Visualizing Math

How can art be used to investigate and visualize mathematical problems and systems?

How can mathematical principles help us to understand the construction of an image and the representation of the world around us?

Just as many artists find inspiration in math, from sequences to symmetry, mathematical principles can help us to understand both artwork and representations of the world around us. This Permanent Collection Portfolio Guide of prints, drawings, and paintings features a sampling of the Addison’s collection offering varied perspectives and discussion points on topics in mathematics. Educators are encouraged to use this Guide and the expanded Portfolio Image List as a starting point, a place from which to dig deeper, ask questions, and make new connections for class plans and projects.

Images and text highlighted in grey are ideas for materials and activities from outside the Addison’s collection of American art that can enhance the potential for both curricular and global connections.

For online use, click the images in this guide to access digital images in the Addison’s online database.

SELECTED THEMATIC APPROACHES

Minimalism and Manipulations — How can images demonstrate relationships between parts of a whole?

Process, Scale, and Probability — How do artists construct and follow formulas, algorithms, and iterations?

Perspective, Depth, and Similarity — How can math be used to understand relationships between objects?

Analyzing the Collection by the Numbers — How can combinatorics help us to understand a museum’s collection?

Systems, Order, and Randomness — How can art and music be inspired by the aesthetic simplicity of math, physics, and code?
Minimalism and Manipulations

In what ways is math, like art, sometimes concrete and other times an abstract subject? When do we follow the rules and when is experimentation more important than precision?

How can images demonstrate relationships between parts of a whole?

In the mid 20th century, educator and artist Josef Albers's experimentation with color interaction and geometric shapes transformed the modern art scene. His nested squares examine the way adjacent colors expand and contract, recede or advance. His painting Bent Black also tests viewer perception, with precisely equal areas of each color: black, dark gray, light gray, and white. By the time artist Frank Stella entered Phillips Academy as a student in 1950, the art department was imbued with philosophy brought in by teachers who had studied with Albers at Yale. Stella's early work is built on relationships between lines and planes, and characterized by order and simplicity.

In the 1960s, Minimalism emerged as an alternative to the emotionally charged gestures of Abstract Expressionism and artists developed images in simplified visual sequences, like mathematical proofs. The work of Robert Mangold, for example, is inspired by geometry and asymmetry; his visual "mistakes" push geometry askew, along with viewers' perceptions of his work.
Connected Activities:

**Ratio and Scale:** Scale a LeWitt diagram onto large sheets of paper.

**Probability:** What is the probability of drawing a complete circle in *Wall Drawing #716*?

**Combinations and Permutations:** How many wall drawings could result from the eight lines of #716?

**Graphing:** Which lines show functions that are increasing, decreasing, concave up, or concave down?

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**Process, Scale, and Probability**

*How can art be used to investigate and visualize mathematical problems?*

*In what ways is the conceptual artist’s role similar to that of an architect? a composer? a mathematician?*

Sol LeWitt was prominent among a group of young artists who, in the 1960s, were searching for alternatives to traditional constraints. His 1975 work *Fifteen Postcards* is made of actual postcards sent through the U.S. postal system over a period of fourteen days. Here, LeWitt presents all possible combinations of yellow, black, red, and blue: first, each color standing alone, then six different two-part combinations, followed by four different three-part combinations, and the final postcard with all four colors combined.

LeWitt was an influential practitioner of Conceptual Art, in which the artist is the originator of the ideas, rather than the craftsman. Each of LeWitt’s Wall Drawings begins as a set of instructions and an accompanying diagram to be followed by draftspeople in implementation. Just as a music composition sounds different each time it is played due to acoustics and interpretation by the musicians, the potential for variation in LeWitt’s Wall Drawings is exemplified in the instructions for *Wall Drawing #716* (see image caption above left). Explore documentation and video of a sample project at [http://www.andover.edu/Museums/Addison/AboutUs/AddisonUpdates/Pages/20141231_LewittMath.aspx](http://www.andover.edu/Museums/Addison/AboutUs/AddisonUpdates/Pages/20141231_LewittMath.aspx).
Perspective, Depth, and Similarity

How can math be used to understand spatial relationships between objects in perspective drawing?

How is three-dimensional space constructed on a two-dimensional plane?

Linear perspective is a mathematical system for creating the illusion of space and distance on a flat surface. The system of perspective we take for granted today originated in Florence, Italy in the early 1400s, demonstrated by artist and architect Filippo Brunelleschi and published by architect and writer Leon Battista Alberti. Artists drafted a receding grid on the floor or ground of their painting to act as a guide for the relative scale of all other elements within the picture. Alberti suggests relating the size of the floor squares to a viewer’s height, a manifestation of the Renaissance shift from painting intended to glorify God—as it had been in Medieval Europe—to relating art to the viewer.

Contemporary systems also rely on math. If you look along a straight road, the parallel sides of the road appear to meet at a point in the distance, called the vanishing point (see image J). In one-point perspective, the objects face the viewer and drawing is guided by the geometry of lines converging at a single vanishing point (image K). When an object or viewpoint is rotated and two sides of an object are angled away from the viewer, each visible side of the object has its own unique lines of perspective. This creates two vanishing points, and is called two-point perspective (image L). If your viewpoint is higher or lower, such as looking up at a skyscraper (image M) or looking down from a high window (image N) a third vanishing point is used to create three-point perspective. Isometric shapes use parallel lines but no vanishing points, and are often used to convey technical information or to create artistic illusions (image O).
Perspective, Depth, and Similarity

Connected Activities:

Explore Ratios and Similarity

1. Draw receding objects using a Pavimenti.
   - Construct a Pavimenti diagram. Instructions can be downloaded from: http://thewalters.org/assets/pdf/lesson-plans/perspective-on-pavimenti.pdf
   - Calculate the ratio between each row on your gridded “floor” and the rows above and below it.
   - How can this information help you to draw receding objects of the appropriate size?

2. Draw receding objects using one-, two-, and three-point perspective.
   - Draw a horizon line and place vanishing points.
   - Use your knowledge of geometry to construct objects within space.

3. Evaluation
   - Can you explain the mathematics that each process relies on?

http://wwwernoteaccess.com/Texts/Alberti/
Analyzing the Collection by the Numbers

How can mathematical calculations, including combinations, permutations, rate of change, and more help us to understand a museum’s collection?

Sequence is important to the curatorial narrative of an exhibition. How does this impact your calculations?

The Addison Gallery of American Art opened to the public in 1931 with a collection of 400 objects. As of July, 2014, the museum’s collection held 17,438 objects, spanning the 18th century to the present. The first photograph entered the collection in 1934. By 1974, the photography collection numbered 592, and today the total collection includes approximately 8,496 photographs. Among the Addison’s holdings there are serial works, consisting of multiple components. The smallest such group consists of two or three objects, such as the triptych photograph of the Hoover Dam by contemporary photographer Mark Klett, while the largest is of 781 albumen prints by 19th century photographer Eadweard Muybridge.

The museum presents three exhibition seasons per year, each season consisting of between two and five unique exhibitions. These include both exhibitions from the permanent collection and exhibitions comprised of works on loan from other institutions.
Systems, Order, and Randomness

How are art and music inspired by the aesthetic simplicity of math, physics, and code?

How can art find a balance between order and randomness, control and uncertainty?

Inspired by the aesthetics of math and physics, Phillips Academy alumnus Tristan Perich (PA ’00) works with simple forms and complex systems. As a visual artist he works primarily with handmade machines to create delicately executed pen-on-paper or marker-on-wall drawings that explore the limits of traditional drawing through randomness and order. Like the work of Sol LeWitt (see page 3), Perich’s work depends on the interaction between planning and the unpredictability of outcome. Perich writes, “While the motors’ movements are the result of code executed precisely by machine, the final drawings come from the motion of pen on surface, and are wedded to effects from the physical world: the ripple of the string connecting pen to motor, the gradual depletion of ink, the texture of the paper. It is this balance between code and physics that excites me most, since the drawings couldn’t be made without the code, and code needs to be realized in the physical world in order to be more than a set of instructions.”

In 2004 he began work on 1-Bit Music to experiment with the foundations of electronic sound, culminating in a physical “album,” a music-generating circuit packaged inside a standard CD jewel case. His circuit album, 1-Bit Symphony, is a long-form electronic composition in five movements. Its music explores the intricate, polyphonic potential of 1-bit audio, uniting simple with complex.

See note 2 above: http://www.tristanperich.com/Artwork/Machine_Drawings
Curriculum Connections and Resources

SUGGESTED CLASSROOM CONNECTIONS

Math
• ratios
• scaling
• similarity
• combinations and permutations
• area and perimeter
• computer science
• coding
• order and randomness
• systems
• rate of change
• functions
• probability
• statistics
• transformation and symmetry
• isometric shapes
• angles
• line and arcs
• polygons

English
• pattern, rhythm, and rhyme
• symmetry
• mood, tone, and color
• perspective and point of view

Art
• abstract art
• conceptual art
• minimalism
• geometry in art
• perspective
• symmetry
• curating

History/Social Studies
• Renaissance, culture, and art
• Minimalism and the 1960s

Science
• color theory
• collecting and analyzing data
• perspective
• symmetry
• curating

CONNECTIONS TO ADDITIONAL THEMATIC PORTFOLIO GUIDES

Visualizing Science
Documentation vs. Art

TEACHER AND STUDENT RESOURCES

General math connections:

Draw inspiration from or adapt projects designed around New York City landmarks that connect math with other subjects including art, design, architecture, science, geography, and history.

Perspective:


Artists:


Explore connections that other teachers are making at http://inspiredbytheaddison.tumblr.com/

Arranging a Visit to the Museum Learning Center

At least two weeks in advance or preferably more, contact:

Jamie Kaplowitz
(978) 749-4037
jkaplowitz@andover.edu
to schedule your visit and discuss possible themes, applicable portfolios of works, and related activities.