



*The Artist Takes Aim on a Target for Optical Imitation: one of Albrecht Dürer's "perspective machines", published in his *Introduction to Measurement* in 1538.*

Kemp's conclusions

What has emerged in this series, despite the core of commonalities linking old masters, classic modernists and living artists, is a clear change in shape for the relationships between art and science across the three areas.

Martin Kemp

Having reached the end of *Nature's Art and Science* series, the time seems right for a summing up. The essays, each centred on a single artefact, were written to a three-part cycle of 'old master' (from the Renaissance to mid-nineteenth century), 'classic modernist' (from the first half of this century) and living artist. Against this pattern were plotted other variables: artistic content; the type of science involved; the style of art-science relationship; artistic medium; geographical spread; and tone of artistic voice. Not all these variables have been respected as much as others — unsurprisingly, given my own uneven knowledge and the personal factors involved in making choices.

Notable vitality

There has been an obvious leaning towards British artists in the essays on living practitioners, reflecting my own contacts, but there need be no apology for highlighting British practice at this time of notable vitality. I have dealt only with western art — so there were no Islamic tile patterns or Chinese nature painting. For the most part I have selected artists to whom I feel a commitment, Salvador Dali being the most notable exception (*Nature* 391, 27; 1998). Hence, no M. C. Escher, the favourite of mathematicians and the ingenious designer of tessellations and spatial conundrums, whom I regard as heavy-handed and aesthetically laboured.

The guiding principle has been to seek what I am calling 'structural intuitions', rather than to describe instances of the

influence of science on art, or (occasionally) vice-versa. By 'structural intuitions' I mean those elements in our perception and modelling of the seen world (including what we believe lies *behind* appearance) that are the common province of anyone who indulges in the critical exercise of our visual faculties in the most searching manner — whether artist or scientist. The 'structural' element relates both to the patterns that can be extracted from nature at various levels of complexity and to the structures that operate in our perception, cognition and visualization. If this sounds alarmingly circular, I should say that I believe firmly in the non-arbitrary relationship between how nature works and the apparatus with which we have been provided — by nature and by nurture — to make functional sense of the sensory chaos of the world.

Human 'structural intuitions' as expressed visually seem to me increasingly to show an enduring core of commonalities across ages and cultures, however different the modes and vehicles of cultural expression. One manifestation of this is the recurrence of decorative motifs in very different civilizations, such as spiral formations, polygonal patterns and diverse symmetries.

That being said, the art historian's job is largely concerned with the search for what is special about a specific cultural moment, emphasizing differences in style, mode of visualization, function, patronage, reception and so on. During the course of the series, what emerged with unexpected clarity — for the author at least — was the nature of the changing shape to the relationships between art and science across the three areas

of old master, modernist and present. This shape was not predetermined, and the three-part cycle worked against the perception of works chronologically. The shape may be described, telegraphically, as analytical description, abstraction and process.

Analytical description refers to a form of representation in which aspects of appearance are remade — literally re-presented — on the basis of an intuitive or intellectual understanding of the nature of what is being seen, how it is seen and how it may be depicted in such a way as to convey 'information' to an attuned viewer. The tools for such remaking include the projective system of linear perspective, the rational description of light effects through shadow and the modulation of colour (manipulation of tone, hue and saturation), and the structural bases of natural form (such as human anatomy or geology).

Leonardo da Vinci, with whom we started (*Nature* 389, 799; 1997), worked with all these tools, and no masters of naturalism could afford to neglect any of the optical means, however selectively they might concentrate on other areas of interest. Given the prominence of empirical analysis in so many sciences during the 'Scientific Revolution', it is not surprising that some artists were able to play an active role in the dialogue between various types of seeing and knowing. They contributed not only in the obvious areas of illustration but also in the more searching evocation of the causes of natural effects — whether the perceptual explorations of Jan Vermeer (*Nature* 392, 27; 1998) or the fiery emissions from the inner Earth in Joseph Wright's volcanoes (*Nature* 391, 645; 1998).

A signal characteristic of modern science is a high degree of remove and abstraction from the sensory parameters of our normal experience, thanks to equipment used to see and often to generate emissions inaccessible to our eyes — X-rays, infra-red, thermal radiation, sonar, electrons and other sub-atomic particles. Spectacular devices enable us to 'see' forms and forces at scales of minuteness and immensity unimaginable with conventional microscopes and telescopes. Particles have etched the febrile geometry of their kamikaze lives across the spaces of cloud and bubble chambers, bearing witness to a realm in which the classical laws of physics are inapplicable. At the same time, modern artists are striving to forge a realm of artistic reality separate from that of the eyewitness and of conventional naturalism. They are seeking an aesthetic autonomy that obeys its own set of unfathomable rules — whether these are seen as residing in the mind or in the greater forces of the Universe, or both in concert.

It is best not to become obsessed with the question of influence, and of seeking demonstrable ways in which ideas from the new physics percolated into educated consciousness (which they undoubtedly did). Rather, we should see art, in its own right, as exploring submerged worlds of mind and matter that had only been implied under the skin of older naturalisms, now that the burden of naturalism had shifted to the photographic media. The desired autonomy of non-figurative art may be manifested in forms hostile to science or in conscious harmony with scientific explorations. In either case, the idea that truth (to whatever) is located in modes of representation that are not dependent upon and may even contradict our commonsense notions of realism places modern art in a reciprocal relationship to the counter-intuitive revelations of modern scientific theories such as relativity and quantum mechanics.

What Lewis Wolpert has called the "unnatural nature of science" came to the fore at the very time that artists such as Picasso were forging an 'unnatural' manner of representation, in which the picture was seen working according to rules specific to the nature of 'pictorial reality' rather than traditional naturalism. The advent of Freudian psychology, as reflected in the collages of Max Ernst (*Nature* 392, 137; 1998), also posited forms of unconscious reality that were quite different from the logical relationships between things we expect in the external world.

How and why these unnatural formulas came to be shared by arts and sciences in the early years of this century are questions that are best for the moment entered through the individual gateways of artists such as Max Ernst, Umberto Boccioni (*Nature* 391, 751; 1998), Naum Gabo (*Nature* 389, 919; 1997),

Max Bill (*Nature* 390, 239; 1997) and Josef Albers (*Nature* 390, 451; 1997), who arrived at comparable degrees of remove from standard visual experience down quite different paths. It would be nice to propose a neat general theory with some confidence, but I suspect the factors behind unnatural art were so complex and variable, and stood in such diverse positions with respect to scientific knowledge, that the best the historian can do is to chart the individual 'mutations' and to search for the conditions that let them thrive.

Dissolving boundaries

The characterization of contemporary art in terms of process is clearly dependent on my choice of artists. Given the plurality of current practice, a different selection might emphasize such tendencies as the need for instant media impact, a tiresomely incestuous self-reference to art and artiness, a resort to found objects, or a dissolving of the fixed boundaries inherent in any definition of 'Art'.

But, at this disadvantageously close viewpoint, it seems to me that one of the factors — perhaps *the* factor — that distinguishes the artistic cutting edge in the last two decades has been process, not so much its description in the manner of Wright's volcanoes but rather the use of a process that is allowed to determine the final configuration of the work — if there is indeed any 'final configuration' rather than an animated image of William Latham's type (*Nature* 391, 849; 1998). A programme is initiated, with chosen parameters, but the end result is not predetermined.

This lack of determinism, even when the means are apparently simple as with 'Callan's canyons' (*Nature* 390, 565; 1997) or Glen Onwin's vats of brine (*Nature* 391, 543; 1998), has clear affinities with non-deterministic chaos and self-organised criticality — those fashionable kinds of iterative computation that have reclaimed the visual dimension for advanced mathematics. And the self-similar properties of fractals stand in a suggestive relationship to the scale-less qualities that frequently characterize artworks which use process as the way of manipulating the chosen medium. But are the relationships more than suggestive?

Jonathan Callan was as surprised as I to be told by Adrian Webster that his "dust-scapes" conformed to Voronoi cells and exhibited "affinities with a recent model of the architecture of the Universe on very large scales" (*Nature* 391, 430; 1998). Clearly, there is no influence at work here. Rather, what I believe is happening is that one of the dominant tenors of an age

obsessed with process — through computer programs, notions of market forces, the remorseless march of 'selfish genes', big bangs and black holes, the transmission of information through cyberspace, and so on — is being addressed by artists, in the same way that artists have always created images framed by the leading paradigms of their society.

Shared intuitions

The artist and scientist both live within, and play active roles in constructing, human mental and physical landscapes. That they should share 'structural intuitions' is less surprising than inevitable. What is surprising and wonderful is how these intuitions have manifested themselves in the works of innovative artists and scientists in culturally apposite ways.

Where next? Our plan is to publish a companion series on visual images from scientific cultures, ranging from models of big molecules to the physiognomy of Dr Jekyll's Mr Hyde, and from the periodic table to a science laboratory. I will be exploring the 'look' of scientific things, to see whether the style of scientific artefacts is no less integral to the communication of content and meaning than style in a 'work of art'. The 'sci-artefacts' will be drawn from the technical and popular histories of their sciences and serve as transmitters within various worlds of communication — the wider areas of science and learning, institutions and funders, and various kinds of public. □

Martin Kemp is in the Department of the History of Art, University of Oxford, 35 Beaumont Street, Oxford OX1 2PG, UK.

e-mail: martin.kemp@trinity.oxford.ac.uk

