dents. His coauthor, Gustavo Deco, a physicist and computer scientist at Siemens, Munich, and the University of Munich, Germany, contributes the chapters on attention. Deco evidently takes a more optimistic view of the mathematical competence of his average reader, though the book does offer some assistance in two remedial appendices (on information theory and linear algebra for neural networks).

For Rolls and Deco, computational neuroscience is valuable because it provides a means of testing whether one has a correct theory. Computer simulations of a brain process lead, in their view, to "a precise definition of how the computation is performed, and to precise quantitative tests of the theories produced." In this regard, Hodgkin and Huxley's experience is worth recalling; they too followed this path, but their conclusion was rather different. At the end of ten years' work, they realized (to their great disappointment) that their electrophysiological data provided only very general information about the class of molecular mechanisms that might be involved in generating the action potential. So, as Hodgkin recalled, they "settled for the more pedestrian aim of finding a simple set of mathematical equations which might plausibly represent the movement of electrically charged gating particles" (*2*).

This paradox of knowing much yet not enough is one that besets all computational neuroscientists. It leads different authors to draw different borders between what they consider to be "biologically realistic" and "biologically inspired" models. Neural networks, which form the basis of most of the models in the book, clearly are highly abstracted versions of the biology, more inspired than realistic. But, as John J. Hopfield (himself a physicist) recognized, the value of his eponymous network lay not only in introducing a useful style of modeling into neurobiology but also in drawing quantitatively oriented scientists into the field. *Computational Neuroscience of Vision* provides encouraging indications that the field itself is spawning a new form of neurobiologist in which experimentalist and theorist share the same brain.

References

1. A. L. Hodgkin, *Chance and Design* (Cambridge Univ. Press, Cambridge, 1992).
2. A. L. Hodgkin *et al.*, *The Pursuit of Nature: Informal Essays on the History of Physiology* (Cambridge Univ. Press, Cambridge, 1977).

BOOKS: TECHNIQUES

Focusing on Truth and Beauty

Jake Miller

"The most beautiful thing we can experience is the mysterious," Albert Einstein once said (*1*). "It is the source of all true art and science." The difference between art and science is the way they approach the great mystery of truth. Art seeks to hold the mystery together in one inexplicable, irreducible whole, whereas science attempts to explain and understand the universe by examining it piece by piece.

Photographer Felice Frankel, a research scientist and artist in residence at the Massachusetts Institute of Technology's Edgerton Center, has spent the last decade harnessing her art in the service of science. Early in her career, she worked as a research assistant in molecular biology, and later she became a landscape and architectural photographer. As a Loeb Fellow at Harvard University in 1992, she began working on ways to combine her passion for science and her talent for image making. Since then, she has collaborated with researchers to produce stunning photographs of the results of scientific experiments and engineering demonstrations, images that use vivid colors, energetic compositions, and carefully designed samples to convey, as clearly as possible, the main ideas of her collaborators' work.

Envisioning Science
The Design and Craft of the Science Image
by Felice Frankel

MIT Press, Cambridge, MA, 2002. 336 pp. $55, £37.95. ISBN 0-262-06225-9.

Frankel's *On the Surface of Things* (*2*) featured her photographs of subjects like ferrofluid and migrating bacteria along with chemist George M. Whitesides's poetic explanations of the scientific phenomena pictured. Last year, she helped organize a conference that brought together scientists, journalists, and imaging experts to discuss new approaches to scientific imaging. Her latest book, *Envisioning Science: The Design and Craft of the Science Image*, is a how-to manual intended to show students and researchers ways to use the aesthetic powers of photography to better communicate their scientific findings to their scientific colleagues and to people outside their research communities.

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BROWSINGS

Vision and Art. The Biology of Seeing. *Margaret Livingstone.* Abrams, New York, 2002. 208 pp. $45, C$65, £29.95. ISBN 0-8109-0406-3.

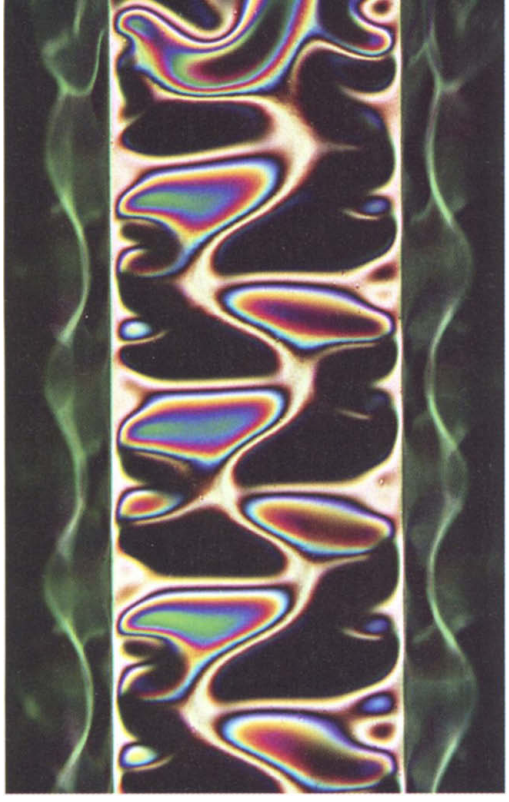
What goes on in our brains when we look at a work of art? Livingstone, a neurophysiologist, offers an account that will help readers appreciate both the science and the art. After reviewing the biology of vision, she explores how various images reflect particular aspects of our visual system. To consider the different roles played by color and luminance ("perceived lightness," what artists call value), she presents color and black-and-white versions of many paintings. Ben Shahn's *Triple Dip* (left) demonstrates that colors having a low-luminance contrast with the background will seem to conform to high-contrast outlines even when they do not.

Measuring Mass. From Positive Rays to Proteins. *Michael A. Grayson, Ed.* Chemical Heritage Press, Philadelphia, PA, 2002. 159 pp. $35. ISBN 0-941901-31-9.

The first mass spectrographs were used to separate the elements on the basis of their mass, but the approach was soon extended to the analysis of chemical compounds. Written for lay readers as well as practitioners, the short, profusely illustrated essays in this volume sketch the history of the tool and survey the diverse uses it has been put to in fields ranging from geology to forensics.

Chips Challenging Champions. Games, Computers and Artificial Intelligence. *Jonathan Schaeffer and Jaap van den Herik, Eds.* Elsevier, Amsterdam, 2002. 370 pp. $40, €40. ISBN 0-444-50949-6.

The development of programs that play classic games has played an important role in artificial intelligence research.



Informative reflections. The stress patterns in a buckling palladium membrane are revealed by the colors in this Normarski differential contrast (or differential interference contrast) image.

Science educator Phylis Morrison contributes a short historical survey of images in science, with samples that range from a Pleistocene cave painting to a radio galaxy. Frankel then introduces the basics of image creation, including tips on lighting and composition. In the following chapters, she discusses techniques for photographing small things (objects measuring 10 cm to 4 mm, which can be captured with macro lenses), samples in the range of 4 mm to 50 μm (where stereomicroscopes are used), and structures as small as 1 μm (which require compound microscopes). Photographer Matthew Footer provides a section on biological fluorescence. The book's references lead to additional information (both about photography and about the science behind the pictures). Visual and textual indices, guidewords, and color-coded pages will help readers find their way through the pages. But Frankel assumes that her readers have a basic knowledge of photography as well as access to information about how to work the microscopes and other high-tech imaging equipment necessary for their own research.

The author uses her own photographs as examples of what to do—and what not to do—while making science photographs. Although she advises readers to edit photographs scrupulously and only present the best, she has generously opened her own files of outtakes to show the lesser images she created on the way to her finest pictures. (Many of the photographs will be familiar to readers of *On the Surface of Things*.) Frankel thinks of the subjects she photographs as landscapes, and she demonstrates how she uses light, shadow, and the forms of that terrain to tell the story of the research. She also offers practical advice for solving problems like composing photographs for journal covers and editing pictures and texts for presentations.

The key to Frankel's approach is her emphasis on the processes of creation and communication. This "new science imaging" is not just about the photographs that are produced. It also addresses how scientists, photographers, and writers can work together; how words and pictures can reinforce one another; and how a sense of wonder can complement facts and data. The book itself is an example of this kind of collaborative, explicitly communicative process. It includes introductions by Frankel and Stuart McKee, the book's designer, outlining what they hope the book will be and do, offering suggestions for how to use the book, and inviting responses from readers. Besides coaching budding science photographers, Frankel wants to open a discussion about the role of photography in science journalism. She asks readers to consider the potential hazards of digital and visual manipulation, and she reminds them of the need to report the methods used to create images.

In an essay about art criticism, landscape photographer Robert Adams writes, "Art is by nature self-explanatory" (*3*). Adams tells a story about the poet Robert Frost: Once when asked what one of his poems meant, he replied, "You want me to say it worse?" Frost wanted his poems, like all works of art, to speak for themselves without further elaboration. But for Frankel, the elaboration—the science that explains, and in an important sense created, the phenomena she photographs—is precisely the point of the pictures.

References and Notes

1. Einstein's comment appears in S. M. Ulam, *Adventures of a Mathematician* (Scribner, New York, 1976).
2. F. Frankel, G. M. Whitesides, *On the Surface of Things: Images of the Extraordinary in Science* (Chronicle Books, San Francisco, 1997).
3. R. Adams, *Why People Photograph* (Aperture, New York, 1994).

This collection of recent papers from the journal *Artificial Intelligence* surveys the state of the art and the challenges that remain. The contributors discuss puzzles, two-player perfect-information games (such as chess and go), and imperfect-information and stochastic games (including poker and Scrabble). The last article explores the properties of games that can be solved, allowing programs to play them perfectly.

Columbus's Outpost Among the Taínos. Spain and America at La Isabela, 1493–1498. *Kathleen Deagan and José María Cruxent.* Yale University Press, New Haven, CT, 2002. 304 pp. $35, £25. ISBN 0-300-09040-4.

Archaeology at La Isabela. America's First European Town. *Kathleen Deagan and José María Cruxent.* Yale University Press, New Haven, CT, 2002. 411 pp. $60, £40. ISBN 0-300-09041-2.

On his second voyage to the New World, with 17 ships and some 1200 men, Columbus established a royal trading colony on the north shore of Hispaniola. It failed within five years. These cross-referenced books present the results of the authors' ten-year investigation of the site. *Columbus's Outpost* offers a materials-based history of La Isabela and considers its influence on colonial development in the Americas; *Archaeology* provides the detailed supporting technical evidence. Deagan and Cruxent conclude that the demise of the colony occurred because Columbus's plans, grounded in European experience, were inadequate in the settlement's American circumstances.

Foundations of Tropical Forest Biology. Classic Papers with Commentaries. *Robin L. Chazdon and T. C. Whitmore, Eds.* University of Chicago Press, Chicago, 2002. 880 pp. $85, £66.50. ISBN 0-226-10224-6. Paper, $35, £24.50. ISBN 0-226-10225-4.

Biologists have long been enchanted by the bewildering diversity and complex biotic interactions of tropical forests. The volume comprises papers from the 19th century through the late 1980s that have shaped the development of tropical biology. The selections, which cover a wide array of geographic regions, are grouped by topics. These include explorers' accounts; the origins of tropical diversity; plant-animal interactions; patterns of species richness and distributions for arthropods, vertebrates, and plants; and conservation and restoration. Commentaries for each section highlight the influence the papers have had on subsequent research.

CREDIT: FELICE FRANKEL