COLOR RESEARCH AND APPLICATION
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About eight percent of men (and ½% of women) in the general population have deficient color vision with the majority of those having some form of deuteranopia. Shigeharu Tamura, Yousuke Okamoto, Seiji Nakagawa, Takashi Sakmaoto and Yasushi Shigeri realized that the transition from current lighting to LEDs provides lighting designers and engineers an opportunity to optimize the light spectrum for special situations. They thought that with a specially selected spectrum people with deuteranopia would be able to discriminate the differences between certain colors better. In their article "Practical color barrier-free illumination for deuteranopia using LEDs" they report how by careful selection of the combination of specific red, green and blue LEDs, they produce an illumination that allows both normal and deuteranopic observers to identify better the color numerals on the Ishihara color test and increase their ability to distinguish the hues of a color chip continuously in Farnsworth Panel D-15 test.

While we are on the topic of color vision tests, in our next article, "Test/retest and inter-test agreement of color aptitude measures" Andrew John Anderson and Alan Johnston examine both the reliablility of and agreement between five color aptitude tests: the Farnsworth-Munsell 100 Hue Test, the HVC Color Vision Skills Test, the ISCC Color Aptitude Test, the Nagel Anomaloscope, and a custom designed two-color discrimination test. Since no test can agree more with another test than it agrees with itself, they demonstrate that a principal reason why the color aptitude tests show poor inter-test agreement is that they each have a high degree of test/retest variability.

Next we have an article on color management. When an image is moved from one device, say a camera, to another device such as a printer or display, the color in the image is adjusted so that it will appear as similar as possible to the original. Usually this is done by mapping to and from an intermediate color space by using a standard chart to develop the correction factors for the colors. If the lighting on the standard chart is not even across the chart the correction factors will be need to be adjusted for the uneven lighting conditions. Graham David Finlayson, Maryam Mohammadzadeh Darrodi, and Michal Mackiewicz have developed a new, simpler method to make the adjustment. They call it "The Alternating Least Squares Technique for Non-Uniform Intensity Color Correction." Their method removes the need for an additional image of the gray chart.

Munsell color order system was created in 1095 by Albert H. Munsell, who was a practicing artist and teacher. By using a coordinate system of hue, value and chroma any color could be described clearly avoiding the confusion arising from common color names. The system is still widely used today. However, now we have computers and other digital devices that use a three phosphor to make colors. When one wants to display on a computer, a color that has be specified by its Munsell notation, the notation must be transformed to a digital system relating to the three phosphors of the computer, e.g., sRGB. To accomplish this Shih-Wen Hsiao and Cheng-Ju Tsai propose "A Residual Modified Transformation Formula from Munsell to sRGB Color System."

A series of articles on "Unique Hue Data for Colour Appearance Models" has been published in this journal in years: Part I: Loci of unique hues and hue uniformity was published in 2011; Part II: Chromatic adaptation transform in 2013 and now in we have "Part III: NCS Unique Hue Data" in this issue. In this study Kaida Xiao, Michael Pointer, Guihua Cui, Tushar Chauhan, and Sophie Wuerger use NCS unique hue data to evaluate whether the NCS unique hue data are consistent with the default unique hue angles used in the CIECAM02 color appearance model. They found a clear discrepancy between the NCS and the default unique hue loci for unique yellow and unique blue of CIECAM02. They also wanted to investigate the agreement of the unique hues in CIECAM02 across different media. So they compared physical samples of NCS colors with unique hue data of CRT self-luminous stimuli, and found that two data sets agree reasonably well in CIECAM02.

In our next article another group of authors also studied the unique hues of the Natural Color System (NCS). Remember, the International Lighting Vocabulary defines unique hue as a hue that cannot be further described by the use of hue names other than its own. The unique hues are red, yellow, green, and blue. The NCS also has intermediate hues placed halfway between the unique hues on the color circle. Renzo Shamey, Weethima Sawatwarakul, and Rolf G. Kuehni invited 24 participants to make a cognitive or mental comparison of a test hue to two reference hues and assess the possibility that the test hue could be generated from two reference component hues, in the mind, without any tools to physically perform a match or make adjustments to stimuli. The test hues were either unique hues or intermediate hues from the NSC system. They found responses for the two sets of panels were significantly different, giving credence to Hering's concept of unique hues that is basis of the NCS. See their article "Cognitive Comparison of Unique and Intermediate Hues" for further details and results.

Most experiments in color naming use colored patches, but people commonly look at objects and confidently give the color of the object, even though the shape of the object causes the color to vary due to highlights, shadows, and dimensional effects. In "Color Naming Experiments Using 2D and 3D Rendered Samples" Midori Tanaka, Takahiko Horiuchi, and Shoji Tominaga describe a study of 218 test colors comparing the color names observers gave to two-dimensional patches or three-dimensional objects colored with the same colors. They found a number of generalizable results, such as for chromatic colors, darker color terms are generally chosen for 3D samples in comparison to the corresponding 2D samples of the same color. They also found that by changing the the illumination position changed the color terms and the average brightness level of the sample. However, the samples with the same brightness level were ascribed different color terms depending on whether they were 2D or 3D.

Continuing with lighting issues we have two articles. First, studies have shown that the correlated color temperature (CCT) of the illumination can affect visual performance of office tasks, but is a higher always better? Rong-Hwa Huang, Leemen Lee, Yi-An Chiu, and Yi Sun investigated the "Effects of Color Temperature of LED Desk Lighting on Work Attention." They compared three LED desk lighting conditions 2700K, 4300K, and 6500K when testing business students with the Chu Attention Test, which measures focused and sustained attention. They found that there was a significant performance improvement under the LED light with the CCT of 4300K as compared to the LED of 6500K.

Spot lights are used in stores, public buildings, and increasingly in homes to highlight particular objects or spaces. Like other lights they have been characterized by their CCT and color rendering index. However, satisfaction of spot lighting seems to be based on the visual perception color uniformity of the field. In our next article Anne Teupner, Krister Bergenek, Ralph Wirth, Pablo Benítez, and Juan Carlos Miñano describe the “Optimization of a merit function for the visual perception of color uniformity in spot lights.” The merit function, a linear regression of four basic functions (color difference, shape, contrast, and symmetry) was developed by looking at the correlation between observer preferences and measureable factors of the uniformity of the illuminated field. The proposed merit function enables an objective analysis of measurements and optical simulations according to human preferences in a wide range of spatial color distributions.

Our last three articles in this issue are from the field of textile coloration. While textiles have traditionally been colored by dying either the threads or fabrics themselves, printing color onto the fabric has also gained acceptance. However, injet printing on textiles can be very different from printing on paper. Textiles can vary greatly in surface textures, and this affects the coverage and penetration of the inks. Kyung Hwa Hong, Jihyun Bae, and Traci Lamar report on The “Effect of Texture on Color Variation in Inkjet-printed Woven Textiles.” In their study, they found that the interaction of color and texture is complex. Texture had sufficient impact on color variation to affect pass/fail evaluation in an industrial setting, even when many printing variables are held constant. They conclude that instrumental measurements of surface texture may be valuable in anticipating visual response to texture in a production setting where use of visual perception measures is impractical.

Next Dejun Zheng proposes “A Novel Method for Fabric Color Transfer.” It involves automatic selection the colors from the natural images to develop a color design for fabric. An image of the color design makes it possible to obtain the membership function of the color deviations of the image. Then colors can be changed and transferred to a new image that preserves a similar texture appearance, but with significantly different color effects.

Color is one of the primary factors in determining whether a textile will be accepted or rejected by the buyer. With complex coloration on some textiles, instrumental determination of whether color variations will be acceptable or not can be involved and complex. Pengfei Li, Jing Wang, and Jun-feng Jing point out that an optimized back propagation neural network has a simple structure, shorter training time and better good accuracy when coupled with the CIEDE2000 color difference formula. In their article, “Application of Improved BP Algorithm in Chromatism Detection of Fabric” they describe an experiment that shows the color difference of fabrics can be detected with a high accuracy and efficiency when using this method.

We end this issue with a brief announcement about the CIE Standard General Sky Guide. Aimed at general users and designers, this report collects information for the application of the CIE Standard General Sky including an extensive list of references and recommendations for prediction methods, tools and computer programs.