PRELIMINARY PROGRAM

# Thirteenth Color Imaging Conference

## Color Science and Engineering Systems, Technologies, and Applications

November 7–11, 2005
Scottsdale, Arizona

Sponsored by
Society for Imaging Science and Technology
Society for Information Display

IS&T SID SOCIETY FOR INFORMATION DISPLAY

**Cooperating Societies**
Inter-Society Color Council (ISCC)
Imaging Society of Japan (ISJ)
Royal Photographic Society of Great Britian (RPS)
Society of Motion Picture and Television Engineers (SMPTE)
Society of Photographic Science and Technology of Japan (SPSTJ)

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**The Location**

CIC13 will take place at The Caleo, formerly known as The SunBurst Resort, in Scottsdale, Arizona, which has more sun-filled days than any other part of the United States. The Caleo combines modern sophistication with Southwest charm. Reservation information can be found on page 20.

# Sponsors

**IS&T and SID would like to thank the following companies* for their sponsorship of CIC13.**

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# Conference Overview

For the 13th year in a row, color scientists, engineers, technologists, and others interested in color imaging will gather in Scottsdale, Arizona to discuss the latest developments in the field at the IS&T/SID Color Imaging Conference (CIC).

CIC has traditionally attracted a diverse set of papers—and this year is no different. As in past years, the conference will kick off with a special two-day, in-depth tutorial, "Basic Color Science and Imaging," by Robert W. G. Hunt. The second day of the conference features 13 exciting two- and four-hour tutorials on topics ranging from "Device Simulation for Image Quality Evaluation" to "Color Science for HDTV and Digital Cinema." The technical sessions begin on Wednesday (November 9th) and continue in a single track format through Friday at noon. Designed to encourage the exchange of ideas across specialized areas of the field, the single-track approach is one of the most appealing aspects of this conference. This year also promises an exciting Interactive Paper Session. These presentations will be previewed during "Spotlight Sessions" held throughout the week. Be sure to join us on Thursday afternoon to view the papers and cast your vote for this year's Cactus Award winner!

Theoretical concerns, as well as industrial applications, of color imaging will be explored and three keynotes will lead the way. The first, on Wednesday morning, will be given by Hiroaki Kotera, professor in the department of Information and Image Sciences at Chiba University in Japan. Kotera will share his perspectives on intelligent image processing. Thursday kicks off with a plenary by Louis D. Silverstein, president, VCD Sciences, Inc., who will discuss color display technology: from pixels to perception. Silverstein's talk will be followed by the presentation of IS&T awards, this year given to many members of our color community. Thursday night C. David Tobie, product manager at ColorVision, Inc., talks about how photographers actually manage color in a special evening lecture. Finally, our week ends with a keynote discussing the changing landscape of digital camera technology, given by Paul M. Hubel of Foveon, Inc.

This year we are also pleased to offer pre- and post-conference programs of added benefit to attendees, making your trip to Scottsdale an even better use of time and resources! On Monday, November 7, the ICC is sponsoring the DevCon '05, a one-day seminar designed for users and product developers working with ICC-based color-management systems. Full information on the event can be found at www.color.org; to make things easy, you can register for their conference when you register for CIC13. At that time, you can also register for the ISCC/IS&T Special Topics Conference "Precision & Accuracy in the Determination of Color in Images," which runs from 2 pm on Friday through Saturday afternoon.

After looking through this preliminary program we're sure you'll agree that this year's meeting promises to be extra special, a time during which you will have the chance to learn much and spend time with colleagues during the conference receptions and coffee breaks.

We look forward to seeing you in Scottsdale!

Po-Chieh Hung and Michael H. Brill
General Chairs

# Pre- and Post-conference Programs

## ICC DevCon '05

### For Users and Product Developers Working with ICC-based Color Managment

Monday, November 7, 8:00 am to 7:30 pm
Chaparral Suites Resort (located across the street from the Caleo)

*Digital information today includes color, but how should it be encoded or processed for a specific application? DevCon '05 provides practical advice using real-world examples to help those who want to implement or use ICC v4 color standards. Experienced developers and users within the imaging, printing, and publishing color community share their knowledge in a series of tutorials designed to answer all your questions.*

*Below is the program schedule; for speaker information and other details visit www.color.org. You may register directly for DevCon when you resgister for CIC13—see page 21 for rates and details.*

**Welcome**
**What do image pixel values represent?**
*Presenter: Ann McCarthy, Lexmark Int'l., Inc.*
**What does ICC color rendering do to color?**
*Presenter: Emmi Enoksson, Dalarna Univ., Sweden*
**How SHOULD applications present color controls?**
*Presenter: Chris Murphy, Color Remedies*
**When and how should a print job be encoded for print?**
*Presenters: Olaf Drümmer, Callas Software GmbH; Phil Green, London College of Communication; and Bob Hallam, Quebecor World*
**What is better about ICC V4?**
*Presenter: Craig Revie, Fuji Film Electronic Imaging*
**How should device drivers use ICC profiles?**
*Presenter: Luke Wallis, Apple Computer, Inc.*
**LUNCH and PANEL DISCUSSION: "From the trenches" Expert User Panel Q&A**
*Panel members: Bob Hallam, Quebecor World; Don Hutcheson, Hutcheson Consulting; Chris Murphy, Color Remedies; Matt Phillips, Adobe Systems Inc.; and David Zwang, Zwang & Company*
**Under the hood: the V4 CMM, V4 ICC profiles, and the new ICC Perceptual PCS**
*Presenter: Max Derhak, Onyx Graphics Corp.*
**V4 LUT structures – advantages, computational models, examples**
*Presenter: Luke Wallis, Apple Computer, Inc.*
**ICC V4 colorimetric rendering intents – applicability, construction examples**
*Presenter: Marti Maria Saguer, Hewlett-Packard Co.*
**ICC V4 perceptual rendering intent – applicability, construction examples**
*Presenter: Jack Holm, Hewlett-Packard Co.*
**Profile Identification and output condition metadata**
*Presenter: Uwe-Jens Krabbenhoeft, Heidelbergerer Druckmaschinen AG*
**DeviceLink profile construction for interoperability**
*Presenter: Eric Magnusson, Left Dakota*
**Profile and CMM computational quality, a.k.a. why "perfect" math may not be enough**
*Presenter: Chris Cox, Adobe Systems Inc.*
**Wine & Cheese Networking Event**

### ICC DevCon '05 Reception open to CIC13 Attendees

Join colleagues at the Chaparral Resort, (across the street from The Caleo) for a special Wine and Cheese Networking Event from 5:30–7:30 pm on Monday, November 7. The event will also feature ICC Color Management Technology demonstrations by DevCon '05 sponsors.





## ISCC/IS&T/SID Special Topics Conference

### Precision & Accuracy in the Determination of Color in Images

Friday, November 11, 2:00 to 4:00 pm and
Saturday, November 12, 9:00 am to 4:00 pm

*A one-and-a-half-day symposium focused on issues related to making reliable measurements for calibrating and profiling the color of digital imaging devices, including emissive displays and printed media.*

Friday, November 11, 2:00 – 4:00 pm

**The Problem of Fluorescence**

**Keynote Speaker:** Patrick Emmel (Clariant), *"Introduction to Fluorescence and Optical Brighteners"*
**Contributors:** Danny C. Rich (Sun Chemical), *"Effect of Brightened Substrates on Color Management;"* Claudio Puebla (Axiphos) *"Compensating or Correcting for Brightened Substrates;"* and Dave Wyble (RIT Munsell Color Science Lab), *"A Dataset for Evaluation of Color Measuring Instrumentation"*

Saturday, November 12, 9:00 am – noon

**Repeatability, Reproducibility, Traceability**

**Keynote Speaker:** Maria Nadal (NIST), *"Fundamental Standards for Image Color Assessment"*
**Contributors:** Dave Wyble (RIT Munsell Color Science Lab), *"Comparison of Repeatability Metrics for Color Measurement Instruments;"* Danny Rich (Sun Chemical) *"Comparison of Reproducibility Metrics for Color Measurement Instruments;"* Charles Leete, (Collaborative Testing Service), *"A Process for Assessment of Inter-Instrument Agreement;"* Tuo Wu (Hewlett-Packard Co.), *"Validation of Colorimeter Performance in the Field;"* and Jack Ladson (Color Science Consultancy), *"An Instrument Correction Program"*

2:00 – 4:00 pm

**Measurements Using Images**

**Keynote:** John McCann (McCann Imaging), *"Radiance Calibration of High Dynamic Range Image Segments"*
**Contributors:** Rejean Baribeau (NRC Canada), *"Predicting Color Corrections from the Measured Spectral Response of a Colorimeter;"* Jeff DiCarlo (Hewlett-Packard Co.) *"Imager Calibration Trade-offs;"* and Mark Fairchild (RIT Munsell Color Science Lab), *"Using HDR Display Technology and Color Appearance Modeling to Create Display Color Gamuts That Exceed the Spectrum Locus"*

**Registration**
*To register, fill out the registration form on page 21 or contact IS&T. ISCC/IS&T/SID Members: $200; Non-members: $250; Students: $100, until October 5. After October 5 rates are ISCC/IS&T/SID Members: $250; Non-members: $300; Students: $100.*

*For more information on the program, visit www.iscc.org.*

# Tutorial Program

## CIC Special Two-Day Event

### The Hunt Course

A 2-Day Special Event
November 7 & 8, 2005 8:30 am to 5:00 pm

### Basic Color Science and Imaging

An in-depth tutorial with Dr. Robert W. G. Hunt

This comprehensive two-day course will cover the principles of color perception, measurement, and reproduction, as applied to photography, television, printing, desk-top publishing, and electronic imaging. Each day will be comprised of six one-hour lectures with discussion.

Prerequisites: a minimum of one year of college chemistry, physics, and math is recommended and some experience with color systems is helpful, but not mandatory.

Benefits: Upon completion attendees will be able to:

- describe normal color vision in terms of system components and their functions, trichromacy, adaptation, and luminance
- discuss light sources including incandescent and fluorescent lamps, daylight, color temperature, and standard illuminants
- understand the principles of spectrophotometry, including the geometry of illumination, and viewing and dealing with fluorescent samples
- explain the experimental basis of colorimetry the reason why some colors cannot be matched by RGB additive mixtures
- explain primaries, chromaticity, the effects of changing primaries, and color matching functions
- describe the CIE system of colorimetry, including the XYZ, u′, v′, CIELUV, and CIELAB systems, and understand the concepts of whiteness, advanced color difference formulae, observer and illuminant metamerism indices, color inconstancy index, chromatic adaptation transform, and color appearance models
- describe color reproduction in terms of both additive and subtractive trichromatic principles and become familiar with television display devices and color film and its processing
- learn about densitometry and describe the factors affecting tone reproduction
- understand the principles involved in broadcast television and digital cameras
- discuss the application of color science to lithographic printing
- appreciate what factors affect quality in digital imaging and desk-top publishing
- understand the essential requisites of successful color imaging

*Robert Hunt worked for 36 years at the Kodak Research Laboratories in Harrow, England, taking early retirement as Assistant Director of Research in 1982. Since then he has been working as an independent color consultant. He has had two books published: The Reproduction of Colour, now in its sixth edition, and Measuring Colour, now in its third. He has attended all the previous Color Imaging Conferences in Scottsdale and is a regular contributor of keynote papers.*

Cost: $650 IS&T/SID members; $825 non-members, before October 5.





## Tuesday, November 8, 2005

**T1 TRACK: COLOR VISION, APPEARANCE, AND IMAGE QUALITY**

### T1A–Color Appearance Modeling using CIECAM02

8:00 to 10:00 am (2 hours)
Instructor: Nathan Moroney, Hewlett-Packard Co.

This course begins with a review of color appearance phenomena and the basics of color appearance modeling, including chromatic adaptation, color attribute correlates, and other topics. The course then focuses specifically on the CIECAM02 color appearance model and its applications. Publicly available software and tools will be used to demonstrate and explore the model. Specific applications such as gamut rendering and quantification, gamut mapping, device characterization, and interpolation will be considered, as will model parameters and configuration. Finally advantages and trade-offs of using the model will be considered.

Benefits: This course will enable the attendee to:

- Understand the basic components of a color appearance model
- Acquire working familiarity with the CIECAM02 color appearance model
- Gain hands-on experience configuring the model for given viewing conditions
- Apply CIECAM02 to specific imaging applications
- Leverage existing tools to immediately implement CIECAM02
- Make informed decisions about the use and application of color appearance models

Intended Audience: Broadly applicable to those researchers and developers working in the area of color appearance and color reproduction, the course will include examples and discussion based on an open source implementation of CIECAM02 so attendees with some software knowledge will be able to make immediate use of the topics covered. An emphasis of this course is solving specific problems with CIECAM02. Attendees will benefit from previous familiarity with colorimetry and the basics of color science.

*Nathan Moroney is a color expert at Hewlett-Packard Laboratories. He holds a BS in Color Science from Philadelphia University and an MS in Color Science from the Munsell Color Science Laboratory of the Rochester Institute of Technology. He was the chair of CIE technical committee 8-01, which developed the CIECAM02 model. Moroney has published papers, been granted patents, and given invited presentations on color appearance modeling, compression, halftoning, image enhancement, and a range of other research areas. He is a member of the IS&T and ISCC.*

### T1B–Spatio-chromatic Vision Models for Imaging

10:20 am to 12:20 pm (2 hours)
Instructor: Jan Allebach, Purdue University

This course describes the context, structure, and applications of spatio-chromatic vision models for imaging. The important characteristics of the visual system and the basic concepts of color science will be reviewed, followed by the development of a general framework for spatio-chromatic vision models based on trichromacy, color opponency, and the limited spatial frequency response of the vision system. Applications of these models to color image quantization and digital color halftoning will be discussed. After this, a more complex group of models will be introduced

### Tutorial Fees

| if you register: | by Oct. 5 | after Oct. 5 |
|---|---|---|
| 4-hour Member | $200 | $230 |
| 4-hour Non-member | $250 | $280 |
| 2-hour Member | $150 | $180 |
| 2-hour Non-member | $195 | $225 |

*IS&T/SID reserve the right to cancel classes in the event of insufficient advance registration. Please indicate your interest early.*

that account for the multi-channel nature of the visual system, the dependence of perception on contrast, and the role of the psychometric function in describing detection and discrimination. The course concludes with a discussion of potential applications of these models to image quality assessment.

Benefits: This course will enable the attendee to:

- Understand the fundamental spatiochromatic aspects of the visual system and how they can be captured in models
- Appreciate how spatio-chromatic models for the human visual system can be used in the development of color image quantization and halftoning algorithms, as well as for image quality assessment
- Comprehend more complex models that incorporate the multi-channel nature of the human visual system, as well as contrast and psychometrics
- Understand ways in which developed models can be applied to image quality assessment

Intended Audience: Intended for scientists, engineers, analysts, and managers involved in the design, engineering, manufacturing, marketing, or evaluation of imaging products, algorithms, or systems, participants should be familiar with the function and basic properties of color imaging systems. A rudimentary knowledge of color science, linear systems, and image processing is helpful, but not essential.

*Jan P. Allebach received his BSEE from the University of Delaware (1972) and his PhD from Princeton University (1976). He was on the faculty at the University of Delaware from 1976 to 1983 and since then has been at Purdue University where he is Michael J. and Katherine R. Birck Professor of Electrical and Computer Engineering. His current research interests include image rendering, image quality, color imaging and color measurement, and digital publishing. Allebach is a Fellow of the IEEE Signal Processing Society and IS&T. He has served as Distinguished/Visiting Lecturer for both societies, and has been an officer and served on the Board of Directors of both as well. He is a past Associate Editor for the IEEE Transactions on Signal Processing and the IEEE Transactions on Image Processing. Allebach is presently Editor for the IS&T/SPIE Journal of Electronic Imaging (JEI). He received the Senior (best paper) Award from the IEEE Signal Processing Society and the Bowman Award from IS&T. In 2004, he was named Electronic Imaging Scientist of the Year by IS&T and SPIE. He has received four teaching awards at Purdue University.*

### T1C/D–Image Quality: Framework and Quantification

1:30 to 5:50 pm (4 hours)
Instructor: Peter G. Engeldrum, Imcotek Inc.

Image Quality: Framework and Quantification puts the various image quality elements together in a unified way; the systems perspective. Using the Image Quality Circle (IQC) as the framework, this tutorial focuses on the big-picture view of image quality. This framework spans the breadth of the product development organization from determining customer requirements—market research—to selecting the technology variables that will deliver the required image quality. Concepts and tools for quantifying customers and images and integrating these results are described.

Benefits: This course will enable the attendee to:

- Understand concept of image/print and use the Image Quality Circle as a process for managing and developing the image/print quality of imaging and consumable products
- Understand image quality and how its many facets can be unified
- Recognize visual perceptual attributes–the "nesses"
- Understand basic human response quantification-psychometric scaling
- Know the essential properties of the human visual system and the principles of connecting image measurement to visual percepts
- Construct simple image quality models
- Identify basic hardware requirements for image measurements

Intended Audience: Intended for scientists, engineers, product program managers, and students, who have a responsibility for, or an interest in, image quality (IQ), no prerequisites are required.

*Peter Engeldrum is the developer of the Image Quality Circle (IQC). He is president of Imcotek, a technical consulting firm that assists organizations to find solutions to imaging system and image and color problems. With more than 25 years of experience in imaging and color systems, he has worked with a variety of imaging and display technologies. Engeldrum has been active in the areas of image and color quality, color scanning, color printing, photography, and color imaging over the Internet. He was a faculty member at the Center for Imaging Science, Rochester Institute of Technology, where he received his degrees. Engeldrum is a member of several professional societies and is an IS&T Fellow. He has also served on several corporate advisory boards and has several patents and patents pending in the areas of display calibration and Internet imaging.*

## T2 Track: Color Systems and Standards

### T2A/B–System Interactions in Digital Color Imaging

8:00 am to 12:20 pm (4 hours)
Instructors: Raja Bala, Xerox Corporation, and Gaurav Sharma, University of Rochester

This course underscores the system aspect of color imaging by providing insight into the common interactions among different functions within a digital imaging system. It begins with a brief overview of the basic color processing functions, including color halftoning, device calibration, characterization, gamut-mapping, quantization, and compression. The tutorial then highlights common system interactions among these functions and illustrates, through specific case studies, how knowledge of these interactions may be beneficially exploited for improving overall system performance and/or image quality. Case studies discussed in the tutorial will include—among others—interactions between input and output device characterization transforms, color and spatial dimensions of perception, device characterization and media, halftoning and color characterization, and quantization and halftoning.

Benefits: This course will enable the attendee to:

- List basic processing functions in a digital color imaging system and schematically represent a system from input to output
- Describe unintended interactions between input and output characterization profiles and ways to mitigate these
- Comprehend and exploit the interactions between color and spatial dimensions in optimizing a color imaging system
- Explain how media characteristics influence the performance of color imaging devices
- Understand the interactions between halftones and color in output devices and some techniques for co-optimization of these
- Appreciate how system design and optimization can surmount problems that are not resolvable in individual components

Intended Audience: Intended for engineers, scientists, students, and managers interested in acquiring a broad system-wide view of digital color imaging systems, practitioners and experts who are familiar with specific components also stand to gain a better perspective for the remainder of the system. Presented case studies on system optimization will be of interest to technologists looking for ways to improve their digital color imaging systems and will, hopefully, serve as inspiration for additional research in this area. Attendees are expected to be familiar with basic image processing and colorimetry.

*Raja Bala, principal scientist at Xerox's Imaging and Services Technology Center, performs research and development in color imaging. He is also an adjunct faculty*

*member in the School of Electrical Engineering at Rochester Institute of Technology. He received a PhD from Purdue University in Electrical Engineering (1992). His research interests include color science and imaging, color management, and color image processing. Bala holds more than 40 publications and more than 30 patents in the field of color imaging. He is a member of IS&T.*

*Gaurav Sharma, associate professor in the Electrical and Computer Engineering Department, has taught at the University of Rochester since Fall 2003, prior to which he was a principal scientist and project leader in the Xerox Innovation Group. Sharma received his PhD in Electrical and Computer Engineering from North Carolina State University. He holds masters degrees in Applied Mathematics from NCSU and in Electrical Communication Engineering from the Indian Institute of Science, Bangalore, India and a bachelor of engineering degree in Electronics and Communication Engineering from Indian Institute of Technology, Roorkee. His research interests include color science and imaging, image restoration, and print and multimedia security. He currently serves as an associate editor for IEEE Transactions on Image Processing, IEEE Transactions on Information Forensics and Security, and the IS&T/SPIE Journal for Electronic Imaging. He is the editor of "Digital Color Imaging Handbook" published by CRC Press (2003).*

## T2C - Color Management Concepts for Digital Imaging Systems

1:30 to 3:30 pm (2 hours)
Instructor: Kevin Spaulding, Eastman Kodak Co.

Color management technology enables predictable and desirable color reproduction to be achieved in digital imaging systems. This tutorial discusses color management concepts in the context of an image state architecture that has been developed to describe the relationship between various types of digital images, image capture and display devices, image processing workflows, and digital color encodings. Color management will be presented as five connected classes of operations including input, rendering, unrendering, effects, and output. The characteristics and properties of color management transforms used for each of these basic operations will be described, together with a discussion of how these transforms can be implemented in the framework of the ICC Color Management System.

Benefits: This course will enable the attendee to:

- Describe common digital imaging workflows within the context of an image state architecture model
- Understand the characteristics and uses of commonly encountered color encodings (e.g., sRGB, sYCC, ICC PCS, RIMM/ROMM RGB, etc.)
- Distinguish between different types of color management transformations used in digital imaging systems
- Understand the relationship between color management systems and the image state architecture model

Intended Audience: This course is intended for scientists, engineers, analysts, and managers involved in the design, engineering, manufacturing, marketing, or evaluation of digital imaging and color management systems.

*Kevin Spaulding received a BS in Imaging Science from Rochester Institute of Technology (1983) and MS and PhD in Optical Engineering from the University of Rochester (1988 and 1992, respectively). He has been with Eastman Kodak Co. since 1983 where he is currently a senior principal scientist in the Imaging Science Division. He serves on several international standards committees that are working on standards pertaining to the unambiguous communication of digital color image data in digital imaging systems. His research interests include color reproduction, digital halftoning, image processing algorithms for digital camera and printers, and image quality metrics.*

## T2D–Implementing, Testing, and Using ICC v4 Color Management

3:50 to 5:50 pm (2 hours)
Instructors: Ingeborg Tastl and Jack Holm, Hewlett-Packard Co.

In 2002, the International Color Consortium (ICC) published ICC.1:2001-12, a specification for version 4 color profiles, and made it available over the Web (www.color.org). This specification addresses a number of ambiguities and interoperability issues that previously caused difficulties in the use of ICC color management. Several companies support v4 profiles in applications, drivers, and operating systems, and software is becoming available to generate customized ICC v4 profiles. This tutorial will discuss the major conceptual, implementation, and use differences between ICC v2 and v4. Furthermore, it will elaborate on different ways to evaluate the functional correctness of ICC profiles and workflows, as well as quality.

Benefits: This course will enable the attendee to:

- Understand the differences between ICC v2 and the new ICC v4 color management framework, and learn what they can expect from color management moving forward
- Generate, analyze, test, and use ICC v4 profiles containing colorimetric and perceptual rendering intents for input and output devices
- Select the most appropriate and robust color management workflow for particular groups of users (professional and consumer) and particular tasks
- Make decisions based on advanced understanding of color management at a systems level

Intended Audience: Intended for application developers, imaging workflow designers, system architects, color engineers and scientists, and anyone in the professional imaging community (professional photographers, graphic designers, etc.) interested in the latest developments of ICC color management, participants should be familiar with the basic principles of color management.

*Ingeborg Tastl has been a color scientist working in the area of digital color imaging and printing at Hewlett-Packard Laboratories since 2001. She is also represents HP within the ICC, playing an active role in the development of ICC color management. Before joining HP, Tastl's focused on digital photography, while working at Sony's US Research Laboratories. The reproduction of color on all kinds of devices and media has been her area of interest since she received her Masters and PhD in computer science from the Vienna University of Technology, after which she did a PostDoc at the Ecole Nationale Superieure des Telecommunication in Paris. Tastl is an IS&T member and was General Co-chair of CIC10.*

*Jack Holm is a senior scientist working on strategic technology in the CTO office of Hewlett-Packard's Imaging and Printing Group. He is HP's primary standards representative on several digital imaging committees, including the I3A Standards Management Board. Holm is chair of the US TAG for ISO TC42 (Photography), and technical secretary for the IEC TC 100 TA2 (Multimedia systems & equipment – Color measurement & management). He also serves as liaison from ISO TC42 to IEC, ICC, and CIE committees. Holm has been active in digital photography research for more than a decade, and was a primary contributor to the development of color processing for HP digital cameras. Previously he served as a digital photography consultant, and on the faculty of the RIT School of Photographic Arts and Science.*

# T3 Track: Color Devices and Technologies

## T3A–Recent Advances in Industrial Inkjet Technology

8:00 to 10:00 am (2 hours)
Instructor: Phillip Bentley, Xennia Technologies

The growth of inkjet printing in recent years has been truly remarkable. Much of this success is due to developments in ink chemistry, which have opened up a world of new applications for inkjet and thus increased the importance of color and polymer chemistry. In the case of color, the use of dye or pigment is now one of the most widely debated topics in the industry, while polymer chemistry has become a central feature of ink development. This course will provide an overview of the key elements involved in industrial inkjet printing with a particular focus on inkjet techniques, systems, and ink design. The course will draw on emerging inkjet appli-

cations to highlight the potential for inkjet as a reliable and cost-effective printing solution.

Benefits: This course will enable the attendee to:

- Form a comparative overview of the various inkjet techniques
- Describe the issues surrounding inkjet ink colorant formulations (dye based vs. pigment inks)
- Identify key features for reliable and successful inkjet ink design across a range of ink types
- Gain a broad understanding of current and emerging markets for industrial inkjet

Intended Audience: Intended for chemists, engineers, and scientists who are working in the color management industry looking to gain a detailed overview of the inkjet proposition, the course would also be of interest to managers/technical staff looking to understand and evaluate the potential for inkjet within their organization.

*Philip Bentley joined Xennia in 1999 and is now principal chemist, responsible for a number of multi-disciplinary projects. He has been involved with all forms of inkjet technology, developing a wide range of products for a variety of complex applications. He is accredited with developing the unique chemistry currently applied in the direct write of conductive inks. Bentley graduated from Loughborough University of Technology (1995) with a BSc Honors degree in Chemistry with Polymer Science Technology. He completed his PhD at Sheffield University, working on the synthesis and characterization of liquid crystalline electroluminescent polymers for use in polarized display applications.*

## T3B—Device Simulation for Image Quality Evaluation

10:20 am to 12:20 pm (2 hours)
Instructor: Joyce Farrell, Stanford University

This course uses the Image Systems Evaluation Toolbox (ISET) to simulate and evaluate the influence that different imaging system components have upon perceived image quality. The course is organized into sections corresponding to the six ISET modules that simulate visual scenes, optics, sensors, image processing, displays, and human observers. The scene module uses high-dynamic multispectral image data to calculate the spectral radiance (photons/ sec/nm/sr/m2) at each point in a sampled scene. The optics module converts the scene radiance data to an irradiance image at the sensor. The sensor module converts the sensor irradiance image into electron counts within each pixel of the image sensor. The processor module transforms the electron count into a digital image and applies both demosaicing and color balancing algorithms. The display module applies rendering algorithms and calculates the spectral radiance generated by the final displayed image. Finally, ISET includes several image quality metrics (e.g., CIELAB, S-CIELAB) that measure the perceptual difference between any two radiance images. When one of the radiance images corresponds to the original scene data, the image quality metrics provide a measure of image fidelity. This course will include many practical examples that illustrate how to use ISET through graphical user interface and scripting. Examples will include methods for visualizing and quantifying different imaging system components that influence perceived image quality.

Benefits: This course will enable the attendee to:

- Install a student version of the Image Systems Evaluation Toolbox (ISET) onto their personal laptop computers
- Describe the apparatus and method for acquiring high dynamic multispectral image data
- Learn in detail how to use the various components of the ISET Scene, Optics, Sensor, Processing, and Display Modules
- Describe the measurement data necessary to simulate a linear display
- Use ISET to evaluate system design tradeoffs that exist between spatial resolution (pixel size) and dynamic range, spatial resolution and color fidelity, algorithm complexity and image quality, etc.





Intended Audience: Intended for engineers, scientists, students, and managers who wish to understand how changes in imaging system components will affect perceived image quality, the course will be especially useful for engineers who are designing optics, sensors, processing algorithms, or displays for digital cameras and cell phone imagers.

*Joyce Farrell is executive director of the Stanford Center for Image Systems Engineering. She received her doctorate from Stanford University and has more than 20 years of research and professional experience working at a variety of companies and institutions, including NASA Ames Research Center, New York University, Xerox Palo Alto Research Center, Hewlett-Packard Laboratories, and Shutterfly (a startup co. specializing in online digital photo-finishing). She is also CEO and founder of ImagEval Consulting, LLC.*

## T3C/D—Color in Electronic Displays

1:30 to 5:50 pm (4 hours)
Instructor: Gabriel Marcu, Apple Computer

This course discusses and compares the most important color reproduction factors in electronic displays, covering CRT, AMLCD (including transmissive, reflective, and transflective displays in mobile devices), plasma (PDP), OLED, and projection systems such as DLP, LCD, LCoS technologies. The tutorial covers display technologies for different applications, ranging from mobile devices to large LCD TV screens. Factors such as display technology, luminance level, contrast ratio, opto-electronic transfer function, color gamut, viewing angle, flare, white point, gray tracking, response time, and color model are discussed. The importance of color management for accurate color control is explained and the influence of viewing conditions and adaptation in the evaluation of the displayed color is highlighted. The tutorial gives an easy-to-understand, yet in-depth, analysis of all the elements that determine the color performance of electronic displays, beginning with the measurement and interpretation of data (including gamut visualization and comparison) to the role of test images in evaluating display color quality.

Benefits: This course will enable the attendee to:

- Understand the principles of color formation for most widely used emissive, reflective, transmissive, and transflective display technologies
- Compare the color performance of CRT versus AMLCD of different modes such as twisted nematic (TN), in-plane switching (IPS, Super-IPS), vertical alignment (MVA), and fringe field switching (FFS) technologies
- Understand projection technologies such as DLP, LCD and LCoS and get an overview of emerging display technologies
- Learn about gray tracking, its importance in color quality on displays, and how to control it
- Select the optimal color model for a display and highlight its dependency on display technology
- Calibrate and characterize different types of displays (including the projector used in the class) using tools varying from visual calibrator to instrument-based ones
- Apply the knowledge from the course to practical problems of color control in display projects

Intended Audience: The course is intended for engineers, scientists, project managers, pre-press professionals, and others confronting color issues in electronic displays.

*Gabriel Marcu is senior scientist in the ColorSync group at Apple Computer. His achievements are in color reproduction on displays and desktop printing (characterization/ calibration, halftoning, gamut mapping, ICC profiling, HDR imaging). Marcu is responsible for color calibration and characterization of Apple display products. He has taught seminars and short courses on color topics at Shizuoka University (Japan), UC Berkeley, EMI Cambridge (UK), and various IS&T, SPIE and SID conferences. Marcu is co-chair of the 2006 Electronic Imaging Symposium and co-chair of one of its conferences, Color Imaging: Processing, Hardcopy, and Applications.*

T4 Track: Emerging Areas

## T4A–Color Science for HDTV and Digital Cinema

8:00 to 10:00 am (2 hours)
Instructor: Charles Poynton, Consultant

High-definition television (HDTV) broadcasting is now commonplace and most television productions are being made in HDTV (even if "downconverted" to standard-definition television, SDTV, for analog broadcast). Digital cinema is also now in the mainstream. Several movies have been captured entirely in the 1080p24 digital format (derived from HDTV) without the use of any film. In post-production, digital intermediates are now used routinely to store entire movies digitally, even those portions scanned-in from film. Digitally-produced movies are "filmed-out" (recorded to 35 mm motion picture film) for exhibition, but digital masters are made for exhibition in the approximately 150 commercial cinemas worldwide now equipped with digital cinema projectors.

Digital HDTV production and digital movie making present important and challenging applications of color science, color image coding, and color management. The high contrast ratio and wide gamut of cinema film set goals well beyond the limits of graphics arts. This tutorial details the application of color science to HDTV and digital cinema. It explores the technologies of HDTV and D cinema, from camera and scanner technology, through processing, to digital cinema display equipment and film recorders. The application of color science to each of these steps is explained and how color appearance models are finding new applications in this domain are explored.

Benefits: This course will enable the attendee to:
- Evaluate the contrast ratio and gamut constraints of various image coding systems
- Understand color image coding for HDTV and digital cinema
- Understand the color signal processing required to process cinema-class imagery

Intended Audience: This course is intended for scientists, engineers, and managers involved in the design, engineering, and evaluation of digital cinema, and more generally, high-quality continuous-tone imaging products, algorithms, or systems. Participants should be familiar with color science and color image coding, and should have no fear of mathematics.

*Charles Poynton is an independent contractor specializing in the physics, mathematics, and engineering of digital color imaging systems, including digital video, HDTV, and digital cinema (D cinema). While at Sun Microsystems, from 1988 to 1995, he initiated Sun's HDTV research project, and introduced color management technology to the company. Soon after its introduction in February 2003, Poynton's book, Digital Video and HDTV Algorithms and Interfaces, was Amazon.com's 3,339th most popular book.*

## T4B–Color in High Dynamic Range Imaging

10:20 am to 12:20 pm (2 hours)
Instructor: Greg Ward, Consultant

This course will describe the techniques and technologies behind high dynamic range imaging, covering methods for HDR capture, representation, editing, and display. Live demonstrations of HDR image capture using a standard digital camera, image-based lighting techniques for rendering synthetic objects into a real environment, and real-time HDR display will be featured. Tone-mapping and gamut-mapping issues for low dynamic range output and printing will also be addressed.

Benefits: This course will enable the attendee to:
- Compare low to high dynamic range imaging
- Outline basic methods for HDR image capture
- List major HDR image formats, their strengths, and weaknesses
- Describe the dual-modulation method for HDR image display
- Summarize the tone-mapping problem as it applies to HDR image printing
- Define image-based lighting and give examples from recent movies

Intended Audience: This course is intended for color scientists, software and hardware engineers, photographers, cinematographers, production specialists, and students interested in the means and rewards of extending the dynamic range of their pipeline. By taking the audience from the basics of HDR to more advanced techniques such as image-based lighting, the goal is to convey the simplicity and power of this exciting new trend in digital imaging.

*Greg Ward is a pioneer in the HDR space, having developed the first widely used HDR image file format in 1986 as part of the radiance lighting simulation system. In 1998, he introduced the more advanced LogLuv TIFF encoding, and more recently, created a backwards-compatible HDR extension to JPEG. He is the author of the Mac OS X application Photosphere and a coauthor of High Dynamic Range Imaging. Having worked in the computer graphics research community for more than 20 years, Ward has developed rendering algorithms, reflectance models and measurement systems, tone reproduction operators, image processing techniques, and photo printer calibration methods. His past employers include the Lawrence Berkeley National Laboratory, EPFL Switzerland, SGI, Shutterfly, and Exponent. He holds a BS in Physics from UC Berkeley and a MS in Computer Science from SF State University. He is an independent consultant in Albany, California and is currently collaborating with Sunnybrook Technologies on their HDR display systems.*

## T4C–Color in Medical Imaging

1:30 to 3:30 pm (2 hours)
Instructor: Mostafa Analoui, Pfizer Global Research & Development

This course will begin with a general overview of key elements in diagnostic imaging, from acquisition to analysis and display. The role of color and spectral methods as it applies to each of these areas will be described. The course will primarily focus on usage of color and spectral information for in vivo imaging. Discussion topics include utility of color in rendering and visualization of multi-dimensional and multi-modality data, as well as device calibration for quantitative tissue color assessment and matching. Clinical examples will be used to discuss case studies in dermatology, ophthalmology, and prosthodontics. In conclusion, current activities and challenges in hyperspectral imaging and selective-band contrast agents will be described.

Benefits: This course will enable the attendee to:
- List key utilities of color in diagnostic imaging
- Comprehend the fundamental optical tissue properties and its color/spectral signature
- Explain calibration and validation procedures for color matching in prosthesis
- Describe the diagnostic value of color in medical imaging
- Understand fundamental usage of color in medical image rendering and visualization
- Appreciate clinical challenges in medical deployment of color
- Identify emerging color/spectral techniques for medical imaging

Intended Audience: This introductory course is intended for engineers, scientists, students, and managers interested in acquiring a broad appreciation of utility of color in medical imaging, as well as challenges and emerging techniques. Clinical examples and cases studies are selected so that audience with minimal background in clinical imaging can comprehend and appreciate the topics. Attendees are expected to be familiar with key concept in image processing and colorimetry. The teaching materials are organized such that prior experience in life sciences and clinical imaging would not be required.

*Mostafa Analoui is senior director and site head for Groton/New London of Global Clinical Platforms at Pfizer Global Research and Development in Connecticut. He is also adjunct professor of Radiology and Oral Pathology Medicine at Indiana University Schools of Medicine and Dentistry. He is actively involved in the development of nov-*

*el technologies and methodologies in diagnostic and quantitative imaging. Analoui was previously the director of Oral and Maxillofacial Imaging Research at Indiana University, and associate professor of Biomedical Engineering and Electrical & Comp Engineering at Purdue University. Analoui has served on various scientific and business advisory committees and has authored more than 120 publications.*

### T4D–Spectral Imaging

3:50 to 5:50 pm (2 hours)
Instructor: Roy S. Berns,
Rochester Institute of Technology

Conventional trichromatic imaging (i.e., RGB) can have a wide range of colorimetric accuracy and is always constrained by metamerism. For color-critical, scientific, and archival applications, trichromatic imaging is often insufficient. Spectral imaging alleviates these limitations. This tutorial will explore current spectral-imaging techniques and applications for quality-critical color reproduction (i.e., spectral color reproduction) and scientific-based digital archives.

**Benefits:** This course will enable the attendee to:

- Understand the advantages and disadvantages of spectral imaging compared with trichromatic imaging
- List and compare different techniques of spectral imaging
- Understand principal component analysis for data reduction and generating statistical colorants
- Become familiar with the foundations of estimating spectral reflectance from multi-channel images
- Comprehend the applications of spectral imaging for multi-ink printing, spectral color management, and scientific-based digital archiving

**Intended Audience:** This course is directed toward those wishing to become more familiar with the opportunities and challenges within the emerging field of spectral color reproduction, which may include color and imaging scientists, camera and printer designers, and image processing specialists.

*Roy S. Berns is the R. S. Hunter Professor of Color Science, Appearance, and Technology at the Munsell Color Science Laboratory, and graduate coordinator of the Color Science Master's program within Rochester Institute of Technology's Center for Imaging Science. He directs a research group that has been active in spectral imaging and spectral color reproduction for nearly a decade. The group is currently designing a spectral imaging system for the National Gallery of Art in Washington and the Museum of Modern Art in New York. He has also collaborated with the Art Institute of Chicago and the Van Gogh Museum in using spectral-imaging concepts for "digital rejuvenation" of cultural heritage. Berns is the author of Billmeyer and Saltzman's Principles of Color Technology, 3rd edition. He is also an IS&T Fellow.*







# Conference At-a-Glance

Registration (in the hotel lobby):
Monday, November 7 & Tuesday, November 8 (7:00 am–6 pm)
Wednesday, November 9 & Thursday, November 10 (7:00 am–5 pm)
Friday, November 11 (7:00–10:30 am)

**Monday, November 7**
- Hunt two-day tutorial
- ICC DevCon '05
- ICC DevCon '05 Wine and Cheese Networking Event*

**Tuesday, November 8**
- Tutorials Program
- Hunt two-day tutorial continues
- Welcome Icebreaker Reception

**Wednesday, November 9**
- Keynote: Intelligent Image Processing
- Technical Sessions
  - High Dynamic Range Imaging
  - Spectral Imaging
  - Color in Medical Imaging
  - Spotlight Session 1: Vision, Image Quality, and Spectral Imaging
  - Color Image Processing
  - Conference Reception

**Thursday, November 10**
- Keynote: Color Display Technology: From Pixels to Perception
- Presentation of IS&T Awards
- Technical Sessions
  - Input Device Characterization
  - Printing
  - Spotlight Session 2: Color Management, Modeling and Characterization
  - Displays
  - Spotlight Session 3: Applications
- Interactive Paper Session
- Evening Lecture: Shortcuts and Detours: How Photographers Actually Manage Color

**Friday, November 11**
- Keynote: The Changing Landscape of Digital Camera Technology
- CIC13 "Cactus Award" Presentation
- Technical Sessions
  - Late Breaking News
  - Vision, Colorimetry, Color Appearance
  - Closing remarks
- ISCC/IS&T/SID Special Topics Conference**

**Saturday, November 12**
- ISCC/IS&T/SID Special Topics Conference continues

### *ICC DevCon '05 Reception open to CIC13 Attendees

Join colleagues at the Chaparral Resort, for a special Wine and Cheese Networking Event from 5:30–7:30 pm on Monday. The event will also feature ICC Color Management Technology demonstrations by DevCon '05 sponsors. For more information see page 2 or visit www.color.org.

### **Special Post-conference Workshop

A special ISCC-sponsored workshop, "Precision & Accuracy in the Determination of Color in Images," is schedule to begin on Friday afternoon. For more information see page 3 or visit www.iscc.org.

# Technical Program

## Wednesday November 9, 2005

**8:00 to 9:00 am**

Keynote: **Intelligent Image Processing,** *Hiroaki Kotera, Chiba Univ. (Japan)*

**9:00 to 9:40 am**

### High Dynamic Range Imaging

Session Chair: Garrett M. Johnson, Rochester Institute of Technology (USA)

**Image Preference Scaling for HDR Image Rendering,** *Jiangtao Kuang, Garrett M. Johnson, and Mark D. Fairchild, Rochester Institute of Technology (USA)*

**Design of a Framework for HDR Sequence Rendering Evaluation,** *Francisco H. Imai, David Kuo, and Ricardo J. Motta, Pixim, Inc. (USA)*

9:40 to 10:20 am coffee break

**10:20 to 12:00 noon**

### Spectral Imaging

Session Chair: Jon Hardeberg, Gjøvik Univ. College (Norway)

**The Chromagenic Colour Camera and Illuminant Estimation,** *Graham D. Finlayson, Peter Morovic, and Steven D. Hordley, School of Computing Sciences, Univ. of East Anglia (UK)*

**Diagnosing and Correcting Systematic Errors in Spectral Based Digital Imaging,** *Mahnaz Mohammadi and Roy S. Berns, Rochester Institute of Technology (USA)*

**Real-time Control of Appearance on the Object by Using High-luminance PC Projector and Graphics Hardware,** *Shoji Yamamoto, Mitsubishi Heavy Industries and Chiba Univ. and Maiko Tsuruse, Koichi Takase, Norimichi Tsumura, Toshiya Nakaguchi, and Yoichi Miyake, Chiba Univ. (Japan)*

**Incidence of Metamerism in Natural Scenes,** *David H. Foster, Univ. of Manchester (UK), and S. M. C. Nascimento, Univ. of Minho (Portugal)*

**Improvement of Spectral Imaging by Pigment Mapping,** *Yonghui Zhao, Roy S. Berns, Yoshio Okumura, and Lawrence Taplin, Rochester Institute of Technology (USA)*

noon to 1:30 pm lunch on own

**1:30 to 3:00 pm**

### Color in Medical Imaging

Session Chair: Norimichi Tsumura, Chiba Univ. (Japan)

**Computational Skin Modeling and Imaging (Invited),** *Kristin Dana, Rutgers (USA)*

**Multispectral Color Imaging for Dermatology: Application to Inflammatory and Immunologic Diseases,** *Masahiro Yamaguchi,[1, 2] Masanori Mitsui,[2] Yuri Murakami,[1, 2] Hiroyuki Fukuda,[2] Nagaaki Ohyama,[1, 2] and Yasuo Kubota;[3] [1]Tokyo Institute of Technology, [2]Akasaka Natural Vision Research Center. and [3]Kagawa Univ. (Japan)*

**Testing the Performance of a Modified Whiteness Formula for Dentistry,** *Wen Luo and Stephen Westland, Leeds Univ.; Iain A. Pretty and Roger Ellwood, Colgate-Palmolive (UK)*

**Digital Staining of Pathological Tissue Specimens with PCA-based Feature Extraction and Linear Mapping of Spectral Transmittance,** *Pinky A.Bautista, Tokiya Abe, and Masahiro Yamaguchi, Tokyo Institute of Technology (Japan); YukakoYagi, Univ. of Pittsburgh Medical Center (USA); and Nagaaki Ohyama, Tokyo Institute of Technology, Frontier Collaborative Research Center (Japan)*

3:00 to 3:40 pm coffee break

**3:40 to 4:10 pm**

### Spotlight Session 1: Vision, Image Quality, and Spectral Imaging

Session Chairs: Nathan Moroney, Hewlett-Packard Co.(USA), and Jan Morovic, Hewlett-Packard Española (Spain)

**Methods for Measuring Viewing Parameters in CIECAM02,** *Chenyang Fu and M. Ronnier Luo, Univ. of Leeds (UK)*





**Evaluating Chromatic Adaptation Transform Performance,** *Sabine Süsstrunk, School of Computer and Communication Sciences (Switzerland) and Univ. of East Anglia (UK); and Graham D. Finlayson, Univ. of East Anglia (UK)*

**The Effect of Image Size on the Color Appearance of Image Reproductions,** *Mahdi Nezamabadi and Roy S. Berns, Rochester Institute of Technology (USA)*

**How Well Can People Predict Subtractive Colour Mixing?** *Phil M. Henry, Stephen Westland, Stephen M. Burkinshaw, and Vien Cheung, Leeds Univ. (UK)*

**A New Method to Quantitatively Evaluate Gradation Smoothness of Output Media,** *Shin-ichiroh Kitoh and Po-Chieh Hung, Konica Minolta Technology Center, Inc. (Japan)*

**Illuminant Estimation from Dichromatic Planes,** *Javier Toro, Djemel Ziou, and Brian Funt, Université de Sherbrooke (Canada)*

**A Novel Approach for Generating Object Spectral Reflectance Functions from Digital Cameras,** *Changjun Li and M. Ronnier Luo, Univ. of Leeds (UK)*

**Calculating Metamer Sets without Spectral Calibration,** *Ali Alsam, Gjovik Univ. College (Norway), and Graham Finlayson, Univ. of East Anglia (UK)*

**Measuring Bidirectional Reflectance Distribution Function Out of the Laboratory: Modeling a Light Source,** *Koichi Takase, Norimichi Tsumura, Toshiya Nakaguchi, and Yoichi Miyake, Chiba Univ. (Japan)*

**Spectral BRDF Measurement and Data Interpolation,** *Yinlong Sun, Purdue Univ. (USA)*

**4:10 to 5:10 pm**

### Color Image Processing

Session Chair: Graham Finlayson, Univ. of East Anglia (UK)

**Color to Black-and-White and Back: Embedding Color in Grayscale Images,** *Karen M. Braun, Xerox Corp. (USA), and Ricardo L. deQueiroz, Universidade de Brasilia (Brazil)*

**Shadow Segmentation and Shadow-free Chromaticity via Markov Random Fields,** *Cheng Lu and Mark S. Drew, Simon Fraser Univ. (Canada)*

**Vectorial Computation of the Optical Flow in Color Image Sequences,** *Bertrand Augereau, Benoît Tremblais, and Christine Fernandez-Maloigne, Laboratoire SIC, FRE CNRS, Université de Poitiers (France)*

6:00 to 8:00 pm Conferencence Reception
Poolside

## Thursday, November 10, 2005

**8:00 to 9:00 am**

Keynote: **Color Display Technology: From Pixels to Perception,** *Louis D. Silverstein, VCD Sciences, Inc. (USA)*

Presentation of IS&T Awards

**9:00 to 9:40 am**

### Input Device Characterization

Session Chair: Fumio Nakaya, Fuji Xerox Co., Ltd. (Japan)

**Colorimetric Characterization of Digital Cameras Preserving Hue Planes,** *Casper Find Andersen, Graphic Arts Institute of Denmark, and Jon Yngve Hardeberg, Gjøvik Univ. College (Denmark)*

**Scanning Calibration Targets,** *R. Victor Klassen, Xerox Corp. (USA)*

9:40 to 10:20 am coffee break

**10:20 to 11:30 am**

### Printing

Session Chair: Gaurav Sharma, Univ. of Rochester (USA)

**Selected Contributions of H. E. J. Neugebauer to Color Imaging: A Centennial Discussion (Invited),** *J. A. Stephen Viggiano, Acolyte Color Research (USA)*

**Improving the Color Constancy of Prints by Ink Design,** *Yongda Chen, Roy S. Berns, and Lawrence A. Taplin, Rochester Institute of Technology (USA)*

**Perception and Modeling of Halftone Image Quality Using a High-Resolution LCD,** *Changmeng Liu, Rochester Institute of Technology; Gustav Braun, Eastman Kodak Company; and*

*Garrett M. Johnson and Mark D. Fairchild, Rochester Institute of Technology (USA)*

**11:30 am to 12:00 noon**

## Spotlight Session 2: Color Management, Modeling and Characterization

Session Chairs: Nathan Moroney, Hewlett-Packard Co.(USA), and Jan Morovic, Hewlett-Packard Española (Spain)

**A Variational Link of Marking to Color for Color Printing Technologies: The Color Gain Matrix for the Simple Estimation of Print to Print Variation,** *Michael Sanchez and Martin Maltz, Xerox Corp. (USA)*

**Suitable Printer Color Reproduction for Office Environment,** *Kenji Fukasawa, Seiko Epson Corp.; Akihiro Ito, Makoto Kunigoh, and Fumio Nakaya, Fuji Xerox Company, Ltd.; Takeshi Shibuya, Ricoh Printing Systems, Ltd.; Hirokatsu Shimada, Konica Minolta Software Laboratory Co. Ltd.; and Hirohisa Yaguchi, Chiba Univ. (Japan)*

**Six Color Separation Using the Additional Colorants with Less Dot Visibility,** *Chang-Hwan Son, Yang-Ho Cho, Kee-Hyon Park, and Yeong-Ho Ha, Kyungpook National Univ. (South Korea)*

**Robust Edge Correction,** *Jon McElvain, Xerox Corp. (USA)*

**Nonlinear RGB-to-XYZ Mapping for Device Calibration,** *Weihau Xiong and Brian Funt, Simon Fraser Univ. (Canada)*

**The Effect of DLP White Channel on Perceptual Gamut,** *Rodney L. Heckaman, Mark D. Fairchild, and Dave Wyble, Rochester Institute of Technology (USA)*

**Innovative Color Interpolation using Fuzzy Logic and Linear Regression,** *Jyh-Jiun Lee,[1] Yu-Sheng Tsai,[1] Yi-Bin Lu,[2] Yi-Ching Liaw,[1] Chia-Lun Chen,[1] Chia-Hung Cheng,[1] and Chen Shih-Chieh;[1] [1]Industrial Technology Research Institute (Taiwan) and [2]National Defense Univ.*

**ICC Color Managment and CIECAM02,** *Ingeborg Tastl, Nathan Moroney, Miheer Bhachech, and Jack Holm, Hewlett-Packard Co.(USA)*

noon to 1:30 pm lunch on own

**1:30 to 2:30 pm**

## Displays

Session Chair: Karen Braun, Xerox Corp. (USA)

**A Novel Spectrum Sequential Display with a Wide Color Gamut and (almost) No Color Breakup,** *Erno H. A. Langendijk, Philips Research Laboratories Eindhoven (The Netherlands)*

**OETF Preference for LCD Televisions,** *Justin Laird, Ethan Montag, Mitchell Rosen, and Jeff Pelz, Rochester Institute of Technology (USA)*

**Visually Determining Gamma for Softcopy Display,** *R. Victor Klassen, Raja Bala, and Nathan Klassen, Xerox Corp. (USA)*

**2:30 to 3:10 pm**

## Spotlight Session 3: Applications

Session Chairs: Nathan Moroney, Hewlett-Packard Co.(USA), and Jan Morovic, Hewlett-Packard Española (Spain)

**Gravitational Reallocation of Halftone Dots for Moiré-free Color Proofing,** *Johji Tajima, Nagoya City Univ. (Japan)*

**Colorization for Monochrome Image with Texture,** *Takahiko Horiuchi and Hiroaki Kotera, Chiba Univ. (Japan)*

**Multi-Spectral Imaging of Fingerprints for Secure Biometric Systems,** *Masashi Kurita, Katsuki Tai, and Ichiro Fujieda, Ritsumeikan Univ. (Japan)*

**Quantitative Analysis of Skin Pigmentation in a Nonlinear Density Space,** *Daisuke Kawazoe, Koichi Takase, Norimichi Tsumura, Toshiya Nakaguchi, and Yoichi Miyake, Chiba Univ. (Japan)*

**Development of New Electronic Endoscopes Using the Spectral Images of an Internal Organ,** *Y. Miyake, Chiba Univ.; T. Nakaguchi and N. Tsumura, Chiba Univ. Hospital; and S. Yamataka, Fujinon Co. Ltd (Japan)*

**Illumination-independent Color Reproduction in Medicine and its Evaluation,** *Masahiro Nishibori,[1] Norimichi Tsumura,[2] Kenji Kamimura,[2] Hiroshi Tanaka,[1] Fumiko Uchino,[3] Shin-ichiroh Kitoh,[3] and Yoichi Miyake;[2] [1]Tokyo Medical and Dental Univ., Center, Inc.; [2]Chiba Univ., [3]Konica Minolta Technology (Japan)*

**Fast Algorithm for Completion of Digital Photographs with Natural Scenes,** *K. K.Biswas, Siddharth Borikar, and Sumanta Pattanaik, Univ. of Central Florida (USA)*

**The Influence of Luminance on Local Tone Mapping,** *Laurence Meylan and Sabine Süsstrunk, Ecole Polytechnique Fédérale de Lausanne (Switzerland)*

**JPEG-HDR: A Backwards-compatible, High Dynamic Range Extension to JPEG,** *Greg Ward, Sunnybrook Technologies, and Maryann Simmons, Walt Disney Feature Animation (USA)*

**A Simple Spatial Tone Mapping Operator for High Dynamic Range Images,** *K. K.Biswas and Sumanta Pattanaik, Univ. of Central Florida (USA)*

**The Role of Color in User Interface Design of Wireless Mobile Devices,** *Yat-Sang Hung, Sprint Corp. (USA)*

**Visual Quality of Watermarking on Mobile Devices,** *Konstantin Krasavin, Jussi Parkkinen, and Timo Jaaskelainen, Univ. of Joensuu (Finland)*

**Evaluating Digital Film Look,** *J. Stauder and L. Blondé, Thomson R&D; A. Trémeau, Univ. of St. Etienne; and J. Pines, Technicolor (France)*

**3:10 to 5:10 pm**

## Interactive Session

Session Chairs: Nathan Moroney, Hewlett-Packard Co.(USA), and Jan Morovic, Hewlett-Packard Española (Spain)

Please note: light beverages and snacks will be provided

**7:30 to 8:45 pm**

## Evening Lecture

**Shortcuts and Detours: How Photographers Acutally Manage Color,** *C. David Tobie ColorVision, Inc. (USA)*

**Advance Registration (conference and tutorial) and Hotel Reservation Deadline: October 5**





## Friday, November 11, 2005

**8:00 to 9:00 am**

**Keynote: The Changing Landscape of Digital Camera Technology,** *Paul M. Hubel, Foveon, Inc. (USA)*

**Presentation of CIC13 "Cactus" Award**

**9:00 to 9:45 am**

## Late Breaking News

Session Chairs: Raja Bala, Xerox Corp., and Marc Mahy, Agfa-Gevaert NV

*This session is intended to inform conference attendees about the latest developments in the fields of color and color imaging. Only those technical results or findings that have become available since April 2005 should be discussed. If you have recent results to report and would like to participate in this session, contact rbala@crt.xerox.com or marc.mahy@agfa.com by October 15, 2005.*

9:45 to 10:25 am coffee break

**10:25 to 12:00 noon**

## Vision, Colorimetry, Color Appearance

Session Chair: Stephen Westland, Univ. of Leeds (UK)

**Can Highly Chromatic Stimuli Have a Low Color Inconstancy Index?**, *Jan Morovic, Hewlett-Packard Española (Spain) and Peter Morovic, Univ. of East Anglia (UK)*

**Uncertainty of Colour-matching Data,** *Boris Oicherman and Ronnier Luo, Univ. of Leeds (UK); Alan Robertson, National Research Council (Canada); and Arthur Tarrant, Department of Colour and Polymer Chemistry, Univ. of Leeds (UK)*

**On the Salience of Novel Stimuli: Adaptation and Image Noise,** *Mark D. Fairchild and Garrett M. Johnson, Rochester Institute of Technology (USA)*

**Size Matters: The Influence of Viewing Distance on Perceived Spatial Frequency and Contrast,** *Garrett. M. Johnson and Ethan D. Montag, Rochester Institute of Technology (USA)*

**Closing remarks**

# CIC13 Hotel Registration

Name_____

Company _____

Mailing Address _____

_____

Telephone _____ Fax _____ Email _____

Arrival Date and Time _____ Departure Date_____

**(Reservations Deadline: October 5, 2005)**

A special block of rooms at a discounted rate is being held at The Caleo for IS&T/SID Color Imaging Conference attendees for the nights of November 5 through 14. The discounted rate will also be extended for 3 days before and after these dates if space is available. Reservations will be assigned on a priority basis to our group provided they are received by October 5, 2005. To guarantee your room, a deposit equal to one night's housing must accompany your reservation request.

Deposits can be made by check or a major credit card.
Payment Method: ___ Check (check # _____ is enclosed).

___ AMEX ___ MC ___ VISA ___ Diner's ___ Discover

Card# _____ Exp. Date _____

Charge Authorization Signature _____

*Notice of cancellation must be given to the hotel **72** hours prior to arrival date to receive a full refund of deposit. Be sure to obtain a cancellation number.*
*Check in is 3:00 pm; early arrivals will be accommodated as soon as possible. Check out is noon.*
*There is no charge for children under 18 years when sharing a room with a parent.*
*Please advise us of any change in date or plan by calling 800/528-7867 or 480/945-7666, ask for reservations.*

Please reserve my room as indicated:

___ Single at $155 + 11.92% state and local taxes

___ Double at $155

___ Smoking ___ Non-smoking ___ Special Requirements (please indicate)

Form should be sent/faxed to

Reservations Manager
Attn: IS&T/SID - Color Imaging
The Caleo - Scottsdale
4925 North Scottsdale Road
Scottsdale, Arizona 85251
480/946-4056 fax

***Transportation Notes:*** *Airport shuttle service from Phoenix Sky Harbor International Airport is available for approximately $25 per car (sharing by small groups of 1 to 4 persons is permitted) through Execucar. Once you have retrieved your baggage, please call 888/255-8726 or 602/678-1500 to arrange your transportation. Taxi service is also available, cost is approximately $25 one way, and taxis may be found outside the airport (follow signs). Complimentary parking is available at the hotel.*





# CIC13 Conference Registration

Name_____

Title/Position _____

Company _____

Mailing Address _____

_____

Telephone _____ Fax _____ Email _____

**Conference registration** includes admission to all technical sessions, coffee breaks, and ticketed receptions. Separate registration fees are required for tutorials. Register online at www.imaging.org/conferences/CIC13

| Conference Registration (CHECK ONE) | until 10/5 | after 10/5 | TOTAL |
|---|---|---|---|
| ___ IS&T/SID Member | $540 | $590 | $ _____ |
| ___ Non-member | $650 | $700 | $ _____ |
| ___ Student (ID required) IS&T/SID Member | $135 | $165 | $ _____ |
| ___ Student Non-member | $165 | $195 | $ _____ |
| ___ Speaker/Session Chair IS&T/SID Member | $425 | $470 | $ _____ |
| ___ Speaker/Session Chair Non-member | $515 | $560 | $ _____ |
| ___ Extra CIC13 Proceedings book (special advance purchase and on-site rate) | $40 | | $ _____ |

Tutorial Registration (be sure to multiply number of classes by per course fee and place on total line)

| | | | |
|---|---|---|---|
| ___ 2-day Hunt Course IS&T/SID Member | $650 | $700 | $ _____ |
| ___ 2-day Hunt Course Non-member | $825 | $875 | $ _____ |
| ___ 2-hour IS&T/SID Member (per class) | $150 | $180 | $ _____ |
| ___ 2-hour Non-member (per class) | $195 | $225 | $ _____ |
| Check all that apply: ❑ T1A ❑ T1B ❑ T2C ❑ T2D ❑ T3A ❑ T3B ❑ T4A ❑ T4B ❑ T4C ❑ T4D | | | |
| ___ 4-hour IS&T/SID Member (per class) | $200 | $230 | $ _____ |
| ___ 4-hour Non-member (per class) | $250 | $280 | $ _____ |
| Check all that apply: ❑ T1C/D ❑ T2A/B ❑ T3C/D | | | |

Pre- and Post-Conference Event Registration

DevCon '05: IS&T/SID/ICC Member, full-time teacher, or student (see www.color.org for more information)

| | | | |
|---|---|---|---|
| ___ first and second registrant from company | $350 | $400 | $ _____ |
| ___ additional registrant from company | $250 | $300 | $ _____ |
| DevCon '05: Non-member | | | |
| ___ first and second registrant from company | $450 | $500 | $ _____ |
| ___ additional registrant from company | $325 | $375 | $ _____ |

ISCC/IS&T/SID Special Topics Conference (see www.iscc.org for more information)

| | | | |
|---|---|---|---|
| ___ ISCC/IS&T/SID Member | $200 | $250 | $ _____ |
| ___ Non-member | $250 | $300 | $ _____ |
| ___ Student | $100 | $100 | $ _____ |

___ IS&T Membership $95 US $105 overseas $ _____

join now and calculate your fees based on membership rates; membership paid for now expires 12/31/06

**GRAND TOTAL $ _____**

Payment Method: ❑ Check (Check # _____) ❑ AMEX ❑ MC ❑ VISA ❑ Diner's ❑ Discover
Card#: _____ Exp. Date: _____
Name as it appears on card: _____
Authorization Signature: _____

Return this form with signed credit card authorization or check payable in US dollars to
IS&T, 7003 Kilworth Lane, Springfield, VA 22151; 703/642-9090; 703/642-9094 fax; info@imaging.org

Thirteenth Color Imaging Conference


Society for Imaging Science and Technology
7003 Kilworth Lane
Springfield, VA 22151 USA
703/642-9090; 703/642-9094 (fax)