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HIGHLIGHTED PAPERS FROM COLOR AND IMAGING: CIC 23

Winner of the Best Paper Award

Spectral and Color Prediction for Arbitrary Halftone Patterns: A Drop-by-Drop, WYSIWYG, "Ink on Display" Print Preview

Peter Morovič, Ján Morovič, Xavier Fariña, Pere Gasparin, Michel Encrenaz, and Jordi Arnabat, Hewlett Packard Company (Spain)

Abstract: Accurately previewing the appearance of a print job can make the difference between producing saleable output and wasting expensive materials and is a challenge to which a host of solutions already exist. However, what the majority of these have in common is that they base their predictions on the inputs to a printing system (e.g., continuous-tone data in ink channels) instead of its outputs (i.e., the halftone data that is then printed) and that they are only valid for a given set of choices already made in the printing system (e.g., color separation and halftoning). Alternatively, attempting to make appearance predictions using general-purpose models such as Kubelka Munk, Yule Nielsen and Neugebauer results in limited performance on systems whose behavior diverges from these models' assumptions, such as inkjet printing. As a result of such constraints, the resulting previews either work only under limited conditions or fail to predict some artifacts while erroneously predicting others that do not materialize in print. The approach presented here takes advantage of the flexibility of the HANS framework and the insights into spectral correlation to deliver a print preview solution that can be applied to any printing system, that allows for the variation of fundamental imaging choices without the need for re-computing model parameters and that delivers ICC-profile-level accuracy.

Winners of the Best Student Paper Award

Investigation of Memory Colours Across Cultures

Yuteng Zhu[1], M. Ronnier Luo[1,2], Lihao Xu[1], Xiaoyu Liu[1,3], Guihua Cui[4], Sebastian Fischer[5], Peter Bodrogi[5], and Tran Quoc Khanh[5]; [1]Zhejiang University (China), [2]University of Leeds (UK), [3]Harbin Engineering University (China), [4]Wenzhou University (China), and [5]Technische Universität Darmstadt (Germany)

Abstract: Memory colours have been extensively investigated. They are important for different image applications, such as colour image reproduction. However, it is possible memory colours vary according to different cultures. The present experiments were conducted to investigate 22 memory colours, which are divided into three types: 12 common colours such as vegetables, fruits and flowers, 6 natural colours such as sky blue, grass, and skin colours, and 4 culture specific colours. Each colour was assessed by 25 Chinese observers and 30 German observers in each country. The inter-observer variations between two groups were compared in terms of mean of CIELAB colour differences in terms of MCDM measure and tolerance ellipses. Also, the colour centers are plotted in CIELAB a*b* diagram to show the culture differences. The intention here is to establish a methodology to study memory colours across different countries based on homogeneous colour patches. continues bottom of page 10

* *These papers were presented at CIC23, held October 19-23, 2015 in Darmstdt, Germany.*

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

INSIDE THIS ISSUE

William R. Towns Remembered

William (Bill) R. Towns, past president of the Society of Photographic Scientists and Engineers (SPSE, the predecessor organization to IS&T), died on December 26, 2015, in Frankford Township, New Jersey. Towns was known as a kind and gentle leader, and a thoughtful and helpful person, who was well-liked and admired by those with whom he served.

Photo: IS&T Archives.

Towns learned photography in the military through his service as an aerial photographer. A graduate of Rochester Institute of Technology, he earned a degree in photographic science then worked for many years as production manager of the former MRI Photo Chemical Corporation.

Towns was president (1985-1989) of the Society during a difficult time in its history. During his tenure on the Board, SPSE represented a mature technology in a rapidly changing world and its financial situation was challenged. Towns led the organization through those complicated times and started SPSE's move in a new direction. Although his education and career were rooted in silver halide photography, he understood the need to involve new people from the wider technical community in order to move the Society into its digital imaging future. A gentleman and a diplomat, Towns was able to make tough decisions. It was his courage and vision that put SPSE on the road to becoming IS&T.

Towns received an SPSE Service Award in 1966 and Senior Membership in 1974. He was presented with a President's Citation in 1979 for establishing a stable financial foundation for the Society in the early 1970s.

Towns served as Chapters Vice-President (1971-1974), Treasurer (1976-1981), and Executive Vice-President (1982-1985) before assuming the presidency.

—IS&T Past President Alfred (Fred) Guevera and Former Executive Director Calva Leonard

Osborn Street Building that Housed Land's Polaroid Lab Designated ACS Historic Chemical Landmark

The American Chemical Society designated the Osborn Street building that housed Edwin Land's Polaroid laboratory as an ACS Historic Chemical Landmark this past August. The laboratory was the site of the development of Polaroid's One-Step photographic films. The Polaroid site is the first site in Massachusetts to bear the ACS-designation, which is due in large part to the efforts of Vivian Walworth, past president of IS&T, editor of The Reporter for many years, editor of the Journal of Imaging Science, and a former Polaroid employee. At the ACS ceremony unveiling the plaque, Walworth was recognized by ACS President Diane Grob Schmidt for being an active member of that society for seventy-four years.

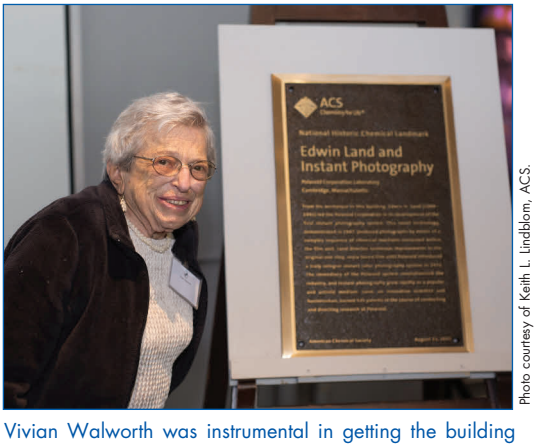


Photo courtesy of Keith L. Lindblom, ACS.

Vivian Walworth was instrumental in getting the building that housed the Polaroid laboratory designated as a ACS Historic Landmark. She is seen here with the plague unveiled August 13, 2015.

The Osborne Street Historic Site designation was celebrated during two events at the nearby MIT Museum, which houses a number of Polaroid inventions, designs, and artifacts. The first event was marked by the unveiling of the plaque and talks about Land and his work. The next day, the museum hosted a gathering that concentrated on Land's contributions, as well as those of the many of the scientists who collaborated with him. Speakers included :

- Victor McEIlheny, author of the biography *Insisting on the Impossible.*
- John McCann, whose talk was based on an article written after Land's death in 1991. (M.A. McCann and J. J. McCann, "Land's Chemical, Physical, and Psychophysical Images," Optics & Photonics News (5)10, 34-37 (1994). McCann collaborated with Land on the retinex theory of color vision.
- Mary McCann, who also exhibited the IS&T's Land's Essays Volumes I, II, and III
- Ronald Fierstein who chronicled the Polaroid-Kodak lawsuit in *A Triumph of Genius.*

—John McCann, McCann Imaging

Material Appearance and Color is Special Focus of CIC23

Twenty-third Color and Imaging Conference Debuts in Europe

By Vien Cheung, Michael Murdoch, and Philipp Urban

The Twenty-third Color and Imaging Conference (CIC23) was held for the first time in Europe. Darmstadt, Germany—The City of Science—hosted the 2015 meeting, combining vivid history with a modern atmosphere for an exciting week of short courses, keynote talks, high-quality papers, and workshops from across the color and imaging community. Material Appearance and Color was the special topic for this year's event.

Attended by 188 scientists, technologists, and engineers working in the broad field of color science, the event featured attedees from Australia, Belarus, Belgium, Canada, China, Finland, France, Germany, Israel, Italy, Japan, Korea, Luxembourg, the Netherlands, Norway, Spain, Sweden, Switzerland, Taiwan, the UK and the US. Without exaggerating, it was truly an international event.

The conference began with an extensive short course program on a range of topics grouped in the tracks of Color & Design, Physics and HDR, Appearance & 3D, and Color & Images.

Photo: Philipp Urban.

188 attendees from 21 countries across the globe enjoyed CIC23 in the Maritim Conference Hotel in Darmstadt, Germany.

JIST-first Paper Option

The conference committee created a strong technical program of 26 oral and 18 interactive papers, including 5 that appeared as JIST-first papers in the *Journal of Imaging Science and Technology*. The JIST-first option allows authors the opportunity to have their work published in a peer-reviewed journal and presented at a conference, with their paper appearing as a reprint in the conference proceedings. To take advantage of this option, authors must submit high-quality papers with little need for revision.

Technical Program

As always, the conference featured a single-track structure in six sessions: Putting Color to Work (colour systems and profiles), Beyond the Rainbow (multispectral imaging), Picture Perfect (image quality), Colorful Matter (material color and spe-

CIC 23

Attendees*:	188
Oral Papers and Keynotes:	28
Interactive Papers:	18
Short Courses:	15
Workshops:	3
Exhibitors:	5
Dates:	October 19–23, 2015
Location:	Darmstadt, Germany

*includes Short Course only and guests

Photo: Vien Cheung.

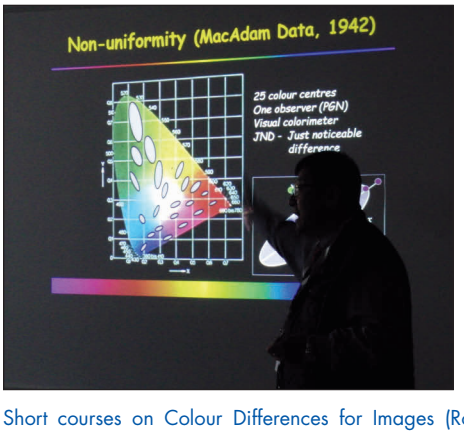


Photo: Michael Murdoch.

Photo: Michael Murdoch.

Short courses on Colour Differences for Images (Ronnier Luo, left), and Color and Appearance in 3D Printing (Philipp Urban, right).

Photo: Vien Cheung.

Meeting new colleagues and reconnecting with old friends at the Welcome reception.

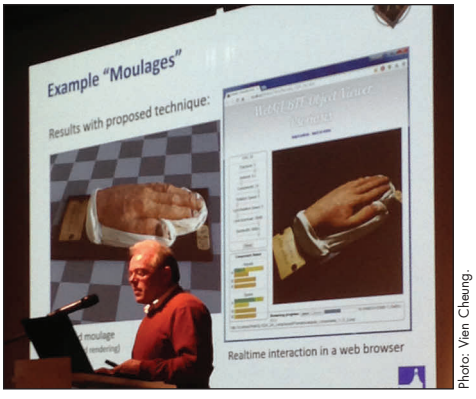


Photo: Vien Cheung.


Photo: Francisco Imai.

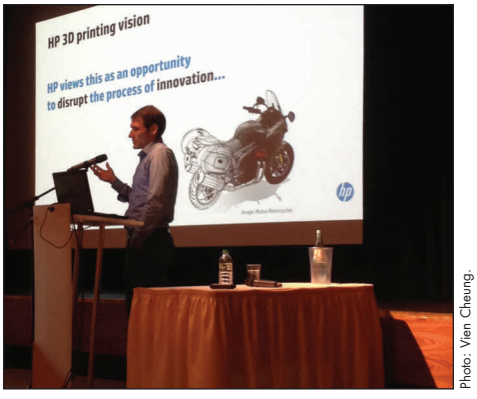


Photo: Vien Cheung.

Keynote presentations by Reinhard Klein (left), Paul O'Brien (middle) and Scott White (right).

cific color applications), Do You See What I See? (color perception), and Bright Ideas (color in illumination and lighting). The oral papers presented in these sessions were complemented by the Interactive Paper Previews and Session, which includes poster displays where participants have the opportunity to explore topics in-depth with authors.

Best Papers Honored

As you might imagine based on the session names, the technical program included a variety of papers in both oral and interactive formats. The conference kicked off in force with the Best Paper Award winner: Spectral and Color Prediction for Arbitrary Halftone Patterns: A Drop-by-drop, WYSIWYG, "ink on display" Print Preview, by Peter Morovič, Ján Morovič, Xavier Fariña, Pere Gasparin, Michel Encrenaz, and Jordi Arnabat of the Hewlett Packard Company. The award was given based on reviews of the submitted manuscript; reviewers of this paper were uniformly impressed with their technical solution and clarity of exposition—and the CIC audience enjoyed Ján's clear presentation of the work.

The Best Student Paper Award—voted by CIC attendees based on the author's presentation of the material—went to Yuteng Zhu and a truly global team of co-authors from China, the UK, and Germany (see page 1 for details). Their paper—Investigation of Memory Colours Across Cultures—detailed experiments conducted in China and Germany in which observers adjusted color patches in CIELAB LCh to their memory of common object names given in the two respective languages.

The CIC's prestigious Cactus Award, given to the "audience favorite" from among the Interactive Papers went to Eric Kirchner, Ivo van der Lans, Alejandro Ferrero, Joaquín Campos, Francisco M. Martínez-Verdú, and Esther Perales, for Fast and Accurate 3D Rendering of Automotive Coatings. Pity there weren't any actual cacti in Darmstadt!

Outstanding Technical Papers

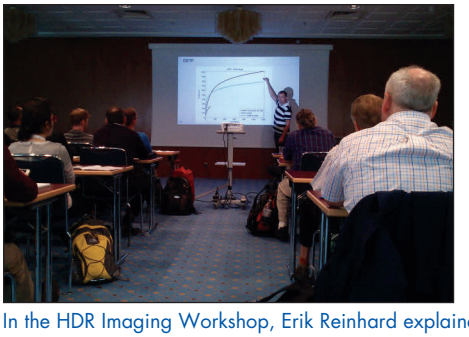
Beside the award-winners, a few other papers stood out to CIC participants.

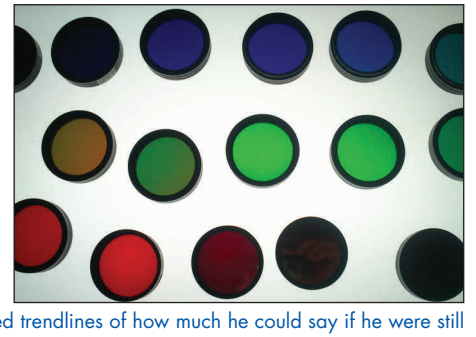
- Shoji Tominaga *et al.* presented an elegant method for inferring the fluorescence of materials with their paper, Bispectral Interreflection Estmation of Fluorescent Objects.
- Presenting their JIST-first paper A Computer Aided Color Appearance Design System for Metallic Car Paint, Clement Shimizu and Gary Meyer wowed with their synched link between a Photoshop-based editing platform and a database of automotive effect paints. They literally connected the art and technology in the world of automotive color stylists.
- Also showing goniochromatic effects, Juan Martínez-García *et al.* gave a fascinating presentation of dichroic glass-plate imaging using laser-aligned silver nanoparticles in their paper, Multi-color Properties of Silver Glaze Images Photo-engraved on Glass Plates.

Keynotes Highlight 3D and New Materials

The keynote presentations were given by three highly-distinguished individuals:

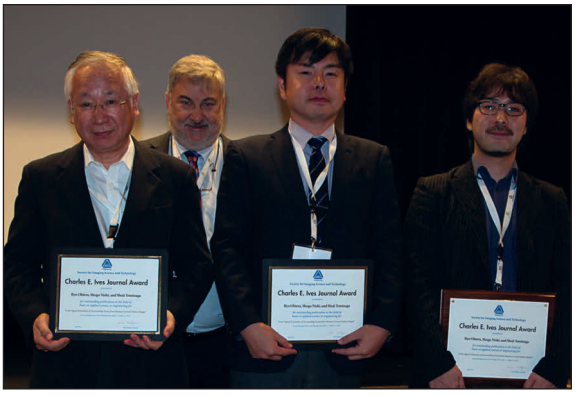
- Reinhard Klein, professor in the University of Bonn's Institute of Computer Science II, gave a talk about the possibilities and limitations of the bidirectional texture function for faithful 3D appearance representation.
- Paul O'Brien, professor of Inorganic Materials at the University of Manchester, described quantum dots—a new colored material—and their potential for technological application from the inorganic material point of view.
- Scott White, distinguished technolo-


Photos: Michael Murdoch.



In the HDR Imaging Workshop, Erik Reinhard explained trendlines of how much he could say if he were still in academia versus how much he can say while working in industry (left). Lindsay MacDonald showed filters related to his presented paper during the CIC Demonstration Session, a new feature of the event.





Photos: Francisco Imai.

A number of IS&T Awards were presented during CIC23. Far left: Zeev Zalevsky (Bar-Ilan University,Israel) recieves the Image Engineering for the development of breakthrough 3-D sensing technologies and products that have advanced the capabilities of digital photography from Image Engineering President Dietmar Wueller and IS&T President Geoff Woolfe. **Middle:** Jennifer Gille (Qualcomm Technologies, Inc.) recieves a Service Award from IS&T President Geoff Woolfe for serving at the General Chair for CIC22 and leading efforts to enhance the Color and Imaging Conference by offering a journal submission option, workshops, and a joint program with the digital pathology conference. **Far right:** The Charles E. Ives/Journal Award was presented in recognition of the best engineering paper published in the *Journal of Imaging Science and Technology* the preceding year to Shoji Tominaga, Shogo Nishi, and Ryo Ohtera for "Color Signal Estimation of Surrounding Scenes from Human Corneal Surface Images."

gist of Graphics Solutions Business / 3D Printing at the Hewlett-Packard Company, spoke on 3D printing, the workflows for advanced fabrication, and the challenges associated with matching designers' intent to fabricated objects, especially for advanced visual and mechanical properties.

Workshops, Exhibits, and Social Events Offer Added Value

The conference offer participant-generated workshops on topics of interest to the community, with the goal of increasing communication and knowledge transfer among attendees. The three workshops Camera Color Characterization, Measurement and Reproduction of Skin Color, and High Dynamic Range Imaging were well-attended, and participants enjoyed the chance to ask and discuss a variety of questions with the presenters.

One of the most valuable aspects of being at the conference lies in the informal interactions among colleagues in the field. Five companies from the color, imaging, and lighting fields exhibited at CIC, namely GL Optic Lichtmesstechnik, Image Engineering, JVCKENWOOD Corp., SILIOS Technologies, and Verivide Ltd. Their presence over the coffee and lunch breaks provided the attendees with another source of knowledge.

The Welcome Reception was held in the conference venue on Tuesday evening and the Conference Reception was held on the grounds of the famous Castle Frankenstein on Wednesday evenings. These social events enabled ample time to meet new colleagues, reconnect with old friends, and delve into the many exciting topics related to color. Some of the speakers were coming to CIC for the first time, bringing a fresh and exciting dimension to the conference.

Hope to see you again at CIC24 in San Diego, California, USA! ▲


Photos: Michael Chang.

The conference reception at Castle Frankenstein was enjoyed by all (see page 6 for more photos).

CIC23 Was Truly an International Event

Photos by Michael Chang

The Standards Roundup: Imaging and Graphic Arts

by Ann L. McCarthy, IS&T Standards Coordinator

As we begin 2016 it seems a good time to pause and reflect on the worldwide membership contributing to this work. Membership in ISO standards work is available to a variety of entities, including corporations, academic institutions, individual experts, and government entities. In many cases, senior technical experts contribute to the industry, working on standards related to their years of technical work in the field. In this article, we will recognize long-serving members and welcome new members, looking at a sampling from among the many ISO/TC 42 contributors around the globe, while noting to those not mentioned, please forgive the omission.

From France we have Innovative Imaging Solutions. In their own words:

> i2S is a company specializing in image capturing and processing technology. We work for international clients, on a wide range of markets like: health and well-being, sport, multimedia, document digitization, food-processing and agriculture, aviation and aerospace, robotics and industrial control systems, and more generally, wherever image capturing is required. i2S designs, manufactures, and distributes cameras and optronic systems.[1]

The i2S vision expresses well the fact that imaging is more essential than ever to progress and security in our modern world.

Image Engineering GmbH & Co. KG, based in Germany, has contributed expertise and leadership to numerous projects within ISO/TC 42, both in digital photography and in imaging permanence. With its core competency in the pursuits of digital image quality,[2] the principals of Image Engineering have understood that incremental improvements in image quality, and the related incremental product improvements, should be based on broadly established objective standards. Such standards can influence such diverse technology fields as mobile imaging, broadcasting, machine vision, surveillance, and medical imaging, all areas essentially incorporating elements of digital imaging.

Since its founding in the US in 2004, Imatest LLC has become a strong contributor to ISO/TC 42 digital imaging standards. Imatest provides software, test charts, and consulting services to customers in a variety of industries, including mobile electronics, security, automotive, and medical imaging.[3] The growth of Imatest over the past 10 years, and its reach into such a variety of industries, again demonstrate that the fundamental importance of imaging has only expanded with the developments of digital technologies.

From the US, Jack Holm's involvement spans a number of milestone developments in digital imaging. For example, Jack created the first camera raw processing application with a user interface for controlling processing steps, with automated, image-specific color rendering. He served in ISO/TC 42 as a principal color scientist from Hewlett-Packard until July of 2008, and since then has continued his strong contributions as an independent. Jack Holm has long provided an essential technical basis for color topics with ISO/TC 42 standards, and currently serves as the convenor of "Colour management," a joint working group (JWG 22) of ISO/TC 42, IEC/TC 100, and ISO/TC 130. His leadership in the International Color Consortium (ICC), and in IEC TC100 (Multimedia) TA2 (Colour Measurement and Management) standards, add breadth to his digital imaging standards contributions.

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. Additional information on graphic technology standards is available from the ISO/TC 130 Secretariat, tc170_cyc@126.com.

Evgeniĭ Aleksandrovich Iozep originally organized the Technical Council of the Russian Federation to work on standardization in the area of optics. This has led to several areas of Russian participation in ISO standards, including ISO/TC 42. This work has been recognized to be of high value in Russia, where Evgeniĭ Iozep was awarded the Gosstandart Medal of Honor "For service in standardization" in 2000.[4] Evgeniĭ Iozep has long been a prominent leader in the optics field, reaching across standardization, research, and industry development.

The Portuguese Institute of Photography (IPF) was founded in 1968 as the first school of photography in the country. Today, IPF promotes national and international cultural activities based in photography, provides extensive training programs for would-be and experienced photographers, and is recognized as the Standardisation Organisation Sector for Photography, which gives jurisdiction over the development of original Portuguese and ISO standards in the area of photography.[5] IPF partners with the Portuguese Quality Institute, which also sponsors membership in ISO/TC 42.[6]

Canon Inc. needs no introduction. This company brings a multi-national powerhouse of contributions to ISO/TC-42 standards, first and foremost in providing the ISO/TC-42 Chairperson. Although Canon is known as a Japanese company, in the ISO context Canon contributes from several nations. At the working group level, with Adobe Systems Incorporated, Canon provides the co-convenor to the "Electronic still picture imaging" working group (WG 18). In support of its broad interests, Canon members from Japan and from Canon Information Systems Research Australia contribute to several digital imaging projects in

WG 18 and its related working groups. In addition, Canon members from Japan and from Canon USA attend to the image permanence work in WG 5.

Nikon Corporation is essential to the world of photography and digital imaging. Nikon traces its roots to 1917, where it began in Japan as a comprehensive integrated optical company.[7] In 1959, Nikon made its mark in photography, marketing its first lens-interchangeable SLR camera, incorporating a number of world-first features such as an exposure meter fully coupled with aperture and the practical application of a motor drive. Today Nikon business domains span semiconductor lithography, industrial metrology, imaging products, and a variety of opto electronics technology areas. ISO/TC 42 benefits from Nikon contributions in a number of areas, including their leadership, providing the convenor to the "Mechanical elements of photographic equipment," working group (WG 4).

Although Apple Inc. is not known primarily as an imaging company, before the days of iPhones and iPads, Apple produced the computing platform of choice for digital photographers, and helped to establish the foundation of color management for digital imaging in its operating system. Today, Apple has announced Apple TV and tvOS to provide the foundation for application-based television of the future. Apple imaging roots go deep. ISO/TC 42 in the US has benefitted these many years from the leadership of technical imaging experts from Apple, serving on the IS&T Standards Management Board, and in the project work of WG 18.

Microsoft was there, collaborating in the definition of sRGB, the ubiquitous RGB color space specified in IEC 61966-2-1:1999. The breadth of Microsoft contributions to digital imaging is staggering, from operating system features for color management, to computer applications for image management, to image processing algorithms, to the Microsoft HoloLens for holographic computing.[8] Through that long history of imaging contributions, Microsoft has been a diligent contributor to a variety of ISO/TC 42 digital imaging projects.

Headquartered in France and the US, DxO Labs S.A. is a member of the US delegation to ISO/TC 42. DxO serves photographers, photo journalists, digital camera manufacturers, and camera component manufacturers, among others, with products ranging from embedded Image Signal Processors, to software for digital photography that faithfully renders silver halide film styles, or that corrects complex perspective problems, to professional tools for image quality evaluation.[9] In its contributions to the digital imaging work of ISO/TC 42, DxO brings its scientific excellence to bear on challenges whose solutions require both collaboration and technical expertise.

Within the US and internationally, ISO/TC 42 owes much to Adobe Systems Incorporated. Adobe places a strong value on corporate responsibility and this can be seen in its decades of leadership in ISO/TC 42 and the other standards organizations to which Adobe contributes both technology and leadership.[10] Within the US, Adobe led the IS&T Standards Management Board, overseeing the management of ISO/TC 42, for many years. Internationally, Adobe provides the co-convenor, with Canon, for the "Electronic still picture imaging" working group (WG 18), and provides the convenor for related working groups developing specific digital imaging sub-projects: "Digital still cameras," a joint working group (JWG 20) of ISO/TC 42 and the IEC; "Extended colour encodings for digital image storage, manipulation and interchange," a joint working group (JWG 23) of ISO/TC 42, ISO/TC 130, and the CIE; and "Use of XMP for digital photography," a joint working group (JWG 25) between ISO/TC 42 and ISO/TC 130. These working groups oversee the development of the digital imaging standards that comprise one of the two focus areas of ISO/TC 42, the other being the preservation and permanence of digital and physical imaging materials.

While Agfa-Gevaert ISO/TC 42 members hail from Belgium, this is truly an international company with production facilities around the world, one of the founding members in the world of imaging. The history of this company spans over 130 years, beginning with the AGFA color dye factory near Berlin and the Gevaert workshop making calcium paper for photography in Antwerp, continuing to the first fully automatic 35mm camera in 1959, and focusing today on imaging technologies in healthcare, graphic arts printing, and other specialized industrial imaging applications.[11] Agfa-Gevaert provides leadership in ISO/TC 42, with the convenor for both the "Physical properties and image permanence of photographic materials" working group (WG 5) and for the recently formed "Image permanence & durability test methods and specifications for digital prints in commercial applications," a joint working group (JWG 27) of ISO/TC 42, ISO/TC 130, and ISO/IEC JTC1/SC 28.

Fujifilm is another of the iconic traditional film and photography companies that has provided longstanding leadership in ISO/TC 42. In recent years, Fujifilm has extended its expertise from photography and printing to medicine and life sciences.[12] Today, Fujifilm provides the convenor for both the "Image measurement, viewing, and sensitometry" working group (WG 3), and the "Imaging materials – Dimensions" working group (WG 8), as well as providing experts from both Japan and the Netherlands to contribute in other working groups within ISO/TC 42.

Henry Wilhelm was a founding member of the Photographic Materials Group of the American Institute for Conservation of Historic and Artistic Works and was a founding US member of image permanence standards work in ISO/TC 42/WG 5.[13] His research and the techniques he developed for use in Wilhelm Imaging Research, Inc., were an important industry reference for the first generations of standardized accelerated test methods for the stability of color photographs and digital print materials. Perhaps more than any other individual, Henry has inspired the worldwide recognition that imaging products can and should be compared on the basis of their permanence capability. Henry continues his research and consulting, and is a member of the ISO/WG 5 task groups responsible for print permanence testing, and for storage conditions for black-and-white films and prints.

No discussion of image permanence can be complete with-

out recognition of the cornerstone work of the Image Permanence Institute at the Rochester Institute of Technology. IPI was founded in 1985 through the combined efforts and sponsorship of the Rochester Institute of Technology and the Society for Imaging Science and Technology. Libraries, archives and museums worldwide look to IPI for reliable information, consulting information, practical tools, and preservation technology. In keeping with this leadership, IPI provided the convenorship for WG 5 for a number of years and today continues its contributions in the ISO/TC 42 permanence standards work.

While preservation of physical materials has been a long-standing work area, ISO/TC 42 work in the relatively new area of digitization standards for archiving and preservation has attracted additional national and prominent libraries and museums to become members, both to contribute their considerable expertise and to learn from one another to further their capabilities in preserving the materials entrusted to their care. These institutions include: The National Library of Norway,[14] The US Library of Congress, The National Library of the Netherlands,[15] The Metropolitan Museum of Art,[16] The Harvard University Library, Zeutschel GmbH (Germany), The National Museum of Denmark, and The Royal Library (Denmark).[17] Those who attended the 2013 ISO/TC 42 Plenary in Copenhagen enjoyed the hospitality of both The National Museum of Denmark, and The Royal Library during that meeting. The involvement of Zeutschel shows the currency of the work; Zeutschel has been a leading provider of scanning and microfilm systems for Library and Information Science for over 50 years, with products and services in over 100 countries.[18] As these institutions work to preserve their cultural heritage, ISO/TC 42 provides them with the means to establish the common understanding of best practice. The Metropolitan Museum of Art and The Royal Library are appreciated for providing the convenor and secretary, respectively, for the "Imaging system capability qualification for archival recording and approval" joint working group (JWG 26), with ISO/TC 46/SC 11 and ISO/TC 171.

Real world applicability is one of the factors weighed in the creation of ISO standards. The ISO/TC 42 work in printed image permanence benefits greatly from the contributions of test equipment manufacturers. From Japan, we have the contributions of Suga Test Instruments Co., Ltd. Suga Test was founded in 1920 under the name of Toyo Rika Kogyo Instruments and since that time has developed continuous advances in its test equipment and measurement instrumentation, designed to evaluate materials for a variety of responses to adverse conditions, such as ozone, salt spray, and light. Suga Test has long placed a high priority on excellence, for example gaining accreditation from the Japanese government as an ISO/IEC17025 certified test laboratory in 2002.[19] From the US, Q-Lab Corporation and Atlas Material Testing Solutions both contribute much appreciated instrumentation expertise. Atlas produced its first instrument, the Solar Determinator, in 1915 to simulate the fading effect that the sun has on fabric.[20] Atlas has headquarters in the US and in Europe, and provides laboratory equipment to simulate weather conditions, and weathering testing services to customers worldwide. Among its many contributions, Atlas has provided invaluable technical information on the new light sources, helping the related standards projects to progress. Q-Lab Corporation began as Q-Panel Co., founded in Cleveland, USA to fill a need for standard test panels for paint research. The company name was changed to Q-Lab in 2006. Today, Q-Lab weathering products and services are used by material scientists and technicians in various industries.[21] One important aspect of print permanence test standards in ISO/TC 42 is to align with material test principles established in the broader industry.

Standard development brings together contributors from a diverse array of industries, often whose connection is formed at a fundamental technology level. For example, HID Global Corporation, a manufacturer of secure identity solutions, provides the chair of WG 5/TG 2, a task group with responsibility for photo book durability standards and a comprehensive set of storage condition standards.

Standards development must also incorporate the views and address the needs of the communities that use the products whose development is influenced and guided by the standards. As ISO/TC 42 work has evolved to include digital photography applications and the concerns of those who use digital photographs in digital print materials, the involvement of members from these areas has become increasingly important. Among these, The Book Manufacturers' Institute, CEWE Stiftung & Co. KGaA, Peleman Industries (Unibind), Sara Wagner, a senior photograph conservator at the National Gallery of Art, and the US National Archives & Records Administration (NARA) have provided much appreciated leadership and technical expertise. Peleman and CEWE both demonstrate outstanding leadership in the digital photo print industry, helping to establish and grow the future of digital photo products. In turn they bring this real world business experience to enrich ISO/TC 42 project work. The Book Manufacturers' Institute joined ISO/TC 42 to work on the photo book durability standards, bringing essential expertise from the world of traditional book printing. NARA instills ISO/TC 42 work in preservation and permanence with perspective on the breadth of preservation demands, representing the needs of family archives, government records, photographic materials, books, digital media, and motion picture film. Sara Wagner is a strong contributor to the WG 5 storage condition standards, bringing the museum and gallery perspective.

Looking back, the Eastman Kodak Company has held leadership roles in ISO/TC 42 for decades. Kodak set an example in the importance of standards, both with its corporate photography standards and with its many contributions to ISO/TC 42. For example, in the mid-1950s Kodak developed a reference print standard, called "the Shirley," that was used to enable independent photo labs to control their processes and produce good photographic prints. Although this was not an ISO standard, it was an early demonstration of the value of standards in photography. Within ISO/TC 42, Kodak led work both in the photography and in permanence stan-

dards. Now in 2016, the Eastman Kodak relationship with ISO/TC 42 has come to an end. We are fortunate that, going forward, Kodak Alaris continues a leadership role within the US delegation, serving as the chair of the IS&T Standards Management Board and leading the US technical committee in the image permanence area. Kodak Alaris has interests in consumer and professional imaging, retail and destination photo services, traditional photography materials, and information management.[22] With these interests, the affinity with the work of ISO/TC 42 is clear.

Looking forward to the continuing evolution of digital imaging, ISO/TC 42 celebrates its newer members, Google Inc., Intel Corporation, NVIDIA Corporation, and Qualcomm Technologies Inc., among them, and looks forward to the contributions of these dynamic industry leaders in developing the standards necessary to the future of imaging.

ISO/TC 42 was formed in 1947, as was the Society for Imaging Science and Technology. From their formation to today, the members of both of these organizations have developed, produced, and improved the dramatic technologies that continues to shape the imaging world.

[1] Innovative Imaging Solutions, 2015
[2] Image Engineering, 2015
[3] Imatest LLC, December
[4] Opticheskiĭ Zhurnal, June 2011
[5] Portuguese Institute of Photography, 2015
[6] Quality Institute, 2015
[7] Nikon Corporation, 2015
[8] Microsoft Studios, 2015
[9] DxO Labs, 2015
[10] Adobe Systems Incorporated, 2015
[11] AGFA-Gevaert, 2015
[12] Fuijifilm Global, 2015
[13] Wilhelm Imaging Research, Inc., 2015
[14] The National Library of Norway, 2015
[15] The National Library of the Netherlands, 2015
[16] The Metropolitan Museum of Art, 2015
[17] The Royal Library (Denmark) 2015
[18] Zeutschel GmbH, 2015
[19] Suga Test Instruments Co., Ltd., 2015
[20] Atlas Material Testing Solutions, 2015
[21] Q-Lab Corporation, 20
[22] Kodak Alaris, 2015

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.

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Winner of the Cactus Award

Fast and Accurate 3D Rendering of Automotive Coatings

Eric Kirchner and Ivo van der Lans, AkzoNobel (the Netherlands); Alejandro Ferrero and Joaquín Campos, Instituto de Óptica, , Consejo Superior de Investigaciones Científicas (Spain); and Francisco M. Martínez-Verdú and Esther Perales, University of Alicante (Spain)

Abstract: The color of automotive coatings varies with illumination and detection angles. For 3D rendering of these coatings currently two categories of methods exist, aiming at either color accuracy or at computational speed. Current methods that aim for color accuracy are based on measurement data from BRDF instruments. Since many hundreds of measurement geometries are needed to capture the color variation with angles, these methods require time-expensive interpolation of large three-dimensional Look-Up Tables. Current methods that aim for computational speed use physically crude approximations, usually taking into account color variations with respect to only one of the four angular dimensions.

Here, we derive a new approach for 3D rendering of automotive and other gonio-apparent coatings, which is a dedicated form of microfacet models. It aims at improved color accuracy as compared to the current computationally inexpensive methods, combined with higher computational speed and lower cost as compared to current color-accurate rendering techniques. The new approach utilizes a recently developed physical analysis method, introducing flake-based parameters and isochromatic lines, for the reflection properties of automotive coatings. This makes it more accurate than current fast rendering methods. The new method naturally leads to two- rather than three-dimensional Look Up Tables, which explains the small computation time it needs. We show that when applied to 3D rendering, this method indeed leads to accurate 3D rendering of automotive coatings while requiring reduced computation times. For numerical errors found in some special cases, solutions are found and tested.

Robust Chroma and Lightness Descriptors

Hamidreza Mirzaei and Brian Funt, Simon Fraser University (Canada)

Abstract: Object colour can be described in terms of three main dimensions, which are often specified as hue, chroma, and lightness. In terms of hue, *Mirzaei et al.* propose using the peak wavelength of a metameric Gaussian-like function (called a wraparound Gaussian) as a hue descriptor and show that it correlates as well as CIECAM02 hue does to Munsell hue, NCS hue, and the hue names in Moroney's color thesaurus. The Gaussian-based hue descriptor is also shown to be significantly more stable than CIECAM02 when the illuminant differs from CIE Standard Illuminant C.

Given a CIE XYZ and the spectrum of the illuminant, the key idea of the hue descriptor is to determine the wraparound Gaussian reflectance function that is metameric (i.e., leads to the same XYZ) under the given illuminant and then base the hue on a property of that reflectance, namely the wavelength at which the Gaussian peaks.

This paper introduces Gaussian-based chroma and lightness descriptors and compares them to CIECAM02 in terms of (i) how well they each correlate with the chroma and value designators of the 1600 Munsell papers, and (ii) how stable the respective descriptors are under a change in the illuminant.

Measuring Human Skin Colour

Mengmeng Wang[1], Kaida Xiao[2] , Sophie Wuerger[2] , Vien Cheung[1], and Ming Ronnier Luo[1,3]; [1]University of Leeds, [2]University of Liverpool (UK), and [3]Zhejiang University (China)

Abstract: Human skin colour measurements from four ethnic groups including 188 subjects were accumulated. Five to ten locations of each subject were measured by using two different instruments, a tele-spectroradiometer and a spectrophotometer. Three repeated measurements were accumulated for each location. Repeatability of the measurements at different locations from different ethnicities was examined using the mean CIELAB colour difference from the mean (MCDM). The colour distribution between different locations of different ethnic groups was also studied by plotting the data in a*b* and L*C*ab planes. Systematic trends were found between different ethnicities and instruments.

Spatio-Spectral Gamut Mapping and Separation

Sepideh Samadzadegan, Technische Universität Darmstadt and Philipp Urban, Fraunhofer Institute for Computer Graphics Research IGD (Germany)

Abstract: Spectral printing aims to achieve an illuminant-invariant match between the original and the reproduction. Due to limited printer spectral gamuts, an errorless spectral reproduction is mostly impossible, and spectral gamut mapping is required to reduce perceptual errors. The recently proposed paramer-mismatch-based spectral gamut mapping (PMSGM) strategy minimizes such errors. However, due to its pixel-wise processing, it may result in severely different tonal values for spectrally similar adjacent pixels, causing unwanted edges (banding) in the final printout. While the addition of some noise to the a* and b* channels of the colorimetric (e.g., CIELAB) image—rendered for the first illuminant—prior to gamut mapping solves the banding problem, it adversely increases the image graininess. In this article, the authors combine the PMSGM strategy with subsequent spectral separation, considering the spatial neighborhood within the tonal-value space and the illuminant-dependent perceptual spaces to directly compute tonal values. Their results show significant improvements to the PMSGM method in terms of avoiding banding artifacts.

Robust Color Extrapolation with Median Matrices

Nathan Moroney, Ingeborg Tastl, and Melanie Gottwals, HP Labs (USA)

Abstract: Color extrapolation is the estimation of color coordinates or transforms for values that lie beyond the sampled colors or training data. For example given a chart of measured color values and a digital image of that chart it is useful to be able to extrapolate values that are beyond the color samples provided by the chart. One option is to use linear multivariate regression based on a sampling of nearby points. This will result in a matrix transform which can be used for extrapolation. This abstract proposes the derivation of a median matrix based on a sampling of nearby points. That is given random triplets of points a closed form inverse of the first order polynomials is used to directly compute matrix elements. The final matrix is determined by the median of the individual elements. The median matrix extrapolation is shown to be more accurate than conventional multivariate regression, more robust to noise, does not require linear algebra, and can potentially be applied to streaming data. ▲

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Archiving 2016

September 12 – 16, 2016; Manchester, UK
Printing for Fabrication
32nd International Conference on Digital Printing Technologies
collocated with **Technologies for Digital Photo Fullfillment**

November 7 – 11, 2016; San Diego, CA
24th Color and Imaging Conference (CIC24)

Jan. 29 – Feb.12, 2017; Burlingame, CA
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