



IS&T

# REPORTER

"THE WINDOW ON IMAGING"

Vol. 30 No. 1 January - March 2015

## HIGHLIGHTED PAPERS FROM RECENT CONFERENCES\*

### Color and Imaging: CIC 22

Winner of the Best Paper Award

#### A Similarity Measure for Large Color Differences

Nathan Moroney, Ingeborg Tastl, and Melanie Gottwals, Hewlett-Packard Laboratories (USA)

**Abstract:** Hundreds of large color differences, of magnitude 20  $\Delta E_{00}$ , were generated and used in a visual sorting experiment. The process of generating these color differences and two specific experiments are described in detail. The results show that small color difference metrics, such as  $\Delta E_{00}$ , do not consistently model the visually sorted differences for large differences. A new similarity measure, based on a cosine similarity between categorical vectors of colors, is described and used to more consistently model large color differences. This similarity metric can be used to better characterize large color errors during reproduction, for image processing operations such as segmentation or as a feature for content retrieval. The new measure can also be applied to visual phenomena, such as categorical perception, in which within category color differences are perceived as smaller than across category differences.

#### Winners of the MERL Best Student Paper Award

#### Adapting Color Difference for Design

Danielle Albers Szafir<sup>1,2</sup>, Maureen Stone<sup>2</sup>, and Michael Gleicher<sup>1</sup>; <sup>1</sup>University of Wisconsin-Madison and <sup>2</sup>Tableau Research (USA)

**Abstract:** CIELAB is commonly used in design as it provides a simple method for approximating color difference. However, these approximations model color perception under laboratory conditions, with correctly calibrated displays and carefully constrained viewing environments that are not reflective of complexity of viewing conditions encountered in the real world. In this paper, we present a data-driven engineering model for parametric color difference that extends CIELAB to be more broadly applicable to real-world conditions. Our model can be tuned to a desired range of viewers and conditions [continues top of page 2](#)

### Technologies in Digital Photo Fulfillment: TDPF2015

#### Proven Digital Output Products Leveraged from Robust Technology Platforms

Patrick Webber, Kodak Alaris (USA)

**Abstract:** Kodak Alaris leverages a number of technology platforms to create a broad range of digital output products. We are able to rapidly commercialize products to meet specific customer requirements, while at the same time serving a wide range of customer applications from a common platform. This advantage is enabled by a clear understanding of individual market requirements combined with a very responsive mechanism for custom product tuning to meet specific customer preferences around the globe. As a global manufacturer and marketer of a broad portfolio of photographic media the ability to efficiently localize products from a common platform is an important aspect of leveraging R&D and manufacturing scale while uniquely serving the needs of a given geographic market. Technology platforms that demonstrate this leverage include the KODAK PROFESSIONAL ENDURA Premier Media's family of silver halide technology, the formulation of professional grade photographic paper base, KODAK ESTAR base support technology, and a deep and continually evolving understanding in [continues bottom of page 7](#)

\* These papers were presented at CIC22, held November 3 – 7, 2014 in Boston, Massachusetts, and the International Symposium on Technologies in Digital Photo Fulfillment, held January 4 – 5, 2015, in Las Vegas, NV.

To view the full papers of these abstracts from either conference for no fee go to [www.imaging.org/ist/publications/reporter/index.cfm](http://www.imaging.org/ist/publications/reporter/index.cfm)

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using a simple modeling procedure, while minimally increasing the complexity of the model. We demonstrate our approach empirically by modeling color differences for the web by leveraging crowdsourced participants.

**Winner of the Cactus Award**

## Colour Separation of $n$ -Colour Printing Process Using Inverse Printer Models

*Kiran Deshpande, London College of Communication (UK); Phil Green<sup>2</sup>, Gjøvik University College (Norway); and Michael R. Pointer University of Leeds (UK)*

**Abstract:** Although the  $n$ -colour printing process increases the colour gamut, it presents a challenge in generating colour separations. This paper evaluates different methods of implementing the inverse printer model to obtain the colour separation for  $n$ -colour printing processes. The constrained optimisation and the look-up table based inversion methods were evaluated. The colour space was divided into sectors of 4-inks and the inverse printer models were applied to each sector.

The results were found to be adequate with the mean CIEDE2000 values between the original colours and the model predicted colours below 1.5 for most of the models. The lookup table based inversion was computationally faster than the constrained optimisation approach. The 9-level lookup table model gave accurate prediction without costing the processing time. It can be used to replace spot coloured inks with the 7-colour printing process in packaging printing to achieve significant cost savings.

## Adaptive and Affective Luminance Contrast on Optimal Brightness of Displays

*Nooree Na and Hyeon-Jeong Suk, KAIST (Korea)*

**Abstract:** In this study was investigated the range of optimal luminance contrast needed to enhance user physiological comfort and psychological satisfaction while viewing displays. Diverse instances of luminance contrast were collected, of which both ambient luminance and object luminance were measured, and subjective judgment was notes for first-time viewing and after continuous viewing. The result revealed that the optimal luminance contrast is not static. The optimal ratio between ambient luminance and object luminance changes gradually as viewing time increases, and in particular, it converges into a smaller range. The optimal brightness of object luminance in a dark environment needs to be increased, whereas that in bright environments needs to be decreased. Therefore, the duration of viewing should be considered to define optimal luminance contrast, and hence a dynamically adaptive luminance contrast is proper to

maintain affective viewing quality of internally lit objects such as smartphone displays and e-books.

## An Image Difference Metric based on Simulation of Image Detail Visibility and Total Variation

*Marius Pedersen, Gjøvik University College (Norway)*

**Abstract:** Many image quality and image difference metrics have been proposed over the last decades. An important factor when evaluating the image quality or image difference is the viewing distance. In this paper we propose a new image difference metric based on the simulation of detail visibility and total variation. The simulation of detail visibility by using shearlets takes into account the viewing conditions and the viewing distance, and calculation of the image difference is done by total variation. Evaluation has been carried out to verify the simulation of image detail visibility, and it is showing promising results. Evaluation of the new image difference metric is also promising.

## Noise Characteristics of a Single Sensor Camera in Digital Color Image Processing

*Tamara Seybold, Arnold & Richter Dine Technik; Özlem Cakmak, Christian Keimel, and Walter Stechele, Technische Universität München (Germany)*

**Abstract:** Denoising algorithms are usually tested on standard test images with artificial white Gaussian noise added. This noise model cannot be applied in the denoising of digital images taken with a single sensor camera because of the signal-dependence of the noise, the demosaicking and the color transformations. We study the noise characteristics with respect to the signal domain. Noise distribution and variance are measured in the raw data and approximated using a Gaussian distribution with a variance linearly dependent on the signal. We evaluate the influence of white balance, debayering and the signal domain and calculate the spatial correlation of the noise. In our experiments we both evaluate the influence of the noise characteristics on human perception and on the performance of denoising methods. Based on a subjective test with 18 participants we can show that the spatially correlated camera noise is more visible than the white Gaussian noise and decreases the visual quality of color image sequences significantly. To evaluate the impact of the noise characteristic on denoising, two state-of-the-art denoising methods are applied to our test data. When the noise is signal-dependent and spatially correlated through debayering the peak signal-to-noise ratio (PSNR) decreases by up to 8 dB. We conclude that it is very important to take into account the correct noise characteristics for increasing the visual quality of color image sequences in future research. ▲

# 2014 CIC Program Explores New Territory

## CIC22: Twenty-second Color and Imaging Conference Travels to Boston

By Jennifer Gille, Vien Cheung, Marius Pedersen, Michael Murdoch, Jon Hardeberg, Dietmar Wueller, and Juan Lin

The Twenty-second Color and Imaging Conference (CIC22) was held, in conjunction with the 2nd International Congress of the International Academy of Digital Pathology (IADP), in Boston (Massachusetts) on November 3-7, 2014. The conference committee took advantage of this collocation to create a program that retained the core features of CIC, but included a half-day program devoted to digital pathology, color, and imaging, as well as keynotes throughout the conference relevant to both groups. Attendees were able to attend talks at either event.

The core CIC program consisted of six oral-paper sessions—Do You See What I See? (color vision), Picture Perfect (image quality), Beyond the Rainbow (multispectral imaging), Bright Ideas (color in illumination), Colorful Language (color difference and measurement), and Putting Color to Work (color systems and profiles)—featuring 21 papers, complemented by 25 Interactive Papers. All CIC submissions are peer-reviewed full papers. In addition, there are two papers in the proceedings that were part of the Workshop program.

### Conference overview

The five day event began with an extensive short-course program on a wide range of topics in the area of color management, color vision and appearance, color systems, and color devices and technology.

### Short Course Summary

The 2014 conference ran 15 courses with topics including CIC classics like colorimetry and displays along with newer topics such as LED lighting, HDR imaging, and—because of the connection with IADP—whole-slide imaging. Nearly 200 class tickets were sold, with many classes topping out at close to 20 or more students. Comments from those taking class-



Photo: Jennifer Gille.

CIC22 successfully debuted four workshops held Friday morning: From Image Processing to Visual Neuroscience Through the Retinex Theory of Color; New Insights on Metamerism; Camera Color Characterization (above); and Next Generation Color Printing.

were very positive about the courses and instructors. Fully 82% of survey responses rated the courses “good” or “excellent” and the same percentage said they would recommend the course to a colleague. Several courses included lively discussions, which were appreciated by attendees and indicates strong interest in the topics.

### Technical Program Structure

The oral papers were presented in a single-track format with the interactive papers previewed during two spotlight sessions, followed by the traditional conference-wide poster display where participants explored topics in-depth with authors.

This year the conference offered a unique opportunity for researchers and practitioners in two overlapping fields to discuss challenges, share knowledge, and look for collaborations of mutual benefit. The collocated meetings shared the keynote talks, while retaining individual conference programs.

Some of the speakers were coming to CIC for the first time, thus lending a fresh and exciting dimension to the conference.

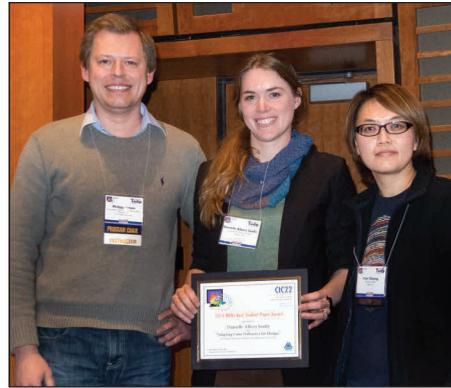
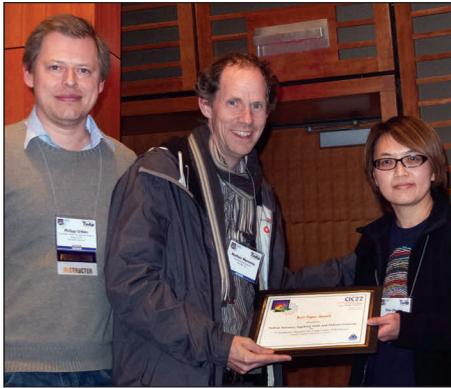
### 2014 Keynotes

The keynote presentations were given by five highly distinguished individuals:

## CIC 22/IADP 2014

Attendees*:	221
Oral Papers and Keynotes:	60
Interactive Papers:	31
Short Courses:	15
Workshops:	4
Exhibitors:	6
Dates:	Nov. 3-7, 2014
Location:	Boston, MA
*includes Short Course only and guests	

- Ted Adelson, John and Dorothy Wilson Professor of Vision Science at MIT and member of the National Academy of Sciences and the American Academy of Arts and Sciences, introduced the conference to a novel technology for measuring high-resolution surface topography in his talk “Sensing Surfaces with GelSight.”
- Dr. Guillermo J. Tearney, pathologist at Massachusetts General Hospital, professor of Pathology at Harvard Medical School, and associate director of the Wellman Center for Photomedicine, discussed “Microimaging: Seeing the Unseen in Living Patients.”
- Todor Georgiev, principal engineer at Qualcomm, inventor of the Photoshop® Healing Brush and other features, and holder of more than 50 patents, shared his insights into a new plenoptic 2.0 imaging



Photos: Jennifer Gille

Program Chairs Philipp Urban and Vien Cheung with Best Paper Author Nathan Moroney (left; see page 1 paper for abstract); MERL Prize Winner Danielle Albers Szafrin (middle; see page 1 for paper abstract); and Cactus Award for Best Interactive Paper winner Kirin Deshpande (right; see page 2 for paper abstract).

approach in “Plenoptic Cameras and Microscopes: Multimodal Capture.”

- Dr. Ronald S. Weinstein, professor at the University of Arizona, and—for 32 years—head of Pathology there, looked at “Human Factors in Telepathology: The 21st Century Agenda.”
- John McCann illuminated the rich history of Bostonians who have studied human color vision, beginning with Benjamin Thompson’s (Count Rumford’s) study of complementary colors in 1793 in “Color Research in Boston.”

**CIC/JIST journal option**

This was the first year that CIC offered the option to submit a paper to the *Journal of Imaging Science and Technology* (JIST) as one path in the CIC paper submission process. Accepted papers were published

in JIST, appeared in the CIC proceedings as reprints, and were presented at CIC within the technical papers program. The published papers needed to meet the high standards of JIST in terms of scope, originality, relevance of topic, completeness of background, references to prior work, completeness of results and discussion, and quality of language. JIST received 13 CIC 22 submissions; of these three were accepted as JIST/CIC papers and presented at the conference:

- *Modeling Observer Variability and Metamerism Failure in Electronic Color Displays* (David L. Long and Mark D. Fairchild)
- *Prediction of Incomplete Chromatic Adaptation under Illuminant A from Image* (Shoji Tominaga, Takahiko Horiuchi, Shiori Nakajima, and Mariko Yano)

- *Image Sensor Modeling: Color Measurement at Low Light Levels* (Mehdi Rezagholizadeh and James J. Clark)
- We consider the CIC/JIST option a success and it will be an option for future CIC submissions.

**Interactive Papers**

This year’s interactive papers were wide in coverage, including color and imaging topics related to display, cameras, printers, and mobile devices. Topics such as color filters applied in wearable displays, camera noise characteristics and spectral sensitivity estimations, perceptual spatial uniformity assessment of projection displays, and different color models to test JPEG were some of those covered. The paper “Color Separation of *n*-Color Printing Process Using Inverse Printer Models” written by Kiran Deshpande, Phil Green, and Micheal Pointer won the Cactus award for best poster. This paper evaluates different methods of implementing the inverse printer model to obtain the color separation for *n*-color printing processes.

**CIC Workshops**

Based on a format that has been successful at other conferences, this year CIC introduced workshops to the CIC program mix. The intention of this half-day event is to give presenters and participants a different format for discussing hot topics, recent research, and topics of interest in more depth. Topics were proposed by individuals who became responsible for chairing the workshop. The proposal included



Photos: Jennifer Gille

Two awards were presented at CIC. At left, IS&T Executive Vice President Geoff Woolfe presented Sabine Süssstrunk with IS&T Fellowship for “for outstanding contributions and research leadership in the fields of photography, image processing, and computer vision.” Right, Hans van Dormolen and his wife Ina celebrate the Service Award he received “for his work in objective capture practices for cultural heritage imaging.”

### One Keynote Indepth: Investigating Plenoptic Cameras

Todor Georgiev introduced his keynote, Plenoptic Cameras and Microscopes: Multi-modal Capture, by discussing image capture with conventional and plenoptic cameras. For a pinhole camera or a traditional lens camera, the angular information that is present in the light rays is lost in projection onto the 2D sensor. By introducing an array of microlenses before the sensor surface, or at the main lens, information about angle and therefore 3D is captured and recovered later through computation or other optical methods. Plenoptic 1.0 and 2.0 image capture was discussed and compared. For the first time a Plenoptic 2.0 microscope and a microscope with microlens array at the objective were introduced.

Georgiev expanded the technique of lightfield imaging beyond re-focus and 3D by showing that through alterations or filtering applied at the main lens, the microlenses, or the sensor elements, plenoptic imaging can be used for High Dynamic Range, Multispectral Color, and Polarization imaging, each from a single snapshot. This method is applicable both for cameras and microscopes, and is irreplaceable especially in the case of video.

A polarization example is illustrated in Figure 1. Four polarizing filters at the main lens aperture allow reconstruction of the image as traditionally recorded (a), or can be used to computationally synthesize the image as if captured with a filter rotated to any polarizing angle—after the fact. Examples are: eliminating the polarized reflected light from the water (b), or separating out the polarized-only light (c). Note that no single filter can produce the polarized-only image (c).

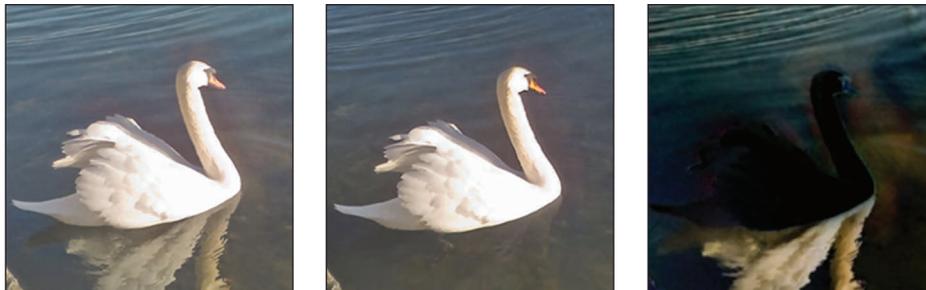


Figure 1: Original image (a); unpolarized only (b); and polarized only (c).

a description of the event (its format and coverage) along with a list of invited speakers. Four workshops were held in Boston; each was run in parallel and attendees were encouraged to choose one, although some navigated between them. The workshops were

- From Image Processing to Visual Neuroscience Through the Retinex Theory of Color;
- New Insights on Metamerism;
- Camera Color Characterization; and
- Next Generation Color Printing.

The workshop format was a hit and succeeded in presenting different sides of color imaging science, from fundamentals to applications. The format allowed more

participation from the audience while being different than a short course as there was more interaction. Scheduled in the morning of the last conference day the atmosphere was suitable for conversation. After a two full days digesting intense color science talks, the workshops provided the possibility of putting everything in a wider perspective: how is the research diffused into the real world, what are the new trends, where is our field of research going, and how are different subfields linked to each other.

#### Exhibit and Social Program

Six companies, including those in both the color and

*continues top of page 11*

### One Workshop Indepth: Camera Characterization

For the first time CIC included a workshop on different topics as part of the program and one of them was on camera characterization. It covered the whole process of camera color characterization—in theory and practice. The workshop's purpose was to demonstrate state-of-the-art technologies as many camera manufacturers still rely on old test chart based color characterization methods because they are either reluctant to change an established system or do not fully understand what modern technology can do.

The goal of the workshop was to identify and demonstrate known issues in this process and provide potential solutions using latest technology like multispectral LED light sources in combination with *in situ* measured spectral radiances of natural objects and modern implementations of color look up tables. In this way, participants received all the information they need to implement advanced color correction in their cameras and software.

Sabine Süsstrunk (EPFL) moderated the event. Presentations given were:

- Why cameras need to be characterized and calibrated (Kevin Matherson)
- Target based versus spectral camera calibration (Eric Walowitz)
- Target based versus *in situ* spectral training data (Dietmar Wueller)
- Minimal Knowledge Techniques for Camera Characterization (Stephen Viggiano)
- CCM versus Color lookup tables (Michael Vrhel)

Attendance was high, with more than 50 participants. Feedback was extremely positive and satisfaction with the presentations given by well-known camera experts was noted. The workshop will be repeated at CIC23 in Darmstadt, Germany.

# TDPF Explores the Photo Fulfillment Ecosystem

From Digital Capture via Smart Devices to Photo Organization to Print and Video Output

By Ann L. McCarthy, IS&T TDPF Coordinator

The International Symposium on Technologies in Digital Photo Fulfillment (TDPF) brings together well-established leaders in the photography industry and puts them in the same room with business owners and technologists from newer and smaller businesses. Presentations generally cover technology and business process innovations. This year the conference included presentations of savvy consumer demographics studies and news of a ground-breaking print technology product.

Anthony Pieters, Photo Imaging Products Business Manager for Fujifilm Europe B.V. (the Netherlands), and Patrick Webber, principal scientist for color paper with Kodak Alaris (USA), discussed their respective industry-leading silver halide output products. Fujifilm Europe B.V. announced a silver halide color paper specifically designed for photo books printed through minilabs and small digital printers. Kodak Alaris announced advances in key physical properties, including color gamut, of their silver halide color paper. It was clear from their presentations that both Fujifilm and Kodak Alaris have significantly advanced color silver halide paper and print capabilities with their recent product announcements.

Peleman Industries continues to intro-

duce new products for photo book retailers. Brigitte Peleman-Vantieghe, Peleman Industries, Inc. (USA), noted that the photo book market is growing. In response, Peleman Industries has expanded their line of photo book equipment, with the emphasis on enabling retailers to build a greater variety of photo book products with the same machine. Lay flat photo book options are now available for fast while you wait production at retail locations.

Reiner Fageth, CTO and Head of R&D at CeWe Colour (Germany), presented eye-opening customer data analysis, stimulating much discussion among attendees, many of whom are in business to engage end user customers with various photo print products. Through knowing their customers, for example, understanding which life events are most likely to be captured on video, or to be preserved in a photo book, CeWe Colour is able to offer product options most attractive for those occasions. Fageth's talk was full of insights about customer preferences, the relationship between in-store footprint and sales, and what customers are doing with photo books; overall providing strong evidence that selling quality, rather than racing to the lowest price, is good business.

Cathi Nelson, founder of Association of Personal Photo Organizers (USA), and Lisa Kurtz, APPO Director of Operations and Training, generated such buzz that people were still in the room talking 30 minutes after the session ended. One of the attractive points for photo business attendees was that APPO may become a source of direct customer behavior, use case, and product preference data. APPO also plays an increasing role in promoting



LumeJet print samples displayed at TDPF

Photo: Ann McCarthy

## TDPF 2015

Attendees:	varied by session
Oral Papers:	9
Dates:	Jan. 4-5, 2015
Location:	Las Vegas, NV

proven new photo apps and services to consumers, a potential boon to small vendors with new products in this space. APPO customers engage an APPO professional photo organizer, on a fee for service basis, to provide personal guidance and assistance in organizing and preserving their photo collections. APPO customers include working moms, young seniors, grandparents, and small business owners, all of whom benefit from assistance in gaining better access to their own photos.

Doug Smith, Merlin International (USA), announced a poster format printing service for pro photographers with pricing set at \$2.50 per sheet for a minimum order of 10. This printing is toner based and is intended for proofing, posters, and large indoor display applications.

In 2014, people around the world snapped 1.3 trillion photographs, the majority with the smart phones they carry. Every day, some 350 thousand photos are uploaded to Facebook. Kevin Gilbert, Mylo Development, LLC (USA), discussed this phenomenal growth in photography as he reminded us that the best camera is the camera that you have with you. Gilbert also reminded us that billions



Reiner Fageth, CTO and Head of R&D at CeWe Colour (Germany), presented eye-opening customer data analysis, stimulating much discussion among attendees

Photo: Joe LaBarca



Photos: Ann McCarthy.



Left: Cathi Nelson (in red) and Lisa Kurtz discussed APPO's role as a potential source of direct customer data. Right: Kevin Gilbert of Mylo Development discussed the continuing growth in photography as he reminded attendees that the best camera is the camera is the one in your hand at any given moment.

of photos are in jeopardy, our personal photo stories are in jeopardy, because we don't understand technology well enough to safeguard against digital decay or against technology transitioning to obsolescence. He urged us all to proactively create our own life story portfolios, pointing out that "generations to come will thank you." Mylio, a photo service offering from Mylo Development, LLC, is a next generation photo management system that can synchronize a photo collection across multiple devices and locations.

TDPF attendees were an enthusiastic audience for the first USA announcement of the ground-breaking LumeJet printer. The LumeJet was presented by Trevor P.

Elworthy, a former Kodak research physicist, now founder and CIO of LumeJet Ltd (UK). LumeJet was spun out from photonic print head research Elworthy initiated at Warwick University and the LJ200S Digital Printer is now being manufactured in Coventry, UK. The LumeJet uses a photonic optical head to "jet" light onto photographic silver halide media with such precision that each light beam strikes an area comprising one 4 micron silver halide grain. Such precision light printing has not been feasible before. Technology advances in the print head mechanism control enable fast print head travel while eliminating edge errors in the region of print head reversal. The printer accepts up



Photo: Joe LaBarca.

Trevor Elworthy (facing) shared prints from the LumeJet printer, demonstrating the printer's phenomenal color gamut and sharp 2 point font text capabilities.

to 11 bits per pixel per color and the printing function is contone, with each light jet turning on specific layers in the silver halide paper. The prints on display demonstrated phenomenal color gamut and crystal clear 2 point font text.

Although the TDPF Symposium lasted only one and one half days, the rich presentation material and warm camaraderie among the attendees made it a most memorable event. ▲

TDPF 2015 papers continued from page 1

imaging science. This paper will discuss the products that have benefitted from these technology platforms and helped advance the photo fulfillment industry.

## LumeJet – Inkless Ultra High Quality Photobook Production

Trevor P. Elworthy; CPhys, MInstP, FRSA (UK)

**Abstract:** The result of 10 years research, LumeJet is commercializing a new photonic 'inkless' printer, the S200, for ultra high quality photobook production. Similar to Ink Jet – but without the inks – LumeJet comprises custom designed print heads (moving or static) with multi-LED arrays and special fiber taper optics. Using light, rather than ink, increases throughput and image quality, whilst reducing media costs for image intensive documents. LumeJet is a continuous tone process that can resolve down to 2pt colored text and graphics, which would require at

least 10-colours and over 4000dpi with inkjet and toner systems. Applications for LumeJet technology have also been identified in label and package printing and printed electronics.

## How the Emerging Profession of Photo Organizing is Reconnecting People with their Photos

Cathi Nelson and Lisa Kurtz, Association of Personal Photo Organizers (USA)

**Abstract:** A new grassroots industry called personal photo organizing has been growing to meet the needs of consumers who are overwhelmed with their lifetime of photos. We live in an increasing, complex technical world, yet, as human beings, we have not changed in our need to tell a story. It is through stories that we connect and one of the ways we tell our stories is through our photos. With the introduction of digital cameras and mobile phones, people are now taking photos at a record pace and sharing them on Facebook, Twitter, Instagram, and other photo sharing sites.

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# The Standards Roundup: Imaging and Graphic Arts

by Ann L. McCarthy, IS&T Standards Coordinator

## Imaging Standards News

### Recent & Upcoming Standards Publications

ISO 17850, *Photography — Digital cameras — Geometric distortion (GD) measurements*, received 100% approval in the DIS ballot and preparation has begun for its publication. The project was led by Dietmar Wueller (Germany, Image Engineering) and Hideaki Yoshida (Japan, Olympus Optical) with the objective to enable manufacturers, reviewers, and users to compare and verify digital camera geometric distortion measurements. Geometric distortion is a result of non-uniform magnification in the image field. The major effect of such distortion is that relative sizes of objects in a scene are not well preserved. In particular, straight lines in a scene are not straight in the captured image. The two main types of distortion dealt with in the standard are barrel (monotonically decreasing from center to border) distortion and pincushion (monotonically increasing from center to border) distortion. Distortion can be described by a two-dimensional map, giving the displacement from a point in the corresponding ideal undistorted image to the same image point in the actual distorted image. A related standard from ISO/TC 172, ISO 9039, *Optics and photonics — Quality evaluation of optical systems — Determination of distortion*, defines methods to measure a lens independent of a camera. ISO 17850 was developed and defines methods to measure the total image distortion of a camera including the lens and the signal processing and includes detailed test methods, reporting guidelines, and examples for use. Additional aids helpful to users of the standard will be available on [imaging.org](http://imaging.org) under the Resources/Photographic Standards menu after publication.

ISO 17957, *Photography — Digital cameras — Shading measurements*, has been submitted for publication having received 100% approval in the DIS ballot. Conceptually, luminance shading (luminance non-uniformity) is the systemic variation of the luminance signal within the image area. Similarly, color shading (color non-uniformity) in this context is the systemic variation of the chrominance signal components within the image area. In each case these variations are problematic as they are not a function of the captured scene. For example, one significant effect can be a decrease in luminance level at the edges of the image field in comparison to the center, often with an associated increase in noise at the image edges due to the correction of the luminance shading. Color shading may be visible as a shift in the color of large, uniformly neutral or monochromatic objects within the image field. Luminance shading may result from non-uniform sensitivity across a sensor array, lens shading, pixel geometry, sensor array illumination non-uniformity, and electronic non-uniformity. Color shading may arise from such fac-

Experts are welcome to contribute to ISO standards development through their corresponding national committees. Additional information on photography standards is available from the ISO/TC 42 Secretariat, [isotc42@ansi.org](mailto:isotc42@ansi.org). Additional information on graphic technology standards is available from the ISO/TC 130 Secretariat, [tc170\\_cyc@126.com](mailto:tc170_cyc@126.com).

tors as an inaccurate match between the lens components, spatially varying filter transmittance, and spectral sensitivity variation across the sensor array. The information provided in ISO 17957 includes guidance on creating a test scene and calculation of the non-uniformity metrics. Luminance and color shading are important attributes of digital cameras. As with the other test method standards, the purpose is to enable manufacturers, reviewers, and users to compare and verify measurements. This standard development project was led by Kevin Matherson (USA, Microsoft) and Naoya Katoh (Japan, Sony). Additional materials helpful to users of the standard will be available on [imaging.org](http://imaging.org) under the Resources/Photographic Standards menu after publication.

ISO 18383, *Photography — Digital cameras — Specification guideline*, is being prepared for publication after the DIS ballot closed with 100% approval. Under the guidance of project leaders Masaaki Nakayama (Japan, Panasonic) and Toru Nagata (Japan, Canon), this standard identifies fundamental features that describe digital still cameras, along with associated definitions, measurement methods, and presentation methods. Existing test method standards are referenced in cases where applicable. ISO 18383 also provides additional test methods as necessary. In this way, ISO 18383 serves as a valuable compilation of digital camera test method standards and their use. ISO 18383 applies to consumer Digital Still Cameras (DSCs) with the aim to enable manufacturers to provide consistent information to consumers concerning these ubiquitous consumer devices. The feature presentation methods given in this standard are intended to be used in catalogues and other materials in which product specifications are noted, and to be used as notations in the relevant software. The presentation methods are also intended to be used in notations on the camera body, packaging box, and sales promotion materials at point of purchase, etc., as well as in advertisement and the publicity. With its extensive feature descriptions and analysis discussion, as well as its comprehensive references and bibliography, ISO 18383 provides a consolidated reference describing the operation and characteristics of consumer digital cameras.

### US Photography Standards

*IS&T Imaging Technology Committee 10 (IT10)*

IT10 has completed balloting and reaffirmation of two IS&T

photography standards. Although these standards will be listed as new with ANSI because of their move to the IS&T standards portfolio, the technical content of these important standards has been retained. The reaffirmation has been conducted to ensure the ongoing availability of these standards. The standards are ANSI/IS&T IT10.2000-2015, *Photography — Digital still cameras — JPEG 2000 DSC profile*, and ANSI/IS&T IT10.7000-2015, *Photography — Digital still cameras — Guidelines for reporting pixel-related specifications*. These standards will be available via the ANSI web store, [webstore.ansi.org](http://webstore.ansi.org).

### International Commission on Illumination (CIE)

The International Commission on Illumination (CIE) recently celebrated its 100th anniversary as the core international organization for cooperation and exchange of information on all aspects of light and lighting.

Those unfamiliar with the CIE may wonder what is meant by a Session. A Session is held every four years and it is both a scientific meeting and a turning point in the lifecycle of the CIE. The CIE General Assembly meets, attended by representatives of all National Committees.

A Session meeting brings an opportunity for everyone with an interest in light and lighting, from any branch of art or science, to come together and discuss their interests with like-minded people from around the globe. The central part of the Session for many delegates is the conference, together with its exhibition, and of course the chance to meet and socialize with friends and colleagues. Divisions and Technical Committees also meet at the Session, giving those new to the CIE a chance to discover the different aspects of CIE work, and to explore in more detail the issues that CIE contributors tackle through Technical Committees.

The 28th Session of CIE is held in Manchester, UK, June 29 – July 3, 2015. With the conference based at the University of Manchester, the CIE is placing particular emphasis on encouraging young scientists to join the meeting. Please participate and celebrate the International Year of Light 2015 with the International Commission on Illumination. For further information visit the CIE homepage at [www.cie.co.at](http://www.cie.co.at).

### ISO/TC 130 Graphic Technology Upcoming Standard Publication — CxF/X

ISO 17972-1, *Graphic technology — Colour data exchange format — Part 1: Relationship to CxF3 (CxF/X)*, having won 100% approval in the DIS ballot, is entering the final stages of preparation for publication. Led by ISO/TC 130, with Ray Cheydleur (USA, X-Rite) serving as project leader, this project enjoyed broad support and participation from members of ISO/TC 42, ISO/TC 171 and ISO/TC 6 committees. This part of ISO 17972 standardizes an exchange format (a way to encode and format digital information that will serve between senders and receivers who are in different locations and in different business entities) for color and process control (printing processes) data and, perhaps most

## IEC TC 119 (Printed Electronics)

### Highlights from the IEC 2014 Annual Meeting

This Standards News column covers work done by the IS&T community on International Standards, focusing mainly on work under the auspices of the International Standards Organisation (ISO). There is another similar organization, the International Electrotechnical Commission (IEC), which is the standards organization responsible for International Standards covering electrical and electronic products. As in ISO, IEC work is allocated to various committees. IEC/TC 119 is responsible for International Standards in Printed Electronics and so is highly pertinent to the IS&T Digital Fabrication community.

Each year the entire IEC community gathers for a General Meeting and in November 2014 that annual meeting took place in Tokyo, Japan. IEC/TC 119 also met at this event, which allowed us to interact with the other application areas represented at the gathering. Following are highlights that arose directly from this opportunity.

- IEC/TC 47 (Semiconductor Devices) are likely to be important, particularly in the Wearables applications area. IEC/TC 47 is also working on a flexible conductor test method that may have application in Printed Electronics. The IEC General Meeting was a good opportunity to catch up on this initiative and ensure that we are all moving in the same direction.
- IEC/TC 91 (Electronics Assembly Technology) is again likely to be important to us with respect to applications such as Wearables. We took the opportunity to meet with officers from TC 91 in Tokyo to start mapping this route forward.
- IEC/TC 110 (Electronic Display Devices) maintains strong connections with IEC/TC 119. Officers from both TCs attended each other's meetings in Tokyo. These connections will become increasingly important as we move further into the field of printed flexible display.

IEC/TC 119 plans to encompass “hybrid” electronics in standardization work. We will define this term more rigorously in the future, but for the moment, informally, consider this as referring to the combination of conventional (silicon) and printed electronics. This is likely to be an important technology in Wearable Electronics, again an application area that IEC/TC 119 plans to cover.

The IEC/TC 119 participant list already contains significant representation from the IS&T community and we look forward to growing this involvement. Wearable Electronics and Printing for Fabrication are strong areas of particular common interest.

—Alan Hodgson, Chair IEC TC 119

importantly, the associated metadata necessary for its correct interpretation. ISO 17972-1 is the base standard describing the use of CxF3 (the industry Color Exchange Format v3) for data exchange. In the early days of digital print data exchange, exchange formats were not designed with today's variety of print systems, inks, substrates, and printing modes in mind. Today, exchange with the CxF/X format can support traditional printing and the various digital print modes. Additionally, the CxF/X format can be extended as needed to support future standards. Although X-Rite Inc. originally developed the CxF format, the company claims no intellectual property rights to the materials used in this standard. Detailed CxF information, including the CxF3 Schema download, is available at <http://www.colorexchangeformat.com/>.

The CxF/X format strives to provide a universal means to communicate color, taking into account appearance effects (such as surround color, absolute brightness, surface effects, angular dependencies), substrate effects (such as color, fluorescence), tolerance requirements, and other factors pertaining to the end product such as the required light resistance of the color. Through the development of this standard, the graphic arts industry is responding to the increasing need for the exchange of measurement data along with the metadata derived from or associated with that measurement data. ISO 17972-1 is part of a multi-part standard in which each part will address a different workflow aspect and will define methods for exchange between document creators, intermediates, and producers in those workflow areas. Each part will define required and optional sets of

CxF3 elements permitted to be used in those cases. The goal throughout ISO 17972 will be to maintain a degree of use case and future flexibility while minimizing the uncertainty of the data exchanged. Of course one advantage of the CxF/X XML-based format is that it is both human readable and machine readable. The format supports multiple language data representations and can be extended by end users. Note that ISO 17972, and its antecedent ISO 28178, are specifically not intended for graphic arts content data, which are covered by ISO 15930, the multi-part standard defining the use of PDF for content exchange, and ISO 12639, the longstanding TIFF/IT standard.

ISO 17972-1 outlines the mapping available in CxF3 for each element in ISO 28178:2009, *Graphic technology — Exchange format for colour and process control data using XML or ASCII text*, and illustrates the underlying concepts of CxF/X. ISO 17972-4, Part 4, also in development, standardizes an exchange format for spectral measurement data of inks to provide a means to characterize spot color inks and thereby enable reliable printing and proofing of products that have been designed using these inks. Unlike process color inks (cyan, magenta, yellow), spot color inks are often printed without combination with other inks and are used to achieve a particular exact color, such as a company logo color, in a printed piece.

*For questions about the activities of TC 42, for suggestions for (or input to) future updates, or standards questions in general, please contact the IS&T Standards Coordinator at [standards@imaging.org](mailto:standards@imaging.org).*

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Yet, people are also finding they don't have time to sort through and organize the thousands upon thousands of photos they are accumulating, let alone print them. The result is a consumer who is overwhelmed and paralyzed. In addition to digital photos, hundreds of thousands of printed photos languish in shoeboxes and bins. Thus, the need for a solution has emerged and the photo organizers are stepping in to fill that need. There are now hundreds of small independent business owners offering their services in 48 states and six countries. By providing personal one-on-one assistance, the photo organizers are helping consumers reconnect with their photos and videos again.

At the conclusion of this presentation, the attendee will have learned why there is a need for photo organizers, who the target market is for photo organizers, how a photo organizer charges for their time, the five most common services a photo organizer provides, and how the Association of Personal Photo Organizers supports this growing industry.

#### IS&T Honors and Awards

celebrate the achievements and service of members of the imaging community. We encourage you to nominate colleagues for these prestigious tributes. To do so, visit [www.imaging.org/ist/Membership/honors.cfm](http://www.imaging.org/ist/Membership/honors.cfm).

## Kodak Alaris Premium Duplex Photo Fulfillment

Robert F. Mindler and Marjorie M. Stell, Kodak Alaris, Inc (USA)

**Abstract:** Kodak Alaris Retail Systems Solutions has been focusing on the growing market for high-demand premium photo products which requires rich photographic detail and double-sided printing. Products such as the KODAK D4600 Duplex Photo Printer with its compact design and flexibility, provides a powerful printer that integrates seamlessly with existing KODAK Picture Kiosks, KODAK Adaptive Picture Exchange (APEX) or stand-alone PC workstations. The KODAK D4600 Duplex Photo Printer and KODAK D4600 Photo Paper enables in store production of vivid, borderless Premium Double-Sided Photo Books, Calendars and Greeting Cards that make it easy for consumers to enrich, share and relive the special KODAK MOMENTS in their lives. This paper will describe the details and features of this new duplex printing system and show how it has been designed to integrate flexibility that is easy and efficient for the retail environment. The ongoing convergence of printing technologies covering both the traditional photographic and graphic arts based printing. This paper will provide an overview of the new standards, the new joint working group, and the benefits these will provide in promotion of hard copy printing throughout the photo fulfillment industry. ▲

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medical imaging fields exhibited at this year's event. Their presence during the coffee breaks and lunches provided attendees with another source of knowledge.

A conference reception took place on the third evening of the conference, enabling the attendees ample time for informal interactions and networking amongst colleagues in the field.



Fountain located in Darmstadt's Marktplatz.

### Planning for 2015

In 2015, CIC will take place in Europe for the first time. Participants will meet in Darmstadt, Germany, October 19-23. The program will include two days of short courses, the traditional CIC technical program, and three workshops. We hope to see you there! ▲

# CIC23

## Twenty-third Color and Imaging Conference

Color Science and Engineering Systems, Technologies, and Applications

October 19-23, 2015  
Darmstadt, Germany

CIC TRAVELS TO EUROPE




www.imaging.org/ist/conferences/cic

## UPCOMING IS&T EVENTS

Sept. 27 – Oct. 1, 2015; Portland, Oregon

**NIP31/Digital Fabrication 2015**

General Chair: Masahiko Fuji

October 19 – 23, 2015; Darmstadt, Germany

**23rd Color and Imaging Conference (CIC23)**

General Chair: Vien Cheung

February 14 – 18, 2016; San Francisco, California

**Electronic Imaging 2016**

Symposium Chairs: Choon-Woo Kim and Nitin Sampat

April 19 – 22, 2016; Washington, DC

**Archiving 2016** General Chair: Kari Smith

Learn more at [www.imaging.org/ist/Conferences/](http://www.imaging.org/ist/Conferences/).  
A complete list of imaging-related meetings is at  
[www.imaging.org/ist/conferences/events.cfm](http://www.imaging.org/ist/conferences/events.cfm)

## IS&T REPORTER

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*The IS&T Reporter* is published quarterly by the Society for Imaging Science and Technology (IS&T). Articles and letters to the editor do not necessarily constitute endorsement or reflect the opinions of the editors or IS&T. Advertising and copy are subject to acceptance by the editor.

IS&T is an international organization dedicated to keeping constituents aware of the latest scientific and technological developments in the broad field of imaging through conferences, journals, and other activities.

IS&T focuses on all aspects of imaging, with particular emphasis on digital printing, electronic imaging, image perception, photo fulfillment, color imaging, image preservation, digital fabrication, and the physics and chemistry of imaging processes. For more information, visit [imaging.org](http://imaging.org). IS&T publishes the *Journal of Imaging Science & Technology* and *Journal of Electronic Imaging* (with SPIE).

Please send inquiries to: [info@imaging.org](mailto:info@imaging.org)  
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ISSN 2327-4395 print  
ISSN 2327-4409 online



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IS&T International Symposium on

# Electronic Imaging 2016

SCIENCE AND TECHNOLOGY

14–18 February • San Francisco, CA, USA



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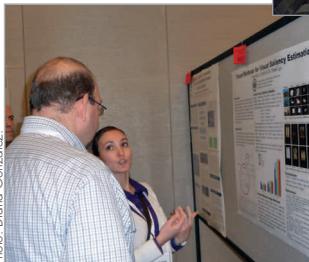


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