Teasing with winsome heresy

The Ascent of Science
by Brian Silver
Oxford University Press: 1998. Pp. 534. $35, £25

John Maddox

The Ascent of Science is written for *l'homme moyen sensuel*, or "*HMS*" as Brian Silver calls him. But who is this *homme*? Not quite "the man on the Clapham omnibus", as the southern English are fond of saying. Silver says his chosen reader has forgotten what little science he learned at school, is "more streetwise than the average scientist", and that, half the time, "he" means "she". In reality, he has written an account of the emergence of ideas in science for people who read broadsheet newspapers, not tabloids. So one should probably translate "*sensuel*" as "thinking" rather than "sensual".

Silver was professor of physical chemistry at the Technicon Israel Institute of Technology until his death a few months ago. It is to be hoped that that sad circumstance does not mean his book fails to win the attention it deserves. For reviewers, the circumstance is an embarrassment: hortatory advice about doing better next time is sadly beside the point.

There are only a few complaints to make. Silver is right to remind us of the importance of the Enlightenment (call it the eighteenth century) in making science respectable, and of the backlash, led by Goethe at the beginning of the following century, making science romantic. But one can (and perhaps should) cavil at the opinion that Michael Faraday and James Clerk Maxwell shrank from the idea of the electron because of Goethe's influence, transmitted to the former by Humphry Davy (egged on by Coleridge) and then absorbed by Faraday's fan Maxwell. One looks (in vain) for chapter and verse.

Unsurprisingly, Silver, a physical chemist, is good on the molecular basis of thermodynamics. His *HMS* will get a feeling for the way molecular motion engenders pressure in a gas, and for the distinction between the collisions of a molecule whose only attribute is mass and the collisions of a person fighting his or her way through the crowd at Grand Central Station, who usually has a goal. That entropy should be linked with probability rings out as clearly as a bell.

Yet Silver also teases his readers unhelpfully, with questions such as "Is determinism dead?". It is easy enough to set up Pierre-Simon Laplace as the exponent of the ultra-Newtonian view that the future behaviour of the Universe and its contents could be calculated if only there were big enough machines, and to follow that with a (superbly clear) account of chaos. The trouble is that the reality of chaotic motion is often taken as a proof (to *HMS*) that causality does not apply. Nothing could be further from the truth, of course, and *HMS* should be told so explicitly.

Much the same (but more) is true of Silver's treatment of quantum mechanics, which is winsome heresy. He lists seven "paradoxes", from Louis de Broglie's wave–particle duality through Schrödinger's cat to the Einstein, Podolski and Rosen experiment and its ramifications. And the conclusion? There "may be things beyond our ken and even our capacity to ken". Many *HMS*s will be content with that, but mistakenly.

The problem of quantum mechanics is not like that at all. The "commonsense" that Silver asks should be applied to quantum phenomena is a creature of our human senses, as refined by natural selection so far. It is no more surprising that we cannot sense the wave properties of electrons than that the reality of atoms has been established only by a long and patient chain of inference. (Even the recent evidence of the scanning tunnelling microscope can be laughed off as artefactual, albeit with difficulty.) So why not accept that electrons (and other particles) are entities that have both wave and particle properties, according to the circumstances? De Broglie did not erect a paradox, but described the real world on a small scale.

Young's experiment (two slits and an interference pattern) is equally inaccessible to commonsense, but Silver goes too far in writing that "it cuts away at our understanding of the way the Universe is". Rather, it is the way the Universe is. Then to cite Richard Feynman as believing that this experiment is "*the* problem in quantum mechanics" (his italics) is unfair; Feynman meant merely that the double-slit problem contains all the commonsense difficulties of the Einstein, Podolski and Rosen experiment. Feynman's own way of doing quantum mechanics neatly resolves the difficulty by allowing a wave–

Mesmerized by meteors

Roberta J. M. Olson and Jay M. Pasachoff look back to what they call the golden age of British astronomy and art in *Fire in the Sky: Comets and Meteors, the Decisive Centuries, in British Art and Science* (Cambridge University Press, £50, $74.95). They say that a greater number and variety of paintings and drawings of comets and meteors were produced in Britain during the eighteenth and nineteenth centuries than in other Western countries. The Smyths, father and son, typified the widespread interest in astronomy at the time. William Henry Smyth was a keen amateur astronomer and an officer in the Royal Navy. His son, Charles Piazzi Smyth, became Astronomer Royal for Scotland in 1845 at the young age of 26, and was a prolific painter of astronomical phenomena. The picture above is his watercolour of Coggia's comet over Edinburgh in 1874. The book's authors say that Charles Piazzi was one of the first to champion the idea of placing observatories on mountains.

particle to follow all possible trajectories.

Silver's overall conclusion is in line with what he says of quantum mechanics: "...the attempt to understand the basic nature of reality may well be a losing game." He cites Gödel's theorem by way of support. All too many of the *HMS*s will be delighted with this nihilist message. □

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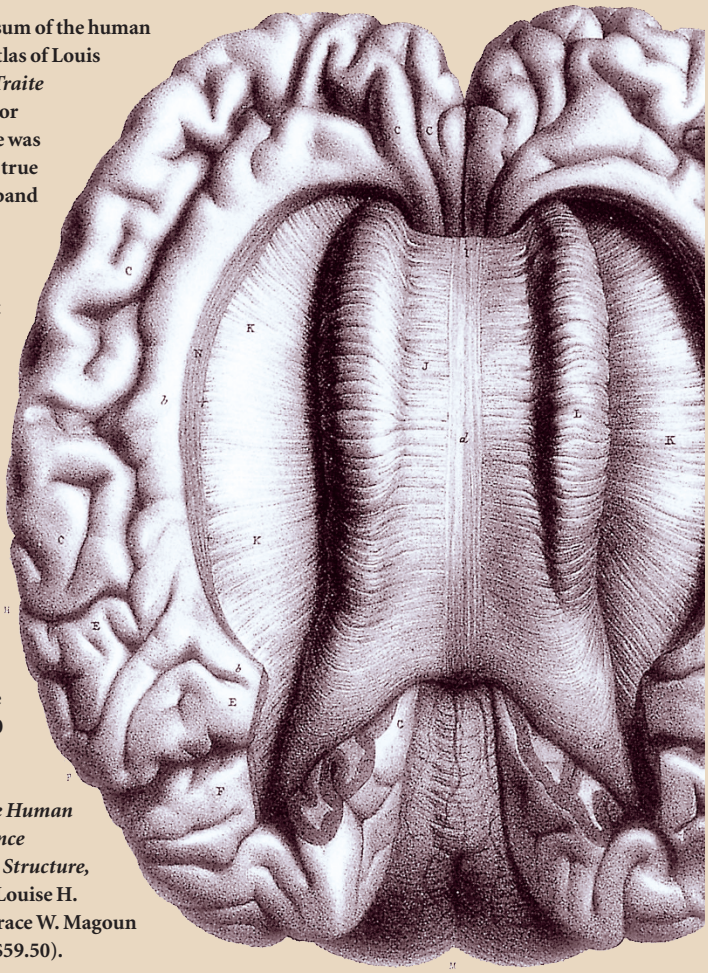
Marrow of the skull bears fruit



The corpus callosum of the human brain, from the atlas of Louis Achille Foville's *Traite complet* (1844). For centuries, so little was known about the true structure of this band of white fibres connecting the cerebral hemispheres that Steno, in 1669, confessed that "a man of a tolerable Genius may say about it whatever he pleases"; indeed, five years earlier, Willis had proposed that it housed the imagination. The plate is one of 300 archival illustrations in *Discoveries in the Human Brain: Neuroscience Prehistory, Brain Structure, and Function* by Louise H. Marshall and Horace W. Magoun (Humana Press, $59.50).

Engineering branch

Design in Nature: Learning from Trees
by Claus Mattheck
Springer: 1998. Pp. 276. $44.95, £30 (pbk)

Julian Vincent

Claus Mattheck grew up in East Germany, where the regime stole his history and his trust. He was a political prisoner for several years after trying to escape (all his East German equipment broke down and failed him; only a West German watch was reliable). Truth and trust are very important to him, and he seeks them in his teachers and friends, the trees.

I spent a happy day with him wandering around the Black Forest near Karlsruhe, hitting trees with a plastic hammer and diagnosing their structural design. I learned to see the lines of force stretching upwards from the roots and to detect the presence of a dead branch by listening to the echo in the trunk.

Later, in his laboratory in Karlsruhe, I saw how he applied his training as a physicist to produce a simple and compelling view of natural structures. By adapting techniques of finite element analysis, a standard tool used by structural engineers to analyse the balance of forces in complex shapes, Mattheck 'grows' shapes in the computer, making them spread the loads as evenly as possible. From simple beams and struts he derives the shapes of nature by erosion and accretion. This would be a pleasant enough pastime, but the method has great utility.

His *habilitation* was in fracture mechanics, so he was well placed to see that the shapes of nature, by eliminating self weight and stress concentrations, represent optimized solutions for engineering design. Throw away the design rulebook. Adopting the rules of nature using the 'soft kill option' (another of Mattheck's little jokes; he is a keen bear hunter, and follows them all day on foot with dogs) makes possible the design of screw threads, shells, levers and shafts that can support greater loads and are less prone to fatigue.

Mattheck has been developing these ideas over the past ten years in a number of publications alongside idiosyncratic illustrations, which his wife taught him to draw, and a multiplicity of photographs and computer models. Much of this is in this book.

He summarizes the computer models he uses, and the reasons for using them, and applies them to growing, damaged and diseased trees, then to bone, claws, thorns, shell structures and bracing. Finally, he applies his methods to the design of a variety of engineering structures. I recommend this book to biologists and engineers alike. □

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Decisive action

Sources of Power: How People Make Decisions
by Gary Klein
MIT Press: 1998. Pp. 330. $40, £33.95

Valerie M. Chase

Like Edwin Hutchins' recent *Cognition in the Wild*, Gary Klein's *Sources of Power* examines how experts make decisions in real-world environments where time is short and stakes are high. Klein, the owner of a consulting company that advises organizations such the military, hospitals and firefighting units, sets out to discover "how people do so well under [such] difficult conditions".

The book's title refers to the tools that can be used to make decisions. To the list of traditional methods such as cost–benefit analysis, Klein adds tools that look less 'rational' but in fact serve experts well. These include 'the power of intuition', 'mental simulation' and 'metaphor'. Although Klein does not express his views precisely in the following terms, he seems to espouse Herbert Simon's brand of bounded rationality, the central idea of which is 'satisficing'. A satisficer sets an aspiration level — for instance, to hire one of the top 10% of job candidates rather than the single best one — and then applies heuristic strategies for meeting it. Satisficing allows people to make decisions that would require unmanageable amounts of information search and computation to make optimally.

The experts Klein has studied often make life-or-death decisions in a matter of minutes on the basis of incomplete, shifting information. Yet time pressure does not seem to compromise the quality of their decisions. In one study, Klein found that the quality of chess masters' moves was the same under blitz conditions (6 seconds per move) as under normal conditions (145 seconds