Shadow strokes

Scientists at the Louvre have discovered the secret to the Mona Lisa's face

THE Mona Lisa's lure is so strong that Louvre Museum officials find it wise to keep her safely stowed behind bulletproof glass. She is let out of her protective cage once a year, for a whiff of fresh air. And this is when many a researcher would love to get their hands on Leonardo da Vinci's most famous muse, in order to find out more about how she was painted.

For a long time, scientists and curators have wondered how da Vinci created shadows on her face with seemingly no brushstrokes or contours. Art experts call this shadowing technique *sfumato*—like the Italian word for smoke, *fumo*. Experts have long suspected *sfumato* shadowing has something to do with the glazes that da Vinci used above the paint layer. But proving this has been difficult because snatching a sample of the Mona Lisa's face for chemical analysis is, unsurprisingly, frowned upon.

Instead, Louvre scientists led by Philippe Walter tried to solve the mystery using a hands-off technique called x-ray fluorescence, which can divulge details about the thickness and chemical composition of a painter's individual brush strokes without damaging artwork. Focusing x-rays on faces in seven of da Vinci's masterpieces, including the Mona Lisa, Dr Walter's team found that the artist would first paint in the basic flesh tones. Then da Vinci applied up to 30 incredibly thin strokes of glaze above the flesh tone—many just a few micrometres thick.

Glaze is mostly translucent, but da Vinci would also slip in small amounts of pigments, such as manganese and lead oxides. By applying many thin coats of this adapted glaze, he achieved the smoky shadowing he became famous for.

A paper describing da Vinci's shadow science, published in *Angewandte Chemie International Edition*, also suggests that the artist was picky about his glaze recipes. For example, in the painting "The Virgin and Child with St Anne", the virgin's face is shadowed by glaze that contains different pigments to those in the shadowing glaze on the child. Da Vinci might have selected different glaze recipes on purpose—or he may have tweaked the painting over years during which time his taste in glaze ingredients could have changed.

Few of the tourists strolling around the museum grounds realise that beneath them are 60 scientists, a particle accelerator and a battery of research equipment dedicated to soliciting secrets from the vast collections of French museums. The scientists who were lucky enough to get close to the Mona Lisa for this work did not have far to travel, as they work in the Centre for Research and Restoration of Museums of France—a subterranean laboratory that lies beneath the Louvre.

All, however, is not happy underground. The French Ministry of Culture wants to relocate this laboratory, as well as the Louvre's storerooms, to a site about 50km (30 miles) outside Paris in a new facility to be built in Cergy-Pontoise. To judge from the blog started by some of the centre's disgruntled staff, their mood is decidedly *sfumato*. ■
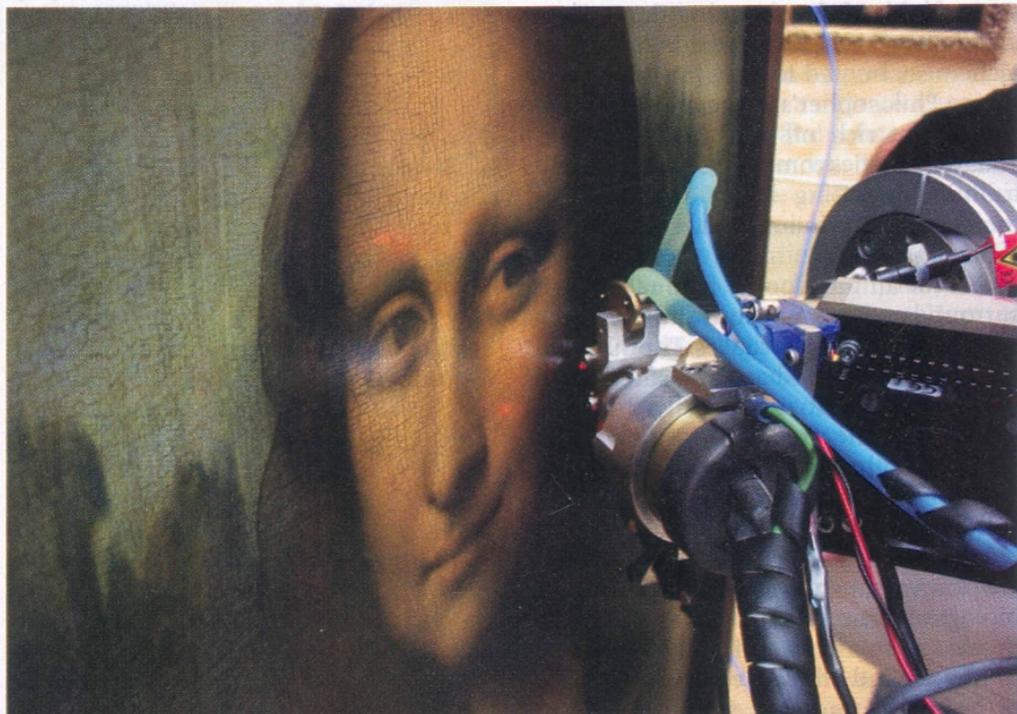
Shedding light on the Mona Lisa's secrets