Unreasonably beautiful

Mathematics and Art: A Cultural History

By Lynn Gamwell

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This book is a gem on any coffee table — but make sure that you keep the coffee machine running. Once picked up, it's hard to put this 576-page tome down again.

Lynn Gamwell has undertaken the mighty endeavour to tell the story of how mathematical concepts have influenced, guided and inspired artists. Not content to explore just some of that story, she seems to have wanted to tackle it all. Her take on the symbiotic development of mathematics and art starts some 1.4 million years ago, when *Homo erectus* started chipping the edges of stones in a symmetrical manner, something our other predecessors had yet to try. Fast forward to more than a million years later, and humans had started to produce hand axes of well-balanced three-dimensional shapes. Gamwell suggests these developments describe the evolution of a perceptual and cognitive system capable of processing three-dimensional spatial information to produce abstract forms marked by both functionality and beauty.

Gamwell, a lecturer on the history of art, science and mathematics at the School of Visual Arts in New York, has written before about modern art as an expression of the scientific worldview (*Exploring the Invisible: Art, Science, and the Spiritual*, Princeton University Press; 2002). A decade on, she now looks at the reflection of mathematics in pieces of art. The result is a captivating cultural history, broad and powerful, enlightening and inspiring, at times sweeping and patchy — but that can scarcely be avoided with a topic so rich.

There's plenty to learn and take in. Most intriguingly though, chapter by chapter, page by page, table by table, Gamwell feeds that astonishment that delights, and occasionally tortures, many of us scientists: why is mathematics not only so unreasonably effective in the natural sciences, as Eugene Wigner famously commented, but also so unreasonably beautiful? (Incidentally, in the epigraph of his 1960 article, Wigner quotes the mighty words of Bertrand Russell on the beauty of mathematics: "Mathematics, rightly viewed, possesses not only truth, but supreme beauty — cold and austere, like that of sculpture, without appeal to any part of our weaker nature, without the gorgeous trappings of painting or music, yet sublimely pure, and capable of a stern perfection such as only the greatest art can show.")

Using 444 art images and 102 diagrams visualizing mathematical concepts, Gamwell guides our view to many awe-inspiring examples of sublime purity and stern perfection in art and architecture, always mindful of underlying or related concepts of mathematics and physics. The examples are drawn both from Western and Eastern cultures, spanning a tremendous variety of topics, from arithmetic and geometry to computers in mathematics and art.

But the connection between mathematical concept and artistic work isn't always as clear as it may seem. For me the most surprising example of this is Gamwell's solid debunking of the "widely held misconception" — held also by me — that the 'golden section' "is the key to beautiful proportion" and that it was "used in major monuments of art history (such as the Pyramids, the Parthenon, and Leonardo's *Mona Lisa*)". Not true, says Gamwell. She explains that the 'extreme and mean' (or golden) ratio did not originally have any particularly outstanding role; it was only one of several irrational numbers described in Euclid's *Elements*. Only some 18 centuries later did the Italian Franciscan friar and mathematician Fra Luca Pacioli single out this particular ratio as a symbol for the Almighty. In doing so, he made "a play on words between the mathematical, musical, and theological meanings of 'irrational'", in that the golden ratio cannot be expressed as a ratio of whole numbers and the divine is "beyond reason" and God's name is "not expressible in words". But, according to Gamwell, Pacioli didn't associate the ratio with beauty, nor did he advocate its use by artists.

The term golden section was only introduced in 1835, and in 1854 the German psychologist and scholar Adolf Zeising declared in a popular exposition that the golden section "underlies the formation of all beauty and wholeness in nature and in the pictorial arts, and from the beginning it provided the model for all representations and formal relations, whether cosmic or individual, organic or inorganic, acoustic or optical, which found its most perfect realization, however, in the human figure." Powerful words. And indeed, he and others found the golden section everywhere, from classical statues to Gothic cathedrals, to the Great Pyramid of Khufu — cherry-picking, argues Gamwell. Not least through Walter Gropius, the golden section entered architectural teaching and the Swiss architect Le Corbusier even designed a tool, the Modulor, to lay out patterns in the golden ratio. And in his painting *The Sacrament of the Last Supper*, Salvador Dalí used the ratio both to ensure beauty and to symbolize the divine. The misconception has come a long way.

The chapter on proportions is beautifully rounded off with excursions into classical proportions, the history of linear perspective and how Charles Darwin's work influenced the thinking about geometric forms, and it does not fail to display contemporary pieces of art. Here Gamwell truly excels. I was less impressed with the parts of the book connecting to modern physics, which feel a bit too sketchy. But then this is not a mathematics or science text book. (Joseph Mazur's 2014 book *Enlightening Symbols*, which tells the history of mathematics in relation to mathematical notation, might be more 'nerd-proof'.) The great contribution of *Mathematics and Art* is that it lays out the timeline of developments in mathematics (and physics) next to that in art and architecture. That is hugely illuminating, and enjoyable.

The question of just where this enjoyment comes from remains open, of course. As Wigner said, "The miracle of the appropriateness of the language of mathematics for the formulation of the laws of physics is a wonderful gift which we neither understand nor deserve." The same might well be said about the great beauty of mathematics. ❐

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