the double helix - feature

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The *Mona Lisa* of modern science

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No molecule in the history of science has reached the iconic status of the double helix of DNA. Its image has been imprinted on all aspects of society, from science, art, music, cinema, architecture and advertising. This review of the *Mona Lisa* of science examines the evolution of its form at the hands of both science and art.

"A monkey is a machine that preserves genes up trees, a fish is a machine that preserves genes in water; there is even a small worm that preserves genes in German beer mats. DNA works in mysterious ways." Richard Dawkins in *The Selfish Gene* (Oxford University Press, 1976).

History has thrown up a few super-images, which have so insinuated themselves into our visual consciousness that they have utterly transcended their original context. This is epitomized by the *Mona Lisa*, painted by Leonardo da Vinci around 1503. The double helix of DNA is unchallenged as the image epitomizing the biological sciences. Both images speak to audiences far beyond their respective specialist worlds, and both carry a vast baggage of associations.

In the worlds of popular image diffusion, particularly on the Internet, the double helix is beginning to rival the *Mona Lisa* as a playground for eccentrics and obsessives (Fig. 1). There is an apparent difference, of course. Leonardo's panel painting is the product of human artifice, whereas DNA is a naturally occurring, large organic molecule. But Leonardo claimed that his art represented a systematic remaking of nature on the basis of a rational understanding of causes and effects. His painting is the result of a complex, nonlinear interaction between concept, subject, plan of action, acquired knowledge, skill, medium and the evolving image itself. In *The Art of Genes*[1], Enrico Coen argues that "biological development and human creativity are highly interactive processes in which events unfold rather than being necessarily pre-planned or anticipated. In other words, in both cases there is no easy separation between plan (or programme) and execution."

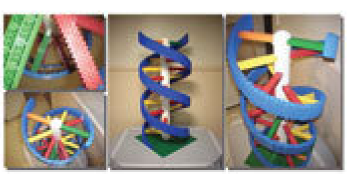

Figure 1 LEGO model of the DNA double helix (in reverse!) by Eric Harshbarger (2001), who also used his mastery of the coloured units of LEGO to compose a 'pixelated' LEGO version of the *Mona Lisa*. (Images courtesy of E. Harshbarger.)
Full legend

High resolution image and legend (51k)

Looking at the investigation and representations of the double helix, we can say that they are cultural activities no less than any painting. Behind the discovery lies the vast infrastructure of a scientific culture that led to the development of the knowledge, theories, institutions, techniques and equipment that made the quest both possible and desirable. The very natures of scientific models and representations, using whatever technique, are integral to the vehicles of science communication. Their visual look is compounded from a complex set of factors, ranging from technical to aesthetic. But, in case anyone should be getting the wrong impression, I acknowledge that the cultural vehicles are designed to deliver non-arbitrary information that is open to rational scrutiny as a way of working towards real knowledge of the physical constitution of the world.

Looked at from a popular perspective (and even from the standpoint of reputation within science), James Watson and Francis Crick are identified with DNA no less than Leonardo is identified with the *Mona Lisa*. The researchers were in a very real sense the 'authors' or 'artists' of the acts of visualization that generated their models of the molecule. But their brilliant achievement was not necessarily of a higher order than that of the other pioneers of molecular modelling, such as the Braggs, John Kendrew, Max Perutz, Maurice Wilkins and Linus Pauling. Rather, they were uniquely fortunate that their molecule was both visually compelling, as a supreme example of nature's 'sculpture', and lay at the heart of the twentieth-century version of the quest to unravel the ultimate secret of life.

The 50-year journey of the DNA molecule from the reticent line diagram in Watson and Crick's seminal article[2] (Fig. 2) to its position in today's world of global imagery is extraordinary. It is therefore timely to look at some of the representational issues involved in science communication, and then at a few selected instances of the various guises in which the molecule has replicated itself within varied visual habitats.

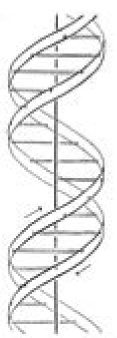

Figure 2 Structure of DNA, drawn by Francis Crick's wife Odile Crick, which was published as the sole figure in Watson and Crick's seminal paper in *Nature*, 25 April 1953 (ref. 2). Full legend

High resolution image and legend (25k)

A model of communication

Looking back on the laconic article in *Nature* that announced the structure of DNA, which we tend to assume in retrospect provided the definitive solution, it is remarkable how little was actually given away. This is true of the article's sole diagram, drawn by Odile Crick, Francis's wife, which represented the sugar chains as directional ribbons, while the bases were rudimentary rods represented flat on (Fig. 2). Along the vertical axis runs the central pole, depicted as a thick line that is broken where the bases lie in front. This axis is a visually useful point of reference, but its early ubiquity seems to depend on the structural necessities of physical models. The developed model, composed from standard brass components with tailor-made metal bases, provided a more detailed and explicit entity for debate and large-scale publicity, although the famous photographs by Anthony Barrington Brown (Fig. 3), taken for an article in *Time* magazine, were actually staged a few months later.

Figure 3 Anthony Barrington Brown's photograph of Watson and Crick with their model of DNA at the Cavendish Laboratory in Cambridge, 21 May 1953. Full legend

High resolution image and legend (4k)

The model of the double helix — like those of other molecules, such as the model of haemoglobin by Perutz — played an important role in scientific understanding, being both based upon and in turn affecting the acts of scientific conceptualization. Overtaken by more refined models made at King's College London, including the widely illustrated space-filling model with Van der Waals surfaces by Wilkins (Fig. 4), the ramshackle masterpiece of Watson and Crick passed the way of so many obsolete bits of scientific paraphernalia. When, 23 years after its making, some of the specially cut plates (Fig. 5) resurfaced in Bristol, they were incorporated into a pious reconstruction by Farooq Hussain of King's College. Like an ancient Greek vase reassembled from chards, the semi-original model is now a treasured cultural icon, displayed in the Science Museum in London.

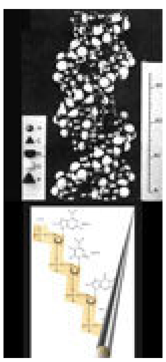

Figure 4 Main image shows Maurice Wilkins' space-filling model of DNA. Inset: a series of lucid and inventive graphics by Keith Roberts appeared in Watson's *Molecular Biology of the Gene*[3]. Full legend

High resolution image and legend (125k)

Figure 5 One of the specially cut plates used by Watson and Crick in their model of the structure of DNA. Full legend

High resolution image and legend (4k)

Communicating the complex structure and, in due course, the awesomely intricate behaviour of the modular molecule, has provided an unparalleled challenge for biological illustrators and model-makers. This is vividly shown by Keith Roberts's illustrations in successive editions of Watson's *Molecular Biology of the Gene*, beginning in 1965, which chart the complex interplay between developing science, graphic ingenuity and technologies of reproduction[3] (see Fig. 4, inset).

As the complex functioning of DNA became increasingly elucidated, so methods and conventions of illustration that privileged behaviour over structure played an ever more conspicuous role. As with sets of illustrations in any science, the visual conventions not only reflect what scientists want to show, but also provide an important framework for thinking and visualization in the process of research itself. Subsequently, the resources of computer design, stereoscopy and, in particular, animation have provided a vivid sense of spatial and temporal processes, only partly possible in conventional text and illustration. Three-dimensional contrivances have had a crucial role from the outset, unsurprisingly given a structure that taxes our powers of spatial visualization. Even in the age of computer graphics, there is still a pedagogic and popular market for kits using a variety of space-filling units.

A number of notable models of DNA and other large molecules have become revered items, typically displayed in protective cases in the foyers of laboratories, where they form part of the visual furniture that speaks of the enterprise of biological science in general and that of the institution in particular. For the sub-species of biologist known as 'molecular', the seductive geometry of DNA helps to underline the fundamental 'hardness' of their science, compared to natural historians and ecologists from whom they have become institutionally distinguished. It is in this spirit, less of didactic instruction than of emblematic signalling, that the double helix has become the icon for the communication of a generalized message. Few have any trouble in recognizing the ghostly twist that emerges from the mosaic of faces on the cover of the *Nature* issue devoted to the human genome on 15 February 2001 (Fig. 6). Similarly, any hint of the double twist in any logo of a laboratory or biotech company is immediately identifiable.

Figure 6 Cover of *Nature* human genome issue, published on 15 February 2001. Full legend

High resolution image and legend (219k)

Aesthetics and meaning

Given the role of aesthetic intuitions in the processes that led to its discovery, and its recognition as 'right', it is understandable that the double helix has itself assumed the guise of a work of art, not least in three-dimensional form. For artists, the attraction of a form that is both beautiful and full of all kinds of scientific and social significance is considerable.

Some grand structures have been commissioned by academic institutions, whereby the artist has basically been given a brief to make a sculpture representing DNA, much like a sculptor might be commissioned to produce an anatomically accurate image of a naked figure. For example, in 1998 Roger Berry produced a huge sculpture hanging down the central well of a multi-story staircase at the University of California at Davis (Fig. 7). Another rendering of the helical structure, *Spirals Time — Time Spirals*, resides on a hillock in the grounds of the Cold Spring Harbor Laboratory (Fig. 8). Designed by the artist, architect and theorist of postmodernism, Charles Jencks, it stands at the heart of a programme of commissioning and collecting artwork that expresses the vision of Watson — who became director of Cold Spring Harbor Laboratory in 1968 and president in 1994 — of an environment in which the visual stimulation of the surroundings is integral to the conduct of high-level mental activity.

Figure 7 *Portrait of a DNA Sequence* by Roger Berry (1998) at the Life Sciences Addition building, University of California, Davis. Full legend

High resolution image and legend (107k)

Figure 8 *Spirals Time — Time Spirals* by Charles Jencks (2000) at Cold Spring Harbor Laboratory. Full legend

High resolution image and legend (120k)

In pursuit of structural aesthetics, the British sculptor, Mark Curtis, proposed a reformed molecular structure for DNA. As an artist concerned with geometrical logic and symmetries, Curtis was worried about the 'ugly' engineering of the Watson–Crick version. Rather than using the sugar phosphate backbones to control the helices, he proposed that stacked base pairs, coupled in an opposite orientation from the accepted bonding, comprises a helix of pentagonal plates around a central void of decagonal cross-section. The geometrical and structural probity of Curtis's models, which eschew a central pole, made it on to a British millennium stamp (Fig. 9), if not into the world of scientific orthodoxy. In a real sense, the molecular biologists' rejection of Curtis's effort to re-design DNA on the basis of *a priori* principles represents an extreme example of the tension within science itself between the polar instincts of the modellers and the empiricists.

Figure 9 Paintings of DNA models on a 'Millennium Collection' stamp, designed by Mark Curtis (1999–2000), from the UK Royal Mail's Scientists' Tale collection. Full legend

High resolution image and legend (78k)

Alongside such sculptural exploitations of the inherent beauty of the double helix has run a strand of artistic iconography that has been more overtly concerned with meaning. The tone for the more fantastical exploitations was set by the flamboyant surrealist, Salvador Dali, as ever concerned with the metaphysical potential implicit in scientific imagery.

During the late 1950s and 1960s, the DNA molecule features as a symbolic vision, lurking in a surreal hinterland between galactic mystery and spiritual significance (as a kind of Jacob's Ladder). His *Butterfly Landscape, The Great Masturbator in Surrealist Landscape with DNA* (1957–8; Fig. 10) locates a prettified evocation of a space-filling model in one of Dali's typically barren landscapes inhabited by sub-Freudian enigmas, designed to conjure up a dreamworld of obscure sexual fantasy[4]. Subsequent artists, particularly those who have engaged with the social implication of molecular biology and genetic engineering, have located images of DNA in contexts of meaning that are less obscure and more polemic.

Figure 10 *Butterfly Landscape, The Great Masturbator in Surrealist Landscape with DNA* by Salvador Dali, 1957–8. Private collection. Full legend

High resolution image and legend (4k)

This savagely selective glance at DNA art — omitting such contemporary luminaries of genetic art as Suzanne Anker[5] (Fig. 11; http://www.geneculture.org/), David Kremers (http://davidkremers.caltech.edu/), Ellen Levy (http://www.geneart.org/genome-levy.htm), Sonya Rapoport (http://users.lmi.net/sonyarap/transgenicbagel/) and Gary Schneider (http://www.icp.org/exhibitions/schneider/) — can barely claim to be representative even of the main range of possibilities (see box). In particular, exploitation of the replicating potential of DNA to generate self-organizing images — exemplified by Marc Quinn's genetic portrait of Sir John Sulston from Sulston's own DNA, fragmented and replicated in bacterial colonies on plates of agar jelly[6] — shows that some artists' engagement with DNA is maturing beyond iconographical opportunism.

Figure 11 *Zoosemiotics: Primates, Frog, Gazelle, Fish* (detail) by Suzanne Anker (1993). Full legend

High resolution image and legend (123k)

But as with the *Mona Lisa*, opportunism will always be the name of a prominent public game. Typical of this tendency is the introduction by the perfume company Bijan in 1993 of a fragrance named DNA. Ironically, we learn from the maker's blurb that "DNA is recommended for casual use". Such is the destiny of one of the greatest popular icons.

References

1. Coen, E. *The Art of Genes. How Organisms Grow Themselves* (Oxford Univ. Press, Oxford, 1999).

2. Watson, J. D. & Crick, F. H. C. A structure for deoxyribose nucleic acid. *Nature* **171**, 737-738 (1953). | ChemPort |
3. Watson, J. D. *Molecular Biology of the Gene* (W. A. Benjamin, Inc., New York, 1965).
4. Descharnes, H. & Neret, G. *Salvador Dali 1904-1989* (Taschen, New York, 1998).
5. Nelkin, D. & Anker, S. The influence of genetics on contemporary art. *Nature Rev. Genet.* **3**, 967-971 (2002). | Article | PubMed | ChemPort |
6. Kemp, M. Reliquary and replication. *A Genomic Portrait: Sir John Sulston* by Marc Quinn. *Nature* **413**, 778 (2001). | Article | ChemPort |

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