teach it. Students who did not know their examiners' opinion on this matter would sometimes answer their examination papers using both 'languages' — that using atomic notation and that using the so-called equivalents in the formulae. Atomic theory was not introduced into French secondary schools until 1902 and was for a long time referred to as the 'atomic hypothesis'. This French reluctance to accept new theories was behind the late introduction of electronic theories in organic chemistry, which were not taught in French universities until the 1960s.

Until the late 1880s, France offered no higher technical education in chemistry. But in 1882, impressed by the quality of the engineers educated by the German Technische Hochschulen, one of Wurtz's students, Charles Lauth, founded the Ecole Municipale de Physique et de Chimie Industrielles in Paris, because he thought that France lacked managers for the chemical industry.

A final reason for the decline in French influence in chemistry was the poor patent policy — the product was protected, but not the process. The French chemical industry thus lagged well behind that in Germany, which had tight links with university research and drew strength from it.

In 1993, Rocke published *The Quiet Revolution: Hermann Kolbe and the Science of Organic Chemistry* (University of California Press), the German equivalent of this biography of Wurtz. Will he produce a useful equivalent for English science — perhaps *The Mauve Revolution: When Perkin made Chemistry Colourful*?

This review would not be complete without a comment on the (too?) famous quotation for which Wurtz is remembered. In 1868, he wrote: "*La chimie est une science française. Elle fut constituée par Lavoisier d'immortelle mémoire*" (Chemistry is a French science. It was founded by Lavoisier of immortal fame). Rocke points out, however, that these remarks, which frightened many scientists outside France, particularly those in Germany, were intended for a French audience. Wurtz wanted to stimulate the national spirit of French chemists and have them adopt the new structural theories of organic chemistry in a second revolution in chemistry (after that of Lavoisier) that he considered to be a consequence of the work of Laurent and Gerhardt.

I strongly recommend Rocke's book, not only to historians of science, but also to any scientist with an interest in the history of chemistry. I hope my chemist colleagues will not miss it and that the book will be widely bought by libraries in universities and research centres. ■

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Science in culture

Maintaining Masaccio

New data from the restored 'Trinity' in Florence.

Martin Kemp

Like cars and the human body, pictures need regular maintenance. This is particularly true of wall paintings, even when executed in the robust medium of fresco, in which the pigments chemically bond with an upper layer of moist plaster. Murals in publicly accessible spaces are particularly vulnerable to fluctuations in environmental conditions and accumulated dirt.

Masaccio's famous image of the *Trinity with the Virgin, St. John, Donors and a Skeleton* has enjoyed a particularly adventurous history. Painted in the mid-1420s in the church of Santa Maria Novella in Florence, it was the seminal demonstration of pictorial perspective in its earliest phase. But the fresco was totally covered up by an altarpiece 150 years later, when the interior of the church was completely remodelled. It was only rediscovered in the mid-nineteenth century, and its upper section was then transferred to the church's entrance wall.

It was finally returned to its original location and reunited with the battered and fragmentary lower portion containing the skeleton in 1950, a feat accomplished by Leonetto Tintori. Large areas of missing paint were restored; almost all the architectural structures in the lower portion were successively reconstructed, according to the best intuitions of how the ensemble originally worked.

Further work has recently been completed by Cristina Danti and her team from the Florentine conservation workshop Opificio delle Pietre Dure to ameliorate the inevitable changes and deterioration that have occurred over the half-century since Tintori's painstaking restoration. The Tintori and Danti campaigns, using traditional and technological means of examination, have together generated vast amounts of data about the highly technical optical construction of young Masaccio's illusionistic spaces (Masaccio died at the age of 27).

The key feature is what we now call the 'vanishing point', at which lines perpendicular to the plane of the picture appear to converge, and which Masaccio has placed at a reasonable height for an 'average' spectator. Even with the guidance of the converging parallels, the construction of the barrel vault is a far from trivial problem. Examination by Danti's team reveals that the left side of the curving vault is criss-crossed with a complex mesh of construction lines, some of which had been 'snapped' into the wet plaster with chords (which are pulled out and sharply released to leave an imprint), and others incised with a pointed instrument along a straight edge or with some form of compass. Having used the left side as his elaborate experimental field, Masaccio completed the right section with a greater economy of constructional effort.

A geometrical analysis of Masaccio's painted space — now confirmed by computer analysis — reveals that he has intuitively adjusted its regular geometry to make it 'work' as a picture in terms of its actual site in the nave of the church. Among the many almost indiscernible subversions of canonical perspective are the circumferential extensions of the lowest row of coffers on left and right, presumably to make them appear to 'sit well' in relation to the arms of the cross. In addition to such empirical manipulations, the painter has insinuated some subtle asymmetries into the axial scheme. For example, God stands slightly off the central axis. We can also see that Christ's hands overlap the edges of his cross only on the left.

OPIFICIO DELLE PIETRE DURE

Although the prime, frontal viewing position was contrived to coincide with the width of the side aisle, the viewer entering from the usual entrance door in the fifteenth century, which was on the opposite side wall, would have seen Masaccio's illusion off-centre to his or her left. Masaccio has not exploited the full effect of parallax — which would have looked too extreme from other viewpoints — but he has subtly accommodated the asymmetrical line of approach.

The collective results arising from the old and new data indicate how the rules of construction and compositional intuition operate together in an experimental process that relies upon a constant interplay between geometry, judgement by eye, and supreme manual control. ■

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