APPLIED SCIENCES AND ENGINEERING

Introduction to special collection on New Scientific Methods for Cultural Heritage

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Paintings fade like flowers. All the more reason boldly to use them too raw, time will only soften them too much.

Vincent van Gogh, letter to his brother Theo, April 1888

He was worried about years, not centuries.

This special issue highlights new developments in a rapidly evolving, highly interdisciplinary frontier: the application of state-of-the-art technologies to enhance cultural heritage science. As an academic with a background in chemical physics, my first exposure to this opportunity was about a decade ago, when I visited the National Gallery in London and toured their exhibit on methods to detect art forgeries. I was not only impressed but also startled: It was clear that the astonishing recent progress in (for example) biomedical imaging had not yet propagated into the conservation community. Over the past decade, this has changed. It has become clear that technologies such as hyperspectral imaging, magnetic resonance microscopy, femtosecond laser pulse control, and pattern recognition can have a major impact on how we understand the past and what we can transfer to the future.

Most of the creative output of humanity is gone forever; what is left to us is fragmentary and fragile. Paintings from the Renaissance spent centuries exposed to sunlight (or candle soot), high humidity, and insects; virtually all of them have been retouched many times. The Terracotta warriors of Xi'an tour the world today, and the statues of ancient Greece can be found in many museums, but they would embarrass their creators—they were originally brightly painted (and, in fact, most of the Xi'an warriors remain underground because the paint disappears within minutes of unearthing)—and those are the favorable cases. More commonly, available materials had little chance of surviving the passage of time.

Understanding how deteriorated pieces looked when they were created, and preventing deterioration for future generations, reflects a hugely multidisciplinary set of challenges. It also connects with many other fields. For example, many of the brightly colored inorganic pigments of the past several centuries are semiconductors with modern applications such as solar cells; localized degradation over decades caused by variations in impurities (then used for color selection, now used for doping) can inform the search for stable modern materials.

I believe that most scientists have an intuitive understanding of the connection between science and art—the creative processes have strong similarities. Five centuries ago, the artist and scientist Leonardo da Vinci was the most prominent practitioner of sfumato, the technique used to create realistic skin tones. The face of the *Mona Lisa* has been shown to have dozens of layers of paint. This was not done because da Vinci was obsessive; rather, it was because he understood, centuries before it could have been quantified, that distributed absorption and scattering would create a more realistic look.

It was a great pleasure to work with John Delaney in assembling this collection and also with the community of scientists who regularly gather for the Gordon Conference on Scientific Methods in Cultural Heritage. That group generated many more submissions than *Science Advances* could publish (overall, our acceptance rate is currently about 12%), but we are grateful for their enthusiasm and look forward to publishing more in the future.

– Warren S. Warren