Note

Picturing Math: Selections from the Department of Drawings and Prints at The Metropolitan Museum of Art, New York

Reviewed By Philip Ording

A collaboration between a fine-art print publisher and a group of math and science luminaries sought art historical context at New York's Metropolitan Museum of Art earlier this year. *Picturing Math* occupied the entire Drawings and Prints gallery on the museum's second floor. The relatively narrow room is midway along the shortest route from the Met's 5th Avenue entrance to the Van Goghs, Manets, and Monets in the early-modern wing, and it can feel like a thoroughfare at times. On a recent bustling rainy spring morning, however, even the most determined tourists slackened their pace when their eyes caught sight of something they very likely weren't expecting to see: equations.

At the core of the exhibition, which was curated by Jennifer Farrell and Noam Andrews, with assistance from Ashley Dunn, is a row of ten black-and-white aquatints of handwritten mathematical formulas, each of which is attributed to an "artist" whose name will be familiar to many readers of this magazine: Michael Atiyah, Enrico Bombieri, Simon Donaldson, Freeman Dyson, Murray Gell-Mann, Richard Karp, Peter Lax, David Mumford, Stephen Smale, and Steven Weinberg. *The Concinnitas Portfolio*, as it is called, is a product of an unlikely collaboration between renowned print publisher Robert Feldman (Parasol Press) and professor of mathematics and computer science Dan Rockmore (Dartmouth), who together commissioned the ten prizewinning mathematicians, physicists, and a computer scientist to transcribe their "most beautiful mathematical expression."

Of course, the notion that mathematics is an art is not new. In *A Mathematician's Apology*, which has served as a sentimental education to generations of impressionable young mathematicians since its publication over 75 years ago, G. H. Hardy famously proclaimed, "I am interested in mathematics only as a creative art." Perhaps its most famous quote—"The mathematician's patterns, like the painter's or the poet's must be *beautiful*; the ideas, like the colours or the words must fit together in a harmonious way"—reflects a conception of mathematics (and art) that Rockmore highlights in the portfolio's title. The Latin *concinnitas* (from *concinnus*, meaning "skillfully put together") is the term that Renaissance architect and artist Leon Battista Alberti used to define beauty.

The exhibition presented a rare opportunity to evaluate this classical way of comparing mathematics to art. Drawing from the Met's extraordinary collection, the curatorial team assembled forty-nine fine art works and antiquarian books, dating from the 15th century to 2015, by thirty-nine European and North American artists. There are three groups of prints and drawings, each offering an alternative picture of mathematics: 16th-century Renaissance engravings and woodcuts, 19th-century (mostly) French drawings, and American etchings, engravings, aquatints, and lithographs dating from the postwar to the contemporary period. (For a mathematical look at the Met's broader holdings of painting, sculpture, and other media, see Joseph Dauben and Marjorie Senechal's September 2015 *Mathematical Tourist* column, called "Math at the Met," in this magazine.)

Although Alberti was not among the artists in the exhibition, his principle of beauty was well represented. In a vitrine, Cesariano's 1521 Italian translation of Vitruvius's *De architectura* lay open to a page that illustrates a geometric analysis of the proportions of a Gothic façade, replete with circles, triangles, and connecting lines, all labeled in the manner of a construction of Euclid. Alberti was central to the formulation of the mathematics of linear perspective, and the exhibition includes several 16th-century master prints exemplifying the technique, including the magnificent etchings based on Wenzel Jamnitzer's study of the Platonic solids, *Perspectiva Corporum Regularium* and Albrecht Dürer's allegorical engraving, *Melancholia I*.

The opportunities afforded by printing served mathematics in novel ways in the early modern period. Printed textbooks, such as Dürer's 1525 *Treatise on Measurement,* began disseminating mathematical knowledge and, as described by the wall text, "precision thinking" to artisans in a variety of trades. In their capacity to blend detailed

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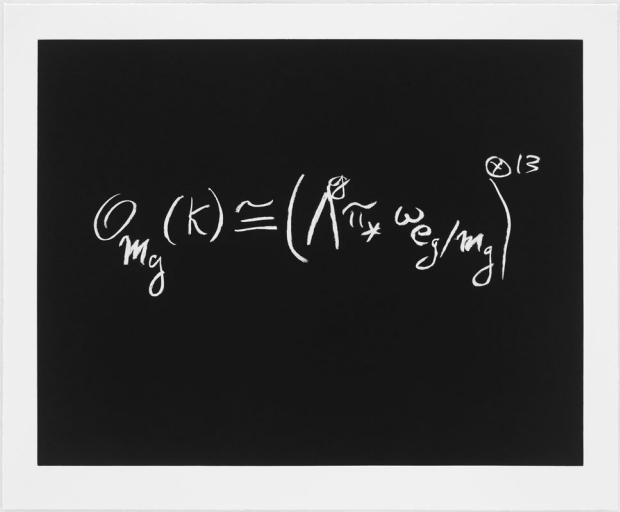
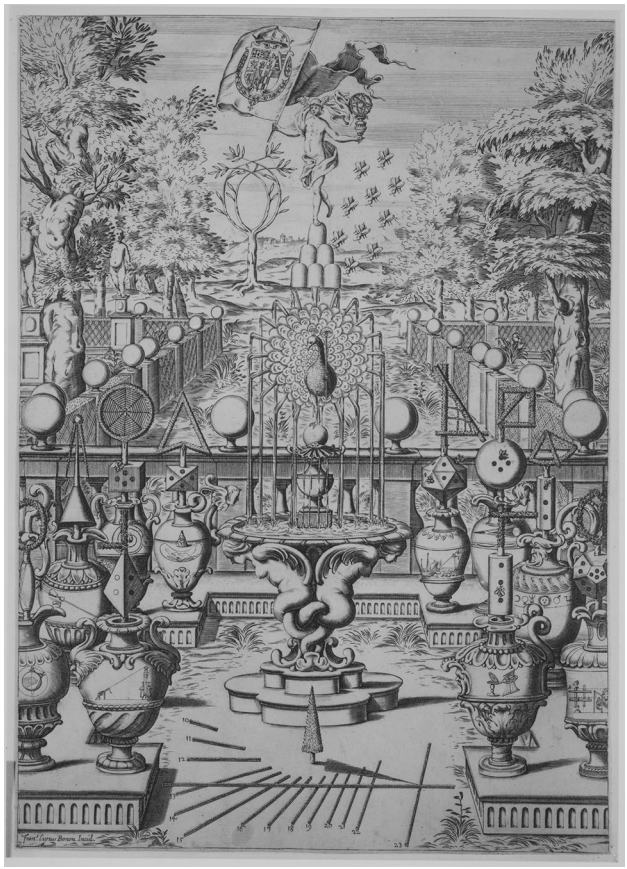


David Mumford
Thirteen?? (from Concinnitas), 2014
Aquatint
30 × 22 in. (76.2 × 55.9 cm)
The Metropolitan Museum of Art, John B. Turner Fund, 2015.



Francesco Curti
Garden of Mathematical Sciences, 17th-century
Engraving
The Metropolitan Museum of Art, The Elisha Whittelsey Collection, The Elisha Whittelsey Fund, 1951.

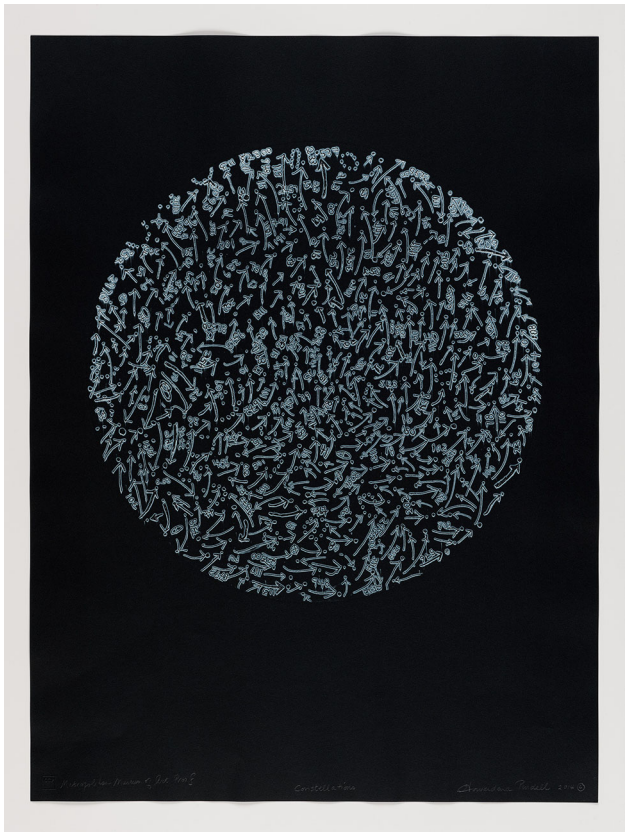
imagery and text, printed pictures also became useful for conveying the newfound breadth of mathematics. A highlight of the show is the delightful *Garden of Mathematical Sciences* by Francesco Curti. According to Volker Remmert's fascinating illustrated history, *Picturing the Scientific Revolution: Title Engravings in Early Modern Scientific Publications* (2011), the Jesuit mathematician Mario Bettini commissioned the engraving for the frontispiece of his 1645 edition of *Apiaria Universae Philosophiae Mathematicae*. Whereas the garden's *apiaria* or beehives take the form of perforated geometric solids emerging from urns that depict different branches of mathematics (one for each of the book's ten chapters), no less prominent are the heraldic symbols associated with various aristocratic families. In a gallery talk with the curators in April, Andrews observed that mathematicians used these allegorical works to make their work attractive to patrons.

Visitors might have accidentally missed a large group of 19th-century drawings in the exhibition depicting neoclassical subjects—nudes, landscapes, ruins, apostles—apparently devoid of mathematical imagery. Closer inspection shows that all these works are in fact crisscrossed with fine grid lines. Known as "squaring," the technique is used by artists to transfer a drawing from one surface to another, typically larger surface, square-by-square. In the preparatory drawing from 1869 for *Mme Théodore Gobillard (née Yves Morisot)* by Edgar Degas, the artist perfectly inscribes his sitter's head within a single square. The resulting painting, about twice the size of the sketch, hangs in another gallery of the museum. What wasn't evident in the drawing is that the squaring lines double as background features of the picture itself: a doorway, a settee, and a picture frame hanging behind the sitter. In this way, the composition supports the calm repose of the sitter. As in mathematics, a felicitous choice of coordinates can be illuminating.

Many of the 20th-century works in the show employ more immediately recognizable mathematical imagery, such as Jasper Johns's *0 to 9* from 1969 and Suzanne McClelland's 2015 collage $0 + 0 = 7$. A small Cy Twombly etching from his 1967–1975 series *Sketches* looks a little like computational scratch work with crossed-out numerals. *Constellations* (2015), by Howardena Pindell, takes the shape of a delicate circle comprised of a multitude of minute symbols and arrows set on a black background. Reminiscent of a simplified perspectival study by Jamnitzer, an untitled aquatint from 1982 by Sol LeWitt depicts an axonometric projection of an incomplete cube. The fine lines of Karshan's 2014 prints trace a grid in one print and a network of triangles in a second. Belonging to her *Foot Falls* series (the title comes from a Samuel Beckett play), these freehand etchings result from a choreographed sequence that alternates between regular intervals of mark making and regular rotations of the printing plate.

Other prints from this group engage the viewer's sense of logic as much as the eye. Two prints from Josef Albers *Transformation* series (1950), using spare and nearly

Edgar Degas
Study for "Mme Théodore Gobillard" (née Yves Morisot), 1869.
Graphite, squared, on buff tracing paper
12 3/8 × 17 5/16 in. (31.5 × 44 cm)
The Metropolitan Museum of Art, Purchase, Harris Brisbane Dick Fund, David T. Schiff Gift, and Gifts in memory of Joseph Thomas, 1984.



Howardena Pindell
Constellations, 2015
Open bite etching
30 × 22 in. (76.2 × 55.9 cm)
The Metropolitan Museum of Art, Gift of the artist and the Center for Contemporary Printmaking, 2015 © Howardena Pindell
Courtesy the artist and Garth Greenan Gallery, New York.

symmetric arrangements of white lines on a black ground, seem to flit between two or more contradictory spatial interpretations. In a catalog essay for Albers's 1988 retrospective at the Guggenheim, mathematician Charles Rickart remarked that the "visualization of certain mathematical notions appears to be very close to the perceptual experience produced by an Albers work." A lithograph from Mel Bochner's *Counting Alternatives: The Wittgenstein Illustrations* (1991), pairs a quote from philosopher Ludwig Wittgenstein's *On Certainty* with a large subdivided square. For each illustration in the series, the artist handwrote consecutive numbers along different sets of lines in the diagram, ordering your visual apprehension of the drawn figure.

Dorothea Rockburne's relief etching *Untitled (from Locus)* took pride of place in the exhibition, hanging high on the otherwise empty wall adjacent to the *Concinnitas* portfolio; at roughly 40 × 30 in. (101 × 77 cm), the unframed 1972 print is the largest in the show. Her *Locus* series was made by an unusual sequence of operations applied to paper, including penciling, creasing, pressing, and aquatint printing with white oil paint. Folding rag paper in the press made it emboss itself—an example of an iterative process unique to printmaking, yet consistent with other works by Rockburne from the period, such as the celebrated *Drawing Which Makes Itself* (1972–1973). For Rockburne, mathematics holds promise for its methods rather than its imagery. "When one is dealing with art and mathematics," she said in a recent interview with Matthew Farina of the *Brooklyn Rail*, "there is always an element of magic. If everything adds up or works out well, you're on the wrong trail."

The same could be said for the exhibition as a whole. If viewers had trouble following the thread, maybe that's just as well. If nothing else, the exhibition makes clear that picturing math is a complex affair, in no small part because the meaning conveyed by a picture is a product of the historical and cultural contexts in which it appears. Viewed in this light, the *Concinnitas* portfolio displays some interesting contradictions.

Consider the medium. The aquatint was favored by printmakers of the Romantic period such as Francisco Goya for the expressive capacity of its characteristic tonal variation—a feature that is strangely absent from the *Concinnitas* prints. The medium could have simulated the material qualities that make blackboards such effective tools for thinking, what Michael Barany and Donald MacKenzie's call the "tentative, transitory marks that try to produce new orders out of old ones" ("Chalk: Materials and Concepts in Mathematics Research," 2014). Instead, the Concinnitas prints rely on the blackboard primarily as a framing device, emphasizing the iconicity of the blackboard. Recalling Roland Barthes' account of the "myth of Einstein," it is as if we are looking at cartoon representations of scientists at the moment of discovery: "chalk still in hand, and having just written on an empty blackboard, as if

without preparation, the magic formula of the world" (*Mythologies*, 1957, cited by Barany and MacKenzie).

The *Concinnitas* prints are likely to remind gallery-going audiences of Joseph Beuys, the influential German artist whose work includes blackboards that he developed through performative public lectures on art and politics. Mimicking Beuys' most famous slogan "everyone is an artist," Rockmore's explanatory text declares "all mathematicians, computer scientists, and physicists are artists!" The force of this sentiment is somewhat undercut by the criteria Rockmore and Feldman set for participation in their project—Nobel prize winners or comparable only—thereby all but ensuring the exclusion of women and people of color. This tension crops up in the way different participants responded to the prompt, "what is your most beautiful mathematical expression?" Some took the opportunity to present their prize-winning formula, their personal $E = mc^2$. Atiyah writes "The Index Theorem"; the two physics Nobel laureates each write a Langrangian, the strong nuclear force by Gell-Mann and the weak nuclear force by Weinberg. Others either overlook the expectation for original work or ignore it, choosing to present classical equations instead, e.g. "Newton's Method" by Smale. The equations by Dyson and Mumford come closest to what I imagine Rockmore had in mind, favoring aesthetic criteria over citation count.

It's no less surprising for mathematicians to find equations in the Met than it is for other tourists. What does *Picturing Math* reflect of the place of our discipline in its current cultural context? No doubt, part of the appeal of the *Concinnitas* prints is the gestural quality that lends them a romantic sheen. The presentation of the prints also foregrounds romantic associations. Rockmore's text describes the prints as "mathematical madeleines," and some of the contributors follow suit in their explanatory texts prepared for viewers. Both Bombieri and Smale quote John Keats' "beauty is truth, truth beauty." Writing on his blog, Mumford sounds less comfortable being cast as the romantic figure: "what worries me is, even with the explanatory cards, these exhibits will become fetishes…a token that people invest with magical powers…instead of taking the time to get a little genuine insight into the math." (Viewing a print up close, especially one as convincingly chalk-like as Mumford's, are lesser mathematicians also at fault for enjoying the fleeting sensation of a private audience with a Fields medalist?) In *Mathematics Without Apologies* (2015), Michael Harris provides an absorbing contemporary take on, among other issues of the lived mathematical life, Hardy's influential defense of the beautiful. Harris concludes his book on the question of the cultural position of math, stating: "More than a century separates us from the time when serious people who were not mathematicians could speak of beauty unfiltered, without apologies. Is it any wonder that, in popular culture's serious precincts, the mathematician has become the romantic figure of choice?"

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