Radiation and Conservation

This week I am touching upon the influence of light in the conservation community. When I say conservation, I mean how does light, or better optical radiation, impact on works of art. I am relying on the work of a former M.S. student in my group, Rachel Ulanch, who did her thesis on the blue wool scale of the textile industry.[1] What is this blue wool scale? It is comprised of a card that has various samples of blue wool affixed to it (see Fig. 1). The card is then hung near the object under test, which includes textiles, printed material, and even precious works of art. Half of each blue wool sample is covered such that it remains in the dark, while the other half of each sample is left exposed to ambient conditions. Over time one can assess the color fading by comparing the two halves – exposed and unexposed, in order to determine if the light exposure is damaging the object of interest. The shorter the wavelength, the more damage one expects to see over a given time. Figure 2 shows the results of the exposure of one of these blue wool cards to sunlight for a couple weeks in April 2017 when located on top of the Meinel Building. Notably there is serious fading of many of the blue wool samples. Thus, the blue wool scale provides a good visual method to ascertain the effects of optical radiation on the color fastness of objects. As mentioned, a precious work of art is one such object which one needs to remain vigilant. As an example consider Rothko's *Green on Blue* (see Fig. 3), which he painted in 1956, and it is hanging in The University of Arizona Museum of Art. This painting is worth more than the Wyant College of Optical Sciences (currently – that will change once the new building is in place). Rothko used a method of embedding egg within his canvases, and then use paints that included organic matter. His paintings provided a desired viewer experience under a prescribed illumination. Additionally, in Fig. 3 you can see to the left of the painting a blue wool sample card that was placed there for the research project of Ref. 1.

Figure 1. Blue wool sample cards from Gaylord Archival.[2]

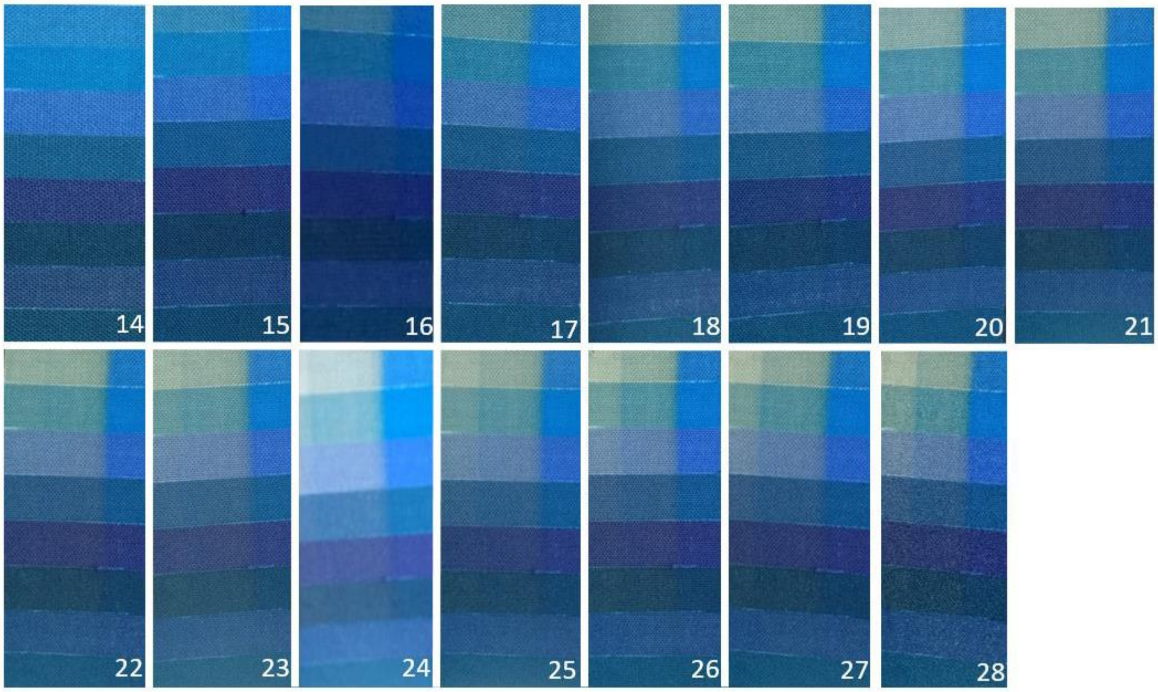

Figure 2. Testing of a blue wool sample card, as seen in Fig. 1, after a couple weeks of exposure on top of the Meinel Building. The testing started 14 April 2017 and the last date shown is 28 April. Note the substantial fading of some of the blue samples.[3]

Figure 3. Rothko's Green on Blue hanging in The University of Arizona Museum of Art. Note the blue wool sample card to the left of the painting.[4]

The bulk of Ref. 1 discusses the research that Rachel performed to replicate the blue wool standard through the development of a calibrated spectroradiometer that used the camera of your smartphone to inspect the absolute spectra of desired objects. I will leave the review of the spectroradiometer for another day, but this spectroradiometer can detect fading of the blue wool standard after one day of exposure to low-level museum lighting. Visual inspection of the blue wool standard within the museum cannot be used to detect such nearly nonexistent changes. It would take months for a barely perceptible visual change to the standard to be evident in such low light level conditions. So, why all this effort to view minor changes in low light situations? Let us end with some examples from Ref. 1 that highlight the damage that can occur over an extended exposure time – the changes are so slow, that the damage is already done before you notice. I have taken two examples straight from Ref. 1.

One of the most dramatic cases of visible deterioration was Mark Rothko's *Harvard Murals* (1962**).**[5, 6, 7] Rothko painted six murals for the penthouse-dining hall of then new Holyoke Center at Harvard University. The murals were hung in 1963, but only five were put on display, and the sixth was placed in storage. An olive-green fabric was chosen for the walls to make the murals "pop" and look less like "decoration".[5] Thick heavy curtains framed the two walls of floor to ceiling windows and were supposed to be drawn when the room was not in use. He was scrupulous about how his work was displayed. Being that the penthouse was on the tenth floor and had breath-taking views of the campus, such that the curtains were almost always open allowing the sunlight to pour across the canvases.[8]

After the installation of the murals no one but the penthouse staff managed the artworks. After four years of being on display, there were visible stains from visitors and there was noticeable fading of the vibrant red pigment, lithol red a well-known fugitive pigment.[9] With no one on staff to manage the situation and Rothko stipulating that only he, or his representative could approve the removal of the paintings. Rothko took his own life in 1970 and there was little interaction with his representative due to legal issues. So, the damage from the illumination was not addressed, and the murals continued to hang in the penthouse for 16 years. They were eventually taken down in 1979 and placed into an environmentally controlled storage with the sixth mural that was never hung. The five damaged murals are shown in Fig. 4. where the left of the pairs is the original mural and the right is the deteriorated mural.

After being removed and placed in a dark environment the damage was analyzed. Next to the sixth piece the five murals showed significant irreversible fading. About 40 years later a team of conservationist and scientist came together to restore the pieces.[6, 7, 9] Samples were taken of the paintings and characterized with chemical spectroscopic techniques which provided evidence of Rothko's photosensitive material choices. Traditional techniques of restoring murals with more paint could not be used due to Rothko's intricate layer of paints and glosses, which were essential for providing the movement of his rectangular figures. Instead the team thought to visibly restore the murals for the observer with projectors.[6]

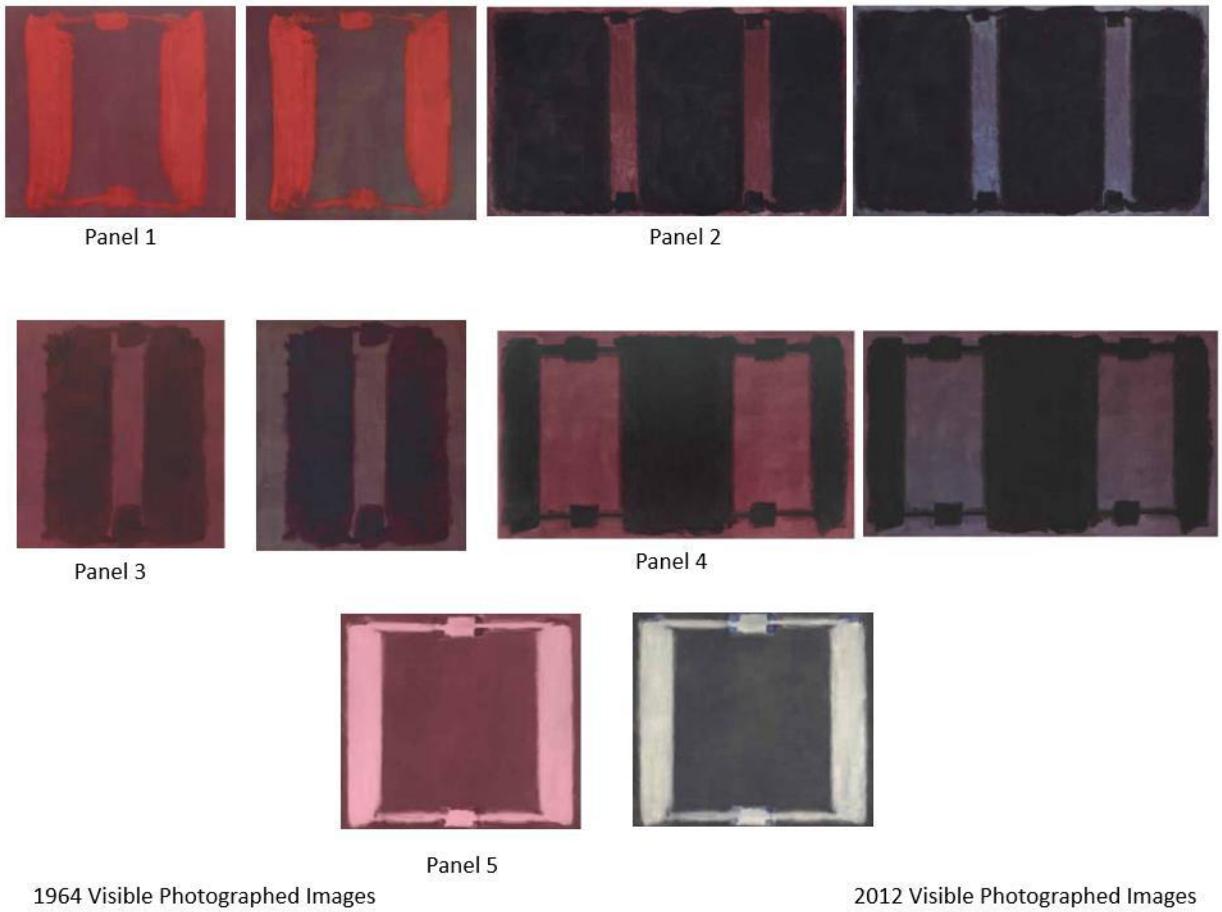

Figure 4. Five Harvard Rothko Murals before and after deterioration as shown in Refs [5] and [6].[10]

The murals are currently on display at Harvard University. RGB projectors are used to project a corrected spectral image that mixes with the current observed color, to trick the observer's eye into seeing what the murals originally looked like. This time the team also took more care into designing an environment that would significantly slow down the deterioration of the murals.

Another case study of photochemical fading was on Renoir's *Madame Léon Clapisson* (1883) at The Art Institute of Chicago.[11, 12] It was suspected that there was significant color fading due to visible fading lines found in the edges of the background after the frame was removed. A micron size sample was taken from the edge of the painting and analyzed using Raman spectroscopy. Analysis showed that indeed the background used to be redder in color. Figure 5 shows the current and the simulated original painting side by side.[12]

Figure 5. Renoir's Madame Léon Clapisson (1883) from Ref. [11]: on the right is the current color content and on the left is the simulated before fading.[13]

In conclusion, five of Rothko's paintings were seriously damaged to destroyed through the radiation incident on them. That is a lot of damage when consider how much a Rothko is worth. Recall that the one on campus is worth more than the College of Optical Sciences. The Renoir from Fig. 5 is not as seriously damaged, but the red vibrancy of the background is substantially faded or muted. Does that diminish its worth? The answer to that is in the eye of the beholder, but we should at least strive to alleviate as much as possible any potential damage. Such can be done through careful illumination, keen observation using optical instruments, and develop tools to make all of this easier.

Updated Survey Results

I am a broken record – I want to hear from you! The survey remains located in Google Forms at: https://forms.gle/ibC9LhPemeniJwhv9, and there are three questions:

- Give your preferences for topics in the Photon Snacks' column of Light Bytes,
- Suggested columns in the above or any other topic areas, and
- Suggested individuals (and topics) who could write a column - including you!

I had a 50% increase in replies after last week! That amounted to one more survey filled out, so 1 + 2 = 3 who have filled out the survey. Thank you for doing that. Note that I will keep this survey open "forever" so that if you want to provide your opinion, your opinion changes over time, or you have suggestions for authors and/or topics, you can submit them at any time. Figure 6 shows the updated survey results for question #1.

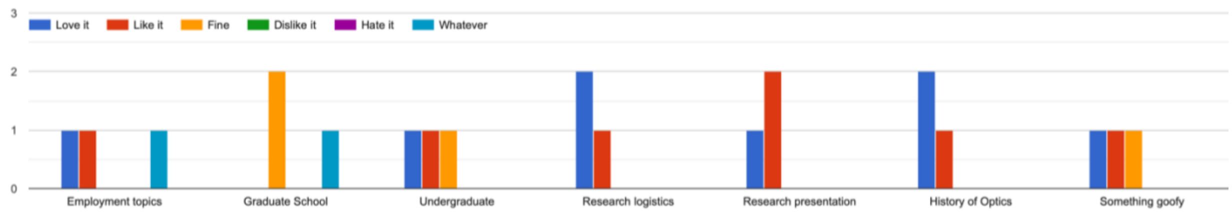

Figure 6. Results after three weeks for the Photon Snacks' survey about the topics that interest you the most.

Two topics have the top rating, so far: research logistics and history of optics. Here are where the previous three columns lie per the topic areas shown in Fig. 6:

- Typesetting Equations (Photon Snacks 4): Research Logistics,
- Working in a Research Lab (Photon Snacks 3): Research Logistics,
- Graduate School (Photon Snacks 2): Graduate School, and
- Animal Optics (Photon Snacks 1): Research Presentation.

The first part of the column was on Research Presentation and it also gets into the History of Optics. I also now have one reply to Question 3, "Suggested individuals (and topics) who could write a column - including you!" I will work on the input I received, and due to the end of the semester being nigh, I will likely address such in the next academic year. If you do the survey, I will write to your interests. So, please go to: https://forms.gle/ibC9LhPemeniJwhv9.

Photon Snacks is a column for Light Bytes edited by John Koshel, Associate Dean for Undergraduate Affairs in the Wyant College of Optical Sciences. You can find the previously written articles at https://wp.optics.arizona.edu/jkoshel/photon-snacks/. Additionally, make suggestions for articles (or even write one!) by emailing jkoshel@optics.arizona.edu or by visiting the survey anytime at https://forms.gle/ibC9LhPemeniJwhv9.

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[1] R. Ulanch, *Replicating the Blue Wool Response Using a Smartphone Spectroradiometer*, M.S. Thesis, Wyant College of Optical Sciences, https://repository.arizona.edu/handle/10150/625689, accessed 6 May 2021 (2017).
[2] Ref. [1], Figure II.VIII, 22.
[3] Ref. [1], Figure VIII.XII, 110.
[4] Ref. [1], Figure IV.IX, 70.
[5] M. B. Cohn, *Mark Rothko's Harvard Murals*, Cambridge: Center for Conservation and Technical Studies, Harvard University Art Museum (1968).
[6] J. Stenger, et al, "Conservation of a Room: A Treatment Proposal for Mark Rothko's Harvard Murals," *Studies in Conservation,* Vol. 61, No. 6, 348-361 (2016).
[7] J. Stenger, et al, "The Making of Mark Rothko's Harvard Murals," *Studies in Conservation*, Vol. 61, No.6, 331-347 (2016).
[8] Ref. [1], Section II.I, Conservation, 14-17.

[9] N. Khandekar, "Bring Back Rothko's Harvard Murals with Light," Tedx Talks, TedxBeaconStreat, https://www.youtube.com/watch?v=QJdino07HoDQ, accessed July 2017(2015, March 3).
[10] Ref. [1], Figure II.III, 16.
[11] The Art Institute of Chicago, *Renoir's True Colors: Science Solves a Mystery*, http://www.artic.edu/exhibition/renoir-s-true-colors-science-solves-mystery, accessed July 2017.
[12] The Art Institute of Chicago, *Renior's True Colors:S cience Solves a Mystery*, https://www.youtube.com/watch?v=t3lcMgWoKY4, accessed July 2017 (2014, March 11).
[13] Ref. [1], Figure II.IV, 17.