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Truth plus beauty

The elegance of mathematics is rarely celebrated as part of our culture. But equations can be an art form in themselves, says **Justin Mullins**

THE British philosopher and logician Bertrand Russell once wrote: "Mathematics, rightly viewed, possesses not only truth, but supreme beauty – a beauty cold and austere, like that of sculpture."

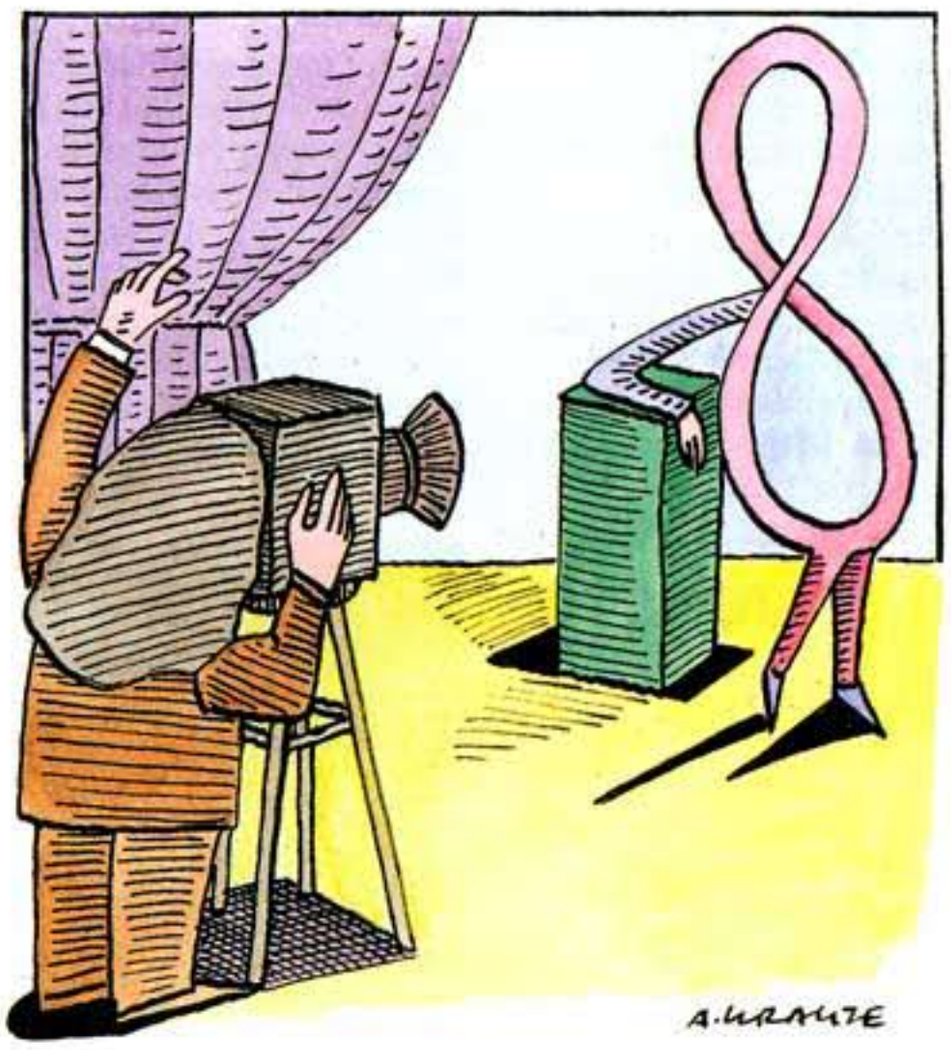
Sculpture is widely admired in our societies – there is hardly a public space in our cities that does not boast a sculpture of some sort. But mathematical beauty is barely recognised beyond the confines of academia, and it is never celebrated.

This seems curious, since it is clear that artists have long found inspiration in mathematics. Greek architects appear to have used a number known as the golden ratio when designing the Parthenon, and Leonardo Da Vinci's *Vitruvian Man*, which depicts an outstretched figure encompassed by a square and a circle, is an attempt to link human beauty with geometry.

And in the 20th century, artists have been exposed even more to mathematical ideas, initially because Victorian mathematicians found ways of visualising formulae and functions in physical form. Now computers have made it possible to visualise even more complex functions such as fractal patterns, and hence mathematical objects like the Mandelbrot set have become household images.

But mathematicians are not usually thinking of images, models and sculptures when they talk about beauty. Mathematical beauty is not a visual quality. Judging a piece of mathematics by the way it looks when modelled in clay, carved in stone or printed on paper is like judging a book by its typeface – it's an absurd notion.

What, then, constitutes beautiful mathematics? This is rarely debated among mathematicians, but there are some generally accepted tests that a piece of work must pass to be deemed beautiful – it must employ a minimal number of assumptions, for example, or give some original and important insight, or throw other work into new perspective. Elegance is perhaps a better term for it. There is a flip side, of course: a piece of mathematics laden with unnecessary assumptions and offering no new insights is deemed ugly.



The most famous example of a function that meets all the requirements of beauty is Euler's formula ($e^{i\pi} + 1 = 0$), which links some of the most fundamental concepts in mathematics and draws together two entirely separate branches of the science – geometry, the study of space, and algebra, the study of structure and quantity. I have never seen a physical model of Euler's formula, but it would be impossible to get a sense of the function's power and majesty from such a thing.

So why has mathematical beauty failed to make a cultural impact? One reason could be that this spectrum of aesthetics, with beauty at one end and ugliness at the other, sounds horribly one-dimensional. And having rules for mathematical beauty feels, as Russell put it, cold and austere: this is beauty devoid of emotion, profoundly different to that which we experience and admire in the physical world.

> "A piece of mathematics must give some important or original insight to be beautiful"

Yet it needn't be like that. Ten years ago, I began assembling the most beautiful examples of mathematics and mathematical physics I could find and exhibiting them as digital prints. My latest exhibition opens next week in London. I imagined the task an intellectual diversion, like hunting for shells on a seashore. Instead, I have found it a profoundly creative experience, and laden with emotional undertones.

The best way I can describe it is to compare it with photography. Just as an ordinary photograph is a snapshot of natural beauty, an equation is a snapshot of mathematical beauty, or indeed ugliness or some other aesthetic. My "photographs" are simply mathematical statements that I have chosen. But like conventional images, making the choice can imbue them with emotion.

Most people's reaction to all this is fascination. They ask questions and demand explanations and answers. I cannot tell them what to think, but now when I display the images I write a commentary for each exhibit – not an explanation of the mathematics, but a snapshot of the ideas and emotions that the mathematics inspires in me.

For example, it's hard not to be awestruck by the language of symmetry, a branch of mathematics called group theory. Likewise, who could fail to be inspired by the mathematical description of the birth of stars? And the quantum phenomenon of entanglement, by which objects separated by great distances share the same existence, has a scent of romance about it. There are rich veins of inspiration wherever you look. And thus, for me, mathematical photography has become an art.

Which is why I have come to disagree with Russell. The beauty of mathematics can be cold and austere, when viewed in a particular way. But viewed in another, it can be rich and warm, funny and sad, romantic and profound. Just like sculpture – he was right about that. ●

"Mathematical photography – beyond beauty" runs from 1 to 12 February at Lauderdale House in London. For further details see www.justinmullins.com