TEACHER'S MANUAL GRADES K–8

MARVELOUS MACHINES

Artmobile

Covering the County • Uncovering the Arts

Traveling throughout Bucks County   September 2019– June 2021

Artmobile is a traveling museum dedicated to providing the students and adults of Bucks County access to fine, original works of art and innovative art education programs through its visits to schools and public sites. Artmobile is a vital component of Bucks County Community College which provides significant cultural outreach programs in accordance with its mission.

Since 1976, Artmobile has been committed to fostering an understanding of art, art making, and the value of art in our lives and communities by exhibiting and interpreting works of art.

This manual was developed to help teachers incorporate the Artmobile experience into their curricula by providing background information and classroom activities related to the exhibition. It is intended to serve as a resource both in conjunction with and apart from the exhibition.

For more information about Artmobile and its programs, call 215-968-8435, email artmobile@bucks.edu or visit www.bucks.edu/artmobile.

NATIONAL ENDOWMENT for the ARTS arts.gov

ARTS pennsylvania COUNCIL ON THE ARTS

Marvelous Machines is supported in part by the **National Endowment for the Arts.**

Artmobile receives state arts funding support through a grant from the **Pennsylvania Council on the Arts,** a state agency funded by the Commonwealth of Pennsylvania and the National Endowment for the Arts, a federal agency.

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Front Cover: Brad Litwin, *Greater Strum-U-Lator,* 2019, mixed media

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Bucks County Community College

Acknowledgments

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- Eileen Streeter for curating this truly marvelous exhibit;
- The artists who graciously loaned their work:

Chris Eckert	Madelaine Shellaby
Arthur Ganson	Elayna Toby Singer
Jeff Kahn	Will Tinsman
Anne Lilly	Jennifer Townley
Bradley N. Litwin	Norman Tuck
Bob Potts	Katie Wynne
John Powers	Dukno Yoon

- Gino White of Bitterroot Design, for producing the hands-on gears and pulleys
- Cynthia Scott, for writing and illustrating the lesson plans;
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- My entire Bucks County Community College family, for their enthusiasm and support—especially Megan Smith and the Marketing, Public Relations & Creative Services team for Artmobile's new wrap.

My deepest gratitude goes to my talented, resourceful and dedicated staff—my dream team:
Cayla Belser, *Artmobile Assistant;*
Jennifer Garey, *Exhibitions Assistant;*
Cassandra Stancil Gunkel, Ph.D., *Artmobile Coordinator;*
Melody Hunt, *Art Handler;* and
Artmobile Educators Michelle Kinney, Rachelle Moes, Pam Soda and Kimberly Troup.

Together, their knowledge and enthusiasm will bring *Marvelous Machines* to life for 35,000 visitors over the course of its two-year tour.

Fran Orlando
Director, Exhibitions and Artmobile
Bucks County Community College

Optimizing your Artmobile Experience

OPPORTUNITIES FOR TEACHERS

In-service training at schools prior to Artmobile's visit to helps you incorporate the lessons we provide into your curriculum. To schedule in-service training at your school, call 215-968-8435.

Teacher Workshops provide an opportunity to earn Act 48 hours for in-depth STEAM learning. See www.bucks.edu/ArtmobileWorkshops for a complete listing. Visit often, as we update our professional development opportunities throughout the tour.

PREPARE YOUR STUDENTS

Pre-Visit Classroom Activities included in this manual will provide the background for your students to get the most from their visit to Artmobile.

THE ARTMOBILE EXPERIENCE

Your students will encounter a variety of artworks during their visit to *Marvelous Machines.* Our Artmobile Educator will engage students in discussion and encourage them to make connections between what they see and what they know. By listening and speaking about the artwork, your students will develop the vocabulary and ideas that they will use later in your classroom.

After the presentation, students will have an opportunity to look at the artwork on their own. They will explore the many interactive displays that reinforce the concepts presented by our Educator.

FOLLOW-UP

Post-Visit Classroom Lessons found in this manual will enable your students to synthesize what they have learned in Artmobile with your curriculum. Encourage students to visit the Artmobile website to review the artworks and videos displayed in Artmobile.

EVALUATE

Complete a written evaluation to help us continue to improve and better understand your needs. Download the survey at the bottom of this webpage: www.bucks.edu/ArtmobileVisit

This manual and the online resources for *Marvelous Machines* found at www.bucks.edu/Artmobile provide all you need to incorporate Artmobile into your curriculum with stimulating and effective lessons that directly correlate to the Pennsylvania Department of Education Standards Aligned System.

About the Exhibition

Marvelous Machines offers an exciting chance for K-12 students to explore the fascinating world of physics, structural design, and mechanical engineering. This exhibition presents the six simple machines, then shows them to be powerful building blocks of innovation and artistic expression in kinetic sculpture.

Our partner in the exhibition, the **Mercer Museum** of the Bucks County Historical Society, has loaned historical examples of the six simple machines—Lever, Wheel and Axle, Pulley, Inclined Plane, Wedge, and Screw. Students will explore kinetic sculptures that use these devices in elegant, unexpected, whimsical, and even humorous ways. Some art pieces closely resemble familiar machines, like the balanced points of a hanging mobile, or a chain and sprocket one might find on the gears of a bicycle. Others take more unexpected forms—an instrument that is strummed by winding a gear, or mechanized creatures whose movement depends upon the bending of a human finger, and another by the careful turn of a key. Further still, artists dare to build machines that can express human thoughts and to physically realize preconceived ideas, sometimes with unintentional outcomes.

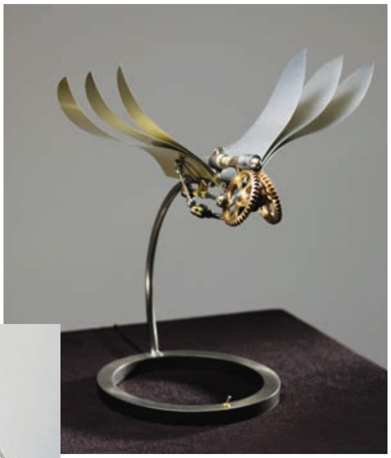
Clockwise, from left Screw Clamp, Pulley Block, Wagon Jack.
Loan Courtesy of the Mercer Museum of the Bucks County Historical Society.

Marvelous Machines is based on STEAM principles, in which Science, Technology, Engineering, the Arts and Mathematics are utilized as access points for guided inquiry, dialogue and critical thinking. Special attention has been given to artists whose work exemplifies the fascinating place where natural laws, mechanics and human ingenuity meet. Like the tools and devices we produce, the artwork in *Marvelous Machines* is a physical extension of human creativity and problem solving—experimental, curious, and awe-inspiring.

ABOUT THE ARTISTS

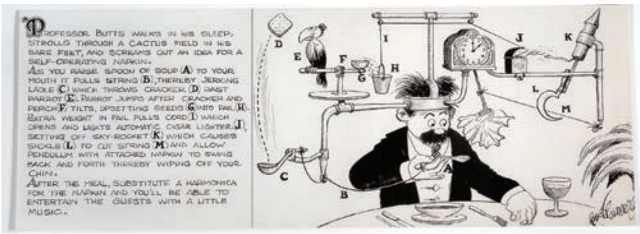
Metalsmith, jewelry and costume designer **Dukno Yoon** explores the connection between machines and humans by creating small-scale wearable kinetic sculptures. *Suspended Wings,* a full-finger double ring, uses a fulcrum and lever to transfer the work done by the wearer. As the wearer extends and then closes the adorned finger, the wings on either side of the piece are raised and lowered. Yoon's artwork plays with the idea of machines as a replacement for, or extensions of, the natural world. Yoon states, "A pair of feathered wings flap as the wearer bends the finger with hinged rings. These interactive flapping wings on the tip of the finger evoke an emotional connection from the wearer as if holding a fragile life."

Humming by **Will Tinsman** also draws inspiration from both the natural and mechanical. Created especially for Artmobile, Humming is largely comprised of found objects, a notable characteristic of Tinsman's work. In this piece, needle nose pliers form the head of a mechanical hummingbird and utensil handles have become the plumage. At the center of the body are two small metal plates that can be wound with a key, giving life to the hummingbird's wings. The direct connection between turning the key and consequential movement of the plates on a wheel and axle uses familiar machines to manifest an enchanting effect.



The similar mechanical elements between Tinsman's work and that of **Bob Potts'** demonstrate how the style of artists and the materials they choose affect the artwork as much as the engineering they employ. A trained carpenter, Potts makes stick prototypes to explore the necessary geometry of his planned artwork. He then creates one-of-a-kind sculptures out of wood, steel, copper, bronze and aluminum that harness the cyclical rhythms around us. In Potts' electrical-powered *Ascension* (presented on video), the materials have been assembled with extreme precision to mimic the fluid motion of a bird in flight.

Likewise, **Jennifer Townley's** large-scale work, *Lift* (also presented on video), runs on electricity. In it, she explores the tension between chaos and order through a configuration of connected gears and pulleys that move in and out of expected geometric patterns as well as seemingly disordered formations. The central axis of most gears has been removed to allow them to be manipulated by each other, resulting in an irregular motion that resolves itself over time. Townley's kinetic sculpture is peaceful and features slowly changing patterns indicative of her interest in the mathematical and physical interactions of her works.



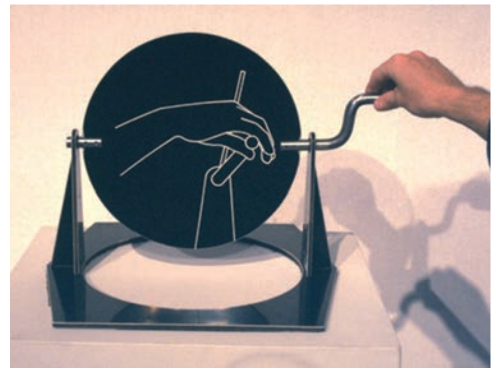
◀ Over-engineering is a common exploration of kinetic art and machines, and was regularly seen in the illustrations of **Rube Goldberg.** His clever machine illustrations are well known throughout the United States as performing a simple task, but in a conspicuously overcomplicated if not absurd fashion. "Often, these machines consist of a series of simple devices that are linked together to produce a domino effect, in which each device triggers the next one, and the original goal is achieved only after many steps." (https://en.wikipedia.org/wiki/Rube_Goldberg_machine). Two reproductions of Goldberg's drawings are featured. *Self-Operating Napkin* is an invention credited to Professor Butts, a recurring character in Goldberg's comics. *Labor-Saving Auto Jack* shows how the everyday man can easily fix his own flat tire, as long as he has an elephant. The two ideas, one complex and one simpler, are both examples of Goldberg's signature style and wit.

◀ Like Goldberg's convoluted contraptions, **Brad Litwin's** sculptural pieces also accomplish simple tasks, while celebrating the process by which the work is achieved. *Greater Strum-U-Lator* gives a clear view of multiple gears of various sizes set into motion by a hand crank. The action ultimately strums guitar strings and, on every fourth crank, shifts the key of the instrument up or down. Unlike many of Goldberg's drawings, *Greater Strum-U-Later* does not begin with one action which sets of a series of chain reactions, but is a continuous effort on the part of the person interacting with the piece. In both cases though the machine is overly complicated; the hand that is turning Litwin's piece could as easily strum the guitar as Goldberg's Professor Butts could wipe his face with a napkin.

◀ *My Little Fiddle* by **Arthur Ganson** continues to play with this idea of inefficiency or the expectations we may have of machines. Although Ganson has had this idea in mind for several years, *My Little Fiddle* is a kinetic sculpture created especially for *Marvelous Machines.* This piece combines a fairly elaborately motorized feather and a violin. The feather dances against the bottom of the violin, moved around by a gear set within a controlled ring. The violin, capable of creating beautiful music, is soundless as the feather needlessly rotates beneath it. Ganson is a self-taught engineer who creates these whimsical, often interactive, machines in which the viewer's thoughts and feelings are critical to the work's intended completion. His work has been displayed continuously at the MIT Museum since 1995, where Ganson is also one of the originators and co-hosts of the Friday After Thanksgiving (F.A.T.) Chain Reaction challenge, in which teams of amateur inventors of all ages work together to build a massive chain reaction device. "It's great to see really young kids making things," Ganson says. "Talking to them about their process has turned out to be as much fun as watching the chain reaction itself."

Using a machine to reflect back human activity is also inherent in the work of mixed media sculptor and installation artist, **Katie Wynne.** Originally part of a larger installation, *Centipediatrics* offers commentary on the way people, Americans in particular, tend to overuse and overvalue machines in an effort to escape the discomfort, banality, messiness, and ultimately temporary nature of human life. In *Centipediatrics,* a purchased tie rack is embellished and redefined to be larger and more festive. Wynne's additions do not change the movement of the tie rack, but they do remove the function of it, swapping out the machine's work for a constant parade of glittering colors and textures. According to Wynne, "We are throwing a party but what cause we have to celebrate is unclear."

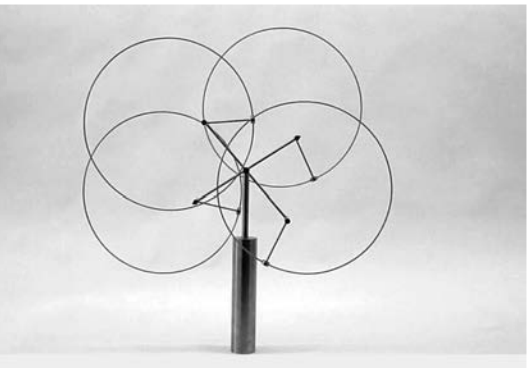
Norman Tuck pushes humor to the ridiculous in his piece *Flipper,* a funny, self-referential work that directs the visitor on how to operate the piece while they actually use it. Made from stainless steel and plastic engraving material, *Flipper* is designed as a simple wheel and axle which visitors can activate. When the handle is down, the image facing the user is of a hand holding the handle down. When the handle is cranked upwards to change the image, the new image shows the handle up higher. The rotating image mimics the actions of the viewer, making a little visual joke.



Elayna Toby Singer's art practice is centered on environmentalism and using everyday objects to convey the vital importance of connecting to the earth, each other, and ourselves. One of her smaller pieces, *Tracks,* is a mobile of recycled toy train tracks and chain-linked beads, which whimsically embodies this universal quest for equilibrium and stability that underpins much of Singer's work. In contrast to some of the other machines displayed in this exhibit, *Tracks* does not require direct human interaction in order to spark its movement. However, only careful and responsive work on the part of its creator facilitates an even distribution of weight and motion with grace.

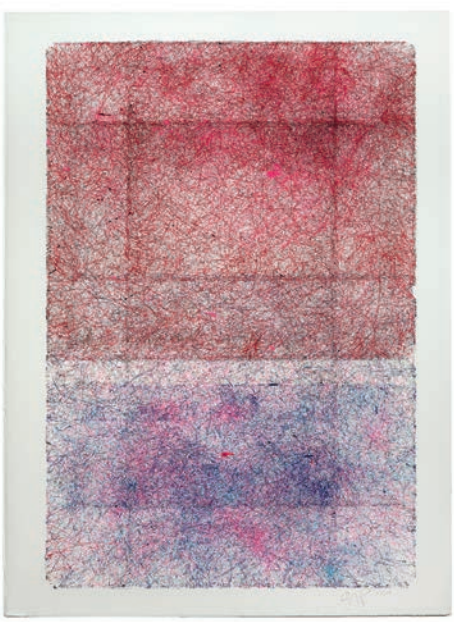
Murder of Crows, by **Madelaine Shellaby** is another piece that does not require direct human interaction to move. Each of the crow silhouettes is attached to a carefully weighted rod (lever) hidden under a metal front panel cut to look like grass. Air currents will cause the crows to move independently of each other. The title refers to the unique term used for a group of crows. As a group of geese is known as a gaggle of geese, a group of crows is called a murder of crows.

Magic Metronom*e* also uses *de facto* principles of physics and geometry, but appears to defy the reality of these laws. **Jeff Kahn** is a sculptor whose current work combines his experience as a jeweler, wood-worker and machinist. His large-scale outdoor sculptures made from steel and aluminum, are powered only by the forces of nature, moving naturally without wires, lights and electronic technology. His work often explores balance and gravity, and Kahn enjoys seeing how the final pieces he creates move in unexpected ways. *Magic Metronome,* a smaller-scale indoor piece, uses lightweight levers to capitalize on even the slightest movement of air to set it in motion. This interplay of pivot and counterbalances presents a clever visual puzzle. Although the work appears to be a standard pendulum, the center of the arm is actually hollow, affecting how the arm swings. When the arm moves it appears to linger in the air longer at the top of each swing, and when it is at rest, it hangs askew.



Sculptor **Anne Lilly** combines the lever and fulcrum with the wheel and axle to challenge the mind with *Conductor/Composer,* displayed in video form in *Marvelous Machines.* Crafted from machined metal, two arms connected to a central rod have an additional arm at either end. These four smaller arms move four metal hoops in opposing directions. The smaller arms jut into the space of these hoops, but they do not actually reach the center. They create a secondary radius for the hoop as it moves around the central rod. Each arm is a lever and the connections between the smaller and larger arms as well as the smaller arms and the four circles are fulcrums. Like much of Lilly's work, *Conductor/Composer* is engineered to encourage the viewer to consider the physical design of the piece as well as one's own reaction to it.

Mechanical engineer and sculptor **Chris Eckert** combines machines with computer technology to reflect deeply personal human thoughts, sometimes his own and sometimes those he finds written by others. *Babel* is an installation piece composed of twenty polychromed metal microelectronic writing machines mounted in a horizontal line high on a wall. Each machine searches the internet for a specific phrase, then uses a ballpoint pen to write the result on long thin rolls of paper in a unique hand-writing and language. The machines dutifully record these global sentiments and continue to share them, rolls of endlessly unspooling thoughts gathering in tangled piles of paper beneath them. *Babel* mirrors genuine human thoughts, anxieties and insecurities that are commonplace throughout the world, all of which were initially—somewhat ironically—expressed via technology.



Another artist and programmer using computers to put pen to paper is **John Douglas Powers,** who is recognized internationally for his kinetic sculptures, installations, animation and video works. *Machine Drawings* appear as geometric forms made up of a myriad of tiny multicolored ink scribbled on large sheets of paper, and are purposely designed to invite viewers to think about how exactly they were made. Powers creates computer code that directs a motorized ball to move in specific patterns within a set area. This ball is contained by a tube with pens on either side, a wheel and self-propelled axle. As the ball moves, it creates a picture he envisioned beforehand. Like the other exhibit artists, Powers employs scientific knowledge combined with a spirit of experimentation and creative expression in his work. He deftly utilizes the simplest and more complex machines to realize his unique artistic vision, of which the process of creation is as much a part of the art as the drawings themselves.

Eileen Streeter, *Guest Curator*
with Rachelle Moes *and* Fran Orlando

K–8 Curriculum Integration & Lesson Plans

All of these activities are designed to be multi-disciplinary, incorporating science, art, math, literature, and technology, among other fields. Our goal is to help teachers incorporate the Artmobile experience seamlessly into their curriculum. Lesson plans were developed in concert with the Standards Aligned System (SAS), developed by the Pennsylvania Department of Education by a Pennsylvania-certified teacher especially for *Marvelous Machines.*

PRE-VISIT: ALL STUDENTS

MUSEUM MANNERS

Take a moment to review proper museum behavior with your students. Leave food, drinks and bags in the classroom. Remind students not to touch the artwork of any of the Plexiglas protecting it. Walk, use quiet voices, and respect the Artmobile Educator.

PRE-VISIT ACTIVITIES

We suggest that all classes at least review the six simple machines before visiting Artmobile. If time allows, add one or more of the Pre-Visit Activities on page 12.

POST-VISIT: CHOOSE ONE OR MORE

POST-VISIT ACTIVITIES

Written and illustrated by Cynthia Scott, the lesson plans on pages 12–17 are inspired by the artworks your students will see in Artmobile. They organized by grade level and include extensions for further projects and research. They can be used as is, or easily adapted to suit your particular class.

POST-VISIT HANDOUTS

Short on time? Use our Post-Visit Handouts on pages 20–23 to reinforce the concepts introduced in Artmobile.

MARVELOUS MACHINES

Pre-Visit Activities

The Mercer Museum has developed an extensive curriculum on the six simple machines that can be found at www.mercermuseum.org/simplemachines.

Choose one or more of their pre-visit activities listed below to prepare your students for their visit to Artmobile.

WHAT ARE THE SIX SIMPLE MACHINES?

Review the six types of simple machines—inclined plane, wedge, lever, wheel and axle, screw, and pulley—with students. Discuss how these machines are used to make work easier. Use the resources on page 18 for background information.

SHOW AND TELL

Ask students to bring in an example of a simple machine from their home, e.g. a toy, a game, a simple (but safe) tool. Have students explain the way the machine works to their classmates.

CLASSROOM EXPLORATION

Have students work in teams to identify as many simple machines as they can find in their classroom.

SIMPLE MACHINES BULLETIN BOARD

Ask students to clip pictures from magazines of levers, screws, inclined planes, pulleys, wheels and wedges for posting. Older students can clip pictures of complex machines and identify the simple machines within them.

Horse Power (Treadmill) Model, Loan Courtesy of the Mercer Museum of the Bucks County Historical Society

Post-Visit Activities

ABSTRACT PAINTING ON AN INCLINED PLANE

GRADES K-3

Language Arts, Science, Art

PA Standards:
ELA CC 1.1, 1.4
Science and Technology 3.2.B, 3.2.A
Art 9.1 A, 9.2 A, G

Objective
Students will discover how to create art using a simple machine.

Method
Inspired by the artwork of Artmobile artist John Powers, students will create artwork using a marble and an inclined plane.

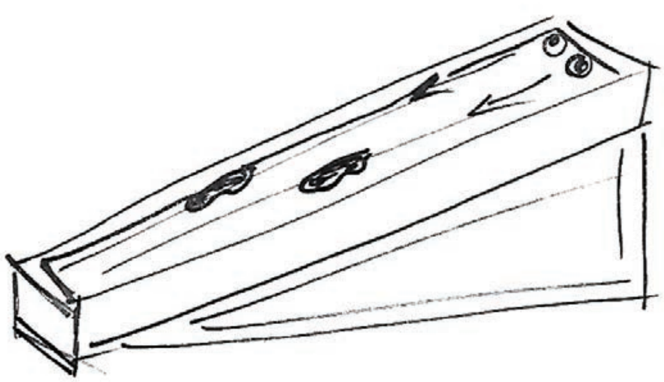
Materials
Cardboard box lid, eye droppers, scraps of corrugated cardboard, glue, several marbles, tempera paints, drawing paper to fit inside the lid

Background
The cardboard box acts as an inclined plane when supported by the extra cardboard pieces attached to the sides. The marble rolls through the paint splotches to create an abstract work of art.

Procedure
1. Cut two pieces of the corrugated cardboard in an elongated triangle shape, attach to the sides of the box lid to build an inclined plane.
2. On a flat surface, lay the drawing paper inside the box.
3. Prepare six cups of different paint colors with an eye dropper in each cup.
4. Using the eye droppers and all the colors of paint, make splotches paint on the paper.
5. Roll marbles at different angles from the top of the inclined plane and watch how they pick up the paint and draw lines on the paper
6. Repeat until your artwork is complete.

Reflection
Explain how an inclined plane works.
How did the marbles pass through the paint?

Adapted from https://www.pinterest.com/pin/522839837983726962/?lp=true



John Powers, *Machine Made Drawing,* ink on Rives BFK

Grades K-5

Language Arts, Math, Science, Art

PA Standards:
ELA CC.1.1, CC.1.4
Mathematics CC.2.1
Science and Technology 3.6
Art 9.1 A, 9.2 A, G

SPINNING SCULPTURE

Objective
Students will make a hand-held paper toy that spins on a string.

Method
Inspired by the work of Artmobile artists Brad Litwin and Rube Goldberg, students will create a simple toy wheel that spins when pulled by a string.

Materials
5″ circle tracer, drawing paper, cardboard, scissors, glue, colored markers, pencil, cotton string

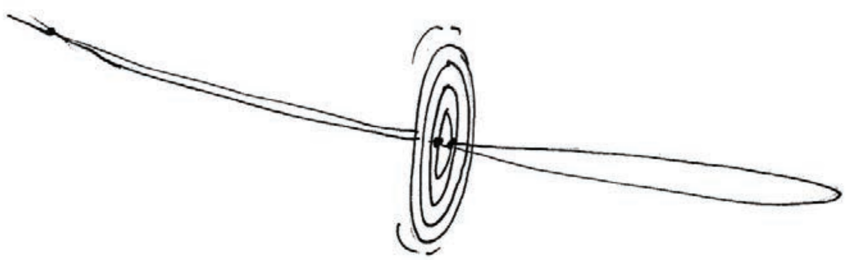
Background
The paper disc is centered between a length of string and this simple toy spins by using the string and a pulling in and out motion to move.

Brad Litwin, *Greater Strum-U-Lator,* 2019, mixed media

Procedure
1. Draw three 5″ circles, two on white paper and one on cardboard
2. With colored markers, draw circular lines starting in the center and coming out to the edge on the paper circles.
3. Cut out all three circles, glue a paper circle on each side of the card board circle.
4. Cut two holes on either side of the center of the circles
5. Cut a length of string and fold in half, Thread through the 2 holes on one side of the circle,
6. Knot the ends of the string together. On the other side pull the loop from the center and even out the strings
7. To make the circle spin. hold the string at both ends and pull in and away from the circle.

Other circle design ideas: repeat pattern, radial art designs, optical illusion designs.

Reflection
Explain how the circle spins, answer how the design drawn on the circles add to the effect of the spinning motion? Could other circles be added? How?



A MOBILE WITH A THEME

Objective
Students will discover kinetic art through mobile making.

Method
Inspired by the work of Elayna Toby Singer, Artmobile artist, students create a mobile that utilizes balance with found objects that tell a story about a place or a culture.

Materials
Dowel stick, string, scissors, white glue, found objects that follow a theme

Background
A mobile is characterized by the ability to move when propelled by air currents, by touch or by a motor. A mobile consists of a group of shapes or objects that are connected by string or wire. They are usually suspended, or can be attached to a platform on the floor. Marcel Duchamp made mobiles in the 1920's, but Alexander Calder is the artist most well-known for his mobiles.

Learn more about how contemporary artists are using mobiles at https://www.nytimes.com/2018/11/29/t-magazine/mobiles-kinetic-sculptures-calder.html. Learn more about *Marvelous Machines* artist Elayna Toby Singer at www.elaynatobyart.com.

Procedure
1. Cut two strings of heavy twine that measure 36″ long and one string 18″ long for hanger.
2. Cut a dowel stick 12″ long.
3. Tie and knot four objects to each string with glue, space the objects evenly on each string.
4. Tie string of objects at either end of the dowel stick: to create the hanger, use the 18″ string and tie that to either end of the dowel, hang mobile from the center of the string for balance. Watch the mobile move freely using air currents.
5. Write a story about your mobile.

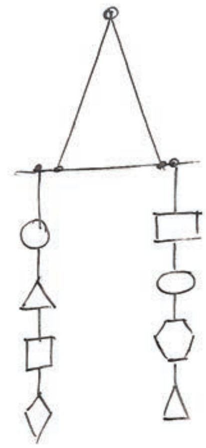
Mobile theme ideas: Recycled pieces of technology: iPod, ear buds, cell phones batteries, SIM cards etc.; Beach theme: shells, driftwood, sea glass, seaweed, rope, etc.; Forest floor: moss, twigs, stones, feathers, bark, etc.; Abstract paper shapes mobile: ovals, rectangles, diamonds, triangles, etc.; Art supplies mobile: paint brushes, paint tubes, colored pencils, crayons etc.

Reflection
Write a paragraph describing your mobile. *What is the theme? How did you create the mobile? What is the message? Where will it hang?*

Grades K-8

Language Arts, Mathematics, Social Studies, Science, Art

PA Standards:
ELA CC.1.1, CC.1.4
Mathematics CC.2.1
Social Studies 8.6
Science and Technology 3.6
Art 9.1 A, C, E, 9.2 A, C, 9.3 C, 9.4



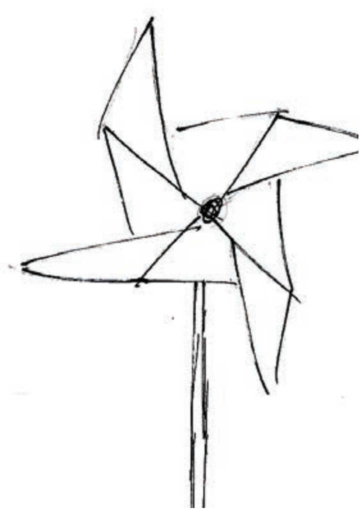
Elayna Toby Singer, *Tracks,*
HO scale model train tracks, onyx, class, brass, bone, wood beads, leather, fishing swivels

Grades K-8

Language Arts, Math, Science, History, Art

PA Standards:
ELA Core 1.1, 1.4
Mathematics 2.1
Science and Technology 3.6
Art 9.1 A, 9.2 A, G

Jeff Kahn, *Magic Metronome*, aluminum



HANDHELD PINWHEEL

Objective
Students will create kinetic sculpture powered by air currents through the creation of a pinwheel.

Method
Inspired by windmills that generate electricity and are powered by the wind, students will learn how to make a pinwheel toy that spins.

Materials
Dowel stick, metal fastener, scissors, markers, 9″ x 9″ lightweight drawing paper, ruler, pencil.

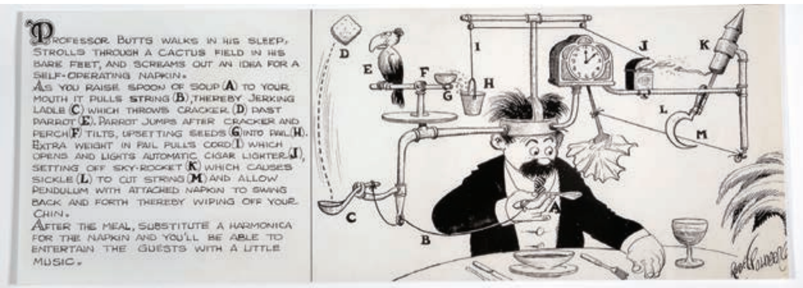
Background
Pinwheels are kinetic sculpture powered by air currents, by hand or a motor. The pinwheel spins and is attached to a stick, the blades of a pinwheel fold inward, cupping the wind that causes the blades to spin. The history of the pinwheel spans the globe, the pinwheel was originally known as a whirligig and dates back to 400 B.C in China, and in the Sasanian Empire by 700 A.D, with the use of windmills. Pinwheels may have arrived in America through immigrants that came from Europe. Interestingly, George Washington carried whirligigs home from the Revolutionary War.

Procedure
1. Cut the drawing paper to measure 9″ x 9″. With colored markers, draw spiral patterns on the paper.
2. Draw two lines using a pencil and a ruler between opposite corners of the square.
3. Make a hole in the center, where the two lines intersect, with a pencil.
4. Cut along each line from the corner 3 ½″ toward the center,
5. Working clockwise, fold the paper along the cut lines with the points meeting the center hole to create four blades of the pinwheel, put a small hole with the pencil point at the point of each folded blade
6. Using a metal fastener, attach the ends together through the hole in the center.
7. Wrap the fastener around the dowel stick and attach with glue only to the back of the dowel stick to allow the pinwheel to spin. Let dry.
8. Hold the pinwheel or stand it up and use your hands or air currents to make the pinwheel spin.

Pinwheel design ideas: use clear colored acetate paper to create the pinwheel, place in a breezy location. Draw Op-Art designs on each blade. Decorate your pinwheel with glitter and buttons, or make your pinwheel look like a flower by attaching paper leaves to the sides of the dowel sticks.

Reflection
Write a paragraph on how a windmill works similarly to a pinwheel.

Extension
Middle School students can read the book *Whirligig* by Paul Fleischman.



Rube Goldberg, *Professor Butts' Idea for a Self-Operating Napkin,* 1931

CARTOON INVENTION à la RUBE GOLDBERG

GRADES 3-8

Language Arts, Math, Science, Art

PA Standards:
ELA CC.1.2
Mathematics CC.2.3
Science and Technology 3.5
Art 9.1 E, 9.2 A, 9.3 C 9.4 D

Objective
Students will collaborate on an invention idea using simple machines. They will create a drawing that illustrates complicated gadgets doing simple tasks in indirect ways.

Method
After coming up with several invention ideas, the group will decide on one idea and illustrate the idea in a cartoon "Rube Goldberg style."

Materials
Drawing paper, pencils, rulers.

Background
"Rube Goldberg (1883–1970) was a cartoonist, an inventor, and the only person ever to be listed in *Merriam-Webster's Dictionary* as an adjective. Of the nearly 50,000 cartoons he drew in his lifetime, Rube is best known for the zany contraptions of Professor Butts. These inventions, also known as Rube Goldberg Machines, solved a simple task in the most overcomplicated, inefficient, and hilarious way possible." (https://www.rubegoldberg.com/rube-the-artist/)

Procedure
Through group collaboration, illustrate an invention like Rube Goldberg.

1. Divide the class into groups of 5-6 students each. Have students discuss ideas for an elaborate machine to accomplish a simple task. What would the machine accomplish? Choose the best idea.
2. Name the project invention, plan out the whole design, start to finish, write down at least 12 steps to describe what it will do and how it will accomplish the task.
3. List at least 5 of the 6 simple machines that will be used in the invention and explain how they are represented and how many times they are utilized.
4. Together, on drawing paper, make a step by step diagram of how the invention will work.
5. Referring to the diagram sketch, create a cartoon style illustration of the invention like the work of Rube Goldberg.

Reflection
Referring to the cartoon drawing, explain the invention to someone other than your group members. Did they understand the machine? Did the parts of the machine fit together? Did the drawing look like something Rube Goldberg would create? Write about the experience of designing an invention.

Adapted from https://media.rubegoldberg.com/site/wp-content/uploads/2017/10/Rube-Goldberg-Lesson-Plans.pdf

Resources

SIX SIMPLE MACHINES

The Mercer Museum has an extensive curriculum on the six simple machines that can be found at https://www.mercermuseum.org/SimpleMachines.

ThoughtCo (https://www.thoughtco.com/six-kinds-of-simple-machines-2699235) has a variety of excellent resources for teachers including descriptions and examples of the six simple machines, discussion of the physics involved. They also have printables like word search, crossword and activity sheets at https://www.thoughtco.com/simple-machines-printables-1832412.

Idaho Public Television has a terrific website http://idahoptv.org/sciencetrek/topics/simple_machines/facts.cfm that clearly explains each of the six simple machines and how they are used everyday. Click on the Teachers tab http://idahoptv.org/sciencetrek/topics/simple_machines/teachers.cfm for links to videos, quizzes, lesson plans and PowerPoints for lower and upper grades.

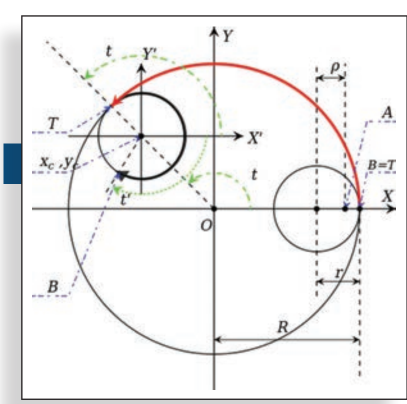
The Museum of Science and Industry in Chicago has several webpages dedicated to simple machines. Find easy pre-visit activities for each of the six simple machines here: https://www.msichicago.org/education/field-trips/learning-labs/simple-machines/activities/.

RUBE GOLDBERG

The official Rub Goldberg website https://www.rubegoldberg.com has lesson plans, videos and complete information about contests.

To learn more about the man, visit http://www.rube-goldberg.com/.

Wilson, Emily. "***The Story Behind Rube Goldberg's Complicated Contraptions,***" Smithsonian, Web 1 May 2018. https://www.smithsonianmag.com/history/story-behind-rube-goldbergs-complicated-contraptions-180968928/



SPIROGRAPH MATH

GeoGebra has a detailed diagram with equations for the math whiz. https://www.geogebra.org/m/a5Hd3hZv

Wikipedia has a helpful explanation for the rest of us. https://en.wikipedia.org/wiki/Spirograph

About the Mercer Museum

The Mercer Museum is a six-story reinforced concrete castle designed by Henry Mercer and completed in 1916. Today, it is one of Bucks County's premier cultural attractions and a Smithsonian affiliate.

Mercer Museum
84 South Pine Street
Doylestown, PA 18901

The museum complex features local and national traveling exhibits, as well as a core museum collection of over 50,000 pre-Industrial tools. This permanent collection offers visitors a unique window into pre-Industrial America through sixty different crafts and trades, and is one of the world's most comprehensive portraits of pre-Industrial American material culture. The museum also features a research library that is a center for local history related to Bucks County and the surrounding region, with its roots dating back to the founding of the Bucks County Historical Society in 1880.

Photos: Kevin Crawford—VBC—Mercer Museum

The history behind humanity's development and use of tools was at the core of Henry Mercer's original interests, and was central to his collecting and research. The Mercer Museum's collection of everyday objects offers numerous practical examples of the physical and mechanical principles that served as the building blocks of modern technology. A visit to the Mercer Museum reveals essential early American tools on display that demonstrate how simple machines made pre-industrial life easier.

The Mercer Museum education team offers special elementary-level school programs all year long focused on simple machines and their relevance to PA educational standards as well as Common Core standards.

To learn more, please visit
www.mercermuseum.org/simplemachines

MARVELOUS MACHINES

Vocabulary Worksheet

INSTRUCTIONS

The vocabulary worksheet on the next page uses the terms and definitions listed in the Mercer Museum Program packet found at www.mercermuseum.org/simplemachines.

TEACHER KEY

Terms

13 Pulley

6 Gravity

10 Load

17 Wheel and Axle

11 Mechanical Advantage

9 Lever

2 Effort

3 Force

12 Mechanism

7 Gear

14 Screw

18 Work

15 Simple Machines

1 Complex (or Compound) Machine

5 Fulcrum

16 Wedge

8 Inclined Plane

4 Friction

SIMPLE MACHINES—VOCABULARY WORKSHEET

Name____ **Date**________________________

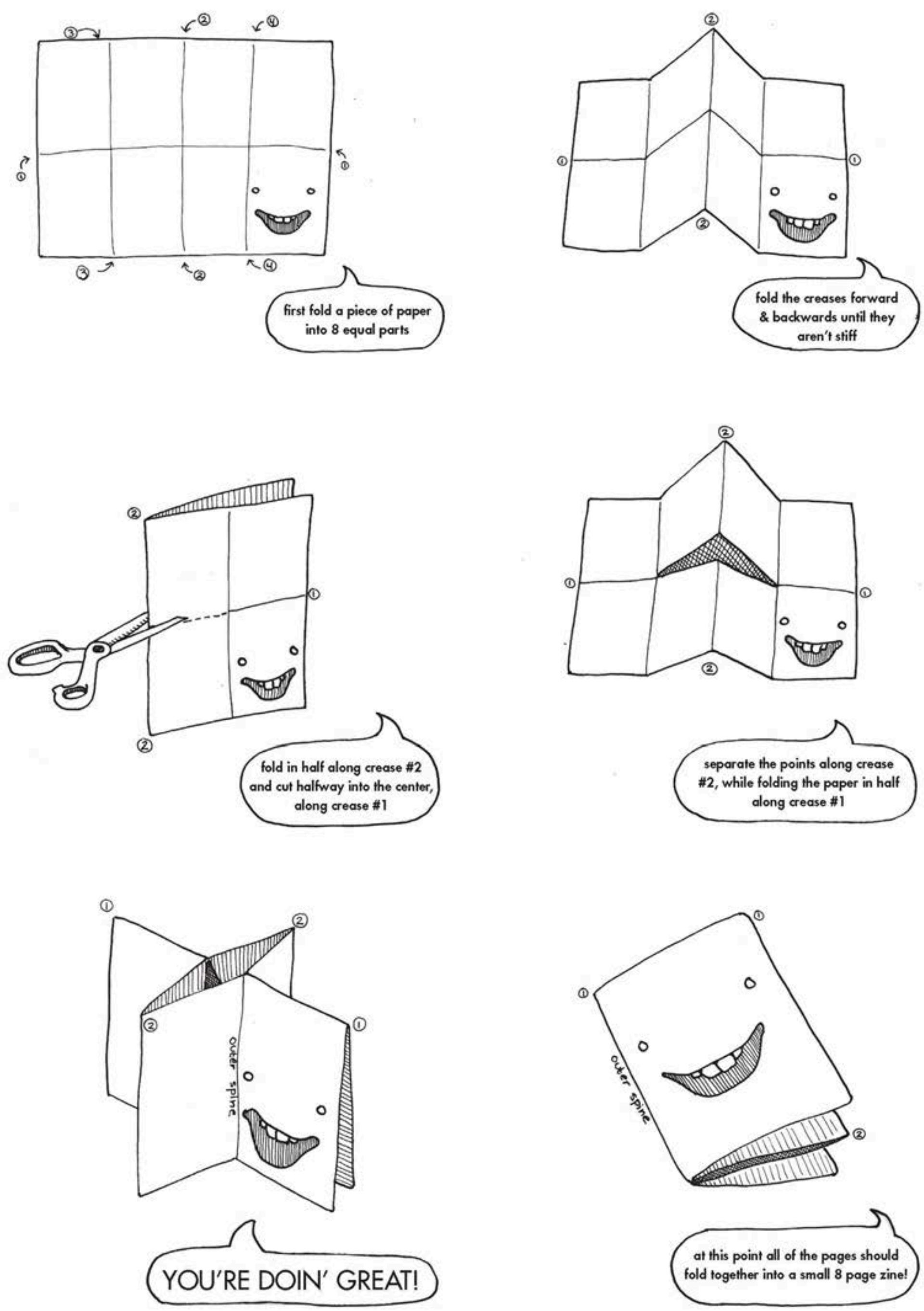
Terms	*Definitions*
___ Pulley	**1.** Two or more simple machines combined.
___ Gravity	**2.** The force or energy you put into a machine to make it work.
___ Load	**3.** A push or a pull.
___ Wheel and Axle	**4.** A force that exists between two surfaces in contact with each other, and that resists motion between these two surfaces.
___ Mechanical Advantage	**5.** The point on which a lever pivots or turns.
___ Lever	**6.** A force that causes objects on earth to fall.
___ Effort	**7.** A wheel with teeth.
___ Force	**8.** A simple machine in the form of a ramp—a slanting surface that connects a lower level to a higher level.
___ Mechanism	**9.** A simple machine made up of a stiff rod or bar that pivots (or turns) on a support called a fulcrum.
___ Gear	**10.** The object or material one is attempting to move or lift using a simple or complex machine.
___ Screw	**11.** The benefit gained by using machines.
___ Work	**12.** A device that changes motion, transmits power or force, or controls motion, power or force.
___ Simple Machines	**13.** A member of the lever family, this simple machine uses a grooved wheel and a rope to move a load.
___ Complex (or Compound) Machine	**14.** A simple machine composed of an inclined plane wrapped around a pole or cylinder. They hold things together, press or crush things, or move things.
___ Fulcrum	**15.** Tools or devices that make work easier.
___ Wedge	**16.** A simple machine of the inclined plane family, used to push things apart. It has at least one slanting side ending in a sharp edge.
___ Inclined Plane	**17.** A simple machine of the lever family, composed of a spoked wheel or disk with a rod through the center.
___ Friction	**18.** The effort needed to move an object multiplied by the distance an object is moved (E x D = W).

Simple Machines Zine

INSTRUCTIONS

Students can make a Zine to recall their visit to Artmobile. Simply duplicate the page at right and have students follow the directions below.

Students can refer to the slideshow at www.bucks.edu/MarvelousMachines.



LAzineFest.com
illustrations by Simon Sotelo

How To Make an 8-Page Zine

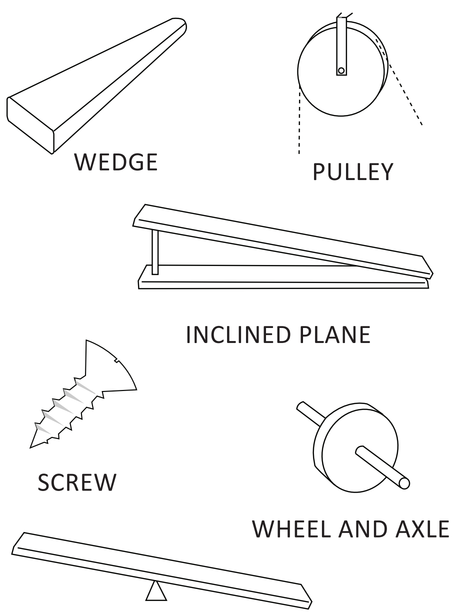
MARVELOUS MACHINES

name

1

6 Simple Machines

2



Wedge

3

Draw an example seen in *Marvelous Machines*:

How does the wedge make work easier?

Inclined Plane

4

Draw an example seen in *Marvelous Machines*:

How does the inclined plane make work easier?

Screw

5

Draw an example seen in *Marvelous Machines*:

How does the screw make work easier?

Lever

6

Draw an example seen in *Marvelous Machines*:

How does the lever make work easier?

Pulley

7

Draw an example seen in *Marvelous Machines*:

How does the pulley make work easier?

Wheel & Axle

8

Draw an example seen in *Marvelous Machines*:

How does the wheel & axle make work easier?

Bucks County Community College

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