Classroom Activity

Building a Metropolis

Essential Questions
What forms serve as the building blocks for a metropolis?
How do artists and mathematicians design the built environment?

Grades
3–6

Time
Two to four class periods

Art & Math Concepts
Form, interval, grid, quadrant, space, sculpture

Materials
Colored masking tape, measuring tape, cardboard, a variety of recycled materials (cardboard cylinders, packing material, plastic containers, bottle caps, etc.), glue, scissors, white and colored tempera paint, brushes, water, paper towels. Optional: construction paper, wooden dowels or sticks.

Talking about Art
View and discuss the photographs and engineering map of Chris Burden's *Metropolis II* (2011) included in the printed and digital curriculum. Watch the spotlight video of *Metropolis II* on *Unframed The LACMA Blog* at http://lacma.wordpress.com/2012/01/10/ metropolis-ii.

What are the first words that come to mind when you see *Metropolis II*? What three-dimensional forms, such as cubes, cylinders, or spheres, do you see? How are the forms arranged to create a city? What other urban elements do you notice? What is the relationship between the building forms and the freeway tracks? How are they integrated into the overall design?

How does looking at photographs of *Metropolis II* compare with watching a video of the sculpture? What did you notice about the artwork from the video that you did not notice in the photographs? What do you think it might look, sound, and feel like to experience *Metropolis II* as a miniature resident? How would it compare to living in a life-size city?

An engineer worked alongside the artist to design and build *Metropolis II*. First, the engineer sketched a simple two-dimensional shape to represent the base of the sculpture. Then, he mapped out the track configurations using string and pen. He marked the string tracks with pen at five-foot scale intervals to guide construction. Lastly, artists added wooden and tiled buildings in between the tracks to mimic the look and feel of a real city.

How does *Metropolis II* compare with the look and feel of your neighborhood? How would you describe the natural landscape of the community? How would you describe the man-made or built environment? What three-dimensional forms comprise these types of environments?

Making Art

Create a classroom metropolis by, first, analyzing a map of the school neighborhood. What landmarks surround the school? What buildings, roadways, bridges, and parks do you notice? Visit some of these structures and sketch the forms that they take (rectangular, triangular, spherical, etc). If you could add forms, structures, or other elements to the neighborhood, what would you add and why?

Place four large pieces of cardboard on the classroom floor, creating four equal quadrants. Lay a simple city grid on top of the cardboard using colored masking tape. Use one color to map north-south thoroughfares and another color to map east-west streets. Keep the map simple, leaving negative space or plots of land in between roads. Divide students into four groups, assigning each group a different quadrant to build. They can use the cardboard as a base to adhere recycled sculptural materials. Forms such as rectangular prisms and cylinders should represent the different structures or spaces that they would add to the neighborhood. Encourage them to work with large forms first, then add smaller forms as details later.

When construction is complete, whitewash the entire city with quick-drying white tempera paint. When dry, add windows, doors, and signage using tempera colors. Use colored construction paper, dowels or sticks, and other recycled materials to add trees, plants, and flowers to the natural landscape. Students can also bring toy cars or toy people from home to turn the sculpture into a full-fledged city.

Reflection

Move the entire sculpture into the auditorium and invite the school community, including local politicians, city planners, and neighborhood council members, to a city ribbon-cutting ceremony. Ask students to reflect on how they used the languages of art and math to build their city, and to share their experience with the professionals in attendance.

Curriculum Connection

Analyze the local city council district's land use map with students. What resources (housing, work, recreation, and transportation) are currently available to residents? What needs will arise in the future? How can artists, mathematicians, engineers, and environmental scientists address these needs together?

Classroom Activity

2-D to 3-D Symmetry

Essential Question

How do artists use geometry and symmetry to create two- and three-dimensional compositions?

Grades

K–3 & Special Day Classes

Time

One class period

Art & Math Concepts

Line, shape, form, two and three dimensions, positive and negative space, symmetry, balance, composition

Materials

Pencil, colored construction paper, scissors, glue, rulers. Optional: cardboard.

Talking about Art

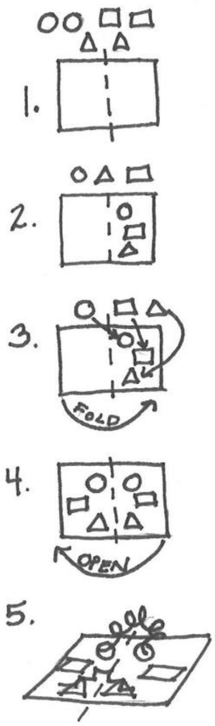
View and discuss the photographs and planning diagrams of Chris Burden's *Urban Light* (2008) included in the printed and digital curriculum. Watch the time lapse video of *Urban Light* from day to night included on the curriculum CD.

What do you notice about *Urban Light*? Describe the lines that you see. Are they straight or curvy? How are the lines arranged? What more can you find, including shapes (two-dimensional) and solids (three-dimensional forms)? The arrangement of lines, shapes, or solids in an artwork is called composition. What are some words to describe this composition? The lines, or lampposts, are arranged to create symmetry. With your hand, draw the composition's line of symmetry in the air. Can you estimate the number of lamps on either side?

Gather students and stand together in a circle. Ask one student to join the center of the circle and lift their arms up like the letter "T," to establish the line of symmetry. Next, ask two volunteers to create lines with their bodies and place themselves on either side of the line of symmetry. Are you a curvy or straight line? Have volunteers join two at a time to add to the composition. Are everyone's lines symmetrical? What do you need to change to create a symmetrical composition?

Burden arranged *Urban Light*'s 202 antique lampposts symmetrically by installing them carefully on a grid. Do you notice any patterns in the arrangement? Lamps of the same design are grouped together and the groups are ordered by height, to create three-dimensional symmetry in the form of a pyramid.

Making Art



Create a symmetrical collage by folding a piece of construction paper vertically or horizontally, to create a line of symmetry. Open the paper and lay it flat on the table.

Cut pairs of geometric shapes out of construction paper. To create two identical shapes, fold a piece of construction paper in half, draw a simple shape such as a triangle or square on one side, then cut along the drawn lines. For younger students, you can also prepare stencils by cutting shapes out of cardboard for students to trace. When you have gathered a variety of shapes, start arranging them on one side of the line of symmetry. When you have reached a desired arrangement, glue them down with a glue stick. Complete the composition by carefully matching shapes and laying them on top of each other. Then, put a small dab of glue on top of each shape and carefully fold the paper again. Open the paper to reveal a perfectly symmetrical composition.

For older students, build on two-dimensional symmetry by adding three-dimensional elements. Measure and cut a variety of strips using a ruler then fold the strips to create texture. Next, arrange the strips so that they connect similar shapes on either side of the line of symmetry, turning the collage into a symmetrical paper sculpture.

Reflection

Turn to a partner and share one thing that you like about your collage. Ask older students to talk about the process of rearranging the composition to reach symmetry. Then, share artworks with the class by answering these questions: What types of lines and shapes did you use? What colors did you use and why? Point out two parts of the composition that exemplify symmetry.

Curriculum Connection

As a team, measure the height of three or more items in the classroom using a ruler. Arrange the items according to length or height. Collect doubles of each item, identify a line of symmetry, and then arrange the items symmetrically as Burden did in *Urban Light*.

Classroom Activity

Levitating a 25-lb Mass

Essential Question	How do artists create art installations using engineering concepts?
Grades	9–12
Time	Two to three class periods
Art & Math Concepts	Estimation, structural engineering, weight-bearing technology, balance, illusion, installation
Materials	Paper, pencil, popsicle sticks, wood glue, objects weighing at least 25 pounds (i.e., rock, cinder block, brick, watermelon). Optional: blueprint paper.

Talking about Art

View and discuss the photographs and preliminary sketch of Michael Heizer's *Levitated Mass* (2012) included in the printed and digital curriculum. Watch documentation of the megalith's planning, transport, and installation from LACMA's Video Library at https://www.lacma.org/video/levitated-mass.

What questions do you have about *Levitated Mass*? If you could, what would you ask the artist and the engineer about the planning, transport, and installation of this work?

Heizer conceived of this monumental sculpture in 1969. At a Riverside, California quarry 40 years later, he identified the perfect rock to serve as the artwork's specimen. First, mathematicians studied the rock, taking detailed measurements. Based on these measurements, engineers designed a massive transporter to carry the rock and construction workers used hydraulic jacks to lift it. To ensure a safe journey to LACMA, city planners devised a travel route, identifying bridges and streets that could accommodate the rock's 340-ton weight. It traveled for 10 days over 100 miles, spanning 4 counties and 22 cities before it arrived at Hancock Park. A custom-built crane lifted the rock into place, on top of a ramp made of concrete and reinforced steel. Lastly, granite landscaping and palm trees were added to reference the rock's desert home. It is Heizer's close attention to the rock and its surrounding environment that transformed this artwork and engineering feat into a sculptural installation.

Making Art

Installations are artworks that take the form of three-dimensional environments. Create your own installation that explores art and engineering concepts of weight and levity by, first, splitting into groups of two to three. Decide who will take the role of artist, mathematician, and engineer and how you will work together to "levitate" a 25-pound mass using just popsicle sticks and glue.

Analyze the challenge at hand by brainstorming engineering designs. Designs that employ triangles and pyramids, shapes and forms with a heavy base and a pinnacle on top, disperse pressure and provide strength and stability. The ultimate goal is to build structural integrity using as few sticks as possible. Have team members work together to create sketches of possible supports with the above limitations. Then, estimate the number of sticks required for execution. Remember, you must use whole sticks as the building units.

Next, transform the sketches into three-dimensional supports. Experiment by testing out your design and making needed adjustments. You can use combinations of triangles and squares to make any geometric solid (e.g., square pyramid, triangular pyramid, trapezoidal prism, etc.). Work together to glue the final configuration.

When finished, engineers should ensure that the adhesives and sticks are structurally sound. Mathematicians should write an equation for calculating the total number of sticks. Artists should document the final arrangement on a sheet of blueprint paper. Allow the structure to dry overnight then work as a team to lift the 25-pound mass into place. Take a look from many angles. Does the rock appear to levitate?

Reflection

Does the final design match the original sketch? If not, what changes did you make along the way? How did you work together to complete the challenge?

Place the results of your experiment outside on the school campus. What can you add to transform the levitating rock into a miniature art installation? Document your installation by photographing it from different angles in the sunlight.

Curriculum Connection

Compare the number of sticks it took to levitate the mass with your original estimate. How accurate was your prediction? If you were to double the weight of the mass, how many more sticks might you need? Try calculating the total number of sticks in different weight and pressure scenarios.

Classroom Activity

Straw Polygon Sculptures

Essential Questions

How do artists find inspiration in nature and math? How do they build patterned forms using three-dimensional units?

Grades

6–9

Time

One to two class periods

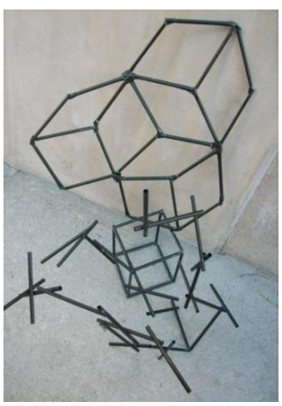
Art & Math Concepts

Line and shape, organic and geometric, polygon, form, polyhedron, volume, space, balance

Materials

Pens, rulers, protractors, compass, plastic drinking straws, paper clips or fasteners, rubber bands, duct tape, cardboard. Optional: air-drying clay, construction paper, colored tape, hot glue

Talking about Art



View and discuss the photographs of Tony Smith's *Smoke* (1967, fabricated 2005) and the artist's diagram included in the printed and digital curriculum. Watch the time lapse video of *Smoke*'s construction from LACMA's Video Library at www.lacma.org /video/ time-lapse-images-smoke.

Take a look at the sculpture from multiple viewpoints. What shapes and forms do you notice? Are they curvy shapes or angular forms? In art, curvy shapes are described as organic because they mimic shapes from life, while angular shapes are called geometric because they exemplify mathematical concepts. Do these mathematical shapes remind you of forms from life?

Smith was known for his minimalist sculptures that employ simple shapes in elaborate construction. The sculpture's outline appears organic, but the individual parts that comprise the structure are geometric.

Two basic polyedra or triangular units—a tetrahedron (a three-dimensional solid made of four triangular faces) and an octahedron (formed by two tetrahedrons opened at a vertex and conjoined)—are scaled to life size, repeated, and combined to make up *Smoke's* frame. The overall hexagonal formation references the shape of a honeycomb, pointing to Smith's fascination with positive and negative space and porous forms from life.

Making Art

Using a pen and a photocopy of *Smoke,* circle the following geometric shapes: square, rectangle, triangle, hexagon (6-sided polygon), octagon (8-sided polygon), and nonagon (9-sided polygon). Are they uniform or irregular shapes?

In small groups, use plastic drinking straws to create a simple polygon. Choose from a variety of materials to connect the straws together, such as rubber bands, clay, paper clips or fasteners, and duct tape. Create a replica of the polygon to serve as the base for a sculpture then produce more polygons to use as building units. Connect the units together or build outward from one unit, both vertically and horizontally, to create a pattern in three dimensions. If necessary, adhere the sculpture with hot glue for structural reinforcement and attach to a cardboard base.

Now that students have created a strict patterned sculpture, ask older students to experiment with form and balance by creating a free-form organic sculpture. Divide students into groups of three and ask each to use straws and adhesives to create a free-form unit. When finished, experiment with attaching the three units together, ensuring balance and structural integrity, to create a collaborative work of art.

Reflection

Display patterned and free-form sculptures together in the classroom and facilitate a gallery walk. View sculptures from above and below, and from many different perspectives. Are the individual units that comprise the patterned sculptures regular? When you walk around a free-form sculpture, how does the outline change and transform? Compare and contrast the different works. Which do you prefer and why?

Ask each group to take their collaborative sculpture and install it in a location on the school campus. Lead a walking tour of all of the sculptures and note, in a sketchbook, the different shapes that you see, such as triangles, hexagons, octagons, and nonagons. Draw a sketch of each sculpture within its natural environment. Are any shapes or forms reflected in the landscape around it?

Curriculum Connection

Revisit the patterned sculpture and measure one of its individual units. Using these measurements, calculate the total volume of the sculpture. Then, work together as a team to calculate the volume of the free-form sculpture.

Building STEAM: Art, Math, and Technology

Selected Resources

Online Resources

A Report on the Art and Technology Program
Los Angeles County Museum of Art
www.lacma.org/art/reading-room
Read about the history of LACMA's commitment to technology through the Art + Technology Program of 1967–71, which paired contemporary artists with the industrial and scientific communities of Los Angeles. Access the report on the Pacific Standard Time tab.

STEAM Education Resource Center
PBS Teachers
www.pbs.org/teachers/stem
Explore STEM lesson plans such as "Heavy Lifting," a challenge to design and build a crane out of recycled materials by experimenting with the properties of weight and force.

MIT+K12
Massachusetts Institute of Technology
http://k12videos.mit.edu
Use MIT's collection of K–12 student-focused videos as classroom teaching tools. Search by grade level or subject area, or create and upload your own video assignments.

MIT App Inventor
Massachusetts Institute of Technology
http://appinventor.mit.edu/teach
Take STEAM Education into the digital age by teaching students how to design an app. Use the curriculum and media library to find lesson plans and visual aids.

Related Curriculum Materials

Evenings for Educators resources include an illustrated essay, color images, classroom activities, and related resources. Printed curriculum is available through LACMA's Education Department or browse selected curricula online at www.lacma.org (Programs/Education/Evenings for Educators).

Preserving the Past: Conservation at LACMA
December 1995

Art, Ecology, and the Environment
May 1997

The Visible World: Observation in Art and Science
April 1999

Wonderment and Interaction: Science, Technology and Art
February 2004

The Urban Environment in Art
March 2006

Books for Teachers

Hallermann, Sara, John Larner, and John R. Mergendoller. *Project-Based Learning in the Elementary Grades.* Novato: Buck Institute of Education, 2011.
A practical guide to Project-Based Learning (PBL), designed for K–5 teachers. Contains project planning, assessment, and management tools as well as sample projects from different grade levels and subject areas.

Larner, John. *Project-Based Learning Starter Kit.* Novato: Buck Institute of Education, 2009.
Tools and tips for PBL in the middle- and high-school years. Includes project-ready rubrics and links to online resources.

Riley, Susan M. *STEAM Point: A Guide to Integrating Science, Technology, Engineering, the Arts, and Mathematics through the Common Core.* Seattle: CreateSpace Independent Publishing, 2012.
A guide for teachers and administrators on *STEAM* and Common Core State Standards integration.

Sousa, David A. *From STEM to STEAM: Using Brain-Compatible Strategies to Integrate the Arts.* Thousand Oaks: Corwin, 2013.
Techniques, lesson plans, and templates to help educators integrate artmaking into daily instruction, building skills critical to STEM Education.

Books for Students

Moscovich, Ivan. *The Big Book of Brain Games: 1,000 PlayThinks of Art, Mathematics, and Science*. New York: Workman Publishing Company, 2006.
A collection of brainteasers that test visual and problem-solving skills using numbers, patterns, geometry, logic, and probability.

Ruffler, Walter. *Paper Models that Move: 14 Ingenious Automata and More*. Mineola: Dover Publications, 2011.
A world of paper engineering through projects that explore levers, gears, cranks, and other devices.

Salvadori, Mario. *The Art of Construction: Projects and Principles for Beginning Engineers and Architects.* Chicago: Chicago Review Press, 2000.
The basic principles of construction for all types of urban structures, including bridges, skyscrapers, and other architectural works. Projects employ accessible everyday materials.

Tang, Greg. *The Art of Problem-Solving.* New York: Scholastic Press, 2003. An exploration of four basic rules in problem-solving through works of art: keeping an open mind, looking for unusual number combinations, using multiple skills, and looking for patterns.

Woods, Michael. Ancient Machine Technology: *From Wheels to Forges*. Minneapolis: Twenty-First Century Books, 2011.
A history of the evolution of technology through the work of ancient artisans to contemporary engineers.