biotechnology would necessarily undermine diversity. His use of analogies from the green revolution ignores the fact that farming systems can be redesigned to reflect new social goals. The book does not distinguish between the limited role that biotechnology can play in solving technical problems and the wider critique of corporate control of technology.

Fundamentally, the challenge lies in the choice of farming system, and this is independent of specific technologies. It is here that DeVries and Toenniessen offer complementary perspectives, especially through their emphasis on identifying technical opportunities for improving crops such as maize, sorghum, rice, cowpea, cassava and banana. Unlike Brookfield, they are concerned with socio-economic viability and offer new insights into the development of the seed sector. However, they pay less attention to ecological issues.

The two books use different units of analysis. Brookfield focuses on farming systems, whereas DeVries and Toenniessen are concerned with improving individual crops. By downplaying the role of technological innovation, Brookfield's analysis ignores the major challenges for African agriculture, such as its low productivity, and his approach tends to be over-optimistic about the ability of Africa's current systems to meet its growing food needs. DeVries and Toenniessen, however, leave themselves open to possible charges of technical determinism by not including a more detailed discussion of the policy implications of their recommendations. But read together, the two books offer unique insights into the relationships between ecosystem management and technological innovation.

They also offer divergent policy approaches. Brookfield makes a passionate appeal for global social justice as a way of protecting small-scale farmers from the risks of new technologies. But political appeals are not enough to protect farming systems from change. Nor will they be protected by diplomatic victories in international forums. DeVries and Toenniessen, on the other hand, pin their hopes on the co-evolution of technological change and institutional innovation, but they underestimate the challenges associated with these processes. And to have a dynamic agro-ecological system, all technological options must be kept open.

If read individually, the two books would only fuel the debate that is raging over agricultural biotechnology. But together, they provide clear indications on how to promote sustainable agriculture. ■

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Science in culture

Spotlight on a visual language

Do Piet Mondrian's beliefs about the aesthetic appeal of his art stand up to scientific scrutiny?

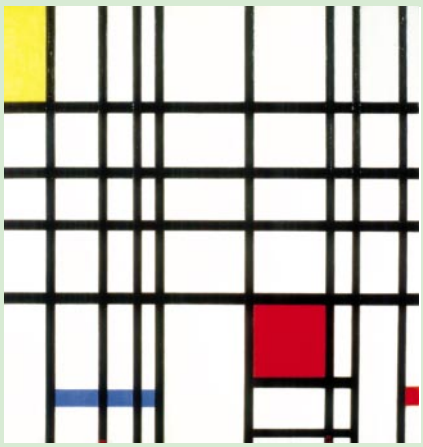
Richard Taylor

Piet Mondrian's abstract paintings are celebrated for their simple yet carefully arranged grids of strong black lines and enclosed rectangles of primary colours, which the painter considered to be reflections of the natural laws of the Universe. His paintings convey an impression of balanced harmony. But, as the audience at a visual-sciences conference was told last December, Mondrian's story is not as straightforward as the lines he painted.

Never before have the Great Masters of the art world received such scrutiny from beyond the traditional boundaries of art theory. Recently, painter David Hockney and optics scientist Charles Falco challenged five centuries of figurative art when they presented evidence that da Vinci, Raphael, Caravaggio, Van Eyck, Velázquez and Rembrandt may have traced images projected onto their canvases using lenses, prisms or mirrors (see *Nature* **412,** 860; 2001). To many, their investigation has relegated masterpieces of figurative art from displays of creative genius to the product of simple copying. So, what does science have to say about the abstract works of modern art?

Abstract art covers a vast visual spectrum, from Mondrian's geometrical patterns at one end to Jackson Pollock's intermingled swirls of paint at the other. Pollock's unorthodox style of dripping paint onto the canvas led to a popular belief that his 'compositions' were devoid of patterns. However, my analysis, with Adam P. Micolich and David Jonas, shows that his paintings are fractal, similar to nature's scenery (see *Nature* **399,** 422; 1999). Fractals consist of structure that repeats at different magnifications, building patterns of immense complexity. Unlike Pollock, Mondrian viewed nature's complexity with distaste, believing that it hid a purer form of natural order, a fundamental balance and equilibrium that "appears under a veil" of nature's erratic surface.

To capture this quality on canvas, Mondrian developed his simple visual 'language' of primary colours and straight lines. He maintained that the correct arrangement would deliver a profound aesthetic impact; sometimes he spent weeks deciding on the precise positioning of a single line. Remarkably, Australian artist Alan Lee told the conference audience that the theory collapses when put to the test. Lee created eight of his own paintings based on Mondrian's basic design elements of intersecting black vertical and horizontal lines enclosing coloured regions. However, he composed his patterns randomly. In visual-perception tests, 10 art experts and more than 100 non-experts were then presented with an array of 12 paintings and asked to identify the four of Mondrian's carefully composed patterns



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Mondrian's *Composition with Red, Yellow and Blue* (1939–42): the artist could spend weeks deciding on the positioning of a single line.

and the eight random patterns produced by Lee. The results were the same as if the subjects had been blindfolded — the two types of pattern were indistinguishable.

Mondrian's obsession with the location of his lines extended to their angle. In one of the more notorious exchanges in modern art history, he argued fiercely when colleague Theo van Doesburg proposed that their visual vocabulary should be broadened to include diagonal lines. Mondrian passionately believed that the diagonal represented a disruptive element, and he threatened to break with the 'De Stijl' art movement that had formed around his aesthetic ideals. Branka Spehar, a perception psychologist from the University of New South Wales in Sydney, presented results that question Mondrian's belief. In her study, she showed 20 subjects images generated by tilting three of Mondrian's paintings at four orientations. The four orientations of each painting, including the one intended by Mondrian, were paired in all possible combinations and the subjects were asked to express a preference within each pair. The results, based on 72 trials for each subject, indicate that people show no aesthetic preference between the original orientations intended by Mondrian and the oblique ones.

Few will dispute the artistic value of Mondrian's visual language. But as scientists turn their expertise towards some of the world's most treasured paintings, their results can be unexpected. Like characters in a detective story, scientists are simply contributing their own unique clues to one of civilization's great questions — the meaning of art. ■

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"The art of seeing and the seeing of art" was held at the Centre for Visual Sciences, Australian National University, Canberra, on 5–7 December 2001.

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