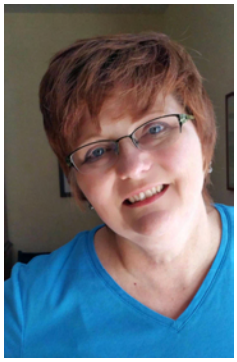
Inter-Society Color Council *News*

Issue 479 Summer 2017

Board of Directors Corner

Greetings, my fellow ISCC members. I am Jodi Baker, bringing you the Board of Directors article this month.



I have served on the Inter Society Color Council Board since 2016. At the first Board meeting I attended, I volunteered to research software programs that would help the organization manage their membership. Little did I know this would become a much bigger commitment. Once the Board adopted the software, my job grew to the implementation of the software. I am so fortunate to serve with other talented and generous people on this Board and thankful for their help in this project.

The Board decided to use Wild Apricot, which is a membership management tool that allows board members to maintain the membership records in a shared database. The Wild Apricot website has many other features. I especially like the ability to share information and knowledge with other members through the on-line directory and blog feature on the website. The membership tool will allow the members to maintain their own contact information. The Board of Directors will be able to post events and distribute the Newsletter through the system. By now everyone should have received an invoice for 2017 through email and have the option to log onto the Wild Apricot system. Please contact membershipadmin@iscc.org to get a membership set up in the system if you have not received an email and invoice. I encourage everyone to update and publish the information you would like to share with the membership. We have such a wealth of knowledge in our membership; it would be nice to build a community where information can be shared.

In addition to attending the monthly Board meetings and webinars, I had the opportunity to attend the CORM/ISCC conference July 30 – Aug 2. Industry lighting and color experts and emerging professionals presented the latest research they have done in the field of lighting and color at the CORM/ISCC Technical Conference at Rensselaer Polytechnic Institute in Troy, NY. (Please see page 5 for more details on this CORM/ISCC Meeting.) The ISCC Annual Business and Awards Meeting was held on August 1st. During the meeting, Jerry Dimas, ISCC President, outlined the current work of the ISCC and conducted a discussion on ways to attract new professionals to the organization. (Please see page 2 for more details on this ISCC Meeting.)

I look forward to bridging communication between art, industry and science by serving on the ISCC Board. My undergraduate education is in art and my Master's degree is in graphic arts systems management. My career has focused on systems

continued on next page

Table of Contents

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Terms end 2018

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Terms end 2017

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Board of Director's Corner continued

support and product development related to printing, imaging and color. Through the ISCC, I have learned more about the science to drive innovation and productivity and I want to see others benefit from this information as well.

Jodi Baker, *Konica Minolta Sensing Americas, Inc.*
ISCC Board of Directors

2017 ISCC Annual Business and Awards Meeting

On Tuesday, August 1st, the 2017 ISCC Annual Business and Awards Meeting was held over lunch during the Joint CORM/ISCC Meeting at the Rensselaer Polytechnic Institute. Our President, Jerry Dimas welcomed all participants and then began his report. Jerry reported that ISCC has a very active group of Officers and Directors that meet holding monthly teleconferences. He also reported on ISCC's two 2017 webinars. The first was held on AIC's International Colour Day, March 21, 2017 given by Mark Fairchild entitled "From Photon to Brain: The Perception of Color". The second will be held in September given by Tony Stanton entitled "Color Management in Digital Cinematography". (See page 7 for more details.) Finally, Jerry reported on the joint ISCC/AIC 2018 meeting that will be a celebration of Albert Munsell to take place at the Massachusetts College of Art and Design in Boston in June. (See page 11 for more details.)

Next our Secretary, Ann Laidlaw, gave her report. Ann discussed our transition to the new online self-service membership solution called "Wild Apricot". Some of the benefits of making the switch are that members are now able to update their own contact information and take care of paying their dues online. This system will issue reminders and invoices for dues. It will replace our previous platform for emailing newsletters and other items to our members. The new

continued on next page

2017 Annual Business & Awards Mtg continued

system will link to our existing web page for content. If any aspect of the new system does not appear to be working, please email isccoffice@iscc.org and a solution will be sought and implemented as soon as possible. Then Ann discussed opportunities for our members. First, she mentioned that ISCC needs input and support from the color community to be a valuable resource. Next, she asked members to consider serving on our Board of Directors. Then Ann asked members to consider helping organize a meeting or helping organize our electronic and physical documents. Finally, Ann reminded our members that we are still looking for someone to serve as Treasurer to chair our Finance Committee and prepare our Annual Reports. She emphasized that implementation of Wild Apricot has eliminated many of the Treasurer's administrative tasks.

The Treasurer's report was given by our Past President, John Conant. Currently there are about 130 members in our organization. Approximately half of our members have responded to the July 2017 invoice that was sent out using Wild Apricot. We have 4 Sustaining Members: Avian Technologies, Datacolor, Hallmark, and Hunter Associates Laboratory, Inc. as listed on the last page of this newsletter. Now that Wild Apricot is up and running, all invoices will be automatically sent to members in January. The ISCC is in excellent shape financially with low overhead costs. The total of our bank and PayPal accounts was reported at $58,456.

A report on the Color History Project started by Paula J. Alessi was given by Jerry Dimas. Marjorie Ingalls is still trying to find good homes for her treasures. For those interested in seeing the inventory of what is left, please contact the Editor at geinhaus@frontiernet.net. Participants were reminded that the ISCC artifacts are housed at the Hagley Museum and Library in Wilmington, Delaware. People were encouraged to visit http://www.iscc-archive.org/resources/hagley.php for more information about this collection. It was noted that we could use help going through the scanned documents from the Hagley visit that Paula and Joy Turner Luke made a few years ago. People wishing to help were asked to contact the office at isccoffice@iscc.org.

Jerry Dimas gave the report on the International Colour Association (AIC) activities due to the absence of our AIC liaison, Paula J. Alessi. The ISCC Board of Directors nominated Leslie Harrington to serve a two-year term on the next AIC Executive Committee. The election will take place at the 13th Congress in Jeju, Korea. (Please see page 9 for more details on this AIC Congress.) Finally, participants were reminded that there will be a joint ISCC/AIC meeting in June of 2018 to celebrate Munsell historic milestones. (More details on this meeting can be found on page 11 of this newsletter.)

Jerry then began the Awards portion of the meeting. First, he thanked our outgoing Directors, Jack Ladson and Dave Wyble by giving them certificates of appreciation for their three years of serving on the Board of Directors.

Jerry Dimas congratulating Jack Ladson

Jerry Dimas congratulating Dave Wyble

Jerry also congratulated Ann on co-chairing the Joint CORM/ISCC meeting.

Jerry Dimas congratulating Ann Laidlaw

continued on next page

2017 Annual Business & Awards Mtg continued

Godlove Award Presentation

Jerry introduced Danny Rich to give the following Godlove Award citation.

"The Godlove Award was established by Mrs. Margaret N. Godlove in memory of her husband, Dr. I. H. Godlove. The fund was presented to and accepted by the ISCC during the 25th Anniversary Meeting of April 6, 1956. The award is usually, but not necessarily, presented biennially in odd-numbered years.

"The Godlove Award is the most prestigious award bestowed by the Inter-Society Color Council, and honors long term contributions in the field of color. Candidates will be judged by their contribution to any of the fields of interest related to color, whether or not it is represented by a Member-Body. A candidate's contribution is to be considered in the light of the objectives of the Council as defined in Article II of the Constitution. This contribution may be direct, it may be in the active practical stimulation of the application of color, or it may be an outstanding dissemination of knowledge of color by writing or lecturing, based upon original contributions of the nominee. The candidate need not have been active in the affairs of the Council, but they must be current or former members of the ISCC. All candidates must have had at least five years of experience in their particular field of color.

"The current nominee, Dr. Ellen C. Carter, meets all of the requirements for this award.

"Dr. Carter began her post-secondary education by attending the Manhattan College of the Sacred Heart, majoring in chemistry. After completing her B.A. there, she went on to major in chemistry at Rensselaer Polytechnic Instrument, becoming part of the second round of students to study under Dr. Fred W. Billmeyer, Jr. in The Rensselaer Color Measurement Laboratory. Her dissertation was titled "Application of Turbid Medium Theory to Metallica Paint Systems". This achievement won her a position as Senior Color Scientist with the Sherwin-Williams Company in Cleveland, Ohio.

"As was the case for nearly all of Professor Billmeyer's students, Ellen has been active in the affairs of the Inter-Society Color Council for many years. She joined the ISCC in 1969 and has been an active member since that time. She chaired the very strategic Project Committee 22 on Materials for Instrument Calibration and issued the first report from the committee. That report has been revised and reissued twice in the years since it was first published by the ISCC. Ellen Carter was President of the ISCC from 1996 through 1998 and was on the Board of Directors from 1991-94. She was heavily involved in establishing the ISCC Office. But this award is not being given to Dr. Carter for her contributions to the ISCC. For those, she received the Nickerson Service Award in 2003.

"Dr. Carter is the Division 1 (Vision and Color) Associate Director (Colour) of the International Commission on Illumination (CIE). She is a member of ASTM International, the Council on Optical Radiation Measurements (CORM), the Detroit Colour Council (DCC), the Optical Society of America (OSA), the Society for Imaging Science and Technology (IS&T), the Society of Sigma Xi, and the U.S. National Committee of the CIE (CIE/USA). She is currently the Technical Committee Chair of CIE Division 1, TC 1-84 and is completing the revision of CIE Publication 15 on Colorimetry, started by the late Dr. János Schanda.

"Currently a consultant, Dr. Carter has previously worked in industry and education. She was a Senior Color Scientist with the Sherwin-Williams Company and later with the KonicaMinolta Corporation.

"But the aspect of her career for which she is best known is her role as the Editor in Chief of the journal, *Color Research & Application.* She has been the Editor of the journal since 1990, 27 years. This is amazing when you think about it. David MacAdam was editor of *Journal of the Optical Society of America* for 11 years as a comparison. Rolf Kuehni was editor for *Color Research & Application* for three years, Billmeyer for 11 years. Dr. Carter had to deal with several large and controversial topics as well as many other small battles. The quality of the journal speaks to Dr. Carter's leadership and her ability to attract articles that cover the range of interest of the members of the ISCC.

"Thus, it is my great honor to present to you the recipient of the 2017 ISCC Godlove Award for a lifetime of service to the field of color, Dr. Ellen deDreux Campbell Carter."

continued on next page

Godlove Award – Annual Meeting continued

Left to Right: Danny Rich, Ellen Carter, Jerry Dimas

Nickerson Service Award Presentation

Jerry introduced Ann Laidlaw to give the citation for the Nickerson Service Award. Ann began by describing the Nickerson Service Award and the criteria for receiving it. "The Nickerson Service Award was established by the Board of Directors at a meeting held on February 3, 1980. This award is presented as the occasion arises but no more frequently than once a year. The Nickerson Service Award is presented for outstanding long-term contributions towards the advancement of the Council and its aims and purposes. The contribution may be in the form of organizational, clerical, technical or other services that benefit the Council and its members. The candidates must be members of the Council and must have been active in the affairs of the Council." The remainder of Ann's citation was exactly as written in the last issue of this Newsletter (*ISCC News No. 478*). The recipient of the 2017 Nickerson Service Award was John Conant, our Past President.

Left to Right: Jerry Dimas, John Conant, Ann Laidlaw

Jerry closed the meeting by inviting all to think about webinar topics that might be of interest to our membership. He also discussed his desire for ISCC to continue to foster the mentoring relationships that we have developed. Finally, he discussed the Board's desire to look for new ways to reach millennials.

Jerry Dimas, *Color Communications, Inc.*
Ann Laidlaw, *ACL Color Consulting, LLC*
Danny Rich, *Sun Chemical Corp*

Summary of CORM/ISCC 2017 Joint Technical Conference

The Joint CORM/ISCC Technical Conference was held at the Darrin Communications Center at Rensselaer Polytechnic Institute (RPI) from July 30 – August 2. Approximately forty participants attended a very successful, informative and intimate conference.

Information related to light in health and safety issues was discussed as well as changes to LED light sources in roadway lighting. Changes to color industry standards were discussed in A. Laidlaw's presentation. Dr. Mariana Figueiro presented the research that has been done at the Lighting Research Center at Rensselaer Polytechnic Institute related to measuring and applying circadian light. This research showed how light can be used to improve wellbeing for nursing home and dementia patients, shift workers and school aged children.

There were six sessions at this conference. Here are more specifics on each session.

Session 1 on Display Metrology featured two presentations. The first was given by Joe Miseli from JVM Research. His talk was entitled *"New and Challenging Areas of Display Metrology – HDR and Color Volume"*. The second was given by John Bullough from RPI's Lighting Research Center. His talk was entitled *"Chromaticity and the Perceived Brightness of a White Stimulus"*.

Session 2 on Solid State Lighting (SSL) Technology and Metrology featured four presentations. The first was given by Eric Bretschneider of EB Designs & Technology. His talk was entitled *"Models for Predicting Color Point Stability"*. The second talk, *"Thinking Ahead for Domestic Solid State Lighting Manufacturing"*, was given by Eric Haugaard of Cree Lighting. The third presentation was given by our ISCC member and former Officer, Cameron Miller of NIST. His talk was entitled

continued on next page

Summary CORM/ISCC Joint Conference continued

Cameron Miller

"Analysis of Spectrometers". The last talk of this session was given by Bruce Kinzey from Pacific Northwest National Laboratory. Bruce's talk was entitled *"Sky Glow Measurement and Modeling"*.

Session 3 was a special session featuring the work of two Emerging Professionals. The first was Rohan Nagare from Rensselaer Polytechnic Institute discussing *"The Effect of the Spectral Content of a Glare Source and its Background on Discomfort Glare"*. The second was Katie Teman from BEGA sharing a *"Method for Quantifying the Spectral Based Error in Luminance Measurements"*.

Rohan Nagare

Katie Teman

Session 4 on Optical Properties of Materials featured four presentations. The first, *"Dynamic Visual Adaptation Lab"* was given by Michael Murdoch from the Munsell Color Science Lab at Rochester Institute of Technology. The second talk was given by David R. Wyble from Avian Rochester, LLC. The title of his talk was *"Dependence of Bidirectional Instrument Performance on Sample Properties"*.

Michael Murdoch

David R. Wyble

Ann Laidlaw of ACL Color Consulting, LLC then discussed *"Status of Work at AATCC, ISO, ASTM, CIE with Relationship to Lighting and Color"*. Finally, Hugh Fairman from Resource III shared *"An Extension to Matrix R Theory"*.

Ann Laidlaw

Hugh Fairman

Session 5 on UV Radiometry featured six presentations. The first speaker was Richard Vincent from the Icahn School of Medicine at Mount Sinai. He spoke about *"UV Germicidal Measurements"*. Then Dave Sliney, a consulting medical physicist, discussed *"UV Safety Measurements – Rationale and Problems"*. Next participants learned about *"Technical Committee: CR10 UV Measurement"* from Richard Vincent, who was giving the talk on behalf of its author, Tom Larason, Chair Pro Tem. The fourth speaker was Ilko Iliev of FDA giving a talk entitled *"LED Studies"*. The next presentation was co-authored by Terry Lyon, a consulting physicist and Dave Sliney, a consulting medical physicist. Their talk was called *"Ultraviolet Safety Assessment – Measurement Alternatives"*. The final presentation of this session was given by Bob Angelo of Gigahertz-Optik on behalf of its author, George Eppeldauer. The title of this talk was *"Broadband UV LED Measurements"*.

Session 6 on Current Research at National Metrology Institutes featured six presentations. Jeanne Houston from NIST gave two of these talks.

The first she co-authored with Howard W. Yoon and Thomas C. Larason also from NIST. It was entitled *"Uncertainty and Performance Results from a Component by Component Upgrade to the Visible Comparator Facility"*. The second, *"Improvements in the Spectral Irradiance Calibrations Performed in the Visible Comparator"*, she co-authored with Howard W. Yoon and Yuqin Zong.

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Summary CORM/ISCC Joint Conference continued

Luke Sandilands from National Research Council (NRC) of Canada gave a talk on *"Highlights of Current Photometry and Radiometry Research Activities"* Luke also gave a presentation in place of the authors, Joanne Zwinkels, Li-Lin Tay, Arnold Gaertner, Andrew Todd, and Angela Gamoura, his colleagues at NRC. Finally, Heather Patrick of NIST discussed *"Robotic Optical Scatter Instrument (ROSI)".*

Luke Sandilands

Heather Patrick

On the last day, a tour of RPI's Lighting Research Center was provided to attendees of the conference. The 30,000-square foot facility is home to a wide array of research projects from how lighting can help with traffic and emergency vehicles to plant health and lighting solutions for eldercare patients in the home. The Lighting Research Center partners with many companies in industry and government departments to further our understanding of light and how it can be used to improve health and well-being. Much of the work they do is through grants or projects funded by partners. For more information about their research please visit their website:
http://www.lrc.rpi.edu/aboutUs/index.asp
Specifically, look at the poster papers they have to summarize most of the work they do at:
http://www.lrc.rpi.edu/resources/newsroom/projectsheets.asp

Paula, J. Alessi, Jodi Baker, and Ann Laidlaw
ISCC News Editor, Board member, Secretary, respectively

Dialog Concerning the March 21, 2017 Webinar

Please recall the article that Mike Brill wrote in the last issue of *ISCC News No. 478* summarizing Mark Fairchild's Webinar, *"From Photon to Brain: The Perception of Color"* held on March 21, 2017 (AIC International Colour Day). One of Mike's colleagues at Datacolor, Nilesh Dhote, an optical engineer, sent the following very astute response with an accompanying picture with text fragment that should be shared with our membership.

"compelling explanation. A final picture of a cliff climber on a brick wall showed metaphorically that

our understanding is underway, but not yet complete".

Nilesh's comment was "Are we ignoring an easier way to climb the stairs of understanding? 😊" Besides Nilesh, how many of our readers thought about this when they saw the above picture?

Mark was then asked to comment. Here is his response: "Aah, yes. That was essentially my point in including the picture…that sometimes there is value (e.g. something to learn) in taking the difficult route even when an easier route is in plain sight."

Next ISCC Webinar – September 27, 2017

Please mark your calendars for September 27, 2017! That is the date of our next webinar. It will take place from 2:00 – 3:00PM EDT. Our speaker will be Anthony P. Stanton, an ISCC Board member. Anthony Stanton is a Teaching Professor and Director of Graphic Media Management for the Tepper School of Business at Carnegie Mellon University (CMU). In addition to teaching, Stanton is responsible for developing the curriculum, administering over adjunct faculty, and advising students in the graphic media track. Stanton has held this position since 1996. In 2003, he received an award for sustained teaching excellence.

continued on next page

Next ISCC Webinar – September 27, 2017

Prior to teaching at CMU, Stanton spent twelve years as Director of Process Controls for the Graphic Arts Technical Foundation. In this position, he was responsible for designing and overseeing the manufacture of quality control devices for the printing industry. He also performed research on print analysis and color reproduction. During his tenure at GATF, Stanton introduced whole-process test forms into the product line, which previously included only individual devices. He also introduced digital targets (and later, native PostScript targets) into the Foundation's product line.

The title of Anthony's webinar is *"Color Reproduction in Digital Cinema"*. Here is the abstract for his presentation:

"Of all popular media forms, the cinema industry was the last to evolve from photomechanical to digital processes. This delay was due in part to the complexity of cinema production. Three distinct phases of production had to migrate from film to digital before beginning-to-end digital cinema was realized. These were:

- Image capture (shooting the scenes of the movie).
- The editing process (putting the captured scenes together with computer-generated imagery to produce the master file).
- Image display (projecting the completed movies in theaters).

"This webinar will begin with a brief description of the history of color in cinema and the means by which color correction and control were achieved with photomechanical processes.

"The adoption of digital processes in each of the three phases of cinema production will be described, as will color control methods and the comparative differences from film workflows. Various mastering, distribution, and projection systems will be analyzed for consistency and quality.

"Color conversion and color correction techniques, as well as the current idealized projection characteristics, will be examined."

For details on how you can participate in this webinar, please visit:www.iscc.org/SeminarSeries

AATCC Announces Lighting Conference

AATCC announces a lighting conference called **LED – A Balancing Act –Don't Be Left in the Dark Conference.** It will be held from October 18-19, 2017 at the DoubleTree Downtown Lakeside in Cleveland, Ohio. "Lighting is moving rapidly to LED sources in the retail industry. This change directly effects what consumers see and ultimately purchase. To ensure that retailers, manufacturers and suppliers are not left 'in the dark', AATCC has organized its second LED Conference to explore new ways to achieve value while limiting risk when switching to LED lighting." Mark Lien from the Illuminating Engineering Society is giving a keynote speech on *"Illuminating the Future of Lighting"*. This conference is designed to meet the needs of the brands and retailers. All participants will be able to take part in networking opportunities and panel discussions. Early registration (before October 3, 2017) is $525 for AATCC members and $785 for non-AATCC members. Registration after October 3, 2017 is $575 for AATCC members and $835 for non-AATCC members. For more information on this lighting conference, please visit: https://www.aatcc.org/evnt/conferences/led/

CIE 2017 Midterm Meeting – Jeju, Korea

The CIE 2017 Midterm Meeting will take place from October 20 – 28 on Jeju Island at the Ramada Plaza in the Republic of Korea. This meeting will feature talks on:

- Adaptive, intelligent and dynamic lighting, including sensing and communication technology for lighting in any discipline or mix of disciplines. Both research-based and practice-based work will be considered.
- Support for lighting recommendations.
- Color quality of light sources.
- Metrology for photometric and radiometric devices.
- Interior environment and lighting design.
- Exterior environment and design.
- Lighting and health.

continued on next page

CIE 2017 Midterm Meeting – Jeju, Korea continued

- Imaging devices and displays with lighting.

The CIE Conference Workshop and Programme will take place from October 23 – 25. The CIE Division Meetings and Technical Committee Meetings will take place from October 26-28. For more details about the meeting, including registration please visit: http://www.cie2017.org/

13th AIC Congress
2017 JEJU
Color & Health

AIC 2017 Congress and 50th Anniversary Celebration!

This AIC 2017 Congress with take place immediately prior to the 2017 CIE Midterm Meeting in Jeju Island, Korea. The dates are October 16 – 20 and the venue is the International Convention Center. The AIC Regular Member who will be hosting this Congress is the Korea Society of Color Studies.

Since 1967 marked the founding of AIC, this 2017 Congress celebrates the **Golden 50th Anniversary** of AIC. To commemorate this remarkable milestone for AIC, there will be an Exhibition of "Color and Culture". This exhibition will provide an opportunity for each member country, including the United States through ISCC, to represent the color and culture of their country through the content that they choose to share at this exhibition.

ISCC had a committee of 4 people working on our exhibit. The committee members were Paula Alessi, Mike Brill, Leslie Harrington, and Jack Ladson. Thanks to Leslie, Rafał Kozera, a designer from HELIOSmedia, helped us realize our vision for this exhibit in the required form of two art walls each 1 meter in width by 2.5 meters in height. The committee tried its best to select colorful images that were indigenous to our culture and easily recognized by people from around the world. The black and white images were selected to honor some of the most prominent color scientists from the United States. The two Munsell images were chosen to underscore the importance of Munsell in our color history and remind participants of our joint ISCC/AIC Munsell 2018 Munsell Centennial Symposium. To further pay tribute to Munsell, each picture frame is shown in a hue that attempts to match one of the 10 Munsell hues defined in the Munsell Color Order System. Here is what the exhibit will look like:

The table in front will hold some ISCC brochures and some information concerning the 2018 Munsell Symposium.

It is not too late to register for the AIC Congress on Jeju Island in Korea. For registration and Congress details, please visit www.aic2017.org

AIC LISBOA 2018
colour & human comfort

AIC 2018 Interim Meeting in Lisbon

The AIC 2018 Interim Meeting will be hosted by the Portuguese Colour Association from September 25-29, 2018 in Lisbon, Portugal. The venue is the Calouste Gulbenkian Foundation. The crow was chosen as the symbol for the meeting because it represents a very important part of Lisbon history. "An ancient legend, which connects the crow of St. Vincent, the patron saint of Lisbon, says that these birds had escorted the body of St. Vincent from his death through his being moved to Lisbon in the 12th century. Since then, the crow has been considered the Lisbon guardian and has always been present in the city symbol. Therefore, the crow was chosen as the iconic symbol for the graphic image of this meeting.

continued on next page

AIC 2018 Interim Meeting in Lisbon continued

The bottom squares represent some of the determinant elements of Lisbon's historic identity, namely its glazed tiles and cobble stones."

The aim of the meeting is to bring together a group of interdisciplinary specialists who use color in all aspects of their lives as it relates to human comfort. Everyone tries to achieve wellbeing in their lives. Color usually plays a significant role in achieving that wellbeing from the clothes we wear, to the house that we live in, to the environment in our workplace, to the things that we love, etc. However, we know that there are many places, objects and things in our lives that make us uncomfortable.

The last newsletter (*ISCC News No. 478*) listed the topics for paper submissions. Here are the important dates to remember as you plan to attend this meeting:

2017

Sept. 10, Nov. 10, Dec. 10 – 1st, 2nd, & 3rd Circulars with Call for Papers, respectively

Dec. 31 – Submission deadline for short abstracts

2018

Mar. 31 – Author notification of Oral/Poster presentations

May 31 – Author Registration and submission deadline for final papers

Jul. 31 – Early meeting registration

Sept. 7 – Normal meeting registration

Sept. 15 – Late meeting registration (on-site and cash only)

For more detailed information on this 2018 AIC Interim Meeting in Lisbon, Portugal, please visit the website at www.aic2018.org

Solar Eclipse Taken with a Smart Phone Camera

On Aug. 21, 2017, skies darkened from Oregon to South Carolina in the first total solar eclipse visible from coast to coast across the United States in 99 years. Millions of people watched this event with various kinds of tools.

It is important that you have the right tool to watch the solar eclipse. You definitely cannot watch the sun directly with your bare eyes. The only exception is that if you happen to have a cloud with the proper thickness to cover the sun and yet let some sunlight pass through, you can then watch the eclipse directly, as shown in the following picture taken with an iPhone in Princeton, New Jersey:

Besides the bare eyes, a pin hole is of course one of the simplest tools to get the image of the eclipse. If you happen to have a pair of binoculars, you will get better images than those projected with simply a pin hole, as shown in the following picture taken with the same iPhone from the same location.

Nowadays smart phones are so popular that almost everybody has one. Many people tried to use their smart phone camera to take pictures of the solar eclipse; unfortunately, the sun is so bright it saturates your camera sensor and you cannot directly take a good picture without proper filters. However, if you are careful enough, you can still get an image of the eclipse with just your smart phone. Please note that the image of the eclipse is inverted.

In the following picture, the sun is so bright that the smart phone sensor got saturated and you can only see a bright round spot. However, in the shadow of the tree, you can clearly see the eclipse. If you think a little deeper, you can easily understand how this image of the eclipse arose. It is from the secondary reflection of the camera lens on the iPhone. With light reflected from the interface between the lens and the air, the light intensity was greatly reduced, and when the second reflection of light

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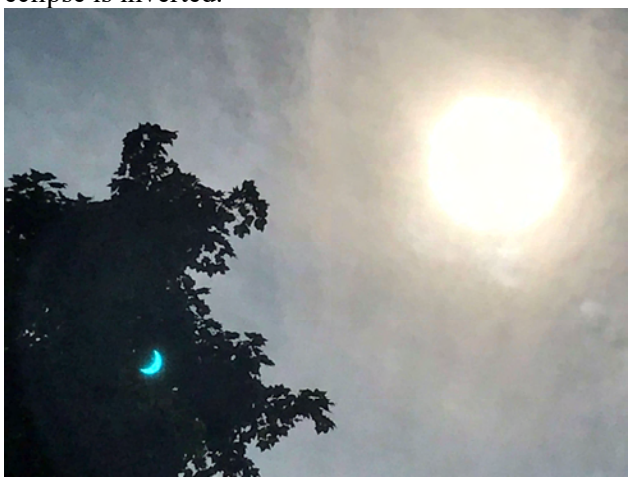
Solar Eclipse Taken with a Smart Phone continued

formed the image, its intensity was proper to avoid the saturation. It is interesting that the image of the eclipse is inverted.



Zhiling Xu, *Datacolor*

We invite comments on this article and seek an explanation as to why this last eclipse image is cyan. Please email the Editor at geinhaus@frontiernet.net

Joint ISCC - AIC Special Event
The Munsell Centennial Symposium

Celebrating the Past | Envisioning the Future

The Munsell Centennial Symposium Committee has made a significant amount of progress in the planning of this celebration. This newsletter column will feature four topics: **Call for Posters, Symposium Update Featuring a Munsell Diary Excerpt, Munsell Centennial Awards Announcement and Housing at MassArt.** For the most current information on the Symposium, please visit the website at www.munsell2018.org

Call for Posters – Deadline: October 31, 2017

2018 marks the 100-year anniversary of the passing of Albert H. Munsell (June 28, 1918) as well as the 75-year anniversary of the Munsell Renotation. ISCC and AIC are excited to host a very special event to celebrate these milestones.

The 2018 Munsell Centennial Celebration will take place from June 11-15th at the Massachusetts College of Art and Design (formerly known as Massachusetts Normal Art School when Munsell graduated and taught there).

The theme of the event will focus on **Celebrating the Past** as we follow the threads of Munsell's influence from the early 1900's to **Envisioning the Future** of color as it develops beyond Munsell's vision in the 21st century. This celebration will feature presentations centered around the three vertices of the ISCC logo; color in science, art, and industry. Education, represented by the circle encompassing the ISCC triangle, promotes cross-disciplinary fertilization. Invited presentations will feature the history, evolution, state-of-the-art, and future directions for Munsell's systems and systems inspired by Munsell as well as other approaches to solving similar problems in color science, art, and industry. Posters are invited that touch on any of these, or any closely related topics. Poster submissions on topics that will enhance the themes of the invited presentations are encouraged. For example, appropriate areas include:

- Color Systems in:
  Art, Art Education, Industrial Applications, Color Reproduction, Color Management, Science, Science Education, Other Applications, Future Applications, etc.
- Creative Uses of Color
- Theory and Comparability of Color Systems
- Color Language and Cognition
- Categorical Color Perception
- History of Color Systems

Poster Abstract Requirements:

All submitted abstracts must include author names and affiliations (with student authors noted), a concise and descriptive title, and a summary of the poster presentation in 500 to 1000 words. Any abstracts exceeding 1000 words will be truncated to that length in the conference book.

Poster abstracts must be submitted in a single PDF file.

Submission:

Poster abstracts must be submitted to submissions2018@iscc.org by **December 15, 2017**. Authors will be notified of acceptance by February 9, 2018. Poster size limitations will also be communicated at that time.

Student authors, please be sure to indicate your student status with your submission. There will be a student poster competition with wonderful Munsell-inspired prizes.

continued on next page

Munsell Centennial Call for Posters continued

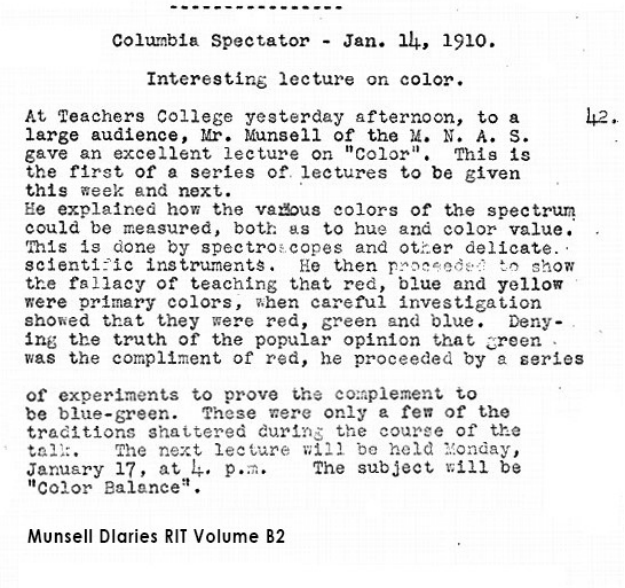
Special Issue of Color Research and Application

There will be a special issue of *Color Research and Application* dedicated to papers from this conference. Those presenting posters will be eligible, but not required, to submit full papers to the special issue. Publication will be dependent on successful peer review through the normal journal procedures. The submission deadline will be shortly after the conference.

More information can be found at: https://munsell2018.org/call-for-posters-1/

Symposium Update Featuring a Munsell Diary Excerpt

The article below was tucked into the diaries of Albert H. Munsell. It is just one of many notes that Munsell made between 1899 and 1918 detailing his never-ending efforts to inform educators about his work on color. Although the entries are unemotional, it is clear from his notebooks that Munsell was driven by a passion for improving color literacy not just for his students at the Massachusetts Normal Art School in Boston, but for teachers and children, and for the public at large.



Columbia Spectator - Jan. 14, 1910.

Interesting lecture on color.

42.

At Teachers College yesterday afternoon, to a large audience, Mr. Munsell of the M. N. A. S. gave an excellent lecture on "Color". This is the first of a series of lectures to be given this week and next.
He explained how the various colors of the spectrum could be measured, both as to hue and color value. This is done by spectroscopes and other delicate scientific instruments. He then proceeded to show the fallacy of teaching that red, blue and yellow were primary colors, when careful investigation showed that they were red, green and blue. Denying the truth of the popular opinion that green was the compliment of red, he proceeded by a series of experiments to prove the complement to be blue-green. These were only a few of the traditions shattered during the course of the talk. The next lecture will be held Monday, January 17, at 4. p.m. The subject will be "Color Balance".

Munsell Diaries RIT Volume B2

Please note that a typewritten copy of the handwritten Munsell Diaries was made by the Munsell Color Company in the 1920's. (PDF's of the transcribed diaries can be found on the website of the RIT Munsell Color Science Lab.) The link for the above excerpt can be found at: http://www.rit-mcsl.org/MunsellDiaries/VolumeB2.pdf on pages 17 and 18.

Improving color education is at the heart of the Munsell Centennial Symposium. The program is divided into three days of General Session talks based on the three sides of the ISCC triangle - Science, Art and Industry. In addition to the general sessions there will be two days of Breakout Sessions with tutorials, workshops and field trips that will build bridges between all three areas. (See the Program Matrix for details on page 15. Also visit the website at https://munsell2018.org/program/)

The three general session days highlight the contributions of Albert H. Munsell in the morning, feature a poster session during the lunch break, and focus on state-of-art topics in each of the topic areas in the afternoon.

In Science, Munsell measured object color in three dimensions and created a perceptual color order system. He invented a photometer to measure the amount of light reflected by a color, used a spectrometer to measure the hue of a color and used Maxwell disks to measure the chroma of a color. Color measurement has advanced tremendously over the last 100 years and many color order systems have come and gone while the Munsell system hangs on. Why?

In Art, Munsell advocated for teaching the three dimensions of color and designed teaching aids for use in the classroom including a color sphere and the irregularly shaped, more accurate Color Tree. Did the teaching of color basics shift due to Munsell's efforts? What, and how, do we teach about color today?

In Industry, Munsell promoted the standardization of color samples and created the Munsell Color Atlas with an easy to use nomenclature for specifying colors according to his system. Although the Munsell System is still used in industry today, its practicality is fading in favor of digital color. What type of color system do we need now?

Let's get together in Boston next June and talk about how we - scientists, artists and industrialists – can answer these questions and work together to improve color literacy for the benefit of everyone!

Munsell Centennial Awards Announcement

While Science, Art and Industry form the sides of the ISCC triangle, Education encompasses all three. One of the Aims and Purposes of ISCC is: "To promote communications between technically oriented specialists in color and creative workers in art, design, and education, so as to facilitate more effective use of color by the public through dissemination of information about color in both scientific and artistic applications."

At this Special Meeting, we will honor three long-time members of ISCC with the Munsell

continued on next page

Munsell Centennial Awards Announcement cont'd

Centennial Award for a lifetime dedicated to color education and the promotion of color literacy:

The Munsell Centennial Award in Science will be awarded to Rolf Kuehni, author of numerous books and papers on color including the seminal 'Color Ordered: A Survey of Color Order Systems from Antiquity to the Present.' Rolf has studied color, color differences, uniform color spaces, and color order systems both from a current technological standpoint and from a historical perspective. Throughout his career, Rolf has been a proponent of closer ties between industrial scientists studying and applying color technology and academic scientists studying color vision and developing the foundational principles of color science.

The Munsell Centennial Award in Art will be awarded to Joy Turner Luke, artist, teacher, and author of the first three editions of the Munsell Student Color Set. Working as an artist and teacher for over 50 years, Joy has participated in many exhibitions, and taught color in composition and design classes. She has authored books and articles, created software, participated in technical committees, and juried exhibitions. Joy has been a leader in work to ensure the safety of artist's materials for children. She wrote and illustrated "The Munsell Color System, A Language for Color" published by Fairchild Publications. Joy's contributions to color education are enduring.

The Munsell Centennial Award in Industry will be awarded to Calvin McCamy, an expert in color measurement, standardization and photography. Cal's industrial career began in 1952 when he worked for the National Bureau of Standards (NBS), which today is known as the National Institute of Standards and Technology (NIST). Cal observed that international standards used by NBS in calibrating densitometry standards called for transmission measurements with an integrating sphere, while industry practice in calibrating densitometers used reflectance of these materials over a white diffuser. Resultant errors in industrial measurements were because of inappropriate procedures in calibrating the standards. Cal led the effort to correct these discrepancies, changing calibration procedures to match industry use of these standards, thus ensuring accuracy of densitometry. Cal's background in color and optics resulted in him teaching the FBI and the CIA how to listen in by monitoring vibrations on glass windows. Cal was also such an expert in photography that he led the congressional investigation of the John F. Kennedy assassination, he observed that duplicate photographs of the autopsy were offset, allowing binocular 3-dimensional viewing of key wounds. Cal played a key role in development of the Macbeth-ColorChecker, which is still used today to evaluate photographic color reproduction accuracy.

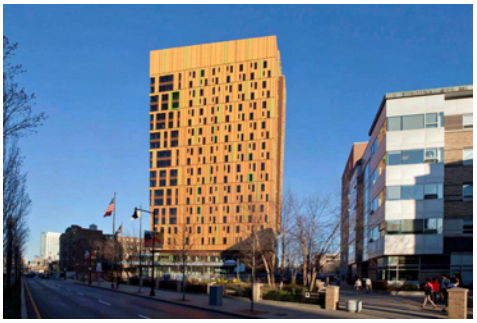
For more information on Awards, visit: https://munsell2018.org/awards/

Housing at MassArt for the Munsell Conference

The Massachusetts College of Art and Design in Boston is the site of the Munsell Centennial Symposium. Munsell spent many years both learning and teaching here when the college was known as the Massachusetts Normal Art School. Located on Huntington Avenue with easy access to public transportation, MassArt is a very small urban campus just west of downtown Boston.

Due to the high cost of hotels in the area during the summer, the choice was made to contract with the college for affordable housing in the brand-new Treehouse dorm across the street from the main campus.

The towering, 21-story Treehouse Residence Hall was inspired by Austrian artist Gustav Klimt's famous "Tree of Life" painting. Conceived with the collaborative input of students, faculty and the neighboring community, it is an award-winning addition to the stretch of Huntington Avenue of the



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Munsell Centennial Housing at MassArt continued

Arts. The building received the LEED Gold certification from the U.S. Green Building Council due to its sustainable construction and has many modern amenities.

Single and double rooms will be available to book for the full six nights – Sunday night through Friday night - for conference attendees and accompanying persons. See the floorplan and rates in the picture below:

The fully furnished units include the following items per person: Twin Bed, Set of Linens, Dresser, Desk, Bookcase and Closet. Additionally, the following services are provided at no additional cost: Air Conditioning, Cable TV connection, Wi-Fi and Ethernet connection port, 24-hour courtesy desk & card access to all exterior doors. Access to Laundry Facility ($1.50 to wash, $1.50 to dry).

For more information on housing, please see: https://munsell2018.org/housing/

In addition to the Treehouse dorm, there are many hotels along the Huntington Avenue bus and streetcar line if you choose to stay off-campus. Copley Square, with many top hotels, is just 1.5 miles (approx. 10 minutes) from MassArt. There are also a number of B&B's in the Back Bay area near the Berklee College of Music.

Maggie Maggio, *Co-Chair Munsell 2018*

Opportunity to Get Involved

If you are interested in helping plan the social events for participants during the Munsell 2018 Symposium, please contact Maggie Maggio at maggiemaggio@gmail.com or Paula Alessi at geinhaus@frontiernet.net.

Take a Minute to:

- Post a link to www.munsell2018.org with your favorite professional contacts and on social media!
- Spread the word about Munsell 2018 to as many of your friends as possible!

Historic Photo from Joint CORM/ISCC Conference

Please enjoy this historic photo of ISCC Presidents, past and current, taken at the 2017 Joint CORM/ISCC Technical Conference.

Left to right: John Conant, Michael Brill, Ellen Carter, Hugh Fairman, Jerry Dimas, Danny Rich, Jack Ladson, Frank O'Donnell

Many thanks to Ann Laidlaw for sending this photo to the Editor.

Editor's Note

I would like to thank 4 people who have made my job as Editor a pleasure. I owe them a debt of gratitude for all their help and support that they have provided me over these last four years!

John Conant, thank you for all the photos of Annual Meetings, especially this year, & other columns during your Presidency.

Mike Brill, thank you for editing, your Hue Angles column and our numerous phone calls to make this the highest quality newsletter possible.

Ellen Carter, thank you for editing, calendar items when no one else would send them and your *CR&A* column.

Dave Wyble, thank you for all your website support.

Ann Laidaw, thank you for all the interesting fillers.


Munsell 2018
June 11-15
AM Celebrating the Past
PM Envisioning the Future
AIC & ISCC
Munsell Centennial Symposium
Massachusetts College of Art & Design
Boston, MA
www.munsell2018.org
Science
Art
Industry
Monday 11 General Sessions
Tuesday 12 Breakout Sessions
Wednesday 13 General Sessions
Thursday 14 General Sessions
Friday 15 Breakout Sessions
MUNSELL HISTORY & EVOLUTION
Roy Berns
Development of the Munsell Color System
Renzo Shamey/Rolf Kuehni
Evolution of Color Order Systems
Michael Webster
Color in Language and Culture
Tutorials
Workshops
Field Trips
Breakout Sessions will be optional additions to the Symposium Registration Fee.
COLOR IN ART EDUCATION
Roy Osborne
Historical Survey of Teaching Color in Art & Design
Joy Turner Luke/TBA
Munsell's Vision for Teaching Artists
Paul Green-Armytage
Relating Color Systems in an Elastic Color Space
THE BUSINESS OF COLOR
Danny Rich
Calvin McCamy's Recollections: Color Checker
Setsuko Horiguchi
From Munsell to a New Color Psychology System
Berit Bergström
Natural Color System: A Visual Approach to Color
Tutorials
Workshops
Field Trips
Lunch & Poster Session
Lunch
Lunch & Poster Session
Lunch & Poster Session
STATE-OF-THE-ART
Osvaldo Da Pos
Subjective Links in Color Names & Stimulus Color
Susan Farnand/Don Williams
Modern Tools for Optimal Color Selection
Mark Fairchild
Munsell's Legacy: The Foundation and The Lab
Tutorials
Workshops
Field Trips
AWARD BANQUET
Keynote by John (The Math Guy) Seymour
STATE-OF-THE-ART
Graydon Parrish/Steve Linberg
Contemporary Realism
Margaret Livingston
What Art Can Tell Us About the Brain
David Briggs
Where is Color Education Now? Color + Tech
STATE-OF-THE-ART
Tom Lianza
The Pantone System: A Short History
Wendy Leudtke
Light and Color: Pixels VS Pigments
Dave Wyble
Symposium Summary
EVENING EXCURSION
SPECIAL TWO DAY WORKSHOP with Graydon Parrish
Saturday, June 16
Sunday, June 17
The Basics of Painting with the Munsell System
Sponsored by the Academy of Realist Art
Bridging the Science, Art, and Industry of Color
ISCC Annual Meeting
AIC STUDY GROUPS
Study Group on Language and Culture
Chair: Dimitris Mylonas
Study Group on Color Education
Chair: Robert Hirschler

Meet Your Fellow ISCC Members

Nilgün Olguntürk: A Passion to Understand Color

People and buildings, how we shape our surrounds, how we interact with the built environment were all very interesting to me since my secondary school years. With this interest, I graduated from the Department of Architecture in 1994 as first in my graduating class of Gazi University in Ankara. Color being the core subject of art seemed to be not as important for architectural education, despite the fact that color is actively used in many admired buildings in architecture. Little did I know then that my passion for color would grow into research work for seventeen years.

I received my M.A. in architecture at the Middle East Technical University, Ankara, exploring art museums from the nineteenth century to the present day. I received my Ph.D. from Bilkent University, Ankara. specializing in the effects of hue, saturation and brightness on attention and preference in color combinations. This work was published in two parts in *Color Research and Application* under my maiden name Nilgün Camgöz, with the preference part being my most cited work up until today. The novelty of this initial and highly cited work published in *Color Research and Application* (a Science Citation Index Journal) is that it was the first work of its kind to look at colors in combination rather than in isolation. In interiors and in the built environment, colors are very rarely viewed in isolation (except in spaces like saunas), which is why all my color research for the past 17 years has considered combinations of colors and materials in real and modeled spaces through their functional or aesthetic qualities.

Within these 17 years, most research I have done has been published in Citation Index ISI journals. The research work I have produced, with my colleagues, so far explored transport environments and how color could be used to help visually impaired travelers for independent travel, on how hospital environments could achieve better quality with color to help the feeling of wellness, on school environments' use of color in wayfinding, on universities' use of color temperature to enhance performance, on airports' use of color temperature for wayfinding, and most recently, on hotel guestrooms' pleasantness enhanced through color.

These studies look at color in a more complex way in architecture, but color is also inseparable from design and could be studied in its more abstract form by itself and in space, which is the subject of my second body of research. These sets of data are more about visual perception, on how color is perceived, before making use of it in a space. Here, I worked on color naming, trying to find areas of color that have a consensus meaning (expressed by names given to them) for people. I also have done research on lighting, predominantly on color temperature, visual performance and space evaluation with different lighting techniques.

In my research, there are a couple of recurring themes, which I would like to share with you. They recurring themes are:

1. Color being non-gendered
2. The curious case of grays

Gender differences in color studies are very common and are very frequently used especially in marketing. Men's clothing colors differ from women's; a baby girl's color would be pink, whereas a baby boy's would be blue. Being raised in a consumer culture, where every day we would purchase something and make a color choice, it was so natural to think there would be a gender difference in my studies as well. But this did not happen. For every single completed research project, I ended up with no statistical difference among male and female participants. So, I began to ask why this unexpected result would occur so persistently.

Now, I think this might be because of the space or object that was being examined. I usually worked in genderless spaces, mostly public spaces, and sometimes semi-private spaces like our living rooms. Even in the living rooms, there were no gender differences between different wall colors and emotions associated with them. Without gender references in the studied objects and spaces, there would be no difference between the responses of male and female participants. A contributory factor could be the testing aspect. If it is a performance issue, like wayfinding, it might be a core human aspect not related to gender.

As for the second theme, grays are usually an important part of color schemes. By definition, grays are hueless. It was very appealing for me to have a control group in my experiments to test whether the difference in results really came from the changing

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Meet Your Fellow ISCC Members continued

hues. Thus, using grays with the same lightness as the hue-endowed colors used in the experiment provided me with an experimental set for the control group. Most of the time, especially when there is a performance test involved like wayfinding, this just worked as I suspected and I could test the effect of certain hues against hueless environments. To my surprise, in some experiments, the gray acted just like another color, having similar impact on participants to reds, blues, greens, etc. This was the case especially in studies testing emotive (emotional) aspects. I now would like to expand on this issue, trying to map out where and when a gray is just achromatic to us and where and when it becomes a color in its own right (as it already is in our language, by having a unique name of its own).

My colleagues and I will be presenting some of our recent research work at CIC 25 Norway and AIC Jeju this year and I would be more than happy to invite you to our presentations. Wishing you all a wonderful fall.

Nilgün Olguntürk
Assoc. Prof. Dr., Ph.D., M.A.
Bilkent University, Ankara, Turkey
onilgun@bilkent.edu.tr

Pantone Makes New Shade of Purple to Honor Prince

Prince, the late music icon and creator of the famous song, "Purple Rain", was honored by the Pantone Institute's development of a new shade of purple. The exact shade that Pantone chose was inspired by Prince's custom-made purple Yamaha piano.

http://www.ocregister.com/wp-content/uploads/migration/o67/o67q9n-b88697426z.120160425162047000gnjg6khh.10.jpg?w=620

The new purple is known as "Love Symbol #2, which was a graphic (on the left) that Prince began using as his name in 1993. For more information, please see:

https://www.usatoday.com/story/life/2017/08/14/prince-piano-inspires-new-purple-color-called-love-symbol-2/566243001/

The Use of Color to Tell When Food Goes Bad

Wouldn't it be wonderful to have a way to detect sour milk that does not involve the smell test? Well some scientists in China have developed some "smart tags" that can be placed on a milk carton and will change color when the milk sours. These tags can also be applied to bottles, cans, and even medication containers. The "smart tags" contain very small gold and silver particles, known as nanorods, that have a gel-like consistency and are about the size of a corn kernel. These tags also contain Vitamin C, acetic and lactic acid, and agar. Color change occurs when the nanorods react with the other ingredients.

At 100% freshness, the gold nanorods have a natural red color. Over time, a silver shell layer forms that alters the shape and composition of the tag and color change begins to occur. The reaction is designed to reflect food deterioration based on expiration date and spoilage due to temperature changes. The color change goes from red to orange to yellow to green as the silver layer becomes thicker. For more information, please see:

https://www.cbsnews.com/news/smart-tags-change-color-when-food-gets-spoiled/

A Blast from the Past: ISCC Newsletter 50 Years Ago

Number 190 – September - October 1967 on ISCC website

Seated, left to right: M. Artom, Y. LeGrand, D. B. Judd, V. E. Kartachevskaia, M. Richter, W. Munch, J. L. Ouweltjes, and P. L. Walraven. Standing, left to right: E. Ganz, Mrs. Artom, W. D. Wright, R. W. G. Hunt, N. Macbeth, H. D. Einhorn, A. Stenius, G. Tonnquist, L. Plaza, J. Krtil, T. Higashi, F. Rotter, T. Fukuda, G. Wyszecki, and O. Bruckmueller.

This 1967 issue is 26 pages and begins with a story about ISCC's role in the formation of the International Color Association fifty years ago! First the ISCC Board of Directors met and they "enthusiastically endorsed" the formation of the International Color Association. They were also asked to agree on what the official names of this organization would be in France, Germany, Britain and the United States. The only difference between the British name and the American name was the spelling of the word "Color" for the Americans and "Colour" for the British. The German, British and American names all started with the word for "International" The abbreviations in French would be (AIC), German (IAC), British and American (ICA). The ISCC Board was asked to agree that the official abbreviation should be AIC for the French name "Association Internationale de la Couleur". The Board agreed and so it remains today 50 years later!

Deane B. Judd was sent as ISCC's representative to sign the AIC founding document in Washington D.C. on June 21, 1967. All those who attended that momentous meeting in Washington D.C. are shown in the picture above. The names highlighted in yellow in the picture caption are the individuals who co-signed the AIC founding document with Judd. Eleven other individuals, whose names are highlighted in green, signed another document to declare their support for this new international color organization, AIC.

It was made clear at this meeting that AIC was to be an organization of National Color Associations from around the world rather than of individuals. So ISCC from the United States of America joined AIC and Deane B. Judd was representing the ISCC Board at this first AIC meeting.

Professor W. David Wright from Britain was elected as the first AIC President and Ernst Ganz from Switzerland was elected Secretary to serve their first terms from 1967 until the next meeting in Sweden in 1969. Gunnar Tonnquist (Sweden) would serve AIC to represent the host for the next meeting in his home country.

I hope you enjoy seeing this classic picture of the founders of the AIC as much as I do! There truly are many great people who formed the foundation of color science as we know it today in this picture!

Another gem found in this newsletter is an announcement of Yves Le Grand's book, Form and Space Vision translated into English by Michel Millodot and Gordon G. Heath and published in 1967 for $17.50. (Please see LeGrand seated in the above picture.) This classic book "is concerned with the physical and physiological bases of vision of details, forms, movements, and depth, through which we obtain our everyday knowledge of the world around us."

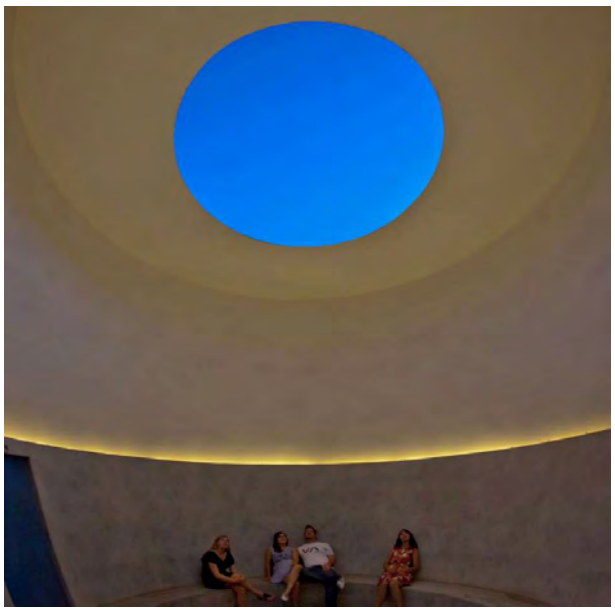
https://www.calibanbooks.com/pages/books/C000012881/yves-le-grand-michel-millodot-trans-gordon-g-heath-trans/form-and-space-vision-revised-edition

Paula J. Alessi,
ISCC News Editor

refractions
seemingly random musings on color

The Shape of Perception

The Art of James Turrell



James Turrell. *Knight Rise* Scottsdale Museum of Art, AZ (Image Sean Deckert, source: http://www.scottsdalepublicart.org/permanent-art/knight-rise-skyspace

You enter a cylindrical structure through a rectangular door. Inside the space is simple and empty; no ornamentation, just a minimalist sense of space and materials, wood stone and concrete. The room is empty except for a bench that runs around the inside of the curved walls. People are sitting here and there, looking up at a circular monochromatic[1] light on the ceiling – the light is intense and uniformly luminous, and surrounding the light is a domed ceiling lit by hidden orange lights. The colors are sharp, saturated and seductive. You sit for a while looking at the central blue disk, a rich saturated colored object, and then you realize it is not an object at all - it's a hole. You are looking at the sky! What seemed so solid, so real, was an illusion. It was not 'in' the room in any usual sense of the word, but you felt like you could just reach up and touch it. And then something else begins to happen – the sky begins to change color. What seemed a rich ultramarine blue is now becoming emerald green, as the lights inside the room shift to red. The sky is changing color, but skies don't change that fast. Between what you see and what you know, there is a disconnect. Do you trust your senses? For the moment, such things don't matter as you become entranced by the sheer presence and beauty of light and color inside one of the *Skyspace* sculptures of American artist, James Turrell.

James Turrell. (1943 -) with Roden Crater in the background. (Photograph by Florian Holzherr 2005, Image source http://fadmagazine.com/2013/12/20/preview-2014-pace-london-presents-james-turrell)

Turrell is an artist whose work is designed to be experienced. You need to take time with it, let your eyes adjust and then revel in the simplicity and sensuality of the experience. He wants to make light tangible, and to give it a presence, almost a solidity. Even the presence of clouds does not disrupt this illusion, such atmospheric phenomena merely create the impression you are looking at a video screen, again *inside* the space. His spaces invite quiet meditation – no doubt an influence of his Quaker heritage, and the meeting house tradition of seated contemplation.

Historically, many artists have dealt with light and color, from Carravaggio's dramatic spot light effects to the ethereal work of the painters, J M W Turner and Claude Monet. But whereas painters dealt with *depicting* light and color, especially the reflective surfaces of the world, Turrell emerged as part of a new wave of artists in the 1960's known as the Light and Space movement, artists that used light as a medium in and of itself.

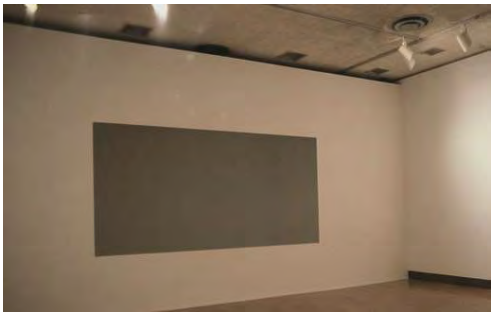
His most popular series, the *Skyspace* works described above, now number some 80 installations all over the world. They are simple concepts that involve a room with an oculus, or geometric window, cut into the ceiling. The oculus isolates a small piece of the sky for the viewer to observe. The walls are then lit inside with a series of colored lights that transform the experience. This is based on the simple principle of *simultaneous contrast*, first codified by Chevreul and Goethe in the 19th century. By changing the color of the ceiling, the color of the sky

continued on next page

appears to change accordingly. It is like an object lesson, right out of Joseph Alber's iconic book *The Interaction of Color*. These works make the color of the sky look somehow tangible and solid – a geometric shape that seems to be in the room with you.

James Turrell. From the Skyspace series. Top right: Installation view of the exhibition James Turrell at the Solomon R. Guggenheim Museum (Image source https://www.guggenheim.org) Top left: *Roden Crater, East Portal*: (Image source https://theartstack.com). Bottom right: *The Way of* Color Crystal Bridges Museum of American Art, Bentonville Arkansas. (Image source http://hirambutler.com). Bottom left: *The Color Inside* College of Fine Arts University of Texas, Austin. (Image source https://news.utexas.edu/2013/10/14/step-inside-uts-newest-masterpiece)

This concept, of light made tangible, grew out of his earlier work such as *Acton* of 1976. In these pieces, a section of the room was walled off with a rectangular 'window' cut into the dividing wall. Both rooms were lit in such a way that the rectangular window looked like a monochrome painting on canvas. It was only after staring at it for some time, or heeding the guard's advice to (get this) 'touch the painting' that the viewer realized there was nothing there!



James Turrell. *Acton* (1976), located in the Indianapolis Museum of Art, which is in Indianapolis, Indiana (Image source https://www.guggenheim.org)

As Turrell often says regarding his work, "*With no object, no image and no focus, what are you looking at? You are looking at you looking. What is important to me is to create an experience of wordless thought."*

For the last several decades, Turrell has been working on his unfinished magnum opus - *Roden Crater,* a giant structure built into an extinct volcano in Flagstaff Arizona. The piece is designed to be a "naked-eye observatory for experiencing celestial phenomena"[2] and incorporates many of his ideas on a grand scale.

Roden Crater, in progress. Near Flagstaff Arizona. (Image source https://www.designboom.com)

The crater is not yet available to the public, only to select guests and friends, but his other works, like the *Skyspace* installations can be found in museums and galleries all over the world and are well worth a visit if you get the chance.

Footnote

1. The term 'monochromatic' as used in this article, refers to the artistic sense of the term; to appear as a single color, and not the radiation of a single wavelength.

References

2. Finkel, Jori. James Turrell Shapes Perceptions. The Los Angeles Times. May 11, 2013.

Carl Jennings
University of Hawai'i
Please visit Carl's blog at
http://cjenning.wix.com/refractions for comments and feedback on his articles!

HUE ANGLES

(Send contributions to mbrill@datacolor.com and see http://hueangles.blogspot.com))

Does a Mantis Shrimp have a Real Color Space?

The small mantis shrimp (a stomatopod crustacean) has a mean right hook--able to accelerate its "punch" to a speed of 50 mph in a few milliseconds, smashing prey and glass fish tanks. It also has an amazing visual system, with 12 or more different receptor cells covering 300 to 720 nm.

Mantis shrimp from the front: https://en.wikipedia.org/wiki/Mantis_shrimp

A fairly recent article by H H Thoen et al. in *Science* [1] describes two hypotheses for the color vision of a particular mantis shrimp (one of more than 500 known species). The first hypothesis is that the color vision is "like ours" in making opponent-pair comparisons between receptor types that allow good discrimination of wavelength. The other hypothesis is that the mantis shrimp processes each kind of receptor input (spectral band) separately, a method that would give poor wavelength discrimination but might have other advantages. It turns out that, despite having many more photoreceptor types than we do, the mantis shrimp has poorer wavelength discrimination. Therefore, Thoen et al conclude that the mantis shrimp has no color space at all, but recognizes reflectances by comparing inputs to each kind of receptor separately. The idea is that color discrimination (e.g., by humans) is facilitated by a ratio (comparison) between spectral bands at the same point in the visual field, whereas the mantis shrimp performs ratios of inputs at different spatial locations to each spectral band separately, and thereby performs reflectance recognition at 12 spectral bins. The authors claim that the mantis-shrimp spectral sensitivity curves are narrow enough so that within-band ratios derived from them exhibit illuminant invariance (color constancy) and allow the mantis shrimp to accurately recognize a reflectance in 12 bins. But the spectral sensitivity curves of the mantis shrimp, shown in Fig. 1A of the same article, tend to have bandwidths of about 100 nm, similar to our own receptor sensitivities. The poor wavelength discrimination of the mantis shrimp seems to be experimental fact, and that would imply a reduced inter-band comparison. However, that does not mean color constancy by within-band ratios must be enhanced in this animal.

Another of these authors' ideas seems to have more traction. If the bands act separately, the neural processing may be accelerated to match the mantis shrimp's top-speed lifestyle. The quickly passing world could be processed by a kind of "push-broom sensor" architecture, whereby the 12 kinds of receptors are arranged in one spatial direction, replicates of the arrangement occupy the perpendicular spatial direction, and motion in the first spatial direction accumulates spatial details in a time-encoded form. Such a design is common for the push-broom sensors that we use in our remote sensing apparatus based on the same principle.

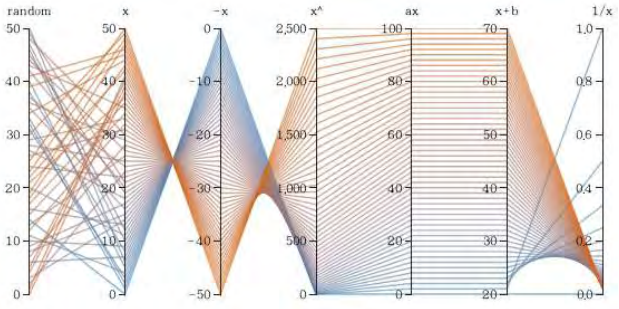
Yet another idea from Thoen et al. is also worth mention: These authors seem to believe that a true color space requires inter-band comparisons, and that such comparisons impose a processing overhead that may not be acceptable to a simple if strongly aggressive creature such as the mantis shrimp. This rationale bears comparison with the idea, briefly explored by Mark Fairchild ([2], [3]), that even humans don't need a color space at all, and that what we call color can be expressed with a small number of one-dimensional scales. By this reasoning, color space is a construct of theory, and not intrinsic to visual information.

Such discussion will inevitably lead to a philosophical and definitional problem. What, after all, comprises a color space, versus "not-a-space"? Mark Fairchild required a space to have a metric, but I think that requirement could be waived, as could Thoen's band-comparison requirement. To me a space is just a representation that allows important features to be salient. It's hard to visualize a structure in a 12-dimensional space (such as that of the mantis shrimp investigated by Thoen, et al.), if that space is represented in conventional rectangular coordinates. But there's an alternative picture, in which the 12 coordinate axes are lined up parallel with each other and evenly spaced in a plane. Each spectrum is a 12-component object in the space, and shows up as a point on each of the parallel one-

continued on next page

Hue Angles continued

dimensional axes. The original 12D point is represented as an open polygon, with vertices being the component values along the consecutive axes, and line segments connecting the consecutive vertices. Such a structure allows you to see 12-dimensional structures in two dimensions. For example, all the points on a line in the 12-dimensional rectangular space generate a set of 11 intersection points that characterize the line. The use of parallel coordinates to represent high-dimensional data was invented by Alfred Inselberg more than 30 years ago [4]. Maybe our champion mantis shrimp is using such a representation to track prey, detect mates, and fool anthropocentric color researchers.



Representative sample of parallel coordinates [By Yug - Own work, CC BY-SA 4.0, https://commons.wikimedia.org/w/index.php?curid=37631153]

References:

[1]. H H Thoen, M J How, T-H Chiou, and J Marshall. A different form of color vision in mantis shrimp. *Science* Vol. 343, 24 Jan 2014, 411- 413.

[2] M D Fairchild. Is there really such a thing as color space? Foundations of uni-dimensional appearance spaces. *ISCC/IS&T/SID Special Topics Meeting Revisiting Color Spaces*, San Jose CA (2011), 21-22.

[3] M D Fairchild and R L Heckaman. Deriving appearance scales. *IS&T Color and Imaging Conference* 20 (2012), 281-287.

[4] A Inselberg. The plane with parallel coordinates. *Visual Computer* 1 (4): 69-91 (1985).

Michael H. Brill, *Datacolor*

COLOR research and application

IN THIS ISSUE, August 2017

We start off this issue with three articles on various aspects of LED lighting. In the first article, Haiting Gu, Michael Pointer, Xiaoyu Liu, and M. Ronnier Luo report on two studies in which they investigated the quality of sources simulating CIE illuminants D50 and A and compared the traditional fluorescent simulators with simulations with the LED sources. Their studies involved observer comparisons of the color appearance of metameric pairs of samples and evaluation of the color inconstancy of one of the samples in each pair in the various lighting conditions. Their findings, reported in "Quantifying the Suitability of CIE D50 and A Simulators Based on LED Light Sources," revealed that LED sources, based on a limited number of channels, can still achieve the desired quality specified by the ISO 3664 standard and LED sources showed priority over the conventional sources, with better or equal performance in simulating International Commission on Illumination (CIE) illuminants D50 and A.

One of the tantalizing ideas with LED sources for general lighting is that LEDs provide an opportunity for spectral engineering, that is, manufacturers can engineer the spectral power distribution by placing the optical radiation at appropriate wavelength regions for better color rendition, whiteness rendition, brightness perception, and/or circadian rhythms. In addition, as mentioned in the first article in this issue, LED sources can also provide standardized lighting conditions for industrial applications, whose spectral power distributions are standardized by the CIE. In "Optimization of a Spectral-Tunable LED Daylight Simulator," Minchen Wei, Biao Yang, and Yandan Lin use a genetic algorithm to investigate optimized channels for each daylight simulator. They found that at least six LED channels are required to produce high quality daylight simulators in terms of the CIE metamerism indices. Using LEDs centered at six specific wavelengths can produce D50, D55, D65, and D75 simulators with good performance, in terms of the CIE metamerism indices and color appearance of various color objects under such a daylight simulator is found to be very similar to their appearance under a corresponding daylight illuminant.

Since LED sources can be engineered to fit special situations, could LED sources be designed to help people with color vision deficiencies? Shigeharu Tamura, Yosuke Okamoto, Seiji Nakagawa, and Yasushi Shigeri decided to determine if certain wavelengths of light could improve color discrimination ability of subjects with deutanopic anomalies. They tried seven different LED lights from 450 to 660 nm and with an additional D65 white lamp to

continued on next page

change the lighting conditions, including the wavelength and intensity, to see if there were differences in the observers' discrimination of color. In "Light Wavelengths of LEDs to Improve the Color Discrimination in Ishihara Test and Farnsworth Panel D-15 Test for Deutans," they report that color identification of deutans was markedly improved when the longer wavelength LEDs were used.

Just as researchers are trying to refine new light sources, instrument manufacturers are seeking to eliminate the sources of measurement errors. One source of errors in spectrophotometers is stray light, which can be divided into two types: near- band and off-band stray light. In our next article, Kenji Imura, Yuzuru Yamamoto, Yohsuke Takebe and Yoshiroh Nagai discuss a method of "Practical Correction of Achromatic Stray Light in Spectrographs for Colorimetry Using No Line Spread Function." Their proposed method was evaluated with two dual-channel array spectrographs with and without 2nd-order-rejection filters. They show that the errors caused by off-band stray light in the pixel outputs from the array were successfully corrected. They report that the method is practical, effective, and robust enough to work in an inexpensive hand-held spectrophotometer with the compact spectrograph, which often suffers from off-band stray light.

Since its introduction about 15 years ago, CIECAM02 has been widely accepted in cross-media reproduction. Now the question is whether it can it be used in illumination-related studies. The reason this is a challenge is because the CIECAM02 calculations require colorimetric values for a reference white and background luminance ratio, neither of which is readily available in lighting applications. Therefore, Pei-Li Sun, Hung-Chung Li, and M. Ronnier Luo set out to study how "Background Luminance and Subtense Affects Color Appearance." They conducted two psychophysical experiments to investigate the color appearance under non-uniform surround conditions with variation of stimulus luminance, surround luminance, background luminance, background orientation and background size. They found that orientation of background pattern and the size of stimuli are not that important. They also found that the luminance of the adapting field could be estimated by Gaussian-like functions, using a UGR-based model, which was also optimized for brightness estimation. UGR refers to the CIE Unified Glare Rating.

In the study of color, often small colored samples are used for experiments rather than evaluating color of objects directly. Our next article, "Color Meaning in Context" is written by Seahwa Won and Stephen Westland. They asked does the context of the color, that is, when the color is applied to an object, change the observer's evaluation? Again, in this research, two experiments were performed; the first showing very little effect of context, but the second showed more significant differences (43%) between chip meaning and context meaning. Is the surprise the degree to which color meanings are invariant to context or the need for context for color planning? It is encouraging that often chips can produce useful information in color research.

The advent of our digital-based electronic systems has made it possible for easy to capture, store and transmit high resolution images, but this requires enormous amounts of space and bandwidth. Therefore, this advancing science is coupled with investigations of image compression techniques. Muhammad Safdar, M. Ronnier Luo, and Xiaoyu Liu report on a "Performance Comparison of JPEG, JPEG 2000 and Newly Developed CSI-JPEG by Adopting Different Color Models." The performance of various image compression algorithms was evaluated in terms of compression rate, color accuracy, and visual quality. They found increasing improvement over the older methods with the CAM02-UCS performing best among other selected models in terms of compression rate and image performance for all three image compression algorithms. It was also found that CIEDE2000 can be reliably used for assessing quality of compressed images with low levels of distortion.

Next, we take imaging into the field of archiving, where Ana López-Montes, Francisco José Collado-Montero, Esther Castillo, Rosario Blanc, Domingo Campillo and Teresa Espejo describe the archiving of a 14th century manuscript "Registro Notarial De Torres." The Registro Notarial de Torres is a compilation of notes made by the public notary, Antón García between 1382 and 1400. Historically before printing became mechanized, the materials upon which books and documents were hand-written or drawn was often reused. In the case of the Registro, the binding, which is a fragment of a parchment belonging to a Visigothic codex, is of extreme historical value. Therefore, it was decided that the parchment binding of the notarial register should be conserved as a separate document. This project is described in our next article, "Aging Analysis of a Color Facsimile Binding for the 14th Century Manuscript "Registro Notarial De Torres."

Our next article, "Color Separation for Improved

continued on next page

CR&A In This Issue, August 2017 continued

Perceived Image Quality in Terms of Graininess and Gamut" looks at printing of images with newer printers. The traditional color printers use four inks: cyan, yellow, magenta, and black. However, multichannel printing allows the use of additional inks: either light inks (usually lighter versions of the traditional inks) or additional inks of secondary colors such as red, green, and blue. Light inks help to avoid the potential flaw of graininess in an image, while additional inks can increase the printer color gamut, but add the need to control the ink overlap in order to avoid over-inking. Paula Yadranka Žitinski Elías, Daniel Nyström, and Sasan Gooran propose a multichannel color separation approach that solves the one-to-many mapping problem when performing the color separation using a cost function, and weighting selected parameters that influence image quality in terms of colorimetric accuracy, graininess perception, and ink consumption.

CIE Technical Committee 1-86 is exploring models of color emotion and harmony based on existing psychophysical data obtained by different research groups or networks for applications in the color design area. However, most available harmony models are based on results found with just uniform color patches, which is a very different situation than color to be used in design applications. Therefore, Min Huang, Guihua Cui, Manuel Melgosa Latorre, Hao Xue Liu, Yu Liu, and M. Ronnier Luo undertook a study of "Color Harmony in Two-Piece Garments" to supplement the materials for TC 1-86. Observers (age 20 to 78) made assessments of the color harmony in 300 images of women with different jacket-trouser color combinations. They found predictions of their current results using three previous color-harmony models were unsatisfactory, showing that five existing color-harmony principles were found to be consistent with their average experimental results, although in only slightly more than 50% of the cases.

"Color Appearance Modeling of Bicolor Striped Woven Fabrics Considering Neighboring Color Effects" is the topic of our next article. In this article, Youngjoo Chae, John H. Xin, Tao Hua, and Nicy Luo investigate the effect of spatial and colorimetric attributes of neighboring color on color appearance shift in bicolor striped woven fabrics. Like the small dots in printing, the fine weave of fabrics has the result of changing color impressions of neighboring colors. Size, lightness, colorfulness, and hue have an effect on a test color's lightness, colorfulness, and hue. They derive an optimal color appearance model predicting the lightness, colorfulness, and hue of bicolor striped woven fabrics, and then verify its performance in color appearance predictions through the numerical and the statistical comparisons between the visually estimated and the predicted color appearances of test colors in 240 woven samples.

How can you make a gold appearance from a black material? Midori Tanaka and Takahiko Horiuchi tell the reader how it is done in our final article of this issue, "Perception of Gold Materials by Projecting a Solid Colour on Black Materials." Read the article to learn how the authors used a simple representation method to create the perception of gold on real objects using projection mapping technology.

We close the issue with two book reviews: Manuel Melgosa reviews Claudio Oleari's book, *Standard Colorimetry: Definitions, Algorithms and Software* and Rolf Kuehni reviews *Visual Phenomenology* by Michael Madary. Also, Juan Luis Nieves, President of the Color Committee of Spain has sent In Memoriam Antonio de la Cruz, who died in January in Madrid at the age of 91.

Ellen Carter
Editor, Color Research and Application

Basketball Court Filled with Color

http://time.com/4856236/paris-technicolor-basketball-court/

What can one do with a city playground lot that has an unusual shape? The solution to this problem was to fill it with a very colorful basketball court for youth!

This was done at the Duperre Pigalle playground in Paris, France. This space features a rubberized court, walls and hoops that the young people seem to enjoy!

The creators of this space feel that the multicolored theme could be the future of basketball and other sports.

Calendar

2017

Sep 11-15 **25th Color and Imaging Conference,** Lillehammer, Norway, Info: color@imaging.org

Sep 16-17 **ACM Symposium on Applied Perception,** Brandenburg University of Technology, Cottbus, Germany. Info: http://sap.acm.org/2017/

Sep 17-19 **SPE-CAD RETEC 2017,** Hilton Milwaukee City Center, Milwaukee, WI, Info: http://www.specad.org/2017-retec-cad-homepage/

Oct 3-5 **Joint Meeting of CIE/USA and CIE/Canada,** NIST, Gaithersburg, MD

Oct 13-15 **17th Annual Optical Society of America Fall Vision Meeting,** American University, Washington, D.C., Info: http://www.osavisionmeeting.org/2017/conf/index.php

Oct 16-20 **AIC 13th Congress,** International Convention Center, Jeju, Korea, Info: www.color.or.kr

Oct 23-25 **CIE 2017 Midterm Meeting,** Jeju Island, Korea, Info: www.cie.co.at

Oct 26-28 **CIE Division 1 and 2 Meetings,** Jeju Island, Korea, Info: www.cie.co.at

Dec 4-7 **International Workshop on Colour and Multispectral Imaging,** Jaipur, India, Info: http://www.sitis-conf.org/en/comi-2017.php

2018

Jan 13-16 **Color Management for Print Production Color (CMC) 2018,** San Diego, CA, Info: http://cmc.printing.org

Jan 24-25 **ASTM E-12,** Sheraton, New Orleans, LA, Info: http://www.astm.org

Jan 28-Feb1 **Electronic Imaging (EI) 2018,** Hyatt Regency San Francisco Airport, Burlingame, CA Info: http://www.imaging.org/site/IST/IST/Conferences/EI/Symposium_Overview.aspx

Apr 9-11 **American Coatings Conference (and Show),** Indianapolis, IN, Info: bettina.hoffman@vincentz.net

Apr 26-27 **CIE 2018 Topical Conference on Smart Lighting,** Taipei, Chinese Taipei, Info: www.cie.co.at

May 18-23 **Vision Science Society (VSS) 2018,** Trade Winds Island Resort, St. Pete Beach, Florida Info: http://www.visionsciences.org/general-information/

May 28-Jun1 **International Conference on Computer Graphics, Visualization and Computer Vision,** Pilsen (Prague), Czech Republic, Info: http://www.wscg.eu

Jun 14-17 **International Multisensory Research Forum (IMRF),** Toronto, ON, Canada, Info: http://imrf.info /wp_imrf/

Jun 25-28 **OSA Imaging and Applied Optics Congress,** Wyndham Orlando Resort International Drive, Orlando, Florida, Info: http://www.osa.org/en-us/meetings/osa_meetings/osa_imaging_and_applied_optics_congress/

Jun 11-15 **Joint ISCC/AIC Munsell Centennial Celebration,** MassArt, Boston, MA, Info: www.munsell2018.org

Sep 25-29 **AIC Interim Meeting, Colour and Human Comfort,** Portuguese Colour Association, Lisbon, Portugal, Info :https://www.facebook.com/apcor.org

Nov 6-8 **International Association of Color Manufacturers (IACM) Global Color Conference,** The Ritz Carlton, Pentagon City, Arlington, VA, Info: https://www.iacmcolor.org/news-events/global-color-conference/

ISCC Sustaining Members

Sustaining Members of the ISCC are organizations who support the mission and goals of the ISCC through financial or other support. With our Member Bodies, Sustaining Members also provide a critical connection to the color community. If you feel your company or organization should support the ISCC in this way, please contact the office for more information about member benefits.

Avian Technologies	www.aviantechnologies.com	603-526-2420
Datacolor	www.datacolor.com	609-895-7432
Hallmark	www.hallmark.com	816-274-5111
Hunter Associates Laboratory, Inc.	www.hunterlab.com	703-471-6870

We could still use your help!

ISCC has positions in the organization that need filling. We can help identify a place for you depending on your skills and desires. Contact Nomination Chair John Conant, jconant@aerodyne.com

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ISCC Member Bodies

At its foundation, the ISCC is composed of many related societies. These societies, our Member Bodies, help the ISCC maintain a relationship with each organization's individual members. We frequently hold joint meetings to further the technical cross-pollination between the organizations.

If you belong to one of our member body organizations, we encourage you to work with ISCC and your society to further the connection. Contacting the ISCC President is a good place to start. If your organization is not on this list and you think it should be, the ISCC office can provide you with details about membership.

Or use our new online application: www.iscc.org/applicationForm.php

American Association of Textile Chemists and Colorists (AATCC)
American Society for Testing and Materials International (ASTM)
American Society for Photogrammetry & Remote Sensing (ASPRS)
The Color Association of the United States, Inc. (CAUS)
Color Marketing Group (CMG)
Color Pigments Manufacturing Association (CPMA)
Council on Optical Radiation Measurements (CORM)
Detroit Colour Council (DCC)
Gemological Institute of America (GIA)
Illumination Engineering Society of North America (IESNA)
International Colour Association Environmental Colour Design Study Group (AIC – ECD)
International Color Consortium (ICC)
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Optical Society of America (OSA)
The Society for Color and Appearance in Dentistry (SCAD)
Society for Information Display (SID)
Society for Imaging Science and Technology (IS&T)
Society of Plastics Engineers Color and Appearance Division (SPE/CAD)