Preventing Dyes, and a Cultural Tradition, from Fading

Technology designed to preserve artwork can also help Afghan rug makers

Yale

Every artwork comes with its own set of challenges for conservators and curators, not least of which is curbing the effects of time. To that end, a device known as a microfading tester (MFT) gives art stewards a much better sense of where and for how long they can safely display a particular work before irreversible fading occurs. At Yale, researchers are working to make this technology not just more accessible to museums everywhere, but as a means to preserve cultural heritage in other parts of the world.

Developed by Paul Whitmore, the now-retired director of the Aging Diagnostics Lab at Yale's Institute for the Preservation of Cultural Heritage (IPCH), the MFT device helps predict how fast colorants, such as pigments and dyes, will fade under normal gallery display conditions. Using fiber optics, the device shines an intense beam of light on a microscopic spot of a material, measures the reflected light, and triggers the photochemical reactions that would cause light-sensitive colors to fade. Every minute the light shines on the material is equal to about one year of aging. Researchers typically use it for up to 5 minutes at a time, allowing them to see five years into the material's future.

"The MFT allows us to monitor dye or pigment fading in real time, predicting fading behavior in gallery conditions," said Katherine Schilling, associate research scientist in chemical and environmental engineering and associate conservation research scientist at the IPCH. Because the microfading test essentially leaves no trace of altered color, objects can be quickly screened for their lightfastness – that is, how long dyes can resist the effects of fading. This helps determine future storage or exhibition requirements.

With the MFT, researchers can get information about the light sensitivity of everything from sloth fur to bird feathers to paintings, drawings, photographs, and textiles. Most recently, IPCH has been using the technique to test dyes used in rugs originating from an indigenous weaving community in Afghanistan, in support of a collaboration between Yale researchers and a non-governmental organization (NGO) that supports Afghan artisans, primarily women. (Due to the political instability in Afghanistan, a representative requested that the NGO's name not be used).

The project aims to help Afghan weavers find the best possible colorants, partly to preserve a centuries-old tradition, but also to give Afghan women a better chance to earn a livable income. Prior to the August 2021 takeover by the Taliban, there were known to be about 1 million rug weavers in the country. Even under the best of conditions, weaving is not an easy way to make a living.

"We partnered with a dynamic organization with the capacity to work directly in regions where weaving and other traditional artforms have been decimated by commercial or political interests, and now war and famine," said Alison Gilchrest, the director of applied research and outreach for the IPCH. "These are communities where skills and methods have been passed through families for generations, and they deserve an opportunity to thrive."

The NGO's representative noted that exporting handmade products has become a significantly growing industry, in part because people are increasingly buying with sustainability in mind.

"We work with a lot of retail partners who know their customers, and know exactly what sort of styles they like," she said. "We have to make sure that we can present a product to them that works, based on their very serious commercial standards, and one of those concerns is fading. It happens in carpets and textiles through light and through touch. If you're going to create high-value jobs for women in rural Afghanistan, you better be able to create a product that doesn't fade."

At the IPCH laboratory on Yale's West Campus, the researchers work with a large dye sampler rug provided by the NGO. In a grid of 190 squares, the sampler features patches of all the dyes used by the weavers.

"We're working through the sampler systematically to arrive at recommendations for which

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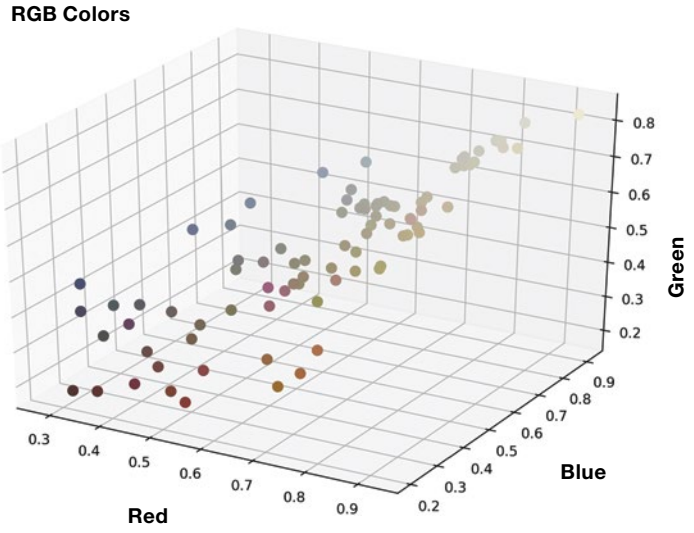
Above: *Vanessa Lamar '23 utilizes the MFT device to predict how fast colors in a given material will fade.*

colors are more prone to fade," Schilling said. "Given the range of options, the weavers can then make substitutions and hopefully still achieve a similar aesthetic effect."

Contributing to the Afghan rug project are two students, Vanessa Lamar, a physics major, and Daniela Flores, a chemical engineering major. Schilling prepared the students for this work by creating an independent study of the photochemistry of colorants during the spring semester. Using the MFT instrument, they measured various materials' lightfastness. Lamar said there was a bit of a learning curve in working the microfading device, but her physics background was a big help. At the end of the semester, she decided to continue with the project through the summer.

"I never thought that I'd be able to do something that combines my interest in art and humanities with science, and this position gives me an opportunity to explore that world," she said. "Even though I usually work with numbers and machines, it's good to know that the work I'm doing has a human impact."

The IPCH researchers also plan to broaden the use of the MFT- a goal that calls for a redesign to make it less costly and more usable for museums around the world. The lab contains a few versions of the MFT that were made since Whitmore invented it in the 1990s. It's time, the researchers said, for a more extensive reworking.



Above: *Distribution of the RBG colors from early testing data of Afghan rugs dyes.*

Background: *The dye sampler rug provided by the organization consists of small squares colored with different dyes, each one commonly used by Afghan weavers.* Above: *An assortment of external fabrics and colors are also tested to inform the lifespan of a certain material.* Left: *The software can measure how long specific dyes can resist the effects of fading.*

"The best way to honor the legacy of the project is to build on its success," Schilling said. It's an ingenious device, but it can be tricky to use, even for other scientists. It's also pricey - creating a new one could cost up $30,000, depending on the components. Several research teams in the U.S. and abroad, including the cross-disciplinary team at SEAS and IPCH - are working to bring the cost down to about $6,000.

"Our goal is to figure out how to make this technology accessible and transferrable at a lower price point," Schilling said. "We want to simplify the instrument design and software so that our partners and collaborators around the world can have access to the same powerful method."

The more broadly the microfading technique is used, the more useful it becomes.

"If we can make the device and the method more accessible, then the global heritage community starts to build larger bodies of predictive data," Gilchrest said.

Adding to the research was Arizona high school student Ella Wang, who worked with the MFT as part of MIT's Research Science Institute program, which recruits top high school students from around the world for immersive science and engineering research during the summer. Working with Schilling and SEAS Deputy Dean Vincent Wilczynski, she used color maps and fading simulations to model the fading effects of UV rays.

When the researchers finish collecting data for the Afghan rug project, they'll provide their research to the NGO, which will use it to help the rug weavers get the best quality materials for their craft. "It's a small project with potentially far-reaching impact," Gilchrest said. Besides getting valuable scientific research out of it, she said, it's a chance to make a difference for a particular community at a time when it most needs help.

"There's a pressing need to support these endangered and under-resourced communities in documenting and preserving their heritage," she said. "And with our deep and integrated science and art capacity at Yale, embodied by IPCH, it is incumbent on us to continuously question what more we can be doing on a global stage."