



IS&T

# REPORTER

"THE WINDOW ON IMAGING"

Vol. 28, No. 4 October - December 2013

## NIP29/Digital Fabrication 2013

### 3D Printing of Self-Glazing Ceramic Materials: An Investigation Inspired by Ancient Egyptian Technology

David Huson, University of the West of England (UK)

**Abstract:** The inspiration and background research for this project is based upon Egyptian Faience because there is an interesting and coincidental synergy between the material properties of ancient Egyptian Faience and the material requirement for the successful 3D printing of ceramic powders. Originating in the 5th Millennium BC, Egyptian Faience was not made from clay, but instead composed of quartz and alkali fluxes and is distinct from Italian Faience or Majolica, which is a tin, glazed earthenware. In its original Egyptian context Faience was a versatile material, used in a variety of ways and in a number of different forms, to create objects such as sculpture, vessels, funeral figurines, tiles, boxes and body ornamentation—all with a highly coloured lustred glaze. In contemporary terms Egyptian Paste has visual qualities desirable to many crafts practitioners.

This paper will chart the progress of the project to date and detail the technical development of 3D printed self-glazing ceramics. The potential of the process will be demonstrated by the production of ceramic artworks using the techniques developed during the project.

### 3D Printed Electronics

Steven Ready, Fred Endicott, Gregory L. Whiting, Tse Nga Ng, Eugene M. Chow, and JengPing Lu, Palo Alto Research Center, Inc (USA)

**Abstract:** PARC has been a leading innovator in printed electronics with over a decade of experience in large area electronics, application of novel and current printing technology to industrial applications and the printing of electronic circuits and devices. We are currently applying this knowledge to the concept of printing multi-material 3 dimensional objects with electronic

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

\* These papers were presented at NIP29/Digital Fabrication 2013, held September 29 - October 3, 2013, in Seattle, Washington.

## Honored Members

Awards presented at NIP29/Digital Fabrication 2013



**IS&T Fellowships** were presented by IS&T President Alan Hodgson to Robert Ulichney (left) of Hewlett-Packard Laboratories for landmark contributions in the field of digital half-toning and to Mohammad Alam (below) of the University of South Alabama for contributions in the areas of image processing, pattern recognition, and high-resolution image reconstruction.



The **Chester F. Carlson Award**, sponsored by Xerox Corporation, was given to Edward Gutman (above), who retired from Xerox in 2001, for critical contributions in the realms of xerographic development and materials.



Thomas Boland (right), accepted the **Itek Award** in recognition of the best student publication in an IS&T journal on behalf of his student, Maria Yanez (University of Texas at El Paso), for "Printed Cellular Scaffold Using Self-Crosslinking Agents," JIST 56(4) 040506-1-040506-5 (2012).



## INSIDE THIS ISSUE

Highlighted Abstracts: NIP29/Digital Fabrication 2013	1
NIP29/Digital Fabrication 2013 Report	3
Standards Update	8
Imaging Standards News: TC42	10

and/or mechanical functionality. The concept is to develop capability and provide means of manufacturing functional objects which may be difficult to manufacture or even not be manufacturable by other means.

In this paper, we will outline the creation of a rapid digital manufacturing system and considerations for building such a “printer” with the ability to integrate a structural material with functional electronic materials. The printer incorporates inkjet and extrusion techniques on the same platform, along with an in-line UV-curing lamp. This platform enables a wide processing window for structural and electronic materials; *i.e.*, it is capable of patterning inks with viscosity ranging from 1 to 25000 cP. The printer has been optimized to yield smooth printed features (down to tens of microns) without implementing pressure-leveling steps.

### Captive Continuous Inkjet

Carolyn Ellinger and Yonglin Xie, Eastman Kodak Co. (USA)

**Abstract:** Captive continuous inkjet (CIJ) is a potentially disruptive inkjet technology recently developed in the Kodak Technology Center. The captive continuous inkjet technology is expected to deliver the best of both drop-on-demand (DOD) inkjet and continuous inkjet (CIJ) technologies: high resolution, compact size, and low cost associated with traditional DOD technologies and the high throughput and high reliability of traditional CIJ technology. In this paper, we will provide a description of this new architecture, its function and why we believe it to be advantaged over both traditional CIJ and DOD technologies. We will discuss the key technology elements with details on the design, fabrication, and characterization of captive CIJ devices, including results from simulations and experimental studies.

### Balanced Aggregation — Snow Man Shaped or Tripod-Like (Fumed) Particles that Allow for Better Fixation on Toner Resin Surfaces

Andreas Hille<sup>1</sup>, Yuki Amano<sup>2</sup>, Robert Johnson<sup>3</sup>, Naohiro Naito<sup>2</sup>, Yusuke Tosaki<sup>2</sup>, and Akira Inoue<sup>2</sup>; <sup>1</sup>Evonik Industries AG (Germany), <sup>2</sup>NIPPON AEROSIL CO., LTD. (Japan), and <sup>3</sup>Evonik Corporation (USA)

**Abstract:** The aggregates for two types of fumed silica are compared with each other and with colloidal silica similar to one used as a spacer additive for toner. These examples of fumed silica differ in that one is made up of very large (sub-micron) sized primary particles with a low degree of aggregation while the second fumed silica example has a much higher, balanced, degree of aggregation. The aggregates of both forms of fumed silica disperse on a toner surface to result in effective particle diameters larger than the colloidal silica particle. Also, because of their fractal morphology, these dispersed aggregates are more likely to remain fixed on the toner surface as compared to the colloidal-based additives.

### Fabrication of Printed Drug-Delivery Systems

Natalja Genina, Ruzica Kolakovic, Mirja Palo, Daniela Fors, Helka Juvonen, Petri Ihalainen, Jouko Peltonen, and Niklas Sandler, Abo Akademi University (Finland)

**Abstract:** Printing technologies specifically digital inkjet printing, offer possibilities in the production of individualized medicines. The main advantage of inkjet printing includes the ability to dispense uniform droplets in the picoliter range with high degree of accuracy to allow dose personalization. The pharmaceutical ink formulation has to be designed with respect to its viscosity and surface tension to guarantee continuous printing and high reproducibility of the forming droplets to allow dose uniformity. The aim of this paper is demonstrate the combined use of inkjet and flexographic printing to fabricate pharmaceutical solid dosage forms with controlled release properties of drug substances. Also the characterization of substrates and final drug-delivery systems is studied with various techniques and discussed.

### Novel Electrophotographic Toners for Providing Metallic Effects

Dinesh Tyagi, Louise Granica and Kevin Lofftus, Eastman Kodak Co. (USA)

**Abstract:** In order to produce toners that are capable of providing metallic sparkle and effect, a number of obstacles have to be first overcome. Since having static charge is an important requirement for toners, it is not practical to use conductive metal flakes in metallic toner formulations. This difficulty was overcome by using mica or similarly based interference pigments. These nonconductive pigments not only provide a large flat reflective surface but can be coated with inorganic and organic coatings. By controlling the thickness of the high refractive index inorganic coating over the mica flakes, the color of the reflected light changed and can be utilized to enhance the metallic sparkle.

These toners can be produced by minimizing the shear conditions in the extruder during the compounding of the toner components. These can be created by optimizing the compounding temperature, screw configurations, molecular weight of the toner resin etc. By imposing a convergence on the toner melt at the die exit and by controlling the draw ratio of the melt slab after the die exit, the pigment flakes can be forced to align in the process direction. The resulting toners have a flat shape as a consequence of the internal structure formed during the melt processing step.

Due to the large size of the pigment flakes in the finished toner, and its shape, these toners are capable of providing remarkable sparkle and metallic effects. These toners produce the metallic effect by themselves but alternatively they can be placed over or under other color toners to generate many interesting effects that were not possible before. A method of measuring the sparkle in metallic images is also described. By measuring color properties at various angles, “Flop Index” can be calculated and used to quantify the extent of metallic effect. ▲

# From Digital Printing to Data Materialization— NIP29/Digital Fabrication 2013 Roundup

by Kate Johnson, with input from Session Chairs and Roundtable Moderators

This year's NIP/Digital Fabrication conference marked a true change in direction from the historic co-location of NIP and Digital Fabrication, to an integrated single conference. The event focused on the traditional content of both, and on the connection between these two topics, under the theme "Printing as Part of Something Bigger." The definition of "printing" is expanding as technologies used to print are being incorporated into a range of complex processes for manufacturing and production of a variety of objects.

The technical program included research and development in traditional digital printing, as well as in a wide range of emerging applications. Short courses and special sessions complemented the conference presentations and posters to create an interactive environment, as delegates explored the use of printing technologies in applications as diverse as 3D, biological, large-format, and cloud printing.

The conference location and layout encouraged the interaction and inter-session networking for which this meeting is known.

## Additive Manufacturing and Digital Processes Kick off Monday

Monday morning began with a warm welcome from the conference committee, and brought news from IS&T President Alan Hodgson and Steering Committee Chair Reinhard Baumann. The combining of the two collocated conferences into a single event is just the beginning. In order to keep pace with the rapidly changing technology landscape, NIP/Digital Fabrication is changing to reflect the broader applications of digital printing in a wide array of markets unimagined a decade ago. Delegates were invited to participate in the evolution of the conference by contributing ideas for a new conference name, topics and content, as the Society looks to-



Photo: Diana Gonzalez.

The Interactive Paper and Demonstration Session provided attendees the opportunity to really explore the science behind and products generated by digital printing technologies.

ward next year's conference in Philadelphia. This news sparked many conversations, some concerns, and great ideas.

Monday's keynote speaker Richard Hague (EPSRC Centre for Innovative Manufacturing in Additive Manufacturing) kicked off the week's technical program with an excellent presentation on the potential of additive manufacturing. Casting ideas into the audience, Hague highlighted the need for reimagined design tools to help designers capitalize on

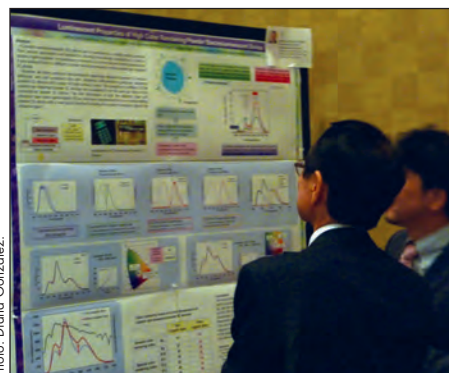


Photo: Diana Gonzalez.

Toshifumi Satoh (far right) from Tokyo Polytechnic University presents "Luminescent Properties of High Color Rendering Powder Electroluminescent Devices" during the Interactive Paper Session.

## NIP/DIGITAL FAB 2013

Attendees*:	354
Oral Papers:	132
Interactive Papers:	33
Short Courses:	14
Exhibitors:	29
Dates:	Sept. 29 – Oct. 3, 2013
Location:	Seattle, Washington
*includes Short Course only and guests	

the expanded degrees of freedom that digital fabrication offers designers during product conceptualization and optimization. "Design for Manufacturing" has shifted with the advent of these technologies and processes, and many of the limitations familiar to designers no longer apply. Materials, color, and print speed were also mentioned as areas for improvement and development.

In keeping with the new direction defined by the combined conference, Monday's sessions focused on both traditional and new applications. The morning's Applications track continued the theme of 3D printing, spanning topics from defining appropriate applications to materials. The printing technology at the core of

most of the discussed applications was inkjet, leaving room for expansion of this topic in future conferences. The track continued with a session on E-paper displays.

The Materials track began with a session on Image Permanence and Print Quality. Image permanence topics included an exploration of the potential impact of low temperature storage on the mitigation of pollution-induced deterioration, and a study regarding the minimum force needed to initiate abrasion damage on digital prints. Image quality papers included a new parallel processing approach to on-line reliability testing of inkjet print-heads, a Black Box model of electrophotographic printing (EP) that was built on scanned images to predict the impact of

design factors. In addition, there was a presentation on a study exploring the impact of color temperature versus color rendering index on perception of color naturalness that indicated that color temperature appeared to have more impact.

The Processes for Applications track focused on Fusing, Curing, and Drying and included two presentations addressing concerns of EP and one for inkjet. The EP papers included an estimation of fusing quality based on an analytical model of toner deformation and an introduction of a new type of surface heating fuser. The inkjet presentation included analysis of methods of drying in high-speed inkjet printing. The track continued with the Thermal Printing session, including a

presentation highlighting the need for accurate estimation in thermophysical properties and contact resistance of thermal papers in direct thermal printing.

The afternoon brought a well-attended Security Printing session with three focal papers spanning topics from the current challenges and opportunities facing the field of security printing, to progressive barcodes (adding incremental data to 2D barcodes with inks that are not detected by traditional 2D barcode readers), to circular encoding of information in print demonstrated in a Stegatone image. An interactive paper preview on the use of rare earths as a security artifact led to a lively demo both at the end of the session and at the demonstration session later in the week.

## Roundtables Offer Insight into Digital Printing/Fabrication Future

Conferences afford attendees the unique opportunity to interact in-person in meaningful ways, to have conversations that impact various points on the value chain. To foster these types of conversations, this year's conference offered four Technology and Application Roundtable discussions, held on two days. During these roundtables, stakeholders with interest in the highlighted topic took part in a group discussion with the assistance of a facilitator.

### The Future of Digital Fabrication

*moderated by Marcel Slot (Océ Technologies BV and the Diginova consortium)*

The Future of Digital Fabrication roundtable was seeded with several provocative questions by the moderator and much of the discussion focused on whether mass manufacturing will be replaced by a more distributed, local, on-demand model, and whether we will see 3D printers in each home in the next decade. During the course of discussion, concerns regarding materials and sustainability, as well as 3D printing as novelty versus having true functional use in domestic settings created perhaps more questions than answers. Top "opportunity domains" included

graphics and communication, additive manufacturing, electronics, healthcare, and mega-scale digital fabrication (such as buildings). Regardless of the application, production speed, material costs, current technology limitations (single-material, for example), quality and sustainability were all highlighted as challenges.

### Digital Packaging

*moderated by George Gibson (Xerox Corp.) and Omer Gila (Hewlett-Packard Co.)*

The majority of the conversation during the Digital Packaging roundtable centered around the market acceptance, requirements, and barriers to penetration of digital printing in the packaging domain. One of the most interesting points raised was that there is one packaging domain—case coding—where digital has become nearly completely dominant. Digital printing of full color packages is, as yet, a niche. The group spent a lot of time exploring the challenges (cost, format and productivity, materials latitude, food safety, supply chain complexity, etc.) that continue to present barriers to adoption. Members of the group had divergent opinions about the potential role for true personalization

in packaging. That said no one in the group expressed any reservations about the desired endpoint. Given the advantages of digital in inventory control, versioning and prototyping, it seems clear that there is a vibrant opportunity for digital print in packaging.

### University/Industry Collaboration

*moderated by Trevor Snyder (Xerox Corp.)*

The focus of the University/Industry Collaboration roundtable was to look at ways to enable and/or increase the rate of innovation and collaboration between industry and academia. There were three main goals going into the meeting: Discuss and share information related to industry/university collaboration, (for example, discuss different methods using real world examples of how individuals currently achieve such collaboration); discuss how to get better representation at future IS&T conferences from universities (staff and students), specifically those within about 100 miles such that the cost barrier is minimized; and discuss how future IS&T conferences can enhance and support these collaborations. Participants provided strong representation and experience

The Processes track focused on inkjet technology with topics ranging from synthesis of dyes to production of printheads, with particular audience interest in reactive dyes.

### Special Session on Printing Technologies for Bio-engineering

Microfluidics and bioengineering expert Paul Yager (University of Washington) opened Tuesday with a keynote on the remarkable development of sophisticated, low-cost, point-of-care diagnostic tools using paper's inherent wicking properties. Introducing many attendees to the world of 2DPN (2-dimensional paper networks), Yager discussed the transition from traditional lab-on-chip methods to paper-



Photo courtesy of Masahiko Fujii.

Each year ISJ and IS&T leadership meet to discuss the direction of the conference, clockwise: Hitoshi Nakai (Brother Industries, Ltd.), Masahiko Fujii (Fuji Xerox Co., Ltd.), Reinhard Baumann (Fraunhofer Einrichtung for Electronic Nano Systems and Chemintz University of Technology), Alan Hodgson (3M UK PLC), Jun-ichi Hanna (Tokyo Institute of Technology), Makoto Omodani (Tokai University), Suzanne Grinnan (IS&T), Teruaki Mitsuya (Ricoh Co., Ltd.) and Shinri Sakai (Tokyo University).

from both industry and academia, as well as from the US, Europe, and Japan.

Ideas for collaboration included university affairs grants, senior design projects, informal arrangements (i.e., short-term, project-based internships), temporary employment, and internship as part of degree program (e.g. Rochester Institute of Technology model). There was considerable discussion around how to increase attendance from University staff/students. Timing of the conference was identified as an issue and creative ideas such as adjusting the timing of limited portions of the program (e.g. student session in the evening) and creating sessions in close collaboration with local universities so that classes are not missed were offered, and a young engineer networking session was discussed. In support of increasing university participation it was noted that there are many connections already formed between IS&T and universities and/or between industry and universities that can be leveraged: identify champions within universities, expand the use of the current job board, and create informal meeting places for students and companies with entry-level openings. The excellent ideas generated during the session

will be used as a platform to work from as we look to expanding student participation in future conferences.

### Additive Manufacturing

*moderated by Sascha de Peña (Hewlett-Packard Co.)*

Participants at the Additive Manufacturing (AM) roundtable arrived at some key conclusions:

- Materials and processes are extremely [interdependent]. In order to grow the AM industry, a guided bootstrapping process will be necessary.
- Traditional and additive manufacturing will end up being complimentary processes (versus competitive), It is an error to position additive manufacturing as replacement for traditional systems.
- There are many essential problems in the current “file to print” workflow, but what seems to be an inherent limitation—that also will require a bootstrapping effort to overcome—is the adaptation of the design through current CAD/CAM systems to the manufacturability with traditional processes. To exploit the full potential of the design freedom enabled through AM,

the user interaction, design practices and flexibility supported through file formats also have to change.

- Though personal fabrication and the dedicated printers may occupy a niche position in developed countries where part acquisition through print shop providers and fast distribution systems could be the better alternative, these personal systems are well suited to meet the specific requirements of small and micro-businesses in emerging countries and enable new local models.
- In terms of any needed changes to the current ecosystem to protect IP, nothing different is required. Current copyright protections, if properly enforced, should be equally valid for additive manufacturing processes and business models derived.

Several additional questions remained open for future discussion: What concepts, technologies, and lessons from the 2D printing industry can (and cannot) be leveraged to 3D printing? What new services business models can be enabled by additive manufacturing? Who will set the standards for the AM industry and what standards are needed first? ▲

based methods that show great promise in addressing the needs for low-cost, disposable, in-situ test kits for a wide range of health-related issues. The clever use of materials' inherent properties was really captivating—use of sponges for flow switches, and using both materials and path lengths for flow speed control represent successful intersections of cutting edge technology and simple materials.

Capitalizing on the groundwork set by Yager's keynote, Tuesday included a full-day, special session on Digital Biology. Topics ranging from Bio-ink, to 3-D bio printing, to printed drug delivery systems indicated the breadth of this field and the potential for future exploration, expansion and collaboration. All of these talks, along with the four keynotes, can be found at links via [www.imaging.org](http://www.imaging.org).

Other talks presented Tuesday morning included digital fulfillment discussions on topics such as adding printed texture to surfaces, texture classification, and the development of an inkjet printhead offering wide fluid latitude. In addition, we heard about new developments in hybrid printing, prediction and correction of image quality, visualization and toner-based processes and materials (seed polymerized emulsion for chemically prepared toner and paper modeling in the simulation of the transfer process).

### Networking Highlighted

A Special Networking Session moderated by Marie Vans (Hewlett-Packard) on Tuesday afternoon

addressed the issue of collaboration/cooperation between companies for solving problems of more universal interest. It was decided that the format would benefit from a more focused and pre-defined topic. To prepare for next year's Special Networking Session, a LinkedIn group has been set up to identify a single specific challenge and realistic solutions for discussion with the goal of developing a proposal for business and academic groups within the printing industry. To join the group, you must first join the NIP (Digital Printing)/Digital Fabrication Conference group on LinkedIn.

### Exhibit Hall Hosts Interactive Papers and Demo Session during Happy Hour

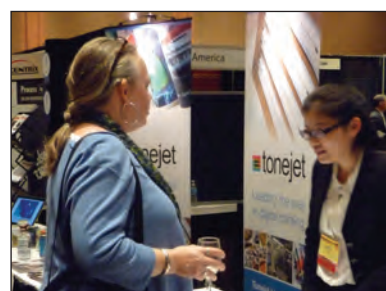
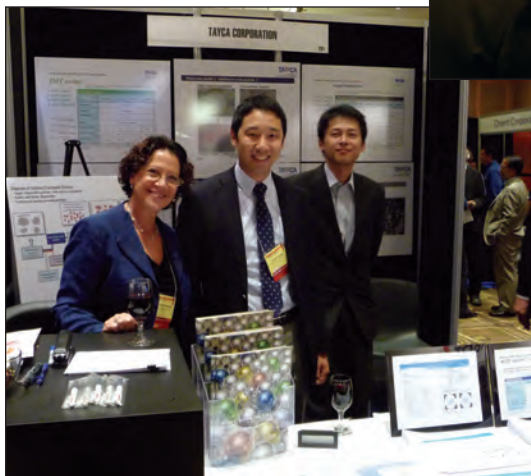
Tuesday concluded with the joint Interactive Paper and Demonstration Session held in conjunction with the Exhibit Hall Happy Hour. In its second year, the demonstration session allows authors and attendees the chance to physically showcase a tangible object or computer program related to their talk. Presenter's tables were often packed several people deep, with lots of discussion and the ability to interact directly with printed output ranging from glossy images to ceramic hippos.

The exhibit hall reflected the diversity of applications and topics of this year's conference with exhibitors offering components, materials, systems, and integrated solutions important to both traditional applications and emerging uses of digital printing. Interaction with exhibitors was encouraged through the use of a punch card where visitors would collect stamps from exhibitors and submit their card for a prize drawing at the close of the exhibition. This year's winner was Sivapackia Ganapathiappan (Hewlett-Packard Co.) who collected more than 12 stamps.

### Wednesday Moves Us From Cloud Printing to Printed Electronics

A wide-ranging presentation on cloud-printing by Phil McCoog (Hewlett-Packard Co.) highlighted new ways to think about what printing means and how technologies must continue to adapt to keep pace with our increasingly mobile-computing dependent culture. McCoog spent some time talking about the innovation that is taking place in the new arena of crowd-sourced printer development. He asserted that crowd sourcing allows small companies and entrepreneurs to cycle quickly through multiple design iterations in a more public manner than established companies dare. However, the types of offerings and the response to these offerings might be truly instructive for established players in the printing technology marketplace. Consumers are used to adopting and adapting to multiple generations of technology-based products every year, and these products and applications are impacting how we think, how and where we work, and how we interact with both each other and with technology. There is clear opportunity in fostering agility in the adaption of traditional technologies and methods to the unique challenges and possibilities that arise as new technologies become part of the cultural vernacular.

In the Printed Electronics Session, there were several talks on inkjet printing of organics and metal layers, one talk on international standards for printed electronics, and one on a current application



Twenty-nine companies participated in the 2013 exhibit, which featured a happy hour and iPad drawing.

of printed electronics in the production of touch screens. The Materials track session on sustainability as it pertains to materials post-printing, specifically addressed issues arising from the need for successful de-inking of digitally produced printed materials for inclusion in the recycling stream. The ink formulation session followed, with several interesting papers including a good introduction to challenges of using low migration UV ink and its use in food packaging. Before continuing with papers on toner-based processes and materials, the Processes/ Materials track began with an engaging and informative ad hoc discussion on “The Future of EP”. The conversation reinforced a genuine interest in continuing EP content at future meetings. Page-wide printing was identified as an interesting topic for the future as it presents new application opportunities for both inkjet and EP technologies.

### Conference Ends with Opportunities, Success Stories, and Industry Tours

Thursday morning began with remarks from IS&T President Alan Hodgson in response to the passionate feedback gathered onsite from attendees about the future direction and identity of the conference. Hodgson thanked all who had voiced their thoughts and affirmed IS&T’s commitment to NIP/Digital Fabrication as the industry-leading event for the exchange of information on topics related to its traditional core content, as well as to related emerging technologies and applications.

Following the closing remarks, keynote speaker Shinjiro Umezo (Tokai University) discussed the important potential of using electrostatic patterning technologies in bio-printing applications

with the goal of someday building organs for human transplantation. Highlighting the array of bio-applications of the electrostatic patterning technologies and the range of technologies that this field truly encompasses, Umezo gave attendees a glimpse into the intersection between traditional digital printing and deposition technologies with this emerging field.

Thursday’s technical sessions included presentations on industrial application for inkjet printing in solar cell fabrication, photonic sintering for functional inkjet inks, lab-to-fab technology transfer, and a compelling talk using hybrid technique of inkjet printing and laser processing to control surface energy during fabrication of high resolution TFT arrays. Challenges of legislation for food product safety, materials costs in printed electronics, droplet coalescence, and print masking were presented in the session on functional materials. Technology developments impacting image quality in EP systems and system reliability in inkjet were also discussed.

### Digital Successes

The conference concluded with a group discussion highlighting success stories of

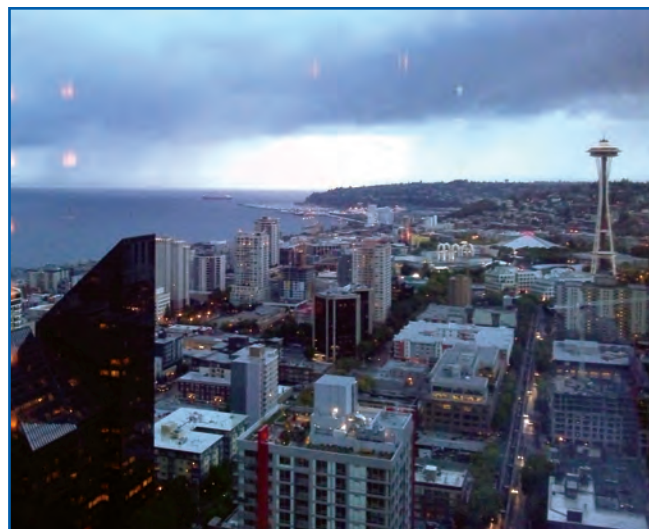
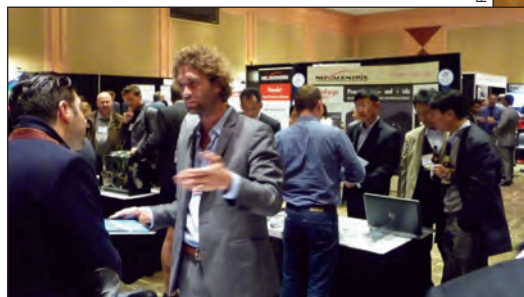


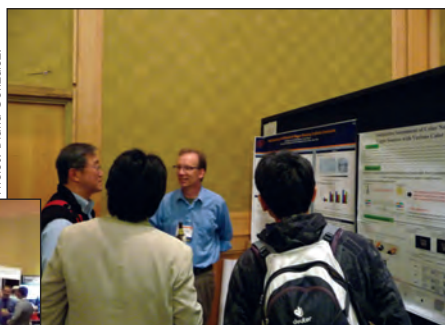
Photo: Alex Fischer.

Although rain was a part of the NIP/Digital Fabrication week in Seattle, the city provided great views, delicious restaurants, fun attractions, and an atmosphere conducive to learning and sharing.

the past year in a session moderated by Werner Zapka (XaarJet AB). In 2012, a similarly styled session on lab-to-fab discussed problems that prevented the speedy implementation of new applications; this year the session focused on what had gone right with specific implementations. Several examples were presented starting with the remarkable progress achieved in ceramic tile manufacturing. Worldwide, more than half of the manufacturing companies in this field have converted from screen to inkjet printing. In another presentation, the Schmid Group (Germany) described their inkjet-based process and machine for producing the front metallization of Si solar cells. Molecular Imprints Inc. (USA) presented their machine and results on producing 24nm resist pattern on 450mm wafers, with inkjet printing providing compatible throughput to this technique. High-speed direct labeling on bottles and cans was demonstrated by KHS (Germany) and Tonejet (UK). A success story presented by [continued on page 14](#)



Photos: Diana Gonzalez.



Networking that brings together individuals from industry and academia is an engaging and important part of the conference, whether it be during the Demonstration Session, Interactive Paper Session, Exhibition, or breaks.



Photo: Alex Fischer.

## Standards Update *by David Q. McDowell, Editor*

**B**ecause this issue of *Standards Update* will be my last, I am indulging personal privilege and using it to reminisce about the history of graphic arts standards development.

I have decided that 2014 is the year for me to bow out of the standards activities. This decision is based on personal and family issues. I have been involved in the graphic arts standards activities since 1982 (as a volunteer since I retired from Kodak in 1999) and it has been a very enjoyable and challenging experience. However, in recent years my wife can no longer travel with me and I realize that I am not as quick as used to be, so my goal is to be fully withdrawn from standards activities by my 80th birthday, October 2014.

Now to some reminiscences about my standards journey.

### The Beginning

In the late 1970s the printing and publishing industry in the United States had no formal (ANSI) standards activities and although there had been some earlier activities to start an ISO committee it had become dormant and essentially ceased to exist. The industry did use some of the standards developed by the Photographic industry—specifically densitometry, sensitometry, and viewing conditions. But these were not optimized for graphic arts use. The prevailing attitude in the industry was standards were the “lowest common denominator” and no one printed that way.

### The Wakeup Call

In late 1979, Scitex introduced the first graphic arts image manipulation system. Such systems were called CEPS or Color Electronic Prepress Systems. The Scitex announcement was quickly followed by systems from Hell, Eikonix, Crossfield, and Dainippon Screen. Such systems were “practical” because the available computer processors and memory had finally become powerful enough to support the image manipulation required by the graphic arts industry. Then, and now, a

typical graphic arts 8.5 x 11 inch image is about 30 MB. These early systems all cost about \$1.5 million, had 2-4 MHz processors, and less than 100 MB of online storage. Although such systems took about 20 minutes to rotate an image, they worked.

The user community was immediately faced with two issues. First, each of these systems stored data in a different format and orientation. Second, the only media available to move data between systems was 8-track magnetic tape. Those tapes carried no standard header or other information about the format of the data encoded on the tape. Therefore, these systems could not easily exchange data and the industry remained isolated islands of electronic data manipulation that continued to use film as its exchange media.

The industry desperately wanted to be able to exchange digital data between systems, and more importantly between organizations. Because this involved multiple companies in both the vendor and user communities, standards seemed to be the logical direction to take. An ad hoc industry group was formed called DDES (Digital Data Exchange Standards) in an effort to start the dialogue between vendors, and between users and vendors. This was the nucleus around which ANSI Image Technology Committee 8 (IT8) was created and chartered with NPES as the sponsoring organization.

The first approach was to simply rationalize and document the various formats being used and to develop standardized file headers to identify the contents of an individual tape. (ANSI IT8.1 to IT8.5, which became ISO 10755 through 10759). This was followed by the development of media independent file formats based on TIFF called TIFF/IT (ANSI IT8.8, ISO 12639) TIFF/IT was subsequently replaced by the PDF/X data exchange file formats (ISO 15930).

### What Does the Data Mean?

As long as halftone film was the principle exchange vehicle for printing “data” there

was usually a close coupling between the organization preparing the film and the printing organization. The only major exception was the magazine publication industry, which had very tight specifications on the preparation of hardcopy proofs that were the formal agreement between the advertiser, publisher, and printer. The proof was the reference for printing.

Exchanging data seemed to be the key to taking advantage of the computer revolution and the step that would allow the graphic arts industry to move into the world of electronics. However, we quickly realized that there was no point in moving data between systems if you did not know what the data meant and how to consistently reproduce the images that they represented.

This led to a whole host of additional standards to define the meaning of the data and its reproduction, and the creation of the ANSI Committee for Graphic Arts Technologies Standards (CGATS) for those standards that were not file format related.

### The Move to ISO

This early standards work started in the ANSI IT8 and CGATS committees. However, by the late 1980s we realized that there was as much international involvement as US involvement and that US standards were not easily referenced nor used by participants from other countries. A small group was formed to investigate the reactivation of the dormant ISO TC 130 committee. The secretariat for TC 130 (Graphic technology) had been given up by France and accepted by Germany on a caretaker basis. However, they were reluctant to reactivate the committee. In addition ISO/IEC JTC1 (Information technology) had been recently formed (1987) to consolidate the work in information technology. JTC1 took the position that anything involving computer data was within their area of responsibility and TC 130 was not needed for data exchange issues. The US ad-hoc group prevailed in discussions with the ISO Technical Management



Board and Germany was requested to call a reactivation meeting of TC 130. That meeting was convened by Germany on July 4, 1989 and was attended by representatives from ten countries. Much of the work that was started in ANSI IT8 and CGATS was immediately moved into the new TC 130 committee.

### Data to Color Relationship

Early in the process it was realized that a key to defining and understanding the meaning of the data was the relationship between data and the color it represented. We naively thought that CIE (the International Colour Commission) had defined color and all we had to do was use the CIE definitions as a reference. We quickly discovered that CIE offered too many options (observer, illuminant, measurement geometry, etc.). An early task was to define a unique selection out of the many options and we settled on many parameters that were already defined for viewing and or density measurements: D50, 2° observer, 0/45 geometry, black backing. These parameters were defined first in CGATS.5 and later ISO 13655.

The other half of the relationship between data and color was the definition of targets (the data). First was a scanner characterization target (based on the Kodak Q-60 target) where the layout of a target was defined along with the methodology for determining the colorimetric values for each patch. The development of this target was a joint activity in which all of the film manufacturers (Kodak, Agfa, Konica, Fuji, Polaroid), along with scanner manufacturers and users, participated.

It was the responsibility of the various film vendors to actually construct the targets on their photographic film or paper products and provide (sell) these with accompanying measurement data. These were the IT8.7/1 and IT8.7/2 targets (ISO 12641). The current best estimate is that more than 700,000 of these targets have been sold for scanner calibration/characterization since implemented.

For calibration of printed output a CMYK target was defined to encompass the printing gamut with reasonable data spacing to allow interpolation and calibration. The initial target had 928 patches and was called the IT8.7/3. A later target, with 1617 patches, was designated the IT8.7/4 target. These became ISO 12642-1 and ISO 12642-2.

### To Control the Process

In the 1980s the only printing specification was for publication work. This was defined by SWOP (specification for web offset publications) which defined the process control aims (paper, reference ink samples, solid ink densities, dot gain) for press proofing for publications. The printed work was controlled by visual reference to the standard proof.

Although initial off-press proofing systems used colorants similar to the reference inks, the use of colorants and processes that did not match the offset proofing aims led to the development and use of characterization data to define the aims. ANSI CGATS TR001, developed in 1992, was the first standardized set of graphic arts characterization data published. This quickly became the definition of SWOP for publication printing that could be used for the evaluation and control of both proofing and printing.

The availability of both scanner and printing characterization data and the associated targets was clearly part of the technology that enabled the creation of the International Color Consortium (ICC) in 1993.

ISO TC 130, led by Germany, expanded the development of printing specifications for both variations in substrate and process (offset, gravure, flexo, screen printing; ISO 12647) along with specifications for ink color and transparency (ISO 2846 series). The ISO 12647 series departed from earlier work by replacing density aims with colorimetric aims for the solids of the inks used.

Today, there is active discussion con-

**THANK YOU**

**IS&T sincerely thanks**

**DAVID Q. MCDOWELL**

**for 23 years of reporting on standards activities for the Society. His insight, historic knowledge, wit, and wisdom will be missed in these pages.**

cerning the preferred way to define printing: process control (ISO 12647) vs. characterization data (ISO 15339). Both approaches have their proponents and the current struggle is to find a way that they can co-exist until user preferences determine the preferred approach for the future.

### Joint Activities

There have been a number of joint activities with other standards committees that have played a major role in the support of the graphic arts standards. Most notable with ISO TC 42 (Photography) to revise the densitometry (ISO 5 series), viewing (ISO 3664), and color measurement (ISO 13655) standards. This work has resulted in consistency between these standards, as well as insured that the needs of both photography and graphic arts were met in a single set of standards.

There has been excellent cooperation between TC 130, TC 42, and TC 171 (Document management applications) in the movement of the PDF reference specification from an Adobe document to an international standard (ISO 32000). This cooperation also produced the PDF archiving standards known as PDF/A (ISO 19005 series).

### Other Tools

As printing has moved from a craft to a manufacturing process many other standards have been developed to support various aspects of the process, such as preparation of test prints (ISO 2834), register systems (ISO 11084), [continued on page 13](#)

## IMAGING STANDARDS NEWS: TC 42

by Ann L. McCarthy, IS&T Standards Coordinator

This Imaging Standards News is focused on both U.S. national and international standards applicable to photographic imaging, including analog, digital and print concerns. IS&T imaging standards encompass the capture, communication, and display of a photographer's desired image content, the advancement and maintenance of analog photographic imaging technologies, and the preservation of physical imaging materials; all practices essential to everyday enjoyment of photography and to our photographic heritage.

### ISO/TC 42: Working Groups and Projects

TC 42 and its contributing experts are conducting current projects within the following working groups and joint working groups. In each of these areas, experts are welcome to contribute through their corresponding national committees. For meeting details for the working groups listed below, please contact the Secretariat, isotc42@ansi.org.

#### Working Groups with current projects within TC 42:

- ◆ WG 3, Sensitometry, image measurement and viewing; next meeting in Gunnersbury, West London, May 12-14, 2014, hosted by BSI.
- ◆ WG 5, Physical properties and image permanence of photographic materials; next meeting in Gunnersbury, West London, May 12-14, 2014, hosted by BSI.
- ◆ WG 18, Electronic still picture imaging; next meeting in Yokohama, Japan, February 12–15, 2014.

#### Working Groups with current projects, joint with other ISO and IEC committees:

- ◆ WG 8, Joint with TC 6, Photographic film and paper products – Dimensions; next meeting in Gunnersbury, West London, May 12-14, 2014, hosted by BSI.
- ◆ JWG 20, Joint with IEC, Digital Still Cameras; next meeting in Yokohama, Japan, February 12–15, 2014.
- ◆ WG 25, TC 42/WG 18 joint with TC 130, Use of XMP for digital photography; next meeting at in Yokohama, Japan, February 12–15, 2014.
- ◆ JWG 26, Joint with TC 46/SC 11 and TC 171, Imaging system capability qualification for archival recording and approval; next meeting is a conference call, January 2014.

### Upcoming ISO/TC 42 Standards Publications

ISO/TC 42 has reviewed, confirmed, published revised, and published new, forty standards as of November 1st, 2013. Currently among the various working groups, there are twenty-four projects in development and under consideration. IS&T is grateful for the ongoing sincere and diligent efforts of the inter-

national members of these project teams. Each standards project involves significant work to understand the related technical and industry issues and to demonstrate viable standardization candidates, as prerequisites to developing the necessary standardization consensus. Three standards in process for publication and recently published warrant particular mention:

- ◆ ISO 18937, *Imaging materials – Photographic reflection prints – Methods for measuring indoor light stability*
- ◆ ISO 18939, *Imaging materials – Digital hard copy for medical imaging – Methods for measuring permanence*
- ◆ ISO 12233 (Ed. 2), *Photography – Electronic still-picture cameras – Resolution measurements.*

### News from the October ISO TC 42 WG Meetings

ISO/TC 42 WG 18, JWG 20, JW G23, and JWG 25 Meetings, Oct. 8–11, 2013, New York City, USA

Twenty-nine representatives from five countries gathered at ANSI Headquarters; progress was reported for approval of the following standards:

- ◆ ISO 15739:2013 (Ed. 2), *Photography – Electronic still-picture imaging – Noise measurements, and 15740:2013 (Ed.3), Photography – Electronic still picture imaging – Picture transfer protocol (PTP) for digital still photography devices,* were published.
- ◆ The proof text of ISO 12233, *Photography – Electronic still-picture cameras – Resolution measurements,* is currently under review.
- ◆ There is a ballot of the second CD 17850, *Photography – Digital cameras – Geometric distortion (GD) measurements,* closed November 6, 2013.

Ten approved projects are in development for CD ballot:

- ◆ ISO 12234-2, *Electronic still-picture imaging – Removable memory – Part 2: TIFF/EP image data format*
- ◆ ISO 12234-3, *Electronic still picture imaging – Removable memory – Part 3: Use of XMP*
- ◆ ISO 17321-4, *Graphic technology and photography – Colour characterization of digital still cameras (DSCs) – Part 4: LED (Light Emitting Diode) colour target*
- ◆ ISO 17957, *Photography – Digital cameras – Shading measurements*
- ◆ ISO 18383, *Photography – Digital cameras – Specification guideline*
- ◆ ISO 18844, *Electronic still picture imaging – Flare measurement techniques for digital camera systems*
- ◆ ISO 19084, *Photography – Digital cameras – Lateral chromatic displacement measurement*
- ◆ ISO 19093, *Photography – Digital cameras – Measuring low*

*light performance*

- ◆ TS 19247, *Photography – Digital Still Cameras – Guidelines for reliable camera testing*
- ◆ ISO 19262, *Photography – Archiving Systems – Vocabulary*

Five potential new projects are awaiting NP ballot:

- ◆ TR 17321-3, *Graphic technology and photography – Colour characterization of digital still cameras (DSCs)*
- ◆ TS 19263, *Photography – Archiving Systems – Best practices for digital image capture of cultural heritage material*
- ◆ TR 19264, *Photography – Archiving Systems – Image quality analysis*
- ◆ *Photography – Digital cameras – Texture Blur measurements*
- ◆ *Calibration method for XYZ capture, and developing a wide gamut color reference*

During the JWG 20 session, Mr. Scott Geffert (USA), representing the Metropolitan Museum of Art, presented “The Observer Referred Imaging State: A key to modern cross-media imaging,” discussing the need for a device-independent intermediate color encoding workspace, not limited by early days digital color devices and their related color encodings. Scott proposes a wide gamut “output neutral imaging state free from the constraints of legacy device Gamma encoding,” instead encoded with an  $L^*$  tonescale. The ROMM RGB gamut, recently standardized in ISO 22028-2:2013 (Ed. 1), *Photography and graphic technology – Extended colour encodings for digital image storage, manipulation and interchange – Part 2: Reference output medium metric RGB colour image encoding (ROMM RGB)*, has a sufficient gamut to encompass source colors of interest, containing the “entire gamut of the popular DCSG characterization target and that of most image sensors.” Scott emphasized the importance of a late-binding workflow, constraining colors to an output



Scott Geffert (USA) presenting an overview of standards adoption at The Metropolitan Museum of Art to the ISO/JWG 20 members.

Photo: Nancy Rulleck, The Metropolitan Museum of Art.

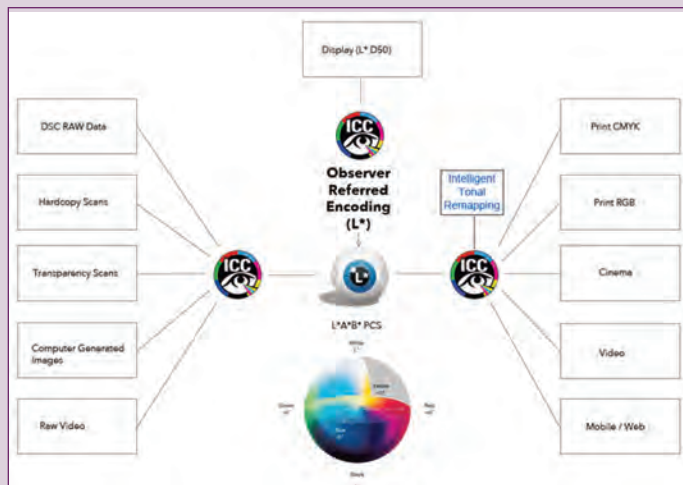
gamut in preparation for a particular visualization rather than during capture or prior to storage. The proposed approach would enable camera readouts to match readouts in raw processor applications, thereby allowing users more control during image capture. Standardization between cameras and raw image processors is a significant opportunity to provide support for users who routinely create content to be used across multiple destination media, e.g., print, web, video, and computer-generated imagery.

#### *CISO/TC 42 WG 5, WG 3, and WG 8 Meetings, October 21 – 24, 2013, Washington, DC, USA*

Separate sessions were conducted for ISO/TC 42 WG 5 Task Group 2 and Task Group 3, ISO/TC 42 WG 3 and ISO/TC 42 WG 8. Representatives of five countries gathered in the James Madison Memorial Building of the U.S. Library of Congress, in Washington, DC.

During the ISO/TC 42 WG 5 session, ISO/TC 42 Copenhagen Resolution 2013-04 requiring update of the TC 42 Strategic Business Plan by the end of 2014 was discussed. The Japan National Committee representative, Mr. Yoshi Shibahara (Japan), ISO/TC 42 WG 8 Convenor, presented new fields of activity discussed within the Japan National Committee, for the purpose of stimulating more ideas among representatives of other national committees. Mr. Shibahara noted the following important trends for consideration in developing the strategic plan: photo capture using smart phones is increasing while photographic printing is decreasing; photo printing products such as photo books and value added variety prints are increasingly important; photographic prints and other photographic products are important archival tools and contribute to the richness of each nation’s cultural heritage; the expansion of photography products and the associated output equipment capabilities have blurred the lines between the photographic print domains of ISO/TC 42 and ISO/TC 130.

Progress on standards development was reported as follows:



Encoding workflow diagram from “The Observer Referred Imaging State: A key to modern cross-media imaging,” by Scott Geffert.

Image courtesy of Scott Geffert.

- ◆ ISO 18902, *Imaging materials – Processed imaging materials – Albums, framing and storage materials*, was published 2013/06/14.
- ◆ ISO 18913, *Imaging materials – Permanence – Vocabulary*, will be revised to accommodate common understanding with ISO/TC 130.
- ◆ ISO 18927:2013 (Ed. 3), *Imaging materials – Recordable compact disc systems – Method for estimating the life expectancy based on the effects of temperature and relative humidity*, is related to three different standards (ISO/IEC 10995:2011, ISO/IEC 16963:2011 and ISO 18927:2008) in addition to the ECMA industry standard 396, with the selection of the appropriate method depending on the content or use case of an optical disc. Consolidation is now organized in JTC 1/ SC 23 (Digitally Recorded Media for Information Interchange and Storage) / JWG 1, which is joint with ISO/TC 42 and ISO/TC 171/SC 1.
- ◆ ISO 18935, *Imaging materials – Colour images on paper prints – Determination of indoor water resistance of printed colour images*, will be revised and will incorporate an edge penetration test into the Annex.
- ◆ The long-awaited ISO 18937, *Imaging materials – Photographic reflection prints – Methods for measuring indoor light stability*, was submitted for publication on 2013-07-20.
- ◆ The DIS for revision of ISO 18938:2008 (Ed. 1), *Imaging materials – Optical discs – Care and handling for extended storage*, has been submitted to ISO for ballot.
- ◆ Publication of ISO 18939:2013, *Imaging materials – Digital hard copy for medical imaging – Methods for measuring permanence*, was announced shortly after the close of the meeting.
- ◆ ISO 18940-1, *Imaging materials – Reflection colour prints – Specifications for indoor stability (Part 1: Consumer Home)*, is in preliminary working draft stage. Resolution of comments from the meeting will be incorporated into a new working draft which will accompany the upcoming NP ballot.
- ◆ The DIS ballot for ISO 18943, *Imaging materials – Storage, Care and Handling of Magnetic Hard Disk Drives*, resulted in 100% approval with comments. Comments are being addressed to prepare document for direct publication.
- ◆ The DIS ballot for ISO 18944, *Imaging materials – Reflection colour photographic prints – Test print construction and measurement*, resulted in 100% approval with comments. Comments were addressed and the document was submitted for direct publication. Following review of the ISO proof, publication was expected in Q4 2013.
- ◆ ISO 18947:2013, *Imaging materials – Printed imaging materials – Determination of abrasion, scuff, and smudge resistance of printed colour images*, was published on 2013-05-02.
- ◆ The NP ballot for ISO 18948, *Imaging materials – Photo Books – Test methods for Permanence & Durability*, accom-

panied by WD 6 with the resolution of comments from this meeting is planned to be issued before the end of January 2014.

**Joint standardization projects are underway in three areas:**  
In relation to the revision of ISO 11798, *Information and documentation – Permanence and durability of writing, printing and copying on paper – Requirements and test methods*, in ISO/TC 46, ISO/TC 42 has appointed Mr. Fumio Nakaya (Japan) as liaison to ISO/TC 46 and PL on behalf of ISO/TC 42/WG 5. From the liaison report provided by Mr. Nakaya, WG 5 was informed that ISO/TC 46 has decided to reactivate SC 10 in 2013. The ISO/TC 46/SC 10 scope of work will include image permanence topics of interest to ISO/TC 42/WG 5 including: de-acidification of paper, document storage requirements, permanence of writing, printing and copying media on paper documents - requirements and testing methods, and binding materials and binding practices. A number of current standards in ISO/TC 46 cover permanence and durability issues that are of interest for WG 5.

At the June 2013 ISO/TC 42 Plenary in Copenhagen, ISO/TC 42 resolved to establish joint work with TC 130 / JTC 1 SC 28 WG 4 / JWG 14 in order to participate in their work on image quality for use in the context of image permanence, i.e., being the change of image quality over time. Mr. Jürgen Jung (Belgium), ISO/TC 42/WG 5 Convenor, reported on the progress of that joint effort. The work of JWG 14 is focused on three areas: i) colour/gloss, ii) print uniformity (mottle, banding, noise), and iii) detail rendition (sharpness, line and letter quality). JWG 14 has begun the work to extend the existing monochrome methods from ISO/IEC/JTC1 SC 28 to monochrome CMYK and colour. These new methods will be incorporated into NWI ISO 18621. JWG 14 will separate standardization of test methods and specifications, with JWG 14 focusing on test methods only. Specifications are anticipated to be handled by the committees having the scope pertaining to each of the use cases, e.g., ISO/TC 130/WG 3 for printing / graphics technology, ISO/TC 42/WG 5 for photographic printing. JWG 14 does not plan to extend its scope to image permanence testing, and welcomes WG 5 address the permanence of line arts elements. For example, WG 5 is invited to investigate whether image quality test methods to assess print homogeneity would be applicable to address visibility of artifacts that are introduced in the course of weathering.

Further topics of interest are shared between ISO/TC 130/WG 3 and ISO/TC 42/WG 5 due to the ongoing technology convergence in digital printing. Two initial clarifications will be considered in WG 5 in an effort to harmonizing the terminology and test methods between the two working groups. Firstly, the definition of photography will be clarified in the revision of ISO 18913. Secondly, WG 5 will investigate the applicability of  $\Delta E$  metrics in place of the density reporting currently required in its test method standards.  $\Delta E$  metrics are commonly

understood in the Graphic Arts industry sector. In general, the applicability of current ISO/TC 42 image permanence test methods for analogue printing warrants investigation.

### American National Standards News

Nearly 70 legal experts and other members of the standards and conformity assessment community came together on October 1, 2013, for the American National Standards Institute (ANSI) Legal Issues Forum. Focused on arbitration of RAND disputes, this year's event examined significant issues connected to the licensing of patents essential to the implementation of a given standard on reasonable and non-discriminatory (RAND) terms.

The forum was held by ANSI as part of the 2013 World Standards Week (WSW) series of events.

In recent years, an increase in the number of high profile patent disputes has focused increased attention on what RAND commitments really mean and how they can be resolved without resort to litigation. Support was voiced for arbitration as a method for resolving such disputes, with the noted advantages that arbitration proceedings are private and can be conducted by an individual with demonstrated technical expertise. The corresponding caveat is that there can be significant variation in outcome depending upon the arbitrator. ▲

continued from page 9

ink testing (ISO 2836, 12634, 12644), printing plate sizes (ISO 12635), and printing blanket requirements (ISO 12636). Other tools that both support printing and have broader application include:

- ISO 12640 series of SCID (Standard Colour Image Data) image sets that provide standard images encoded in various image states from plain CMYK images (Part 1) through scene reference image data (Part 5);
- Variable printing data exchange (ISO 16612 series);
- ICC color management profile specification (ISO 15076);
- Black point compensation (ISO 18619);
- Colour data exchange using CxF (ISO 17972 series);
- Extensible metadata platform (XMP) specification (ISO 16684 series).

### The Future

The standards work that started in the US in 1982 to solve the problem of file identification to allow electronic data exchange has grown into an activity that has revolutionized the printing and publishing industry from a craft-based, largely localized business into an internationally based manufacturing operation. Standards have played a major role, but the key enabling driver has been the change in computing and data storage capabilities over this same time period. Our role has been to help the industry develop the common framework to take advantage of these capabilities.

It has been an exciting ride and I will be sorry to become an observer rather than an active participant.

My sincere thanks to IS&T for allowing me a forum to report on standards activities in almost every issue of the Reporter since 1990. Also my appreciation to

NPES for providing the support for travel and expenses to actively participate in these activities since my retirement.

Thank you.

For suggestions for (or input to) future updates, or standards questions in general, please contact Ann McCarthy at [standards@imaging.org](mailto:standards@imaging.org).

# JOIN US IN BERLIN

## ARCHIVING2014

May 13-16, 2014 • Berlin, Germany



[www.imaging.org/ist/conferences/archiving](http://www.imaging.org/ist/conferences/archiving)



imaging.org

continued from page 7

CeWe (Germany) talked about their digital printing of photo books, and the first worldwide installation of machines for online printing of newspapers by Swedish company Meganews was also highlighted.

### Where We're Headed

As this year's conference came to a close, it was clear that traditional topics for digital printing remain important, including improvements and innovations in marking technologies, materials, processes, image permanence, and image quality. These familiar topics continue to be relevant, but they will also find increased relevance and opportunity in the fields opening up by innovative and novel applications.

This year's digital fabrication and emerging application content also ex-

posed a wide range of development opportunities in the areas of metrology and inspection, standards, hybrid printing, and production processes, as well as wide-open opportunities for collaborative work with fields such as biology and additive manufacturing. Several attendees noted that these sorts of collaborations could truly benefit from the printing process, color and imaging science, and paper/materials science expertise of our members and attendees.

As the Society looks toward the future, input received from attendees and stakeholders in Seattle will impact the course of the conference. We thank attendees so much for the time they took to talk with staff members, sharing ideas for future topics and areas of possible expansion. We are dedicated to our evolving NIP/Digital Fabrication conference, and we look



Photo: Alex Fischer

Many attendees took advantage of our location in Seattle to visit Boeing (seen here), Microsoft, and Paul Yager's lab at the University of Washington.

forward to seeing you at the 2014 conference in Philadelphia. ▲

## IS&T EVENTS: 2014

February 2 – 6, 2014; San Francisco, California

### Electronic Imaging 2014

Symposium Chairs: Sergio Goma and Sheila Hemami

May 13 – 16, 2014; Berlin, Germany

### Archiving 2014

General Chair: Christoph Voges

September 7 - September 11, 2014;

Philadelphia, Pennsylvania

### NIP30/Digital Fabrication 2014

General Chair: Branka Lozo

November 3-7, 2014; Boston, MA

### 22nd Color and Imaging Conference (CIC22) /

### 2nd International Congress of the International

### Academy of Digital Pathology

General Chair: Jennifer Gille (CIC22)

For a list of IS&T  
and other imaging-related meetings,  
visit [www.imaging.org](http://www.imaging.org)



Held once every four years, ICIS provides a unique forum for scientists from different disciplines of imaging—image processing, spatial optics, super resolution, photography, printing, display technologies, and remote sensing—to meet.

**What:** International Congress of Imaging Science (ICIS)

**When:** May 12-14, 2014

**Where:** Tel Aviv, Israel

<https://event.pwizard.com/icis2014/>