

explicitly separates spectral reflectance from conditions of illumination and atmospheric clarity.

Anderson and Winawer created patterns that appear to be objects viewed through a light or dark obscuring medium, like clouds during the day or night. In one example, they took disks and overlaid them with a continuous pattern of light and dark. First, they manipulated the pattern so that every point around the border of the disk was darker than the immediately adjacent area. In a second case, the disks were lighter than their surroundings. The actual albedo patterns on each set of disks were identical in the two cases.

As shown in the figure, the disks appear black in the first case and white in the second. The viewer perceives variations in the degree of contrast between disk and background as variations in the transparency of the obscuring medium.

The researchers explain that the brain generates the illusion by forming a pattern based on the partially obscured objects. The brain takes the least obstructed portions of the disks to be the “true” albedo and assigns that value to the entire disk. The lightest part of the scene is assigned the perception of whiteness; the darkest, blackness.

To verify that the brain makes a global perception, rather than a point-by-point comparison, the researchers rotated each of the disks by 90 degrees, so that the patterns were no longer continuous across the borders of the disks. This rotation destroyed the illusion that the disks were in the background and that they were obscured by objects in the foreground. The disks in the two cases now appear as identical in albedo and are “floating” in front of the cloudlike pattern instead of obscured behind it.

Anderson and Winawer conclude that purely local mechanisms that generate contrast with point-by-point comparisons cannot explain these illusions. Instead, they contend, the brain must be using information from the entire image—or at least the entire disk—to determine which layers of the image are obscuring which, and therefore what the real albedos of the objects are.

Kunsthistorisches Museum, Vienna; Photo by Andrea Kapuscik



Portrait of a Cardinal (Niccolò Albergati) by Jan van Eyck, c. 1438.

Staatliche Kunstsammlungen, Dresden



Silverpoint on paper drawing for Portrait of a Cardinal, c. 1435.



Superimposition of silverpoint drawing (red) and painting (blue). [Illustration by Bernard Illerhaus.]

Van Eyck's Dividers: Simple Geometry?

For the past several years, artist David Hockney and scientist Charles Falco have created a minor tempest with their speculations that Renaissance artists traced their paintings from images created by lenses (OPN, July 2000, p. 52). Many art historians reject these claims, however, arguing that other techniques could easily have created the paintings' illusion of realism. For example, Jan van Eyck and other masters could have used almost lapidary stokes in critical areas and other then-new painting techniques to create a striking appearance of jewel-like reality.

In the latest salvo in this debate, a team of art historians and scientists from Germany and France have re-inlayed a famous van Eyck portrait of a cardinal and the silverpoint drawing on which the painting was based (*The Burlington Magazine*, March 2005, p. 170). Both works were completed between 1435 and 1438. Hockney had proposed that van Eyck used a concave mirror both to assist in creating the drawing and then to transfer it to the canvas; in the process, the image would have been enlarged by about 40 percent.

The team examined the drawing microscopically and found a pattern of prick marks at certain points on the paper—on the outline of the left eye, at

both ends of the mouth, on the chin and earlobe. Groups of two or three prick marks were found together. The pricks could indicate that van Eyck used dividers, a common geometric tool at the time, to measure critical distances on the drawing, and then used a geometric construction to make the enlargement. That technique alone could easily enlarge the drawing by a factor of the square root of 2, or 1.41—the actual ratio that was used.

In addition, the researchers found that, in all the regions close to the prick marks, the painting and a mathematical enlargement of the drawing accurately coincided. But in other areas, there were considerable differences—including a significant repositioning of the ear. Such discrepancies, the researchers concluded, would be easy to understand if dividers were used in only some places, but impossible if the painting's outline had been traced from an optical projection.

Falco, who is an optical scientist at the University of Arizona, counters that the number of pinpricks that the authors found—nine holes in five locations—was far too small to have resulted from the painter's use of a divider to copy the drawing with sub-millimeter fidelity to the original. “Since holes cannot be fingerprinted or carbon dated, there is no way to know who made those pinpricks.”