in this guide in any order that you'd like. This guide is designed for families, children ages 8 and up, and all adults.

Artists creatively express ideas and emotions through a wide array of materials and techniques. The artistic process involves diverse math concepts including:

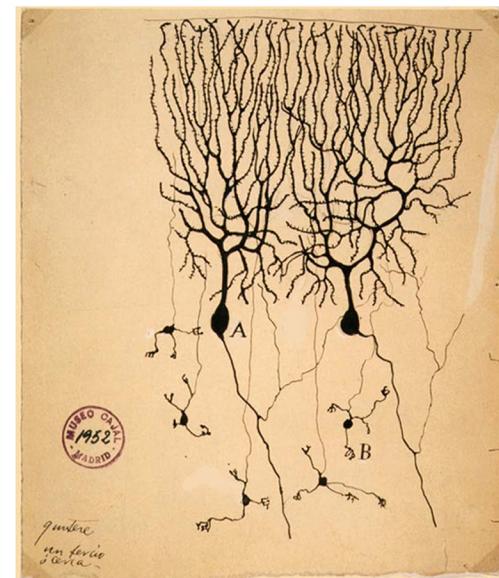
- estimation,
 - color theory,
 - scale and proportion,
 - mathematical patterns,
 - geometric and non-geometric shapes,
- and more!



We hope this fun math walk through just a handful of our exhibits will inspire our young artists, designers, scientists, engineers, and mathematicians! We've included math-related questions on this guide designed to help you explore the artworks more deeply. We hope you enjoy your mathematical explorations of these artworks!

This guide is designed in collaboration with DMA partners, the talkSTEM nonprofit organization and SMU. It is part of a National Science Foundation funded-grant project. For more information, visit talkstem.org/mathfinder.

This material is based upon work supported by the National Science Foundation under Grant DRL 2115393. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation



Santiago Ramón y Cajal, Drawing of Purkinje cells and granule cells from a pigeon cerebellum, 1899.
| Instituto Cajal, Madrid, Spain.

"From the science of conservation to the alchemy of mixing paint, innovations in science, technology, engineering, and math continue to shape and transform the arts.

Inter-disciplinary investigations of art can expand our understanding, foster learning in multiple subject areas, and illuminate authentic connections."

Claire Moore - The Allen and Kelli Questrom Center for Creative Connections Education Director, Dallas Museum of Art

"Every child is a STEM child. Every space is a STEM space. Exploring the world using STEM is fun for children and families."

Koshi Dhingra, Ed.D - Founder and CEO, talkSTEM



How Do Artists Use Math to Mix Colors?

Miguel Covarrubias, *Study for Genesis, The Gift of Life*, 1954

- Outside the front doors of the museum, right across from Klyde Warren Park



Watch Dr. Glen Whitney, Founder of the National Museum of Mathematics in New York, as he explores this mural through the lens of math. Watch the video to look at the color wheel and at this artwork in an exciting new way!



Miguel Covarrubias, *Study for Genesis, The Gift of Life*, 1954.
Tempera on cardboard laid on panel | Dallas Museum of Art



Touching the Sky

Robert Delaunay, *Eiffel Tower*, 1924

- European Art - James H. and Lillian Clark Galleries of 20th-Century Art, Level 2

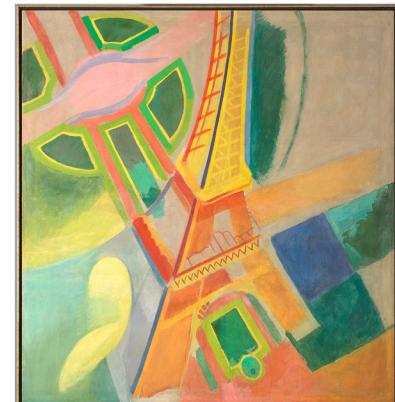
The Eiffel Tower with its soaring wrought iron girders, erected for the Paris International Exposition in 1900, was already an icon of modernity when Robert Delaunay painted it in 1924.

The whirling propeller forms at the upper left are also symbols of technological advancement, referencing pilot Louis Blériot's unprecedented flight across the English Channel in 1909. Using a jumble of multiple perspectives — bird's-eye view toward the tower; straight down on the Champ de Mars; head-on toward the plus-shaped pattern of the propellers — the artist imitates the dizzying effects of height and speed.

When the tower was built, many were shocked by its unusual shape. Eiffel was accused of making art while ignoring engineering, designing something that simply couldn't be made. However, Eiffel and his team of experienced bridge builders understood the kind of stresses a tall structure like the tower would be under - most importantly wind forces, and how to make sure that their new tallest structure in the world could withstand them. Using graphical methods and empirical evidence wind and strength was accounted for, and a basically exponential shape created, in which all parts of the tower were overdesigned to ensure maximum resistance to wind forces.

Why this exponential design works so well is still up for debate, and a number of ideas have been proposed over the years. An idea from 2004 suggests that the tension in the tower's exponential curves is just enough to bounce back against the wind, like the springiness of a bow being pulled.

[Explore More](#)



Robert Delaunay, *Eiffel Tower*, 1924. Oil on canvas | Dallas Museum of Art



Can you spot the plane in this painting? What other connections to math and engineering do you see?

Where are the perspectives used in this painting coming from? Why might they have been chosen? How does it make you feel?



What is an exponential shape?



Man and Machine

Suspended Power - American Art - 20th Century, Level 4

As handcraft gave way to technological and manufacturing progress in the early 20th century, many workers questioned their importance and relevance. Think about how the artist has chosen to illustrate the scale of the hydroelectric turbine - it is the main feature and dwarfs the workers near its point. Notice that there are only 3 people in the picture when the electric plant should be full of people working.

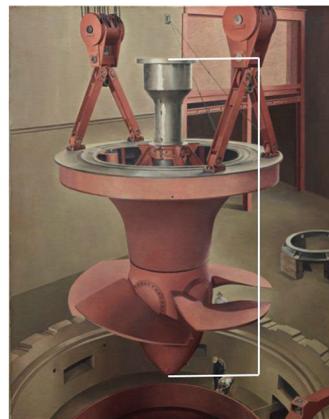


What message do you think the artist was trying to convey? Also notice the color of the turbine and the posture of the men.

How many of these men standing head to foot would make up the height of the turbine? Use your answer to help estimate the height (in feet) of the turbine from tip to top, as shown in the picture?

Hint: Assume the standing worker is 6' in height and use your handy dandy measuring tool known as a thumb or pen.

Could you fit this turbine in a standing position within the room?



Explore More



Picture of the actual Guntersville Dam in Marshall County, Alabama.



Mechanical engineer Rob Bell shows us an easy activity to demonstrate how hydroelectric dams work.



Artists and others use pencils and thumbs to do some quick math estimations. Here's how.



Grinding Gears

Gerald Murphy, Watch, 1925 - American Art - 20th Century, Level 4

In March of 1925, two years after he began making art, Gerald Murphy exhibited *Watch* at the Salon des Indépendants in Paris. *Watch* is both personally symbolic and coolly analytical. In a letter, Murphy wrote that he was "always struck by the mystery and depth of the interiors of a watch—its multiplicity, variety, and feeling of movement, and man's grasp at perpetuity." Beginning with a linear study on graph paper, the artist visually exploded and pieced together two timepieces with specific biographical associations. One was a railroad watch designed for his family's company, Mark Cross. The other was a gold pocket watch given to him by his wife Sara.

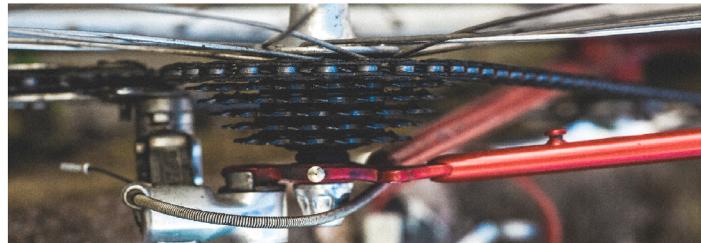
The heroic scale of Murphy's painting reflects his fascination with modern machinery's complexity and efficiency. The huge canvas is filled with overlapping, interlocking forms representing gears, dials, wheels, hands, winders, and screws in metallic and vivid colors. Its palette enhances the visual tension, as vibrant shades of orange and yellow share boundaries with a range of cooler blues and grays.

In fragmenting the timepieces and incorporating multiple points of view, *Watch* testifies to the ever-changing nature of time itself. It also evokes the cubist practice of representing the dynamic act of seeing through a seemingly arbitrary collection of visual data from various perspectives.



Observe the *Watch* painting.
 Compare the number of teeth on gears.
 Which gear has the greatest amount of teeth?
 Which has the least? Do all gears have teeth in the real world?
 How about in this artwork? Why do you think some gears don't have teeth in *Watch*?

Do you recognize the item pictured below that has these gears?
 Where else have you seen gears?



Gerald Murphy, *Watch*, 1925. Oil on canvas | Dallas Museum of Art



Find a pair of connected gears in *Watch*, where both gears have teeth. Imagine that the larger gear turns once. Guess how many times the smaller gear turns for every turn of the larger gear. Would the smaller gear turn once, more than once, or less than once?

How do the number of teeth affect the way a gear works? Watch the "How Do They Move?" video with Dr. Glen Whitney listed in Explore More.
 How many gears TOTAL can you count in this painting?

Explore More



How do different sized gears work in an eggbeater?



Dr. Glen Whitney explains how gears and gear ratios work



Just how big was radio?

Nocturne Radio - Decorative Arts and Design, Level 3

Imagine that it's the 1936, and you've just finished dinner. What would your family do? Remember that this is before televisions were widely available to the public consumer. You might have gathered to listen to a Fireside Chat from President Roosevelt or a number of radio programs, such as what you can listen to here. Without computers, televisions, or cell phones, the radio was the main source of information and entertainment - however small or big.

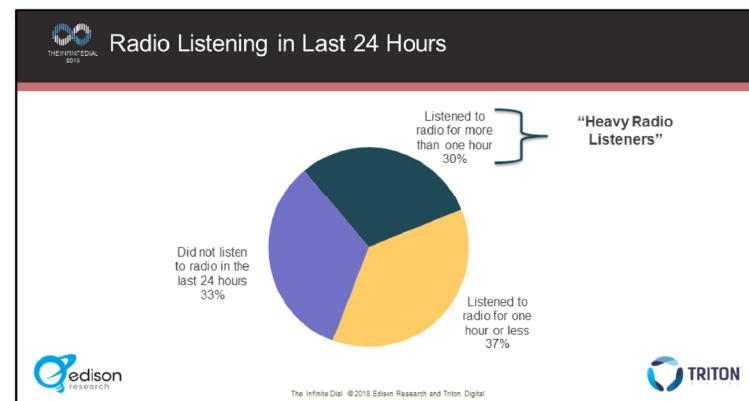
This radio was a luxury good - much like big screen televisions today - and cost almost as much as a car (\$375 in 1930s)! Most families could not afford such a radio, with large mirrored face and chrome detailing. But for \$375, how much radio were you getting?



How many times bigger or smaller is this radio compared to a smartphone screen? An average smartphone screen is 6" X3"

*What is the area of the average smartphone screen? How does this compare to the area of the Nocturne Radio?

Although television and streaming video dominate our media consumption, people continue to listen to radio. The following graphs show us some of the characteristics of modern radio listeners.



Source: "Heavy-Radio-Listeners-Document.pdf." Edison Research, Apr. 2018.



Of the people surveyed, most people fell into which group?

How are "heavy radio listeners" defined?

Out of 100 people, how many people might be heavy radio listeners?
Out of 10 people?

Explore More



Simple explanation of how loudspeakers work.



Fun activity, build your own speaker with parent help



Harold Van Doren & John Gordon Rideout, "Air-King" radio (model 66), 1933. Plastic, metal, and cloth | Dallas Museum of Art



Mechanical Nature

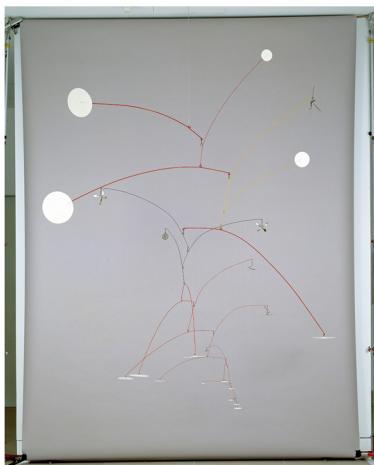
Alexander Calder, *Flower*, 1949 - 333 Balcony Overlook

Alexander Calder's *Flower* is a delicate and whimsical study of balance and motion. Informed by the most important art movements in early 20th-century Europe, Calder's work has always been greatly inspired by the rhythms and movements of nature. Liberating sculpture from its pedestal, Calder revolutionized the medium and introduced motion into modern art. Dallas's mobile, *Flower*, combines a Constructivist's love of the mechanical, a Dadaist's sense of play, a Futurist's celebration of movement, and a Surrealist's exploration of the organic and biomorphic. *Flower* is a unique universe of forms, turning, moving, and dancing, quietly and gently. It represents not only the earth, said Calder, but also "the miles of gas above it, volcanoes upon it, and the moon making circles around it."



Observe this artwork.

What shapes or forms give the impression of a flower?
How do you think the artist was able to balance the many protruding parts of this sculpture?
Can you think of an example of how this sculpture related to each of the four elements (Water, Fire, Earth, and Air)
Look at the shadows made by this artwork. Do the shadows create shapes of their own?



Explore More

Use different light sources to explore how shadows are made

Alexander Calder,
Flower, 1949. Iron,
silver, aluminum
and paint | Dallas
Museum of Art

Cartier and Islamic Art: In Search of Modernity

May 14, 2022 to September 18, 2022 - Chilton I and Chilton II Galleries



This major exhibition traces Islamic art's influence on the objects created by Louis Cartier and the designers of the great French jewelry Maison from the early 20th century to today. The exhibition explores how Cartier's designers adapted forms and techniques from Islamic art, architecture, and jewelry, as well as materials from India, Iran and the Arab lands, synthesizing them into a modern stylistic language unique to the house of Cartier.

Co-organized by the Dallas Museum of Art and the Musée des Arts Décoratifs, Paris, in partnership with the Maison Cartier, Cartier and Islamic Art presents over 400 objects from major international collections, including the Department of Islamic Arts at the Louvre Museum and the Keir Collection of Islamic Art on loan to the Dallas Museum of Art.

For over a millennium, plant motifs in the form of vines, leaves, flowers, fruits, and trees were among those most frequently used in the art of the Islamic world. Traditionally, living creatures and humans are very rarely depicted in Islamic art, primarily for religious reasons. The great diversity of the plant kingdom provided a neutral subject that could be artistically stylized and made abstract. This exhibition reveals motifs of plants and ornamentation depicted on everything, from tiaras to chest pieces. Pay close attention to the design of these pieces.



Is there symmetry? What type?
How are the symbols transformed or positioned in order to create pattern?
What effect does repetition have on the way you experience these artworks?
Notice the geometric shapes of the jewels? How many different types of shapes, and angles can you count?



Tiara, Cartier London, special order, 1936. Cartier Collection.
Vincent Vulveryck, Collection Cartier © Cartier

Bib necklace, Cartier
Paris, special order,
1947. Cartier
Collection. Nils
Herrmann, Cartier
Collection © Cartier

