D. HATFULL/THE OXFORD SCIENCE PARK

Conrad Shawcross's *Fraction (9:8)*: inspired by nineteenth-century machines that visualized sound.

CULTURE

Metallic music

Sculptor Conrad Shawcross captures the fundamentals of physics and music, finds **Martin Kemp**.

The physics of music was apparently born in a Greek blacksmith's shop in the sixth century BC. The philosopher Pythagoras, who believed that everything was governed by numbers, heard the hammers beating out a piece of iron on the anvil. According to his later biographer Iamblichus, he recognized in the sounds "the concord of the octave, the fifth, and the fourth". Pythagoras' intervals were encapsulated in equations in the centuries that followed — from the 'music of the spheres' that explained the heavenly orbits, to the proportionality of the human body, as believed by Leonardo da Vinci.

During the eighteenth and nineteenth centuries, ingenious devices translated music into visual form. Among them were the famous plates of physicist and musician Ernst Chladni from 1787, which recorded in sand the nodal patterns of vibrations produced by drawing a bow across the edge of pieces of metal. The harmonograph, perfected by Scottish mathematician Hugh Blackburn, was more theoretically driven. It consists of two adjustable pendulums swinging at right angles to one another, one holding a pen, the other a drawing surface. By varying the relative frequency and phases of the pendulums — which can be adjusted to musical intervals — a range of ellipses, spirals and complex loops can be created. These include the figure-of-eight curves named after Jules Antoine Lissajous, the French physicist who used tuning forks and beams of light to see sound waves.

The harmonograph has inspired a notable new sculpture by Conrad Shawcross, a young British artist who is becoming famed for his invention of wondrous scientific and philosophical machines that are usually on a large scale (see go.nature.com/o3x8ts). Shawcross's devices often exploit natural ratios and movement in many planes. His recent works include *The Nervous System* (2003), a loom spinning hundreds of metres of helical rope per day; and *Continuum* (2004), a wooden spring wound into a toroidal form to signify the cycles of time. Shawcross's sculptures reflect his well-informed thoughts about the theories of science, uncertainty and the limits of knowledge. He champions theoretical physicist Werner Heisenberg's dictum that "what we observe is not nature itself, but nature exposed to our method of questioning".

Shawcross's hanging sculpture, *Fraction (9:8)*, installed last month in the foyer of the Sadler Building at the heart of the Oxford Science Park, UK, is both typical and atypical of his work. True to his canon, Shawcross devised a machine to sketch the sculpture's form, adapted from the harmonograph. He set the pendulums to achieve a ratio of 9:8 in frequency — the musical interval of a major second, corresponding to the note D in the Pythagorean scale. Rather than using a fixed drawing surface, he pulled a roll of paper across the swinging plate to create a long oscillation that tapers away into silence. The trace, he confesses, involved "a lot of human intervention".

The figure was translated by computer into three dimensions, and fabricated by automotive-industry robots into the aluminium vortex, 14 metres long, which hangs from wires attached at critical balance points. Its machine finish is a departure for Shawcross, whose sculptures usually retain signs of the 'visual noise' that arose during their making. However, although it represents a Platonic, archetypal note, the sculpture is not invariable. As the spectator walks by, different visual rhythms appear together with varied degrees of order and disorder. Only from the bridge crossing at first-floor level do its symmetries emerge clearly.

Music in metal is an appropriately Pythagorean idea. It recalls the name given to the final movement in Handel's harpsichord *Suite No. 5 in E major*, the 'Harmonious Blacksmith'. Like Pythagoras' story, its alternative name came later and belongs to legend. But legends have their own kind of truth, as does capturing the essence of what science and art find it productive to investigate. ■

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