Program of Color Science / Munsell Color Science Laboratory

Annual Report 2017

DIRECTOR'S REFLECTIONS: The Munsell Resistance

I'm writing this after recently watching Star Wars: The Last Jedi with my family. Somehow I am seeing an analogy between the sacred Jedi texts in the film and our sacred Munsell books in the lab. There also seems to be some similarity with the never-ending trilogy of victory, defeat, and then ultimate victory but I will leave that for another time.

Seen & heard in the film:

Yoda: Time it is. For you to look past a pile of old books, hmm?

Luke: The sacred Jedi texts?

Yoda: Oh. Read them, have you? Page-turners they were not.

Visualized in the lab:

Professor: The Munsell diaries, on our website they are.

Student: Oh. Read them, have you? Page-turners they were not.

There are abundant opportunities for the student to become the master, and for us all to realize it is important to read the original source instead of the distilled conventional wisdom. As we enter 2018, Munsell's legacy has been brought directly to our attention the Munsell 2018 Symposium to be held in June at MassArt in Boston. We look forward to the opportunity to celebrate the "sacred texts." Our own evolution progresses as PoCS/MCSL became part of RIT's new Integrated Sciences Academy; a home for multidisciplinary programs in the College of Science. I am also happy to say that the renaming to *Munsell Color Science Laboratory* has been "completed" with the installation of a new sign above the door. Some other highlights of the past year include:

~ We continue to admit outstanding new graduate students and the applicant pool continues to improve.
~ We offered our summer, on-line, course in Fundamentals of Color Science for the second time and hope to continue to expand in that effort.
~ Dr. Farnand moved into a tenure-track assistant professor on our faculty.
~ The Huan Zeng Student Research Fund was initiated based on several generous donations from its namesake.
~ Epson America made a very generous gift of a 4K laser video projector for the Grum Learning Center.
~ Dr. Samuel Morillas Gomez spent the year with us as a Visiting Scholar from the Polytechnic University of Valencia in Spain.
~ Xiangzhen Kong spent six months with us as a Visiting Student from the Technical University of Eindhoven in The Netherlands.
~ Dr. Berns spent six months on sabbatical working on a revision of *Principles of Color Technology* and his collaboration with *The Getty*.
~ Dr. Berns was also nominated for an Inventor of the Year award by the Rochester Intellectual Property Law Association.
~ And we had a wonderful PoCS/MCSL retreat at the NY Wine & Culinary Center while witnessing a solar eclipse.

For those who participate in social media, we have created a Facebook group called "Munsell Color Science Laboratory". The group is public, meaning anyone can see the posts, but only members can post. You can check it out at www.facebook.com/groups/MunsellColorScienceLab/ . Alumni, students, staff and faculty members are warmly welcomed to join. Email Val (vlhpci@rit.edu) with any questions. As always, we thank all those who have provided financial and in-kind support over the year including the Family of Cal McCamy, Epson America, Scot Fernandez, Hallmark, Qualcomm, and a very significant gift of student research support from former student Huan Zeng. In this report you can find lists of our students and alumni, brief research highlights from ongoing projects, a list of publications over the last year, and a directory of our people. We have kept it brief and visual out of respect for you. There is much more information about PoCS/MCSL on our website and we invite you to explore <*mcsl.rit.edu*>. Thank you to everyone who has supported the lab and our students in various ways over the years. Please enjoy this report and let me know if you have any comments, suggestions, or questions. Stay tuned for our next episode …

Sincerely,

Mark Fairchild
Founding Head, Integrated Sciences Academy, College of Science
Professor and Director, Program of Color Science / Munsell Color Science Laboratory

STUDENTS & GRADUATE ALUMNI

Visiting Researchers

Xiangzhen Kong, Eindhoven University of Technology
Samuel Morillas Gómez, Universidad Politécnica de Valencia

MCSL Current Students

Anku, PhD, CS
Ben Bodner, MS, CS
Katherine Carpenter, PhD, CS
Josh Gallaro, PhD, CS
Nargess Hassani, PhD, CS
Fu Jiang, PhD, CS
Olivia Kuzio, PhD, CS
Yongmin Park, PhD, CS
Adi Robinson, PhD, CS
Matt Ronnenberg, PhD, CS
Gaurav Sheth, MS, CS
Hao Xie, PhD, CS
MingMing Wang, PhD, IS
Lili Zhang, PhD, CS

Alumni

2017
Brittany Cox, PhD, CS
Morteza Maali Amiri, MS, CS
Chris Thorstenson, MS, CS

2016
Yixuan Wang, MS, CS
Joel Witwer, MS, CS

2015
Yuta Asano, PhD, CS
Maxim Derhak, PhD, CS
Jennifer Kruschwitz, PhD, CS
David Long, PhD, CS
Ashley Penna, MS, IS

2014
Farhad Abed, PhD, CS
Stephen Dolph, MS, IS
Adria Fores Herranz, PhD, CS

2013
Justin Ashbaugh, MS, CS
Lin Chen, MS, CS
Benjamin Darling, PhD, CS
Susan Farnand, PhD, CS
Jun (Chris) Jiang, PhD, CS

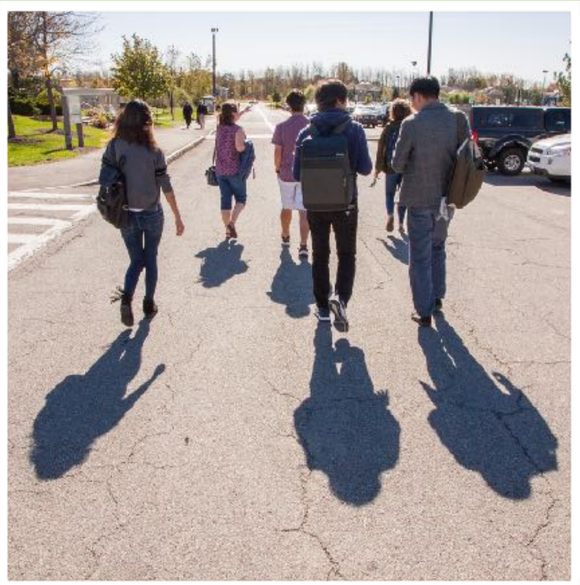
2012
Ping-Hsu (Jones) Chen, MS, CS
Simon Muehlemann, MS, PM

2011
Brian Gamm, MS, CS
John Grim, MS, CS
Marissa Haddock, MS, CS
Dan Zhang, MS, CS

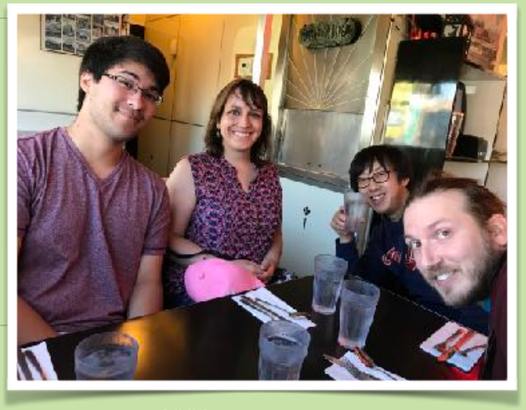
2010
Bingxin Hou, MS, IS
Suparna Kalghatgi, MS, IE

2009
Erin Fredericks, MS, IS
Rodney Heckaman, PhD, IS
Mahnaz Mohammadi, PhD, IS
Shizhe Shen, MS, CS

2008
Stacey Casella, MS, CS
Ying Chen, MS, CS
Mahdi Nezamabadi, PhD, IS
Abhijit Sarkar, MS, CS
Yang Xue, MS, IS
Hongqin (Cathy) Zhang, PhD, IS
Yonghui (Iris) Zhao, PhD, IS



STUDENTS & GRADUATE ALUMNI



Even More Alumni

2007
Kenneth Fleisher, MS, CS
Jiangtao (Willy) Kuang, PhD, IS

2006
Yongda Chen, PhD, IS
Timothy Hattenberger, MS, IS
Zhaojian (Li) Li, MS, CS
Joseph Stellbrink, MS, CS

2005
Maxim Derhak, MS, IS
Randall Guay, MS, IS
Jim Hewitt, MS, IS
Justin Laird, MS, CS
Joseph Slomka, MS, CS
Erin Murphy Smoyer, MS, CS
Yoshio Okumara, MS, CS
Michael Surgeary, MS, IS

2004
Rohit Patil, MS, CS
Sung Ho Park, MS, CS
Xiaoyan (Yan) Song, MS, CS

2003
D. Collin Day, MS, CS
Ellen Day, MS, CS
Scot Fernandez, MS, IS
Edward Hattenberger, MS, CS
Steve Jacob, MS, IS
Xiaoyun (Willie) Jiang, PhD, IS
Garrett Johnson, PhD, IS
David Robinson, MS, IS
Mitchell Rosen, PhD, IS
Deniz Schildkraut, MS, CS
Qun (Sam) Sun, PhD, IS

2002
Arturo Aguirre, MS, CS
Jason Babcock, MS, CS
Anthony Calabria, MS, CS
Jen Cerniglia Stanek, MS, IS
Scot Fernandez, MS, CS
Jason Gibson, MS, CS
Shuxue Quan, PhD, IS
Yat-ming Wong, MS, IS

2001
Alexei Krasnoselsky, MS, CS
Sun Ju Park, MS, CS
Michael Sanchez, MS, IS
Lawrence Taplin, MS, CS
Barbara Ulreich, MS, IS

2000
Sergio Gonzalez, MS, CS
Sharon Henley, MS, CS
Patrick Igoe, MS, IS
Susan Lubecki, MS, CS
Richard Suorsa, MS, CS

1999
Gus Braun, PhD, IS
Barbara Grady, MS, CS
Katherine Loj, MS, CS
Jonathan Phillips, MS, CS
Mark Reiman, MS, CS
Mark Shaw, MS, CS
Di-Yuan Tzeng, PhD, IS
Joan Zanghi, MS, CS

1998
Scott Bennett, MS, CS
Fritz Ebner, PhD, IS
Garrett Johsnon, MS, CS
Naoya Katoh, MS, CS
David Wyble, MS, CS

1997
Peter Burns, PhD, IS
Christopher Hauf, MS, CS
Brian Hawkins, MS, CS
Jack Rahill, MS, IS
Alex Vaysman, MS, IS

1996
Karen Braun, PhD, IS
Cathy Daniels, MS, CS
Yue Qiao, MS, IS
Hae Kyung Shin, MS, IS

1995
Richard Alfvin, MS, CS
Seth Ansell, MS, CS
Susan Farnand, MS, IS

1994
Taek Kim, MS, IS
Audrey Lester, MS, CS
Jason Peterson, MS, IS
Debra Seitz Vent, MS, IS
James Shyu, MS, CS

1993
Nathan Moroney, MS, CS
Elizabeth Pirrotta, MS, CS
Mitchell Rosen, MS, IS

1992
Mark Gorzynski, MS, IS
Rich Riffel, MS, IS
Brian Rose, MS, CS

1991
Yan Liu, MS, CS
Ricardo Motta, MS, IS
Amy North, MS, CS
Greg Snyder, MS, IS
Michael Stokes, MS, CS

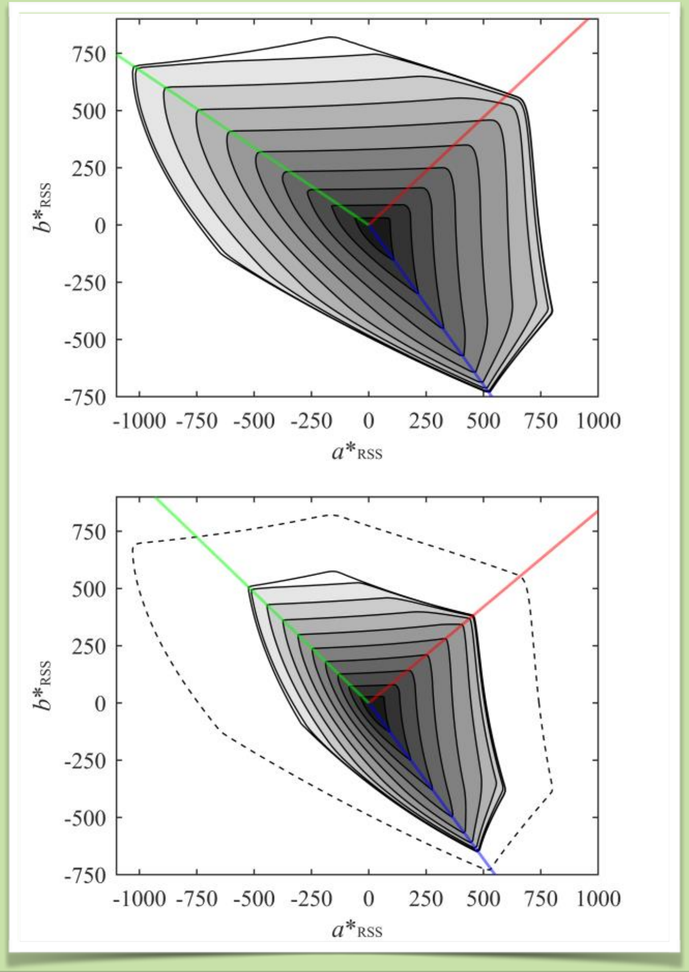
1989
Mitch Miller, MS, IS
Kelvin Peterson, MS, IS
Lisa Reniff, MS, CS

1987
Denis Daoust, MS, IS
Wayne Farrell, MS, IS

1986
Mark Fairchild, MS, IS

Key:
CS: Color Science
IE: Industrial Engineering
IS: Imaging Science
MS: Master of Science
PhD: Doctor of Philosophy
PM: Print Media

RESEARCH HIGHLIGHT: Television Gamut Volume Metrics in HDR



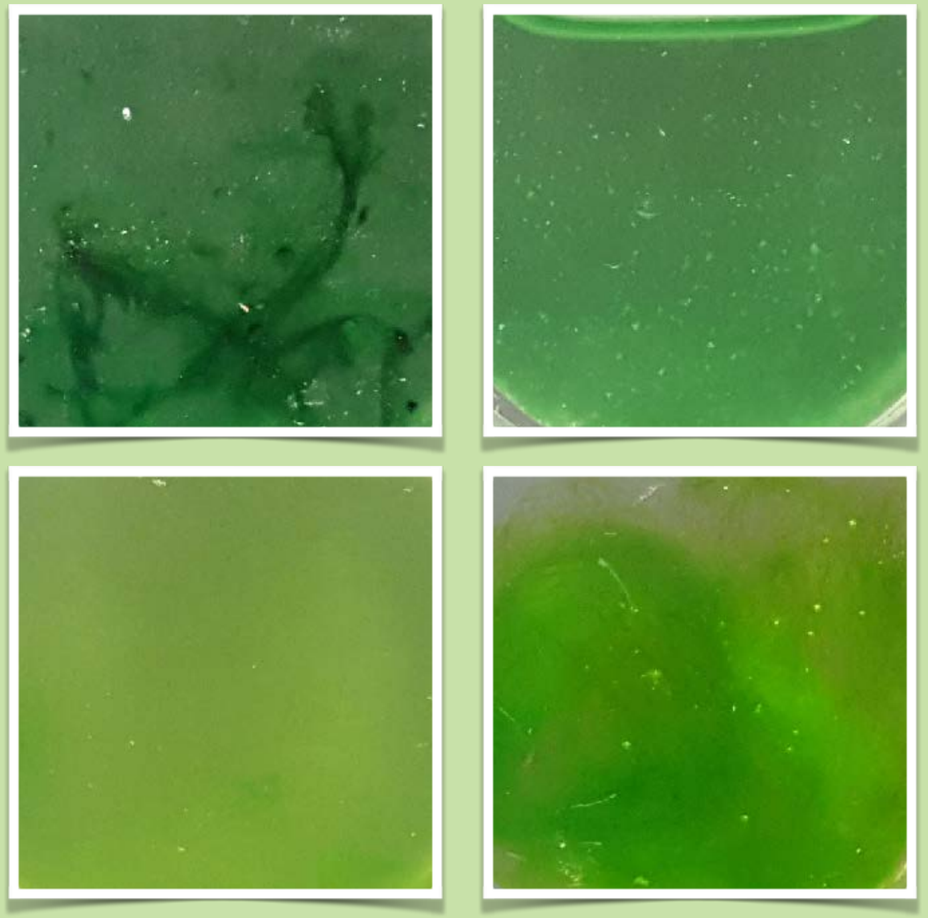
A former MCSL visiting scientist, Kenichiro Masaoka of NHK in Japan, returned for a visit and we ended up starting a new collaboration on color metrics and perception in high-dynamic-range television displays. Due to inherent differences in display technologies, the measurement of color gamut volume, and its relationship to perceived color quality, are not simple and have been discussed widely in standardization bodies. Our collaboration is looking to examine simplified metrics of gamut area, luminance ratios, and gamut volumes while correlating them with psychophysical results. We hope to be able to make some straightforward recommendations to the industry when the project is complete.

Fu Jiang, Mark Fairchild

RESEARCH HIGHLIGHT: Measuring Cyanobacteria with a Smartphone

Current techniques for identifying the presence of cyanobacteria in a water sample are cumbersome. This project is an attempt to simplify the process by using smartphone images. Experiments were designed to ascertain if it is possible to use a smartphone to detect cyanobacteria in a water sample. Four types of organisms were measured and compared: colonial and filamentous variants of cyanobacteria and green algae. In this study, the four smartphones followed the same trends, displaying a linear relationship between C* values measured spectrophotometrically and those determined from smartphone images for both variants of cyanobacteria and for the colonial green algae. The behavior of the filamentous green algae differed from that of the other organisms, presenting an S-shaped curve when comparing the C* values from the spectrophotometer and camera. Each phone was able to capture this strange behavior, lending hope that it may be possible to successfully use smartphone cameras for the purpose of detection with further work.

Katherine Carpenter, Susan Farnand



RESEARCH HIGHLIGHT: Perceived Speed of Periodic Dynamic Lighting

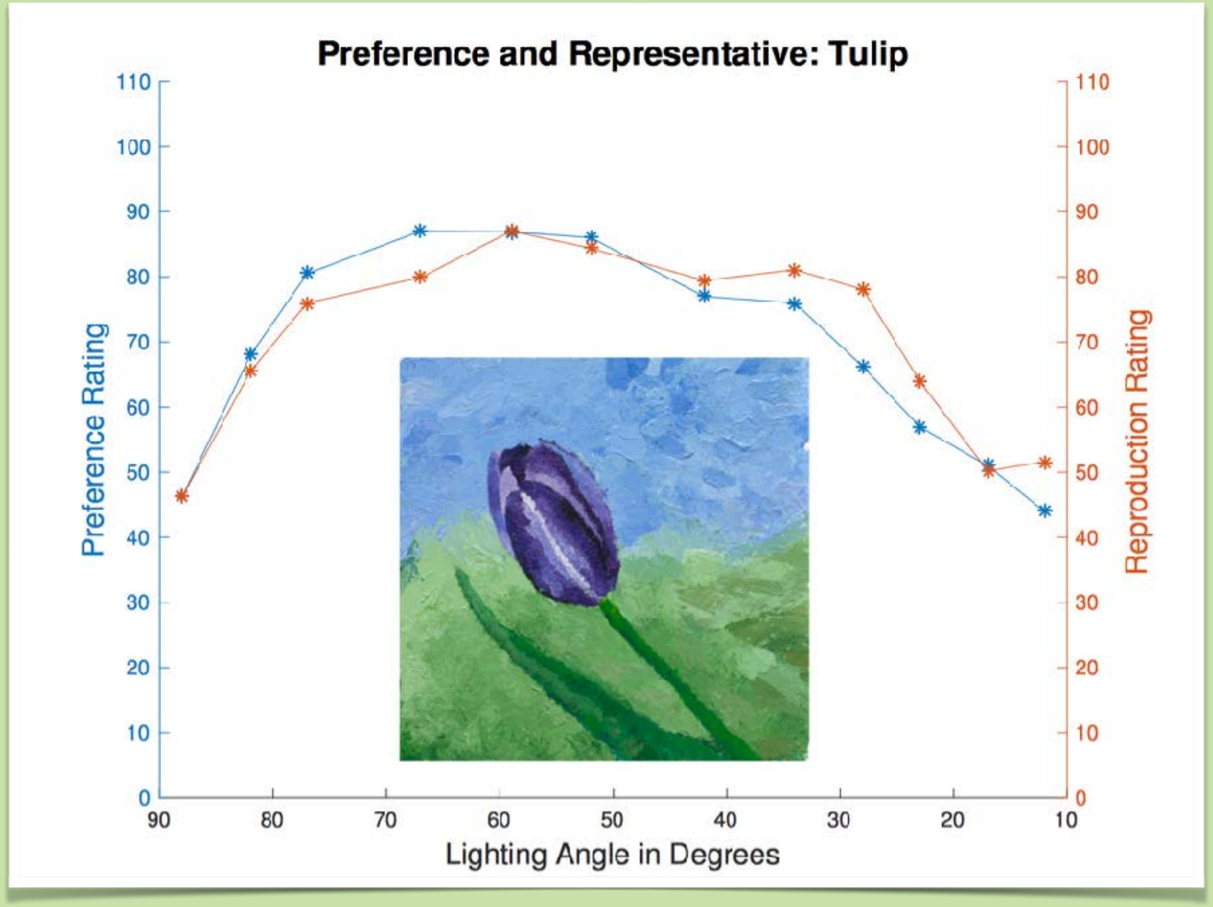
In MCSL's new Dynamic Visual Adaptation (DVA) Lab, we are uniquely prepared to study the visual effects of dynamic lighting, that is lighting that changes color smoothly over time. With the help of Xiangzhen Kong, a PhD student from Eindhoven University of Technology (Michael's alma mater) who visited RIT for the fall semester, an experiment was performed to perceptually measure periodic color changes. The stimuli were smooth "triangle wave" transitions in either hue or chroma directions around each of a set of base colors of the Munsell principle hues, varied in speed. Observers were shown sequential pairs of dynamic color stimuli, choosing which of each pair was the faster color transition. Results show that a candidate measure of speed, Delta E per second, is very perceptually non-uniform, with some perceptually equally-fast stimuli more than twice the Delta-E speed of others. A publication and follow-up experiments are planned.

Xiangzheng Kong, Michael J. Murdoch

RESEARCH HIGHLIGHT: Measuring Artwork Surface Properties

Brittany D. Cox completed her Ph.D. during August. Her research was a continuation of our four-light imaging aimed at measuring surface properties and the use of computer graphics for re-lighting. One aspect of her research was a visual experiment scaling both preference and best reproduction of paintings illuminated in a gallery setting. For this painting, results were similar with an optimal illumination angle of 60° from the normal and a small amount of diffuse fill light. Roy has used these results at the end of the year while imaging a Vincent van Gogh painting at the Nelson-Atkins Museum in Kansas City.

Brittany D. Cox, Roy S. Berns



RESEARCH HIGHLIGHT: Samuel's Fuzzy Logic

Samuel, a faculty member in applied mathematics at Valencia, joined us in January 2017 for a full calendar year as a visiting faculty member. We developed many rich and interesting collaborations with him that will continue into future years. In addition, he twice taught a short course on fuzzy logic, his speciality, to RIT graduate students and faculty. He collaborated with several faculty and students in the lab on topics including fuzzy models of color tolerances, psychophysics and modeling of noise perception in images, spectral estimation, and models of cognition. We already miss Samuel and his family and look forward to seeing publications on the work done at RIT coming out in the coming year.

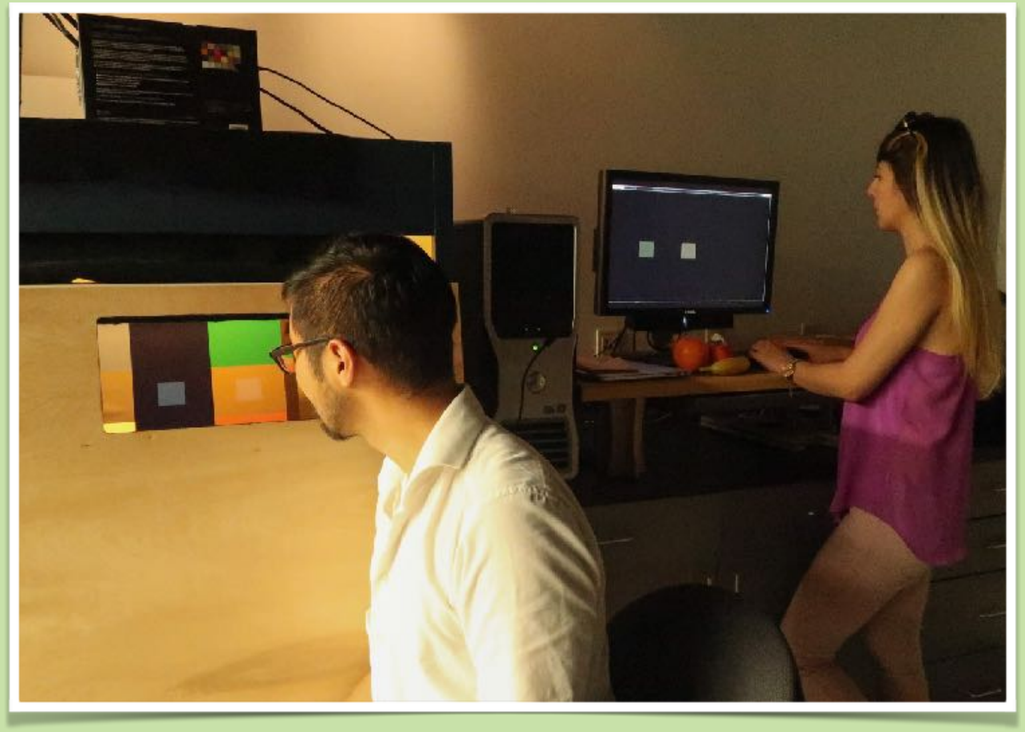
Samuel Morillas, Mark Fairchild

RESEARCH HIGHLIGHT: 3D Printer Color Management

3D printing has become increasingly popular in recent years due to rapid technological advances. One such advancement is the ability to print an object with multiple colors. Traditional printers work on the assumption that the printing surface is flat and that the surface geometry has a negligible effect on appearance. Profiles for color communication amongst devices, including traditional 2D printers, are readily available. Effects of surface geometry on the appearance of 3D printed objects add complexity to 3D printer profiles. To evaluate these effects, 3D objects having goniochromatic effects (angular dependent color – such as is seen on the elytra of the emerald ash borer pictured here) were designed and printed on a Stratasys® J750 printer. Spectral radiance and BRDF measurements of the 3D printed samples were taken to test for changes in appearance. The measurements indicate color differences that should be readily visible. Visual testing will be conducted in the coming year to determine if the perceived color differences are as significant as the measurements would suggest.

Matt Ronnenberg, Susan Farnand

RESEARCH HIGHLIGHT: Color and Material Appearance in Mixed Reality

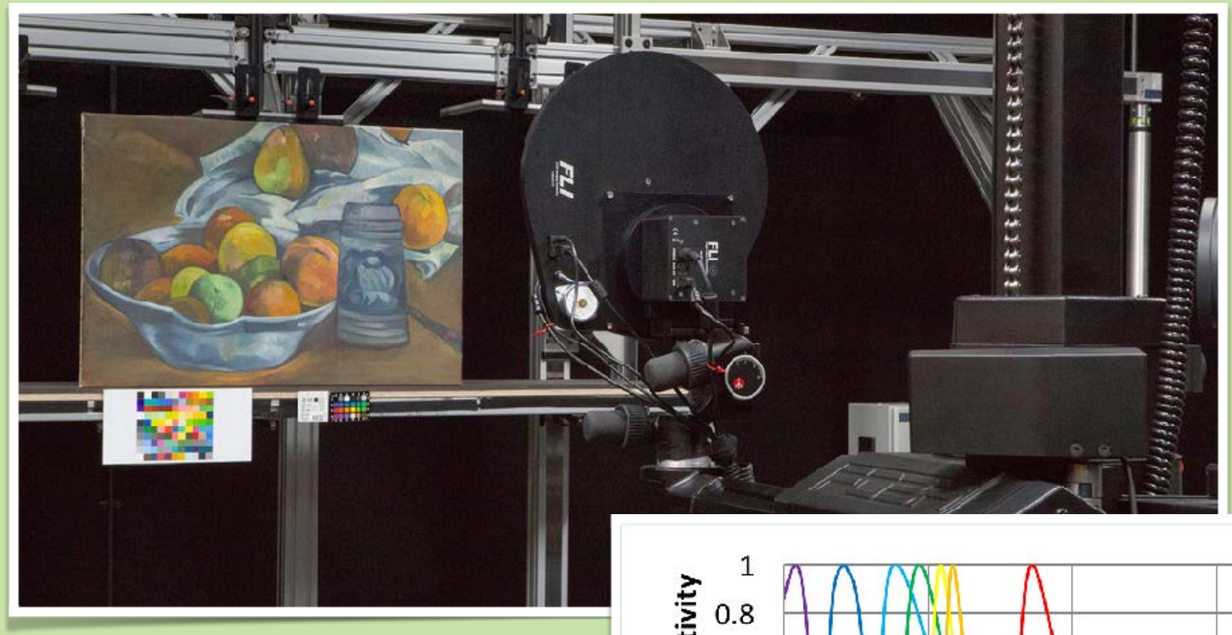


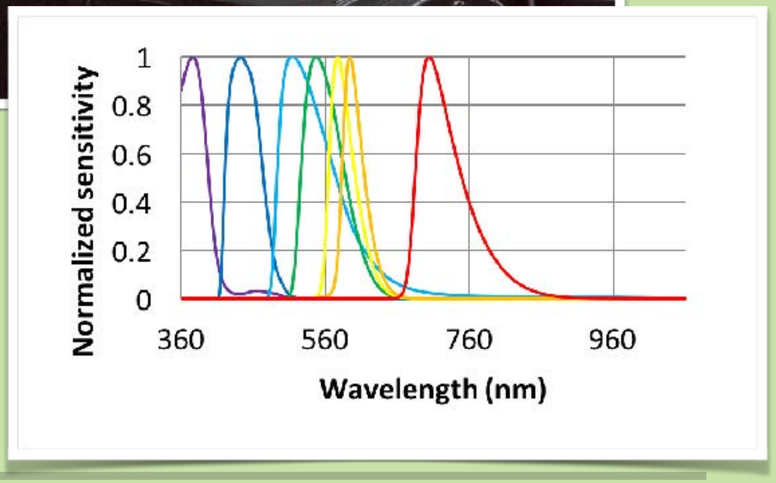
Our research continues on color appearance in augmented reality (AR). In a recent experiment using our AR simulator, the optical mixes of different real physical backgrounds combined with different virtual foreground colors were created and measured. Observers performed color matches across backgrounds, and the results showed that CIECAM02 does not accurately predict color appearance in AR . To improve the model, we added the effect of chromatic simultaneous contrast, but there still are inaccuracies comparable in size to the inter-observer variation. Our next steps will include a follow-up experiment to see if the discrepancies in CIECAM02 are due solely to the chromatic surrounds or if there is something unique about the AR environment that CIECAM02 did not foresee. Our goals for this research are to further understand the visual processing of mixtures of real and virtual stimuli as well as improve future AR technology.

Nargess Hassani, Michael J. Murdoch

RESEARCH HIGHLIGHT: Multi-Spectral Camera

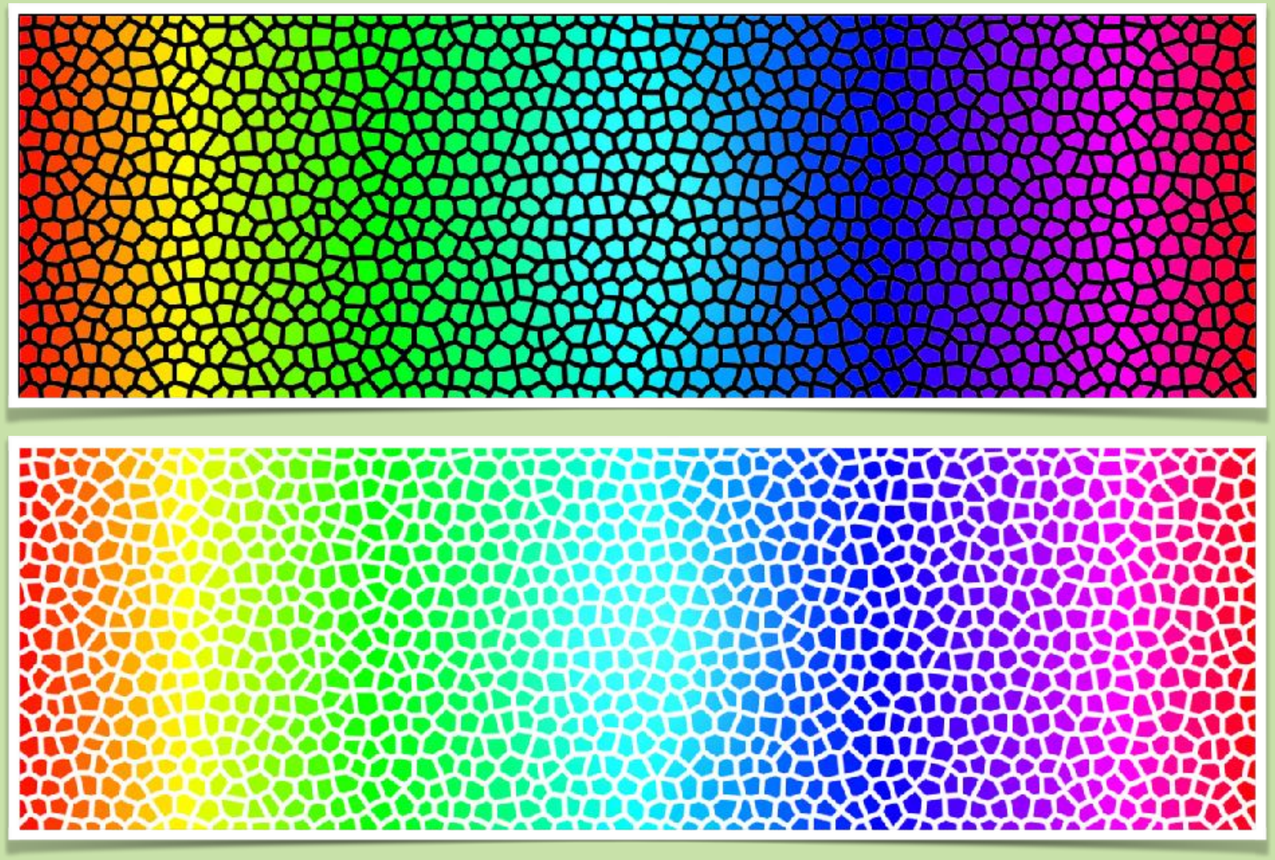
Roy has been working on a new multi-spectral camera for over one year. The system is complete and consists of a Finger Lakes Instrumentation (FLI) Microline camera with an achromatic KAF-50100 microlens CCD sensor, FLI CFW10-7 seven position filter-wheel holding 65 mm square filters with a maximum filter thickness of 5 mm, FLI Atlas Focuser, and Rodenstock Digaron-S 100 mm f/4 apochromatic lens with Copal shutter. The figure on the left was taken during a workshop at the National Gallery, London. The figure on the right are the system spectral sensitivities. The visible spectrum is unevenly sampled by design as a compromise to achieve high color accuracy, spectral accuracy, and spatial image quality. The optimization was performed by Yixuan Wang as her M.S. thesis. Yixuan now works at Apple. This research is supported by the Andrew W. Mellon Foundation.





Yixuan Wang, Roy S. Berns

RESEARCH HIGHLIGHT: American Glass Guild Visits Rochester



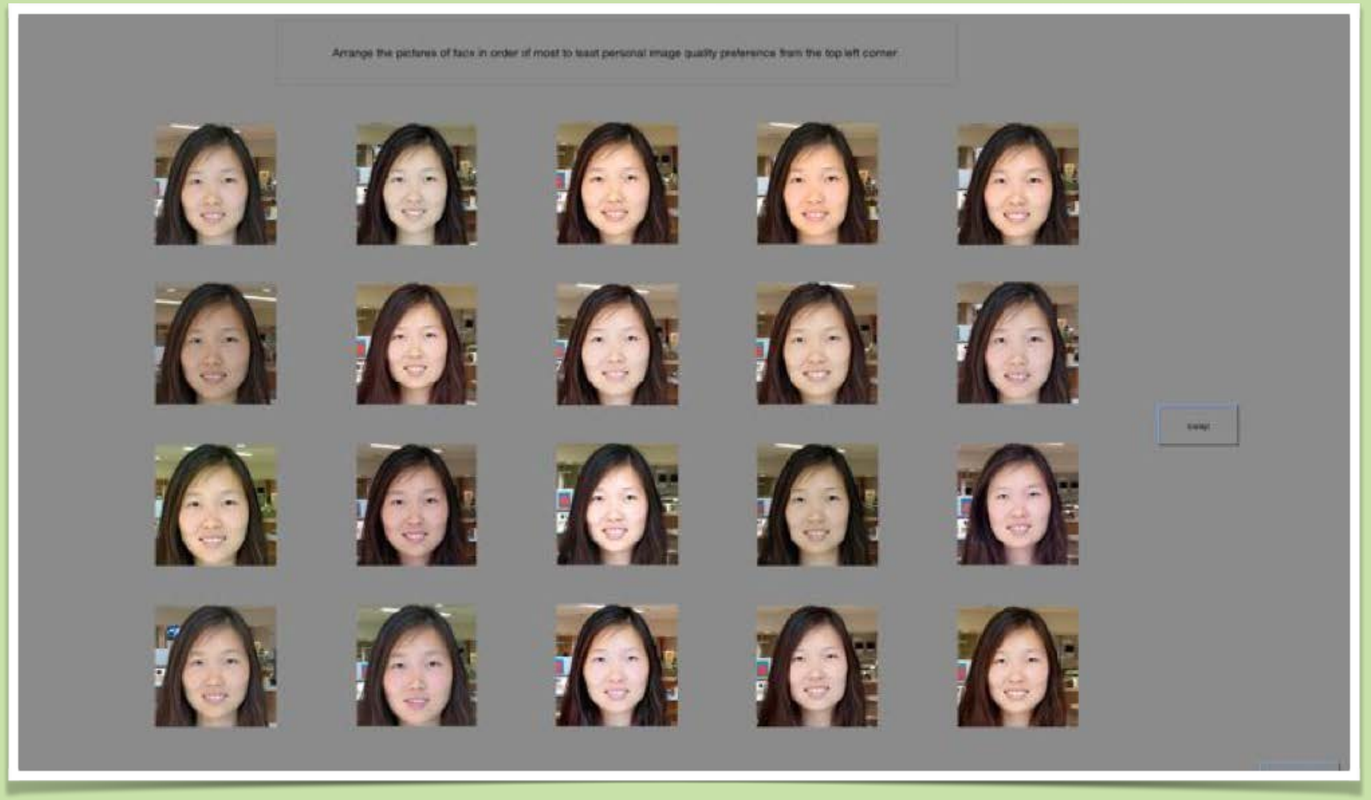
The American Glass Guild held its annual meeting in Rochester in May. Mark was an invited speaker and used the opportunity to discuss the importance of context (e.g. lighting, luminance, surround, background, etc.) on the color appearance of very colorful, complex, and often backlight (when they are typically most appreciated) objects — stained glass. It was great to experience the interest in color science from such a very diverse and color conscious audience. He also learned that Rochester is a hot bed for glass artists and historical stained glass installations.

Mark Fairchild

RESEARCH HIGHLIGHT: Smartphone Image Color Quality

Smartphone image color quality is a topic of keen interest today. Providing insight into what users prefer is useful when engineering cameras and displays that engage and attract consumers. In this project, color quality was evaluated in two perceptual tests. In the first, observers were asked to order images of images containing common objects including human skin, grass, sky, wood, and sand taken with twenty different cameras from most to least preferred color quality. In the second test, observers were asked to recreate their memory color for the common objects by adjusting a uniform color patch. The results show that the preferred camera varies by scene and that the memory color varies across observers, possibly reflecting influences of geographic location, cultural background, and other factors. Comparing the results for the two experiments indicates that memory color is more saturated than image color, in agreement with previous research

Anku, Susan Farnand



RESEARCH HIGHLIGHT: Characterization of Head-Mounted Displays

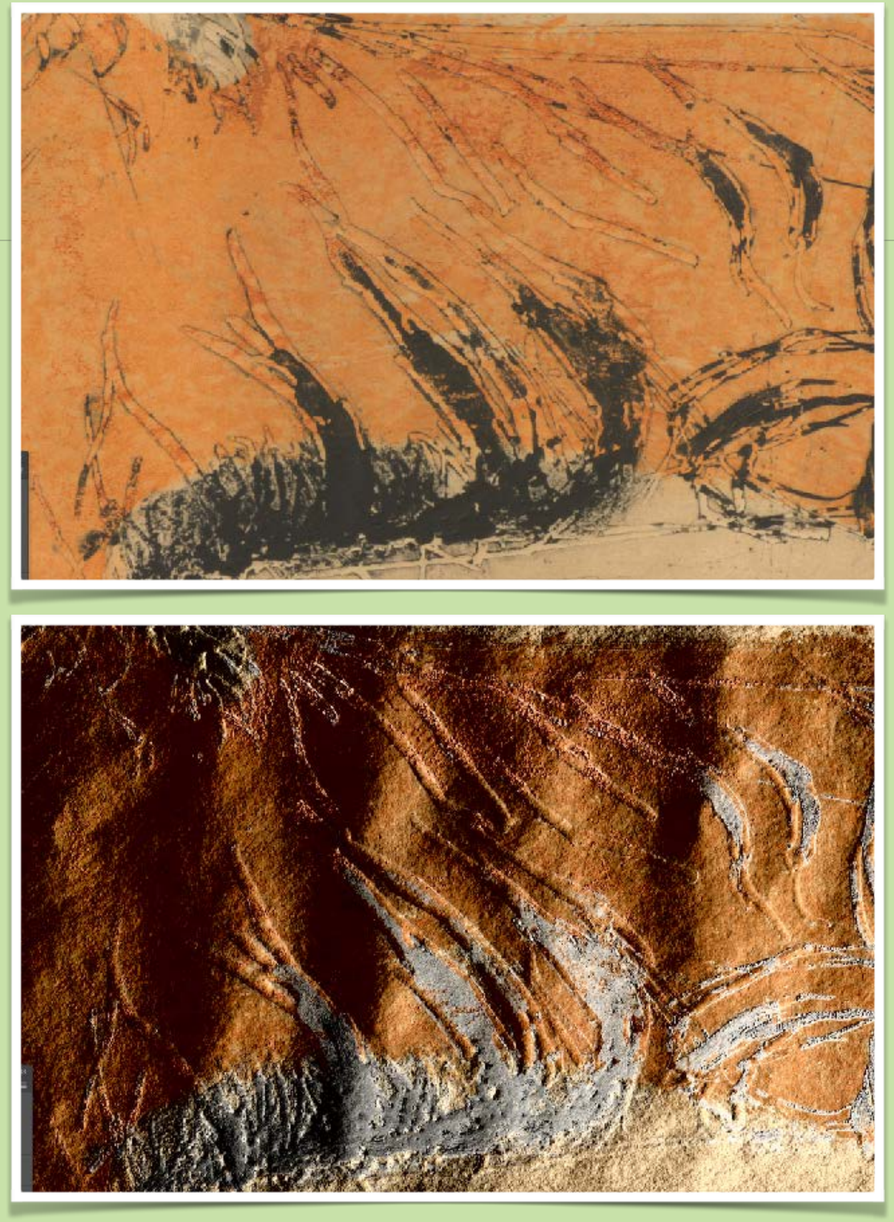
As we seek to understand color perception in augmented reality (AR), characterizing the color performance of head-mounted-devices (HMDs) for AR becomes critically important. The purpose of this research is to characterize the spatial uniformity of the Microsoft HoloLens diffractive waveguide display and study the color perception in AR when presented colors are not uniform. Objective measurement was performed on the display using a camera as colorimeter to build a display model with spatial variance per color channel. Software was written to direct colors in the HoloLens through the Unity gaming engine in a MATLAB-controlled perception experiment. A color matching experiment was carried out to study the observer's matching criteria when matching non-uniform patches and improve the relevance of the physical model. Future work will focus on improving the model for color accuracy, quantifying the non-uniformity, and studying the how the background color and texture effect the uniformity perception.

Lili Zhang, Michael J. Murdoch

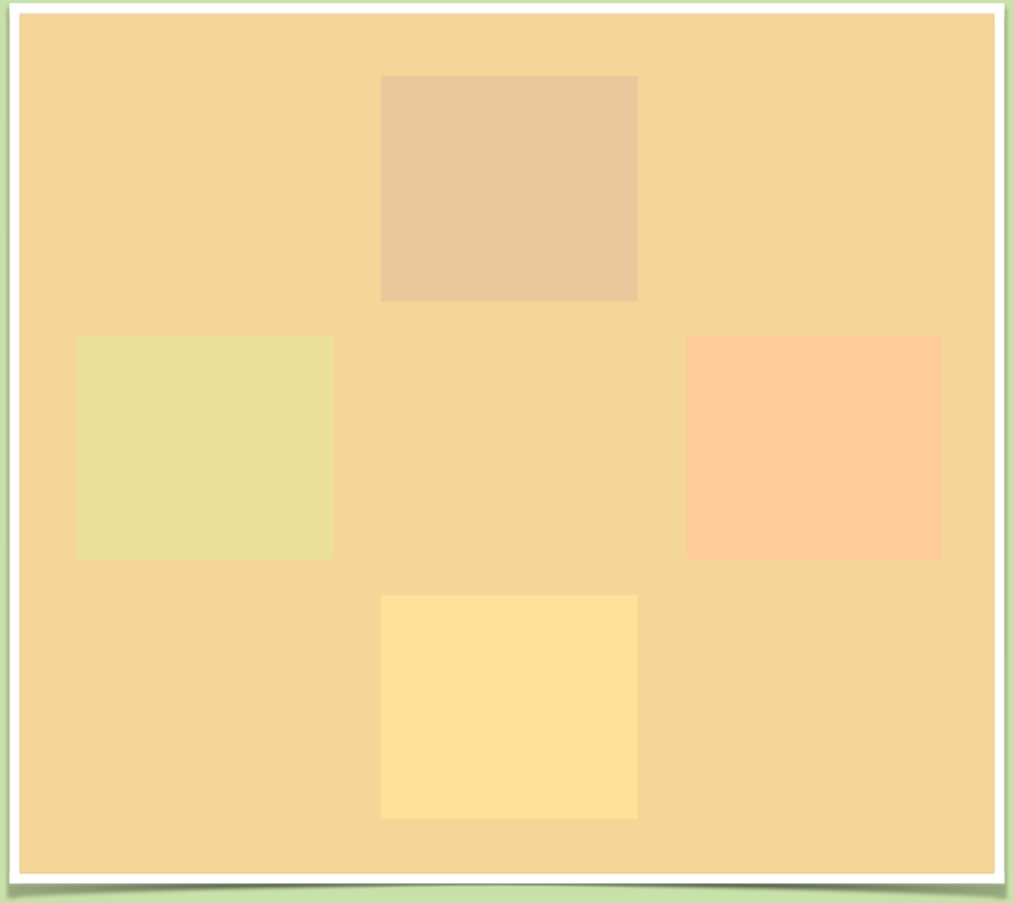
RESEARCH HIGHLIGHT: Rendering at The Getty

Roy spent January and February at the Getty Research Institute in Los Angeles testing his new multi-spectral camera and evaluating four-light imaging of drawings placed on a copy stand. The results were excellent, particularly being able to measure surface normal of black colors. This is a close-up of Tiger, by Rolf Nesch. Conventional imaging was used to create the top image. The bottom image was rendered using diffuse and normal maps. The success of the research was such that the President of the Getty Trust, James Cuno, visited Roy to discuss the technique and see these images.

Roy S. Berns



RESEARCH HIGHLIGHT: Estimating Skin Spectral Reflectance



Chris Thorstenson completed his M.S. in Color Science this past year. His thesis was on using digital cameras to quickly and accurately capture face color. His goal was to be able to measure hemoglobin levels and blood oxygenation such that he could correlate the "reddening" of the face with emotional responses to various situations. The latter is the topic of his Ph.D. dissertation in Psychology at the University of Rochester. Chris is using the tools developed at RIT to complete his Ph.D. and plans to move on to an academic career in psychology. The image shows increasing hemoglobin (right to left) and oxygenation (to to bottom) levels in a typical skin color (background).

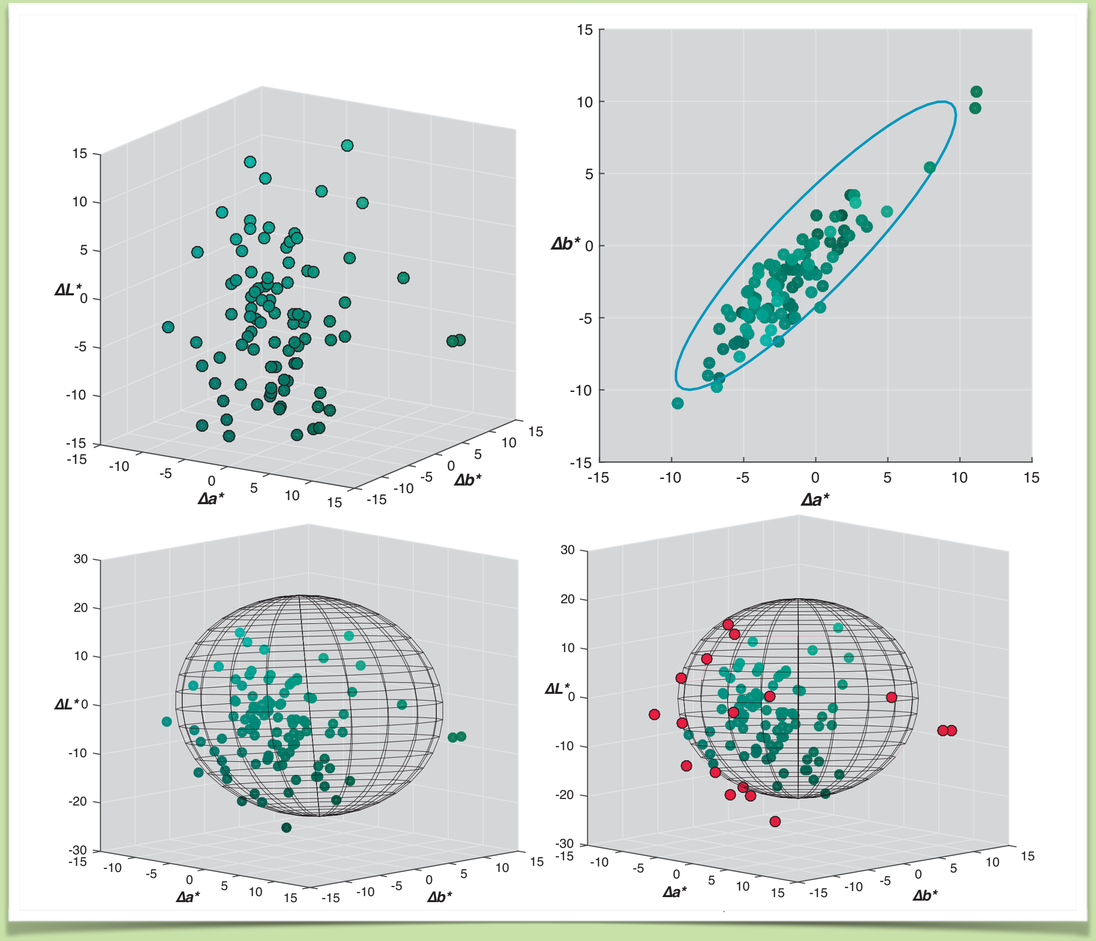
Chris Thorstenson, Mark Fairchild

RESEARCH HIGHLIGHT: Viewing an Eclipse through Pop-Tart Wrappers?

Preparations for the "Great American Eclipse" captivated astronomers and the general public alike. With the preparations came numerous warnings about how the eclipse could be viewed safely. There was a suggestion online that Pop-Tart® wrappers, which are made of Mylar®, a metallized plastic sheeting that reflects almost all incident light, can be used to create homemade eclipse glasses. This could be appealing to novices who want to be able to look at the sun without having to buy ISO and CE certified eclipse glasses. This could potentially be dangerous if the Pop-Tart® wrappers don't filter out enough of the sun's rays to protect the viewer's eyes. This project ascertained the safety of Pop-Tart® wrapper eclipse glasses by comparing their spectral transmission to that of verified glasses. The measurement results indicate that a double-layered Pop-Tart® wrapper performs comparably with eclipse glasses in the visible range and filters more radiation in the near UV and near IR regions.

Katherine Carpenter, Susan Farnand

RESEARCH HIGHLIGHT: Principles of Color Technology 4th Edition



During Spring semester, Roy was on sabbatical writing the 4th edition of Billmeyer and Saltzman's Principles of Color Technology. He hopes to be finished with the first draft by June 2018. One change is the inclusion of matrix algebra throughout the book for topics that are best explained with mathematics, for example tolerance ellipsoids. Here are manufacturing data (top left), its 95% confidence limit looking down ΔL* (top right), its 95% confidence limit in ΔL*Δa*Δb* (bottom left) and an optimized color difference formula ignoring lightness and chromaticness covariance (bottom right), calculated from the data's variance-covariance matrix.

Roy S. Berns

RESEARCH HIGHLIGHT: Operator Interface Color

This project focuses on choosing the appropriate combination of display background and foreground color for chemical industry operator interface displays. We will explore the relationship between visual search time and the color differences between background and foreground colors, and the effect of different types of screen glare due to lighting environments. In our upcoming experiment, observers will be asked to search on screen to find specified targets among distractors and other operator interface details. An eye-tracker will be used to measure search time and record the searching path during the experiment. We intend to recruit some observers with color vision deficiencies, and choose color combinations with the intention of good performance for both normal and deficient color observers. Our results will be used to improve color combinations for operator interfaces, hopefully leading to better and safer operation of chemical plants.

Fu Jiang, Michael J. Murdoch

RESEARCH HIGHLIGHT: Wine Colorimetry

Our earlier work on wine spectrophotometry was completed and submitted for publication this past year (now in press in the International Journal of Wine Research). The spectral transmittance data were analyzed using a variety of illuminants, luminance levels, and in both the CIELAB and CIECAM02 color spaces. The results showed that both the lighting level and lighting color can have significant effects on the perceived colors of wines. Additionally the color rendering quality (measured by any metric!) of the illumination can have a significant effect on wine color appearance. Since color clearly impacts flavor, and lighting impacts color, it could reasonably be argued that lighting impacts wine flavor. Recommendations for wine lighting were also made.

Mark Fairchild

RESEARCH HIGHLIGHT: Human Perception While Driving

Autonomous driving has the potential to positively impact the daily life of humans. Technologies such as image processing, computer vision, and remote sensing have been highly involved in creating reliable and secure robotic cars. In comparison, the knowledge that could be provided to autonomous driving by understanding human perception while driving has not been deeply explored. The analysis of human perception during the cognitive driving task, while making critical driving decisions, may provide great benefit to the study of autonomous driving. To achieve such an analysis, we have collected eye movement data of human drivers with a mobile eye tracker when they are driving in an automotive simulator, built around an actual physical car, that mimics a realistic driving experience. The initial experiments have been performed to investigate the potential correlation between the driving behaviors and fixation patterns of the human driver.

Mingming Wang, Susan Farnand

2017 PUBLICATIONS

Journal Papers

M.M. Amiri and M.D. Fairchild, Use of spectral sensitivity variability in reflectance recovery from colorimetric information, Journal of the Optical Society of America A 34, 1224-1235 (2017).

K. Carpenter and S.P. Farnand, A Validation Study of a Perceptually-Based Metric of Smartphone Image Quality, IEEE (2017).

M.J. Murdoch, Characterization and Control of a Multiprimary LED Light Lab, Optics Express 25(24), 29605-29616 (2017).

M.J. Murdoch and M.D. Fairchild, Modeling the effects of inter-observer variation on color rendition, Lighting Research and Technology 49, 10.1177/1477153517744387, 1-18(2017).

Theses & Dissertations

M.M. Amiri, Novel Approaches to the Spectral and Colorimetric Color Reproduction, Rochester Institute of Technology, M.S. Thesis, 2017.

B.D. Cox, Scientific Imaging of Cultural Heritage for Computer Graphics Rendering, Rochester Institute of Technology, Ph.D. Dissertation, 2017.

C.A. Thorstenson, Validation of a Method to Estimate Spectral Reflectances Using a Digital Camera, Rochester Institute of Technology, M.S. Thesis, 2017.

2017 PUBLICATIONS

Conference Proceedings & Articles

M.D. Fairchild, Color perception: Contexts and individuals, American Glass Guild Proceedings, Rochester, (2017).

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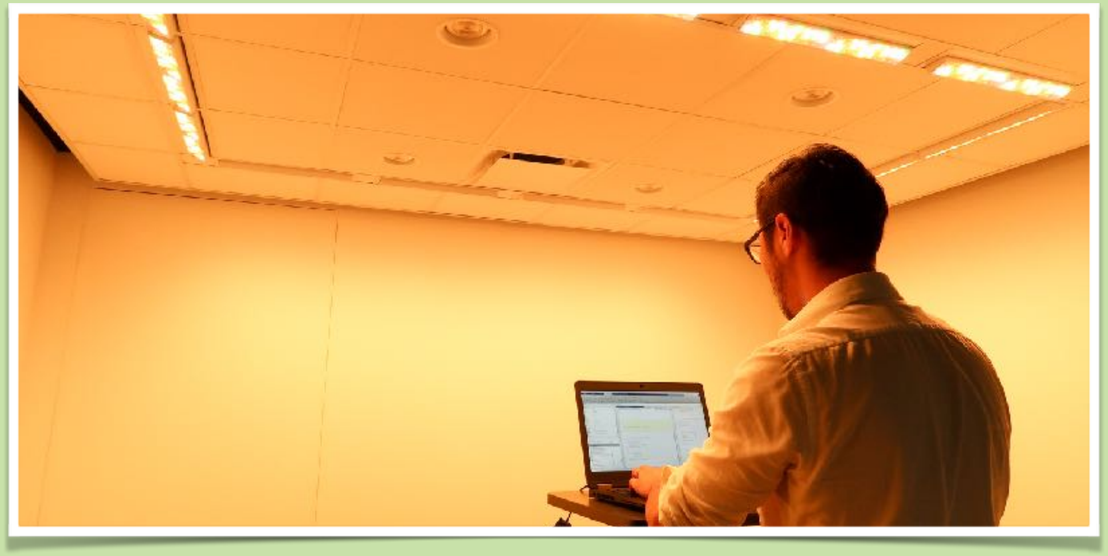

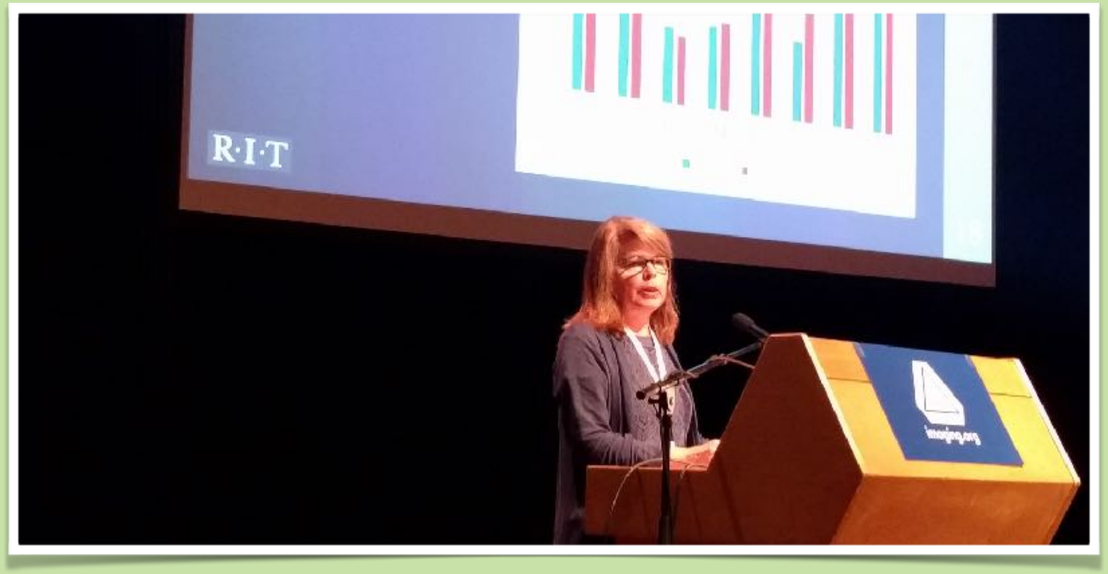
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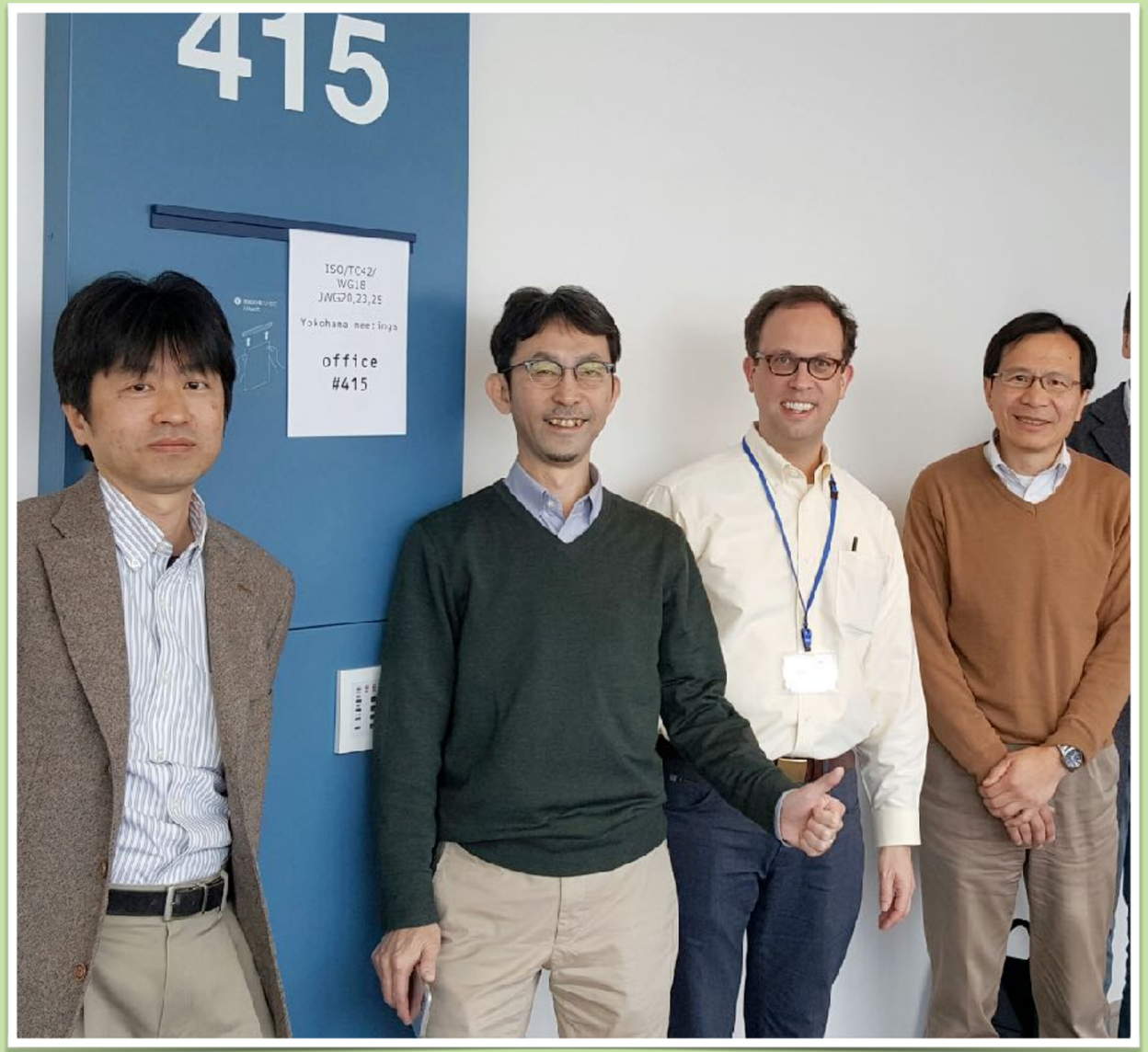
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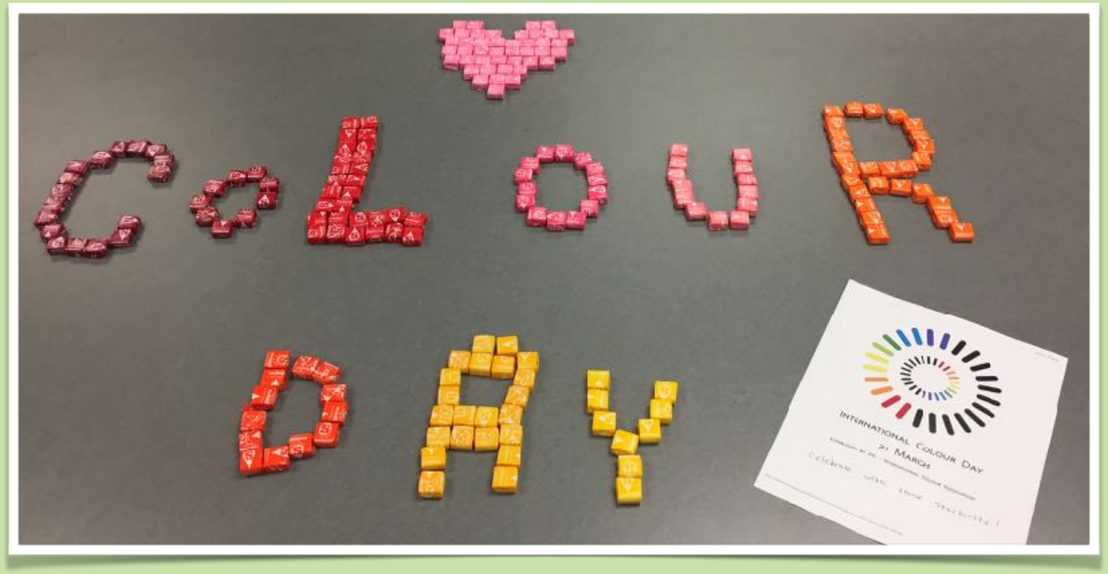
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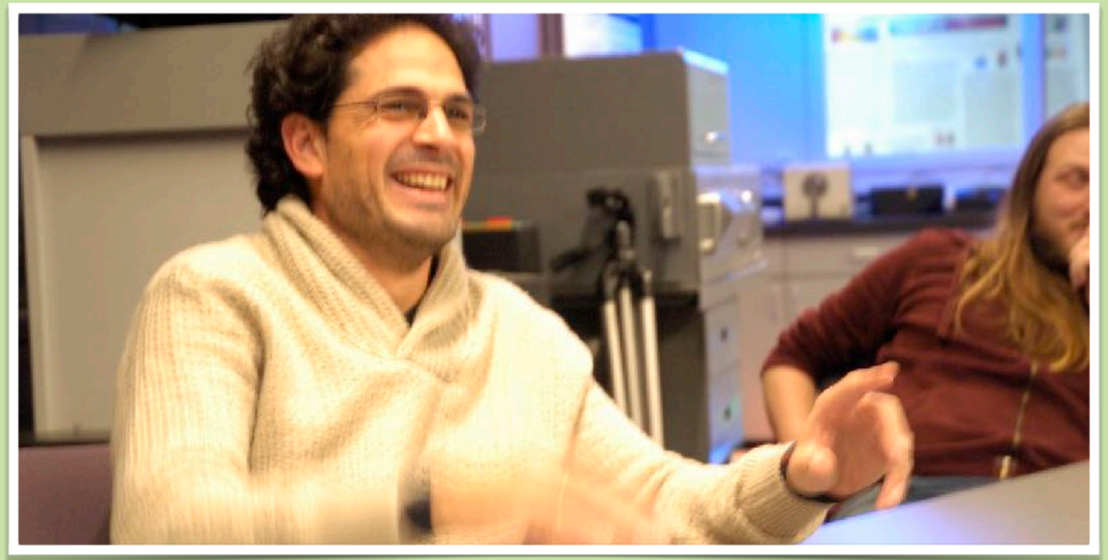


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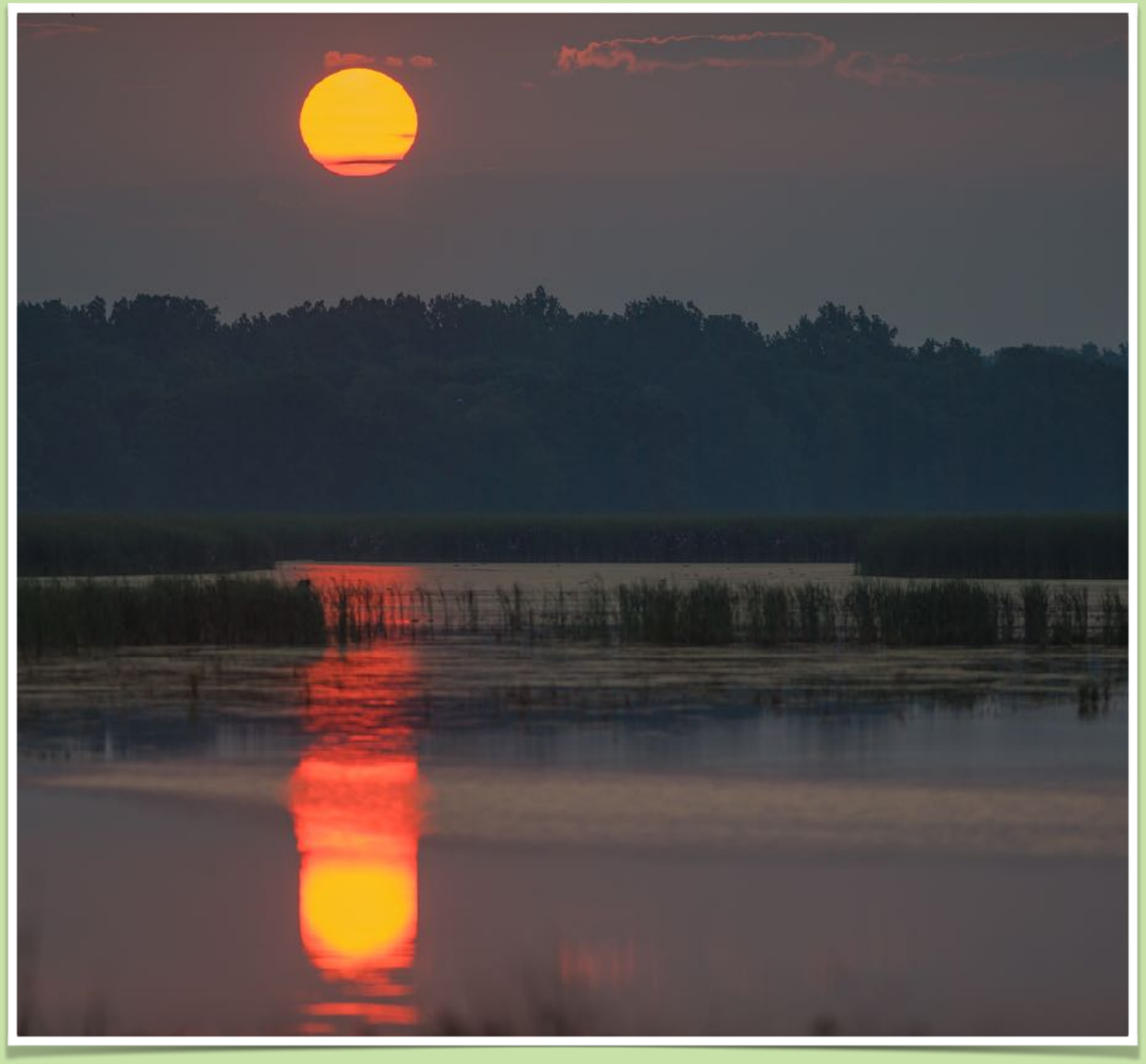


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