

NIP/DIGITAL DIGITAL
Printing for Fabrication 2017
Materials, Applications, and Processes



November 5-9, 2017
Denver, Colorado, USA



Collocated event
**2017 International Symposium on
Technologies in Digital Photo Fulfillment**

Early Registration Deadline:
October 8, 2017

www.imaging.org/print4fab



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Printing for Fabrication 2017



Technologies in
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Printing for Fabrication

A journey from marks on paper to the next industrial revolution

The printing industry continues to move forward. Familiar digital and non-impact printing technologies continue to evolve and advance, particularly in the areas of high-speed and single-pass output and new digital printing applications continue to demand better print quality, more sophisticated image processing technology, and high performance digital workflow processes. Concurrently, technologies that extend beyond marks on paper are playing an increasingly significant role in redefining what it means to print something. More than a decade has passed since the first IS&T sponsored Digital Fabrication Conference. In that time, there has been remarkable and unexpected discoveries as traditional digital printing technologies were repurposed and then reinvented to print functional things in two- and three-dimensions. From the earliest examples of printable electronics in 2005 to recent significant advances in 3D biofabrication, it has been an

amazing journey. This year, the Printing for Fabrication conference will continue the journey with informative short courses, keynote presentations from industry thought leaders, and a technical program that cover topics ranging from new developments in graphics and document printing, to recent advances in digital fabrication and, of course, the latest information and updates in 3D printing and additive manufacturing. This year, the program also includes several networking events designed to bring together experts from industry and academia for in depth discussions on topics that cover new developments in security printing to recent advances in pharmaceutical 3D printing. Come join us in Denver and be part of a community of scientists, engineers and technologists who are shaping the future of printing and setting the stage for the next industrial revolution.

—General Chair James Stasiak

Week At-a-Glance

Sunday, Nov. 5

- Short Courses
- Welcome Reception at Denver Hyatt

Monday, Nov. 6

- Opening Keynote: Evolution Theory of Ink Jet Technologies—Progress by Component or Architectural Knowledge, *Masahiko Fujii, Fuji Xerox Co., Ltd. (Japan)*
- State-of-the-Art Keynote: From Prototyping to Production: Rethinking Materials for Additive Manufacturing, *Jason Rolland, Carbon (USA)*
- Technical Sessions:
 - Inks, Toners, and Substrates
 - Workflow for Digital Printing
- Technology Networking Event: Deepdive with Jason Rolland — From Diagnostics for All to Carbon: A Personal Technical Journey
- Young Professional/Student Get Together

Tuesday, Nov. 7

- Keynote: Reactive Inkjet Printing in Nanoparticle Manufacturing and Device Applications, *Ghassan Jabbour, University of Ottawa (Canada)*
- Technical Sessions
 - Inks, Toners, and Substrates
 - Security Printing
 - Printed Electronics
- Technology Networking Event: Security Printing
- Exhibition
- Interactive Paper (Poster) Sessions
- Demonstration Session / Happy Hour

Wednesday, Nov. 8

- Keynote: Attractive and Innovative Solutions for Highly Qualified 3D Printing Process Development in Next Generation, *Takashi Fukue, Iwate University (Japan)*
- IS&T Awards
- Exhibition
- Technical Sessions
 - Ink Jet Processes
 - 3D and Additive Printing
- International Symposium on Technologies in Digital Photo Fulfillment 2017
- Technology Networking Event: Review of State-the-Art of 3D Printing
- Technology Networking Event: Intellectual Property
- Conference Reception at Wynkoop Brewing Company, Colorado's first Brew Pub

Thursday, Nov. 9

- Keynote: From Gutenberg Bible to 4D Printing, *Shlomo Magdassi, The Hebrew University of Jerusalem (Israel)*
- Technical Sessions
 - Industrial Digital Printing
 - Special Topics
- Technology Networking Event: 3D Printing and Pharmaceuticals
- Technology Networking Event: Late Breaking News
- Technology Networking Event: Technology Tours

Technical and Social Program

All papers are oral unless marked as focal or interactive. Program is subject to change.

See page 9 for details on Sunday's Short Course Program, which offers 19 classes on a wide range of topics.

SPECIAL EVENT: WELCOME RECEPTION

Kick off the conference by meeting friends and colleagues Sunday after the Short Courses.

Sunday, November 5th

17:45 – 19:00

Colorado Ballroom Foyer, Denver Hyatt

SPECIAL EVENT: STUDENT AND YOUNG PROFESSIONALS GET TOGETHER

Join other students and young professionals to explore Denver's nightlife.

Monday, November 6th

beginning at 19:00

Monday November 6, 2017

ALL TRACKS

OPENING KEYNOTE

9:00 – 10:00

Evolution Theory of Ink Jet Technologies—Progress by Component or Architectural Knowledge, Masahiko Fujii, Fuji Xerox Co., Ltd. (Japan)

STATE-OF-THE-ART KEYNOTE

14:15 – 15:05

From Prototyping to Production: Rethinking Materials for Additive Manufacturing, Jason Rolland, Carbon (USA)

TECHNOLOGY NETWORKING EVENT

Deepdive with Jason Rolland—From Diagnostics for All to Carbon: A Personal Technical Journey
16:55 – 18:00

TRACK 1

INKS, TONERS, AND SUBSTRATES

10:10 – 17:40

Sponsored by Ricoh Company Ltd.

RICOH

The Influence of pH on the Stability of Inks of Two Dimensional Materials for Digital Fabrication, Viviane Forsberg, Renyun Zhang, and Håkan Olin, Mid Sweden University (Sweden)

Manufacturing of Micro-Scale Polyurethane Foams by Reactive Inkjet Printing, Fabian Schuster¹, Fabrice Ngamgoue Ngako², Thomas Hirth³, and Achim Weber^{1,2}; ¹University of Stuttgart, ²Fraunhofer Institute for Interfacial Engineering and Biotechnology IGB, and ³Karlsruhe Institute of Technology KIT (Germany)

The Effect of Drying Behavior of Coatings Containing Pigment and CaCl₂ on Inkjet Print Quality (Focal), Katriina Mielonen^{1,2}, Sami-Seppo

Ovaska^{1,2}, Johanna Lyytikäinen^{1,2}, Leena-Sisko Johansson³, Monika Österberg³, and Kaj Backfolk^{1,2}; ¹Lappeenranta University of Technology and ³Aalto University (Finland)

Ink Formulation and Printing of Superhydrophobic Paper, Michelle Jensen, Jacob Petersen, Christopher Schultz, Jon Kellar, and William Cross, South Dakota School of Mines and Technology (USA)

The Inkjet Dispensing and Control of Explosive Solutions on Surfaces (Interactive), Alexandra Charleson, Catherine Skidmore, Lauren Holley, Peter Glover, and Marie Shackleford, Dstl (UK)

Experimental Study of Filament Break-off of Dense Suspensions, Gustaf Mårtensson^{1,2}, Fabian Carson¹, and Katrín Emma Ammendrup^{1,2}; ¹Mycronic AB and ²Royal Institute of Technology (Sweden)

Tuning Inkjet Printability of Ydroxypropylated-Starch-based Coatings by Mineral Selection, Sami-Seppo Ovaska, Katriina Mielonen, Johanna Lyytikäinen, and Kaj Backfolk, Lappeenranta University of Technology (Finland)

Visualization Analysis on Melting Deformation of Toner Particles in a Fusing Nip (Focal), Kenichi Hamada, Minoru Ohshima, Toru Ogawa, and Yoshihisa Kitano, Fuji Xerox Co., Ltd. (Japan)

TRACK 2

WORKFLOW FOR DIGITAL PRINTING

10:10 – 16:55

3D Visualization of Out-of-Gamut in Graphic Communication, Meiqi Lin, Qilu University of Technology (China)

Using IIO Structure to Enable Additional Workflows, Margaret Sturgill, Steven Simske, and Marie Vans, HP Inc. (USA)

From 8-Bit to 4K: A Leading Computational Imaging Algorithm for Digital Printing Technology (Focal), Chunhui Kuo, Eastman Kodak Company (USA)

Photogrammetry-based 3D Digitization Method for Oil Paintings, Chen Chen and Guangxue Chen, South China University of Technology (China)

OPENING KEYNOTE

Keynote: Evolution Theory of Ink Jet Technologies—Progress by Component or Architectural Knowledge

Masahiko Fujii, Fuji Xerox Co., Ltd. (Japan)

Ink jet technology has extended its market by upgrading functions and improving performances of a few key components (printhead, ink, and media) under simple marking processes for years. However, this trend has saturated in the personal market and the activation of markets has dulled. In this situation, two directions for ink jet technology progress have become obvious. One is expansion of ink jet to various applications such as digital fabrications utilizing a simple process and the other means challenges (to commercial printing market) against performance limitations derived from imaging process achieved only by the interaction between ink and media.

Differences of technical approaches in each direction also exist. Progress of elemental technology (key components) has been noticeable in extending possibilities. Challenge against limitations has been dazzling in system integration or peripheral technologies progress. The former evolution (concentrating functions progress) can be called incremental innovation and needs component knowledge to improve component performances. The later (sharing functions progress) demands architectural knowledge to test the optimum combination of components (dominant design) maximizing systems performance and is called as architectural innovation.

Generically, venture companies or small start-ups play a role in pushing architectural innovation because they are free from resource allocation mechanism or organizational forms of incremental innovation. But in the current commercial printing market, many big names have introduced printers with different component combinations and the dominant design has not yet been fixed. The shift from incremental innovation to architectural innovation also has occurred in additive manufacturing.

STATE-OF-THE-ART KEYNOTE

From Prototyping to Production: Rethinking Materials for Additive Manufacturing

Jason Rolland, Carbon (USA)

Additive manufacturing processes use time-consuming, stepwise layer-by-layer approaches for part fabrication. We demonstrate the continuous production of monolithic polymeric parts with feature resolution below 100 micrometers. Digital Light Synthesis (DLS) is achieved with an oxygen-permeable window below the ultraviolet image projection plane, which creates a “dead zone” (persistent liquid interface) where photopolymerization is inhibited between the window and the polymerizing part. We define critical control parameters and show that complex solid parts can be drawn out of the resin at rates 25-100X that of conventional technologies.

Additionally, we show that DLS enables a wide range of new and commercially relevant materials. These include: tough, resilient elastomers; rigid, impact-resistant plastics with excellent abrasion resistance; flexible materials capable of producing living hinges; high-temperature cyanate ester resins; and other novel polymer formulations. These materials open possibilities across a range of industries including automotive, footwear, medical, aerospace, wearables, and many others.

The combination of rapid, layerless printing with high-performance engineering polymers having a range of mechanical properties represents a major step toward fulfilling the promise of additive manufacturing.

HDR Image Reproduction based on ICAM06 and Bilateral Filtering (Interactive), Xiaozhou Li, Yang Zhao, and Jingqiang Jia, Qilu University of Technology (China)

A CUPS-based Print Control and Management Solution for UNIX-Like Operating Systems

(Interactive), Wenjing Song, Bo Wan, Weiwen Cai, and Min Pang, Xidian University (China)

Embedding a Standard within a Standard Using Mobile Progressive Barcodes, Marie Vans, Matthew Gaubatz, and Steven Simske, HP Inc. (USA)

Optimizing Fuser Power Control for ISO/IEC Compliance (Interactive), Benjamin Johnson and Paul Etter, Lexmark International Inc. (USA)

Structure Design and Synthesis of Waterborne Resins and Their Application in Processless Computer-to-Plate (Interactive), Shuyun Zhou, Technical Institute of Physics and Chemistry (China)

Study on Synthesis and Properties of Photo Acid Generator and Water-Soluble Resin Used in Cationic Photo-Polymerization System

(Interactive), Shizhuo Xiao, Technical Institute of Physics and Chemistry (China)

Fatigue Life Prediction of SUS Sleeve in Laser-Printer Fuser (Interactive), Sun Ho Park, S-Printing Solution Co., Ltd. (South Korea)

TECHNOLOGY NETWORKING EVENT

Deepdive with Jason Rolland—From Diagnostics for All to Carbon: A Personal Technical Journey
16:55 – 18:00

Tuesday November 7, 2017

ALL TRACKS

TUESDAY KEYNOTE AND AWARDS

9:00 – 10:00

Reactive Inkjet Printing in Nanoparticle Manufacturing and Device Applications, Ghassan Jabbour, University of Ottawa (Canada)

2017 EXHIBITION

10:00 – 17:30

See inside cover for current list of exhibitors.

TECHNOLOGY NETWORKING EVENT

Security Printing

15:15 – 16:15

INTERACTIVE PAPER SESSION/ DEMONSTRATIONS/EXHIBITS/HAPPY HOUR

16:15 – 17:30

TRACK 1

INKS, TONERS, AND SUBSTRATES

10:05 – 11:00

JIST-FIRST: Enhancing the Color Performance of Pigment Inkjet Printing of Cotton Fabric by Electrostatic Attraction Force, Kuanjun Fang, Tianjin Polytechnic University (China)

Water based Green Lithography (Interactive), Haihua Zhou and Yanlin Song, Institute of Chemistry, Chinese Academy of Sciences (China)

A Study on the Factors Affecting Ink-Substrate Interactions in Maplitho Papers (Interactive), Mahuya Biswas^{1,2}, Shankhya Debnath³, Munmun Dey¹, Srabana Kundu¹, and Abhijit Bandyopadhyay²; ¹DIC India Limited and ²Calcutta University (India)

Growth and Characterization of Nd-Doped Niobate Laser Crystals (Interactive), Shoujun Ding^{1,2}, Qingli Zhang¹, Wenpeng Liu¹, Jianqiao Luo¹, and Dunlu Sun¹; ¹Anhui Institute of Optics and Fine Mechanics, CAS and ²University of Science and Technology of China (China)

SECURITY PRINTING

11:30 – 15:15

Visible to Infrared Converting CaCuSi₄O₁₀ Security Ink (Focal), Jacob Petersen¹, Jeevan Meruga², Aravind Baride³, William Cross^{1,2}, P. May³, and Jon Kellar^{1,2}; ¹South Dakota School of Mines and Technology, ²Center for Security Printing and Anti-Counterfeiting Technology, and ³University of South Dakota (USA)

Inkjet and 3D Security Printing, Vitaly Talyansky, Stardust Materials, LLC (USA)

The Expected Lifetime for Printed Security Cards, Mark Mizen, HID Global (USA)

Development of a Mechano-Responsive Ink for Security Printing, Rohit Dulal¹, Delaney Clouse², Cassandra Degen¹, Jeevan Meruga¹, and Jon

TUESDAY KEYNOTE

Reactive Inkjet Printing in Nanoparticle Manufacturing and Device Applications

Ghassan Jabbour, University of Ottawa (Canada)

Reactive inkjet printing (RIJ) is becoming a versatile and promising technique in materials synthesis and device engineering. In this regard, Ghassan Jabbour will discuss the application of RIJ, for the first time, in modifying the sheet resistivity of conducting polymer layers, and in combinatorial mapping of such property. In addition, we will introduce our latest accomplishments in this field, including the self-assembly of nanomaterials, quantum dots, and conductive textile.

Kellar¹; ¹South Dakota School of Mines and Technology and ²The University of Southern Mississippi (USA)

Cupric Oxide Loaded Porous-Wall Hollow Glass Microspheres for Printable Security Features,

Forest Thompson¹, Abigail McBride¹, George Wicks², and Grant Crawford¹; ¹South Dakota School of Mines and Technology and ²Applied Research Center, Inc. (USA)

TECHNOLOGY NETWORKING EVENT

Security Printing

15:15 – 16:15

INTERACTIVE PAPER SESSION/ DEMONSTRATIONS/EXHIBITS/HAPPY HOUR

16:15 – 17:30

TRACK 2

PRINTED ELECTRONICS

10:05 – 16:25

Conductivity and Microstructure of Inkjet Printed Nanoparticle Silver Layers Processed with Intense Pulsed Light (IPL) Sintering on Various Polymeric Substrates, Dana Mitra¹ and Reinhard Baumann^{1,2}; ¹Technische Universität Chemnitz and ²Fraunhofer Institute for Electronic Nano Systems ENAS (Germany)

Electrically Conductive Polymer Composite Dispensing Process for EMI Shielding Structure, Oh Hyun Baek, Keon Kuk, and Eun-Bong Han, Samsung Electronics (South Korea)

Green Printing Technology for Manufacturing Functional Devices, Yanlin Song, Institute of Chemistry, Chinese Academy of Sciences (China)

Development History and Current Achievements of Printed Primary Batteries, Andreas Willert¹ and Reinhard Baumann^{1,2}; ¹Fraunhofer Institute for Electronic Nano Systems ENAS and ²Chemnitz University of Technology (Germany)

New Digital Printing Process for Manufacturing of Conductive Patterns in Flexible Electronics, Yu Liu, Jiangnan University (China)

INVITATION TO SHOWCASE YOUR SOFTWARE AND/OR HARDWARE

Printing for Fabrication Demonstration Session

Technology demonstrations by industry and academic participants showcase the latest developments driving next generation printing products.

This popular event provides authors with an additional opportunity to showcase their work. Authors are offered a complimentary half-table on which to display hardware and/or software related to papers presented at the conference (assuming they register by the Demo Session deadline). Non-authors may take advantage of this opportunity for a small fee that covers expenses.

Indicate your interest in demonstrating when you register for the conference.

Effect of the Nano-Cellulose on the Preparation and the Conductivity Properties of the Polyaniline,

Fuqiang Chu, Qilu University of Technology (China)

Rewritable Paper Sheets having Kapok Fibers

Containing Chromic Materials, Maeda Shuichi, Shuichi Kiyama, and Shinichi Yoshinari, Tokai University (Japan)

Evaluation of Inkjet Printed Electronic Devices by Investigating the Manufacturing Yield and Performance Tolerance for the Application in Flexible Electronics,

Kalyan Mitra¹, Christian Zeiner¹, Enrico Sowade¹, Eloi Ramon², Carme Martinez-Domingo², Henrique Gomes³, Stefanie Kreissl⁴, Christine Boeffel⁴, and Reinhard Baumann^{1,5}; ¹Chemnitz University of Technology (Germany); ²Institut de Microelectronica de Barcelona (Spain); ³Universidade do Algarve (Portugal); ⁴Fraunhofer Institute for Applied Polymer Research (IAP) (Germany); and ⁵Fraunhofer Institute for Electronic Nanosystems (ENAS) (Germany)

Novel Organic Multi-Color Electrochromic Device for E-Paper Application,

Norihisa Kobayashi, Masahiro Yukikawa, Zhuang Liang, and Kazuki Nakamura, Chiba University (Japan)

Dynamic Analysis of Organic Conductive Ink Jet Printing (Interactive),

Ting Chen¹, Wei Li², and Guangxue Chen¹; ¹South China University of Technology and ²Hunan University of Technology (China)

Paper-based 3D Printing Industrialization for Customized Wine Package Applications (Interactive),

Jiangping Yuan^{1,2}, Xingyan Yan², Xiaochun Wang², and Guangxue Chen²; ¹Yuncheng University and ²South China University of Technology (China)

INTERACTIVE PAPER SESSION/ DEMONSTRATIONS/EXHIBITS/HAPPY HOUR

16:25 – 17:30

Wednesday November 08, 2017

ALL TRACKS (INCLUDING TDPF)

WEDNESDAY KEYNOTE AND AWARDS

9:00 – 10:00

Attractive and Innovative Solutions for Highly Qualified 3D Printing Process Development in

Next Generation, Takashi Fukue, Iwate University (Japan)

2017 EXHIBITION

10:00 – 16:20

See inside cover for current list of exhibitors.

CONFERENCE RECEPTION

19:00 – 22:00

Wynkoop Brewing Company

TRACK 1

INK JET PROCESSES

10:05 – 16:55

Sponsored by Xaar.



Improved Water-Resistance Test Methods Utilizing a Multispectral Imaging System to Quantify Black and Color Ink Bleeding for Plain Paper Office and Legal Documents Printed with Pigment- and Dye-based Inkjet Inks,

Henry Wilhelm¹, Richard Adams², and Charles Wilhelm¹; ¹Wilhelm Imaging Research, Inc. (USA) and ²Ryerson University (Canada)

An Electrohydrodynamic (EHD) Jet Printing

Method for Increasing Printing Speed, Thanh-Huy Phung, Soobin Oh, Seora Kim, and Kye-Si Kwon, Soonchunhyang University (South Korea)

Study on Printing Quality Improvement for Continuous-Type Inkjet Printer Using Multi-Objective Genetic Algorithm and Ink Droplet Trajectory Simulation,

Koma Sato¹, Eiji Ishii¹, Nobuhiro Harada², and Tsuneaki Takagishi²; ¹Hitachi, Ltd. and ²Hitachi Industrial Equipment Systems Co., Ltd. (Japan)

AcuDrp™ Technology - Implementation and Application of Per-Nozzle Trimming,

Michael Hook and Stephen Jeapes, Xaar (UK)

A New Standard for Thin Film Actuators with Sol-Gel PZT,

Peter Mardilovich, Charalampos Fragkiadakis, Song Won Ko, and Mani Sivaramakrishnan, Xaar (UK)

Newly Developed UV-Curable Inkjet Technology for Forming High Quality Image with High Productivity (Focal),

Toshiyuki Takabayashi, Konica Minolta, Inc. (Japan)

Software Alignable Printheads, Jesus Garcia Maza and Jason Remnant, Xaar PLC (UK)

JIST-FIRST: Real-Time Jet Failure Detection of Inkjet Heads with 1024 Ejectors, Kye-Si Kwon, Soonchunhyang University (South Korea)

TECHNOLOGY NETWORKING EVENT: INTELLECTUAL PROPERTY

16:20 – 17:35

Intellectual Property (IP) Rights of Inventors and Employers with extended discussion, Scott

Slomowitz, Caesar Rivise, PC (USA)

10 Things you Don't Need to Know About Inkjet

Patents followed by discussion, Michael Willis,
Pivotal Resources Ltd. (UK)

TRACK 2

3D AND ADDITIVE PRINTING

10:05 – 15:40

Inkjet Printing Strategies for High Laydown and Its Potential for 3D-Applications, Wolfgang Voit,
Xaarjet Limited filial (Sweden)

Development of Polyester Composite as Water-Soluble Support Material for 3D Printer, Tomoya

Tsuboi, Tadanori Yoshimura, Hiroki Sawada,
George Hirai, Akihiro Onoue, Akira Takenaka, and
Katsutoshi Aoki, Kao Corporation (Japan)

Four-Dimensional (4D) Printing and It's Applications (Focal), Yu Ju Wu, Appalachian State
University (USA)

High Temperature (500°C) Hotend for FDM 3D Printer, Hideo Taniguchi, Nobuhisa Ishida, and Jiro
Oi, HIT Research Corporation (USA)

Inkjet Printing of Microlenses: A Study on Post-Processing Parameters, Sophie Sauva, Fraunhofer
IOF (Germany)

Function of Fumed Metal Oxides for 3D Printing

Materials, Yuki Amano, Evonik Corporation (USA)
2.5-Dimensional Inkjet Fabrication Using UV Curable Ink, Manabu Arita, Mie Yoshino, Toshihito
Kamei, and Shinichi Hatanaka, Ricoh Company,
Ltd. (Japan)

Density Matrix Generation for 3D Printing, Robert
Ulichney and Andrew Fitzhugh, HP Labs, HP Inc. (USA)

TECHNOLOGY NETWORKING EVENT

Review of State-the-Art of 3D Printing

16:55 – 17:45

INTERNATIONAL SYMPOSIUM ON TECHNOLOGIES FOR DIGITAL PHOTO FULFILLMENT 2017



PHOTO BOOK MARKET OVERVIEW

10:05 – 12:40

Expanding the US Photo Printing Market: The Shift from Analog to Digital Printing (Keynote), Don
Franz, Photo Imaging News (USA)

The Ever-Growing On-Site Photo Book Market,
Brigitte Peleman-Vantieghem, Peleman Industries,
Inc. (USA)

High Variety of Photo Books as Result of a Wide Choice of Materials and Production Methods,
Matthias Hausmann, CEWE Stiftung & Co. KGaA
(Germany)

WEDNESDAY KEYNOTE

Attractive and Innovative Solutions for Highly Qualified 3D Printing Process Development in Next Generation,

Takashi Fukue, Iwate University (Japan)

The dawn of 3D printing technologies has ended and it is entering the development phase. Two years ago, due to the slowness of 3D printers, it was understood that much time would be needed to apply 3D printers to production facilities. Now, many types of 3D printers have already been prepared on designer's desk. Designers are now using 3D printers to make product prototypes. 3D printers are already a useful tool for small-lot and custom-made production, such as in the medical device industry. 3D printers have also established their status as a popular industrial technology.

Soon 3D printer use will be expanded beyond prototype development and customization to become a mass production tool in an assembly line. To effectively use 3D printers as part of this process, advanced printing process controls must be developed to inhibit the occurrence of

variations. While in prototypes, individual differences are less important, producing something that is globally competitive requires decreased development and manufacturing costs and an improvement in the quality of 3D printing.

Against this background, this keynote proposes considerations that should be addressed in the next generation of 3D printing processes from the viewpoint of building new products using 3D printers in the assembly line. An important key factor in improving the quality of 3D printing is the effects of heat on the printing process. For example, in the case of fused deposition modeling, the printing quality of the first layer has a dominant effect on the printing accuracy of the whole product. However, due to the occurrence of a distribution of a contraction in a solidification process by temperature distribution, curling can happen. Similar thermal problems are also caused in selective laser sintering printers and binder jetting printers. In this lecture, we investigate our understanding of "invisible" thermal problems in the 3D printing processes and how to obtain "next generation attractive quality".

SPECIAL EVENT: CONFERENCE RECEPTION

Join colleagues for an evening of learning and connecting at Wynkoop Brewing Company, Colorado's first Brew Pub, 1634 18th St.

Wednesday, November 8th
19:00 – 22:00

MATERIALS AND METHODS FOR LONG-LASTING HARDCOPY AND GIFTS

10:05 – 17:30

Image Permanence of Fujifilm Original

Photopaper, Evert Groen, FUJIFILM Europe BV
(the Netherlands)

Kodak Professional KC2 Software and Kodak Professional Endura Premier Paper: The Technology Combination to Make Photo Gifting Easy and

Long Lasting, Patrick Webber, Kodak Alaris (USA)

Comparison of L-37 Filtered Xenon Arc Illumination and Glass-Filtered Cool White Fluorescent Illumination in the Accelerated Light Fading and Staining Behavior of Digitally-Printed Color

Photographs, Henry Wilhelm, Wilhelm Imaging Research, Inc. (USA)

Photo Book Construction and Image Preservation, Mark Mizen, All About Images (USA)

Materials of Construction Test: Insuring the Use of Safe Materials in Photo Books, Joseph LaBarca, Pixel Preservation International, and Stuart Gordon, independent (USA)

Thursday November 9, 2017

ALL TRACKS

CLOSING KEYNOTE AND REMARKS

9:00 – 10:10

From Gutenberg Bible to 4D Printing, Shlomo Magdassi, The Hebrew University of Jerusalem (Israel)

TECHNOLOGY NETWORKING EVENT

3D Printing and Pharmaceuticals

11:50 – 13:15

TECHNOLOGY NETWORKING EVENT

Late Breaking News

11:55 – 13:15

TECHNOLOGY TOURS

14:00 – 17:30

To be announced on the website in late September.

TRACK 1

INDUSTRIAL DIGITAL PRINTING

10:05 – 11:55

Prediction Technology of Paper Curl in Fusing

THURSDAY KEYNOTE

From Gutenberg Bible to 4D Printing

Shlomo Magdassi, The Hebrew University of Jerusalem (Israel)

Functional printing brings additional performance of printed patterns, beyond graphic output. Our research is focused on synthesis and formulations of nanoparticles and inks, and their utilization in printed devices and responsive and 3D objects. The formation and application of inks composed of nanoparticles and polymerizable materials in smart windows and electrical circuits will be reported. These inks address major challenges in fabrication of flexible and 3D electronics devices, in which the printing should be performed at sufficiently low temperatures that will not damage the polymeric substrates. New approaches for formation of porous 3D objects and conductive electrodes will be also described, based on using new UV curable oil-in-water emulsion inks, and for rapid 3D and 4D printing in water by using new nanoparticles of photoinitiators. Utilization of 3D and 4D printing technologies for fabrication of objects composed of shape memory polymers, elastomers and hydrogels will be demonstrated, for applications such as soft robotics, delivery systems, responsive connectors, dynamic jewelry and medical devices.

System, Masato Ando, Tomoyuki Ito, and Takashi Ogino, Fuji Xerox Co., Ltd. (Japan)

Development of Method for Evaluating Uniformity based on Human Vision Property, Hideyuki Kihara and Makoto Hino, Ricoh Company Ltd. (Japan)

Where Next for Industrial Inkjet Printing? (Focal), Peter Brown, TTP (UK)

TECHNOLOGY NETWORKING EVENT

Late Breaking News

11:55 – 13:15

TRACK 2

SPECIAL TOPICS

10:05 – 11:50

Design and Application of a 3D Printing Digital Workflow, Hao Yin and Guangxue Chen, South China University of Technology (China)

3D Fakes: Chemical Fingerprinting in Additive Manufacturing, from Pharmaceuticals to Engines, Sharon Flank, InfraTrac (USA)

Towards Printing of Medicine in 2D and 3D, Maren Preis, Åbo Akademi University (Finland)

TECHNOLOGY NETWORKING EVENT

3D Printing and Pharmaceuticals

11:50 – 13:15

Venue and Special Events

The Venue

Denver, Colorado

Printing for Fabrication 2017 takes place in downtown Denver, Colorado—The Mile High City and state capitol. The conference will be held at the Grand Hyatt Denver hotel, located one block from the 16th Street Mall, a tree-lined, shopping- and restaurant-filled, pedestrian-only promenade that runs through the center of downtown. A free shuttle runs up and down the mile-long Mall.

With its stunning backdrop of the Rocky Mountains, Denver has a rich history; “cowboy and indian” tales, the American gold rush, and building the transcontinental railroad are part of the lore and fabric of its past. An in-depth look at this history can be found at the Denver Art Museum housing one of the largest collections of Native American art works in the world. Other museums include the “unsinkable” Molly Brown House; the quirky, but wonderful, Kirkland Museum; the Denver Museum of Science and Nature; and Wings Over the Rockies Air and Space Museum. The spectacular Rocky Mountain National Park and numerous ski areas are within a two-hour drive.

Denver is known for its more than 200 locally brewed beers—and the world’s largest beer festival. Regional specialties to enjoy with the beer are Southwestern dishes, buffalo, and Colorado lamb.

Many corporations call Denver and its surroundings home such as Ball Aerospace & Technologies Corp., Lockheed Martin, Raytheon, IBM, and Sun Microsystems; others such as HP Inc. and Lexmark have campuses here.

2017 International Symposium on Technologies in Digital Photo Fulfillment

Wednesday, November 8th



The digital photographic ecosystem—image capture, processing/organizing images, and soft/hard copy output of images—is the overall focus of this collocated conference. Now in its eighth year, TDPF features talks on materials and technologies that enable, encourage, and help people preserve their stories.

TDPF offers a unique opportunity for product engineers, researchers, photographers, and printers to meet and discuss the advances, synergies, and future directions of creating, printing, sharing, displaying, and archiving consumer and professional photos and photo-related products.



Special Events

TECHNOLOGY NETWORKING EVENTS

Monday 16:55 – 18:00

Deepdive with Jason Rolland—From Diagnostics for All to Carbon: A Personal Technical Journey

Tuesday 15:15 – 16:15

Security Printing

Tuesday 16:15 – 17:30

Interactive Paper Session/Demonstrations/Exhibits/Happy Hour

Wednesday 16:20 – 17:35

Intellectual Property

Wednesday 16:55 – 17:45

Review of State-of-the-Art of 3D Printing

Thursday 11:50 – 13:15

3D Printing and Pharmaceuticals

Thursday 11:55 – 13:15

Late Breaking News

Thursday 14:00 – 17:30

Technology Tours

2017 EXHIBITION

Tuesday 10:00 – 17:30 / Wednesday 10:00 – 16:20

SOCIAL EVENTS

Sunday 17:45 – 19:00

Welcome Reception

Monday starting at 19:00

Student/Young Professional Get Together

Wednesday 19:00 – 22:00

Conference Reception

Short Course Program

The conference Short Course Program offers a wide range of introductory and advanced classes in the fields of digital printing and fabrication given by internationally recognized experts. Attendees receive e-copies of the instructor's notes with course registration. We encourage you to sign up for short courses by the early registration deadline to ensure that a course runs.

Please Note: IS&T reserves the right to cancel short courses in the event of insufficient advance registration. Please indicate your interest early.

Sunday November 5, 2017

8:00 – 10:00

SC01: Intelligent Packaging — NEW

When: Sunday 8:00 – 10:00 am (2 hours)

Instructor: George Gibson, Xerox Corporation

Track: Digital Printing Technology and Applications

Level: Overview

Intelligent packaging is a rapidly growing area of innovation. It is used to build the brand relationship with the consumer, provide safety and security, prolong product life, and give aid to consumers among other things. Many approaches employ electronics, including printed electronics, as well as other ways of embedding intelligence. Intelligent packages are even used as the on-ramp for the internet of things. This course discusses the entire domain including “what” is being done (e.g. medicine packaging that helps people take their meds), “how” these things are accomplished, and the market sizing and outlook for the domain.

Benefits

This course enables an attendee to:

- Learn the market structure, size, and growth outlook for intelligent packaging.
- Understand the taxonomy of intelligent packaging and see examples of each.
- Discover how intelligent packaging can make the package a part of the product value proposition.
- Learn the fundamental technologies that are being used to create intelligent packages.
- Explore and analyze the most successful examples of intelligent packaging.
- Connect the technologies and designs of intelligent packages to the customer benefit they are trying to create.

Intended Audience: scientists, engineers, and managers interested in exploiting intelligent packaging to grow their business and create new and highly-innovative packaging offerings.

George Gibson is the director of technology scouting for Xerox Corporation. He has worked at Xerox for 24 years holding varying roles in research, development, and tech-

Short Course Monitors are needed to help with classes. Monitors take courses for free. Interested? Contact Karen Francisco at kfrancisco@imaging.org for more information. Priority is given to students.

nology management. Gibson did his undergraduate and graduate work in chemistry at Binghamton University and holds an MBA from the University of Rochester's Simon Graduate School of Business. He is inventor or co-inventor of 64 patents and has published 20 papers in the technical and trade literature. He serves on the Board of Trustees of the Rochester Museum and Science Center.

SC02: Let's Make an Inkjet Ink: Stabilizing Pigments and Dyes with Dispersants for Water-based (Textile) Inkjet Ink Applications — NEW

When: Sunday 8:00 – 10:00 am (2 hours)

Instructor: Christian Maus, Evonik Corporation

Track: Inkjet Materials

Level: Introduction

This course focuses on the preparation of inkjet ink concentrates, starting with the pigment or dye and ending with the dispersant. It employs a practical approach to help students better understand the theory of particle stabilization, which in turn explains the role of dispersants in an ink.

The course content provides a clear explanation of a complex and intricate topic, while also diving into the most exciting inkjet sector in the current market: textile inkjet. It looks at the textile inkjet market, explores the key challenges facing formulators when working with dyes instead of pigments, and discusses how grinding equipment plays a vital role in the preparation of concentrates.

Benefits

This course enables an attendee to:

- Understand the basic chemistry and theory of stabilizing particles within a formulation.
- Determine the role and effect of a dispersant on an ink.
- Gain general understanding on the composition of an ink and how it is prepared.
- Gather information on the potential of textile inkjet, but also its hurdles.
- Provide first-hand experience, leaving the attendee motivated with greater inkjet knowledge.

Intended Audience: engineers, scientists, students, technical sales, and managers who want to refresh or gain knowledge in inks and additives used in inkjet inks, especially for the textile market.

Christian Maus is currently an ink market segment manager (focus on inkjet inks) for Evonik. He received his PhD at the University of Bonn (Germany) where he studied chemistry. Upon graduation, Maus launched his career in the coating and surface technology industry where he has resided for more than ten years. He also has a personal passion for scientific-related themes, as he and his colleagues recently achieved the first-place prize in a call-for-papers by the NPIRI Association.

SC03: Fluid Dynamics and Acoustics of Piezo InkJet Printing

When: Sunday 8:00 – 10:00 am (2 hours)

Instructor: J. Frits Dijkman, University of Twente

Track: Inkjet Technology

Level: Advanced/Specialist

Inkjet printing is all about depositing on demand droplets with well-defined volume and speed on a precisely given location on a substrate.

A piezo driven print head is an ensemble of closely-packed and highly-integrated micro channels, each channel partly covered with a piezo-electric actuator. Each channel acts as an acoustic cavity, of which the fluid dynamical and acoustical characteristics in the time and frequency domain determine the droplet generating characteristics of the print head.

The aim of this course is to couple the characteristics of droplet formation and landing to the acoustics of the fluidics of the print head behind the nozzle all the way up into the ink supply. Special attention is paid to non-linear effects related to the meniscus motion in the nozzle, inertia effects due to partly filling of the nozzle and droplet formation, and the jetting of viscoelastic inks.

Benefits

This course enables an attendee to:

- Understand the interactions between the acoustics of the fluidics of the print head and the characteristics of piezo inkjet droplet formation, landing, spreading, and permeation.

Intended Audience: engineers and scientists interested in piezo driven print heads, students in the area of print head physics; engineers and scientists working with biomedical applications of inkjet technology.

Frits Dijkman is emeritus professor in the field of innovative biomedical applications of inkjet technology at the University of Twente, the Netherlands. He has worked

with Philips Research for more than 30 years and his main area of interest has been inkjet technology for consumer and non-consumer applications, such as PolyLED display manufacturing and the printing of biomolecules.

SC04: Toner Materials—Engineering and Print Relationships

When: Sunday 8:00 – 10:00 am (2 hours)

Instructor: Dinesh Tyagi, Lexmark International, Inc.

Track: Toner/EP Technology

Level: Introduction

Toners play a very critical role in establishing the value of an electrophotographic print. Since toner comes in physical contact with all critical steps of an electrophotographic cycle, its properties not only affect the final printed document but also the life time of components used in other sub-systems. Thus, it is not a surprise that the composition of toner is often determined by the requirements of the finished print, as well as the technology selected in other steps of electrophotography. A toner polymers selection is also dictated by the toner manufacturing process used to produce them. This course describes how toner polymers are selected for both Melt Pulverized Toners (MPT) and Chemically Prepared Toners (CPT). Effect of toner additives, such as pigments, surface treatment, etc. on fusing and other toner properties are also explained. The underlying polymer architecture and viscoelasticity concepts that govern toner binders are described and briefly discussed. Polymer models described in this course are equally applicable to polymeric substances used in other parts of the fuser, such as, elastomers and release fluids. Since the toner composition and fusing performance are intricately intertwined, the course describes the influence of toner and the fusing technology employed on the print's physical and image permanence. During the course, the selection process for most toner components is described including how these requirements are being continuously guided by environmental, governmental, and health regulations. The course includes a discussion of new developments taking place in toners, such as low energy requirements, "green" toners that comprise bio-resins, and toner/print recyclability.

Benefits

This course enables attendees to:

- Gain insight into toner component selection and their manufacturing processes, along with the impact of each on toner properties, image fixing, and print physicals of a print.
- Understand the polymeric concepts that influence fusing and various considerations necessary in toner formulations.
- Comprehend viscoelastic behavior of toners

SHORT COURSES					
DIGITAL PRINTING TECHNOLOGY & APPLICATIONS		INKJET MATERIALS	INKJET TECHNOLOGY	TONER/EP TECHNOLOGY	3D/DIGITAL FABRICATION TECHNOLOGY
TUES 10:30-12:30 8:00 - 10:00 10:15 - 12:15 13:30 - 15:30 15:45 - 17:45	NEW SC01 Intelligent Packaging	NEW SC02 Let's Make an Inkjet Ink . . .	SC03 Fluid Dynamics and Acoustics of Piezo InkJet Printing	SC04 Toner Materials — Engineering and Print Relationships	SC05 Intro. to Digital Fabrication: Methods, Materials, and Apps
	SC06 Paper Recycling and Ecolabels, Deinking, and Deinkability	SC07 Inkjet Pigment and Dispersion Technology for Industrial Applications	SC08 Insight into New InkJet Technological Developments from Patent Literature	SC09 Liquid Toner Printing: Technology and Applications	NEW SC10 Overview on 2D and 3D Printing
	SC11 Digital Packaging	Updated & Expanded SC12 Colorants for Inkjet Applications	NEW SC13 Industrial Inkjet: Applications, Challenges, and Considerations	SC14 Fusing Physics and Technologies	NEW SC15 Advanced Materials for Printed Electronics
	SC16 Role of Inkjet in Commercial and Industrial Printing Applications		SC17 Fabrication Materials & Processes of Inkjet Printheads		SC18 Surface Ink Interactions and Surface Characterization
					SC19 Introduction to 3D Printing of Metals

- and polymers; this knowledge can then be used to develop an understanding of gloss control and other image requirements.
- Understand toner components selection criteria and limitations imposed by toner manufacturing technologies.
 - Learn about advances in toners and new regulations from various agencies that may impact toner formulation.

Intended Audience: all individuals directly or indirectly involved in toner formulation development efforts, no matter the image requirements or limitations imposed by a toner manufacturing method. The course is particularly useful for engineers and scientists who wish to gain insight into controlling image permanence, gloss, and print physicals via toner component selection and design. A basic understanding of the electrophotographic process is assumed, although many underlying polymer concepts are described in the course.

Dinesh Tyagi received his PhD from Virginia Tech (1985) before joining Eastman Kodak Company as a research scientist where he specialized in the field of digital printing and polymer research. He was inducted into Kodak’s Distinguished Inventors Gallery in 1994. In 1999, he joined NexPress Solutions (later acquired back by Kodak). Tyagi recently joined Lexmark International where he continues to work in the area of toners and electrophotography as he has done through most of his professional career. He has been granted more than 300 patents worldwide. In 2011, he was awarded the Chester F. Carlson Award for his innovations and broad contributions to electrophotographic

toner technology. In 2014, Tyagi received the Robert F. Reed Technology Medal in recognition for his involvement in graphic communications industry.

SC05: An Introduction to Digital Fabrication: Methods, Materials, and Applications
When: Sunday 8:00 – 10:00 am (2 hours)
Instructor: James W. Stasiak, HP Inc
Track: 3D/Digital Fabrication Technology
Level: Introduction

During the past decade, there has been a remarkable convergence of two disparate technologies: digital printing of text/images and the fabrication of physical objects. This convergence—a blending of traditional printing methods, recent advances in materials science, and established manufacturing methods—has brought about the foundation of a new technology: digital fabrication.

Digital fabrication approaches are enabling new discoveries at the laboratory bench and providing new efficiencies and unprecedented product customization on the manufacturing floor. Digital fabrication methods—along with the development of “functional inks”—are making it possible to print complete electronic circuits, optical devices, mechanical structures, and even new biological materials.

The objective of this short course is to provide an introduction to the rapidly emerging science and technology of digital fabrication. It includes an up-to-date overview of the methods, materials, and processes that are reshaping manufacturing and

enabling new commercial applications in electronics, MEMS, and the life sciences. Finally, the class examines factors that are moving digital fabrication from a niche technology toward a new manufacturing paradigm.

Benefits

This course enables an attendee to:

- Develop an understanding of different digital fabrication methods and materials.
- List and compare different applications that range from printed electronics to the life sciences.
- Evaluate the technological issues and challenges of digital fabrication.
- Develop an understanding of the technology landscape, key players, and practitioners.
- Recognize the market opportunities addressed by this emerging technology

Intended Audience: this is a survey course for engineers, scientists, and technical marketing professionals working or interested in digital fabrication and printed electronics.

Jim Stasiak is a distinguished technologist in HP Inc.'s 3D printing operations center in Corvallis, Oregon. His current responsibilities are focused on leading the design and development of new printable materials, printing methods, processes, and applications. In a career spanning more than 30 years, he has made important contributions in the fields of condensed and soft matter physics, molecular electronics, nanotechnology, and inkjet-based digital fabrication. He is recognized as one of the pioneers who helped to transform digital printing technology from conventional applications to a new fabrication and manufacturing paradigm. In recognition for his contributions and leadership in a wide range of digital printing science and technology he was the recipient of the 2012 IS&T Johann Gutenberg Prize. Stasiak has been an active member of IS&T; was instrumental in organizing and launching the inaugural Digital Fabrication Conference (2005), serving as the conference's General Chair in 2005, 2006, and 2017, and as the Executive Program Chair in 2015 and 2016. He is a named inventor on more than 50 issued US patents and is the author of numerous scientific and technical articles and book chapters.

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10:15 – 12:15

SC06: Paper Recycling and Ecolabels, Deinking, and Deinkability

When: Sunday 10:15 – 12:15 (2 hours)

Instructor: Axel Fischer, INGEDE

Track: Digital Printing Technology and Applications

Level: Advanced/Specialist

The paper recycling process has been developed to unlock the “urban forest” of read newspapers and magazines as an inexpensive source for paper fibers. In the meantime, the recycling cycle has proven to be an essential part of the sustainable handling of resources and all members of the paper chain need to contribute to its continuance.

While digital printing has many environmental benefits, some print processes can lead to severe problems in paper recycling. This short course—supported by videos and other descriptive material—explains deinking in the industrial paper recycling process, how this is simulated and evaluated in the lab, and the challenges presented by different printed products. It also looks into the current and future European ecolabels and tax regulations for printed products that have gained importance.

Benefits

This course enables attendees to:

- Identify different printed products and printing technologies.
- Understand the environmental impact of printed products after leaving the shop.
- Understand the paper recycling process, and the importance and mechanism of deinking as a key of this process.
- Understand what European and US paper recycling have in common and how they differ.
- Learn about the different challenges of different printing processes.
- Comprehend the principles of deinking in the laboratory and how it relates to industrial practice.
- Learn how good deinkability can be achieved for different types of inks and printing processes.

Intended Audience: anyone interested in environmental issues and the impact of printed products, such as product development engineers, product stewards, environmental regulatory managers, sales engineers, field application engineers, ink developers, and others.

Axel Fischer studied chemistry at Munich Technical University. Since 1994, he is responsible for the public relations of INGEDE, the International Association of the Deinking Industry. He represents INGEDE at international events and working groups dealing with recyclability, digital printing technologies, and sustainability in the paper chain. He chairs the International Round Table on the Deinkability of Digital Prints

and consults printers in Europe on the recyclability of printed products. His teaching experience includes composing and presenting a science TV show for three years.

SC07: Inkjet Pigment and Dispersion Technology for Industrial Applications

When: Sunday 10:15 – 12:15 (2 hours)

Instructor: Alan Hudd, Alchemie Technology Ltd.

Track: Inkjet Materials

Level: Advanced/Specialist

This course describes the inkjet ink design process and requirements for successfully and reliably using a wide range of organic and inorganic pigments and of functional materials for inkjet printing. Methods of pigment stabilization are discussed. Details of dispersion technology and DVLO theory are used to highlight the importance of chemically stabilizing the surfaces of pigment particles. The Stokes-Einstein equation describing Brownian motion and Stokes law describing gravitational settling are used to understand the inkjet pigment ink requirement for flocculation and not agglomeration. Practical examples of processing pigment dispersions and the types of chemical dispersants used in inkjet formulations are also be presented.

Benefits

This course enables an attendee to:

- Understand the key challenges involved in preparing a pigment ink for use in inkjet printing.
- Appreciate DVLO theory.
- Consider the factors that influence long-term stability.

Intended Audience: material scientists, print professionals, and engineers interested in ink preparation.

Alan Hudd started an inkjet career with Domino before founding and managing Xennia Technology for 20 years. He is now cofounder and chairman of Alchemie Technology, which provides a wealth of industrial inkjet experience with a strong commercial awareness of the drivers and benefits of digital technology. Hudd has more than 30 years experience in the inkjet printing industry.

SC08: Insight into New InkJet Technological Developments from Patent Literature

When: Sunday 10:15 – 12:15 (2 hours)

Instructor: Mike Willis, Pivotal Resources

Track: Inkjet Technology

Level: Overview

There are around 300 new patent applications published each month that can give an insight into new inkjet-related developments. However search-ing for these patents, then filtering out the most in-

teresting ones is time consuming. Willis has been following inkjet patents since the 1980s and regularly monitoring patent applications since 1997. This course reviews some of the developments that have occurred over the past 2 years, in particular encompassing printhead and system technology such as ink supplies, nozzle maintenance, and drop detection. The assessment includes thermal inkjet, Landa Digital, and other transfer processes; challenges for high-speed printing such as misting, condensation, and missing nozzle detection and correction; and new applications such as flooring, footwear, and cosmetics.

Benefits

This course enables attendees to:

- Appreciate the value of the information contained within patent literature.
- Understand the limitations of patent research to avoid false interpretations.
- Understand and benchmark the state of the art in areas examined.
- Understand some of the issues being faced at the forefront of technology development.

Intended Audience: anyone interested in what inkjet developments are taking place that are not yet commercialized, such as scientists, engineers, and program and business development managers.

Mike Willis founded Pivotal Resources, a digital printing industry consultancy, in 1995. He has experience in a wide range of technologies and markets including drop-on-demand and continuous inkjet printing, electrophotographic technology, grayscale and color reproduction methods, and light sensitive materials. He was a founder member of Xaar—a spin-off company from Cambridge Consultants—and before that spent six years at Gestetner developing photocopiers. He graduated from the Polytechnic of Central London with an honours degree in photographic sciences.

SC09: Liquid Toner Printing: Technology and Applications

When: Sunday 10:15 – 12:15 (2 hours)

Instructor: George Gibson, Xerox Company

Track: Toner/EP Technology

Level: Introduction

Liquid toner technologies have long been held as versatile methods for imaging in a variety of applications. Known for high image quality—especially high-quality color—liquid toners are undergoing a renaissance. Important applications include not only document printing, but a number of industrial printing, display, and fabrication applications. In spite of demonstrated strength, liquid toners are employed in a minority of printing systems today.

HP, the dominant provider in the technology continues to innovate. In addition, new offerings from several large and sophisticated firms (Océ and Xeikon) have served to create new interest and energy into the technology. This course explores how the fundamental strengths of this technology have led to this current state and project where liquid toner will continue to be a vibrant force. The course covers the variety of liquid toner processes that are and have been used, including the strengths and limitations of each, and the major application areas in which these techniques are employed. The course includes an analysis of improvements of liquid toner systems found in recent technical literature and patents. Participants receive a copy of several chapters of Gibson's forthcoming book-length treatment of the technology.

Benefits

This course enables attendees to:

- Recognize the fundamentals of five generations of liquid toner device architectures.
- Appreciate the composition and preparation methods for liquid toners.
- Describe how the components of the toner and characteristics of the process drive print properties.
- Identify the major market applications where liquid toners are used today.
- Have a vision of where liquid toner technologies are fundamentally advantaged.
- Learn about recent innovations in liquid toner technology.

Intended Audience: technical professionals who want to become more knowledgeable about liquid toner printing technology.

See bio under SC01: Intelligent Packaging, page 9.

SC10: Overview on 2D and 3D Printing - NEW

When: Sunday 10:15 – 12:15 (2 hours)

Instructor: Kock-Yee Law, Research and Innovation Solutions

Track: 3D/Digital Fabrication Technology

Level: Overview

As modern manufacturing technology is evolving, the trend is to be digital, on demand, and green. Of course, cost and performance—along with risk and benefit—will always be factors when choosing a manufacturing technology. This short course starts with a brief overview of modern printing technology, such as screen, offset, electrophotography, inkjet, etc., and its migration to become a 2D additive manufacturing tool for modern electronic devices: displays, photovoltaics, flexible/wearable electronics, sensors, RFID, etc.

This is followed with a review of 3D printing technology, specifically stereolithography, selective sintering, selective melting, direct ink printing, hot melting printing, and inkjet printing, and so on. The technical challenge to implement these technologies is discussed.

Benefits

This course enables attendees to:

- Benefit by seeing the entire landscape of 2D and 3D printing technologies.
- Become familiar with the field and thereby apply this knowledge in the workplace.
- Broaden their knowledge base and lead to the possibly creation of cross-discipline research areas in the future, especially for scientists and engineers.

Intended Audience: scientists, engineers, managers, and executives from both industry and academia.

Kock-Yee Law previously of Xerox is now founder at Research and Innovative Solutions, a global provider of technical advices and education services to the high-tech industry. He has been a prolific researcher with more than 120 papers and 116 US Patents to his credit. He is on the editorial boards for Surface Innovations and Advances in Colloid and Interface Science. Law has been active in the NSTI Nanotech Conferences, organizing and chairing symposia and teaching short courses.

13:30 – 17:45

SC12: Colorants for Inkjet Applications — Updated and Expanded

When: Sunday 13:30 – 17:45 (4 hours)

Instructor: Alex Shakhnovich, Cabot Corporation

Track: Inkjet Materials

Level: Advanced/Specialist

This course has undergone major revisions and expanded to 4 hours. It is an introduction to available colorant choices for office and commercial inkjet printing focused around four areas:

- Color measurement
- Colorants for inkjet applications
- Dispersion methods
- Failure modes

The color measurement discussion addresses color space, color differences, and instrumentation. The review of colorants covers both dyes and pigments, with focus on yellows and magentas as the most challenging parts of the color gamut. Using colorant combinations to achieve specific color targets is addressed. Dispersion methods extensively covers three approaches: surface modification, polymer encapsulation, and synergist adsorption. Technologies of major participants are discussed based on published IP. Finally, colorants failure

modes in inks during storage and printing process is discussed.

Benefits

This course enables an attendee to:

- Intelligently choose the colorants for inkjet inks, understanding differences in properties, and tradeoffs.
- Understand what questions should be addressed when selecting colorant(s) for a new application or a retrofit.
- Become familiar with major technologies used for preparing inkjet dispersions.

Intended Audience: technical and commercial people who want to gain fundamental understanding of pigment chemistry and the selection of pigment dispersions for inkjet printing.

Alex Shakhnovich is a research fellow at Cabot Corporation in Billerica, Massachusetts, and an adjunct chemistry professor at UMass Lowell (Polymer Center of Excellence). He has more than 45 years of experience in chemistry and the application of colorants for plastics, textiles, and inkjet. His specific focus at Cabot is preparation of surface-treated organic pigments. He has 12 US and international patents in inkjet. Shakhnovich received his MS in chemistry from Moscow State University and PhD in heterocyclic chemistry from the Institute of Dyes and Intermediates (Moscow, Russia). Shakhnovich is a co-author of the chapter Pigments for InkJet Applications (World Scientific Publishing Co. ©2010). His research interests include synthesis, surface modification, and application of organic colorants.

13:30 – 15:30

SC11: Digital Packaging

When: Sunday 13:30 – 15:30 (2 hours)

Instructor: George Gibson, Xerox Company

Track: Digital Printing Technology and Applications

Level: Overview

The role of the package is becoming increasingly complex and valuable. Packages are no longer just “the-thing-you-put-the-thing-in” but are becoming an active part in the pre- and post-sale experience. Packaging has been shown to play a significant role in improving consumer experience, establishing and protecting brand image, and product protection. Fulfilling these roles has led to the demand for new package functionality with some packages even beginning to show up as citizens in the internet of things (some even employing printed electronic componentry). Packages are becoming part of the overall customer value creation ecosystem. Digital packaging particularly is enabling brand owners to build stronger relationships with their customers, increasing satisfaction,

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and indeed loyalty from increasingly demanding shoppers.

The benefits of digital printing and fabrication techniques include the ability to economically produce short runs, targeted versioning, and even personalization using simplified workflows and in record time—all with a superior sustainability profile. Further, the integration with (for instance) the previously cited printed electronics allows entre into packaging with entirely novel functionality.

Packaging is an incredibly diverse domain encompassing metal and glass containers, corrugated and folding cartons, and flexible packaging including labels on a wide variety of substrates. Selecting the best digital technique requires a detailed understanding of the printing, the substrates, and the end use requirements. Examining the available digital techniques and the application requirements, we examine a number of successful implementations and derive heuristics to guide applications. We explore where additional technological improvements will have the greatest leverage.

Benefits

- Understand the changing role and requirements placed on packaging in this rapidly changing domain.
- Understand the forces driving adoption of digital print in various package printing applications including the provision of functionality inaccessible to conventional approaches and how these can enable market growth.
- Understand the applications and requirements for package printing in label, folding carton, corrugated packaging, and flexible packaging.
- Map the technology characteristic onto the market requirements identifying the relative strengths, weaknesses, opportunities, and threats of each technology in the context of packaging markets.

Intended Audience: technical professionals who want to become more knowledgeable about how digital printing is likely to fit into the package printing markets.

See bio under SC01: Intelligent Packaging, page 9.

SC13: Industrial Inkjet: Applications, Challenges, and Considerations — NEW

When: Sunday 13:30 – 15:30 (2 hours)

Instructor: Rich Baker, Integrity Integration

Track: Inkjet Technology

Level: Overview

Inkjet is finding increasing utility in industrial product manufacturing. The breadth and scope of these applications are wide, ranging from product decoration to product functionalization; additive to subtractive manufacturing; and flat items to direct to shape contour printing to 3D build processes. The applications may vary, but the general challenges and considerations to successfully assess, develop, and implement inkjet processes are universal. This course helps guide the attendees through the questions: What is inkjet? What chemistries can go through a printhead? Is inkjet right for my application? What are the development and design considerations? How to get going? Plus showcase a number of current and future applications of inkjet used in manufacturing.

Benefits

This course enables an attendee to:

- Understand inkjet technologies and limitations.
- Understand the chemistries/potential chemistries available.
- See the direction and challenges of using inkjet in industrial applications.
- Understand the potential strategic advantage of “Digital Manufacturing”.

Intended Audience: those considering using inkjet in a manufacturing process (engineers, scientist, marketing, business development), as well as those generally interested in understanding the scope and strategic potential of inkjet in non-traditional applications.

Rich Baker received a PhD in chemistry at the University of Massachusetts. He has spent his entire career working on inkjet systems and applications, originally with Markem-Image, then FujiFilm Dimatix, and currently with Integrity Industrial Ink Jet Integration. Integrity Integration designs, develops, and fabricates bespoke industrial print systems for industrial clients.

SC14: Fusing Physics and Technologies

When: Sunday 13:30 – 15:30 (2 hours)

Instructor: Dinesh Tyagi, Lexmark International, Inc.

Track: Toner/EP Technology

Level: Advanced/Specialist

In spite of the numerous technological advances that have been made in the area of toners, development, and rendering schemes, image quality is

ultimately determined by the customer holding the final print. From image gloss to color reproduction, and including print physical performance, the print’s final properties are directly dictated by the fusing step.

Most conventional electrophotographic (EP) printing systems require a fusing sub-system that takes the discrete toner particles and both fuses (coalesces) them together and fixes them to the media. This process is required to produce an attractive, durable image that is bonded tightly to the substrate.

This course reviews the fundamental functions of fusing and details past and current fusing technology trends in the EP industry. The physics of each fusing technology is discussed, with a specific focus on each technology’s strengths and weaknesses. Physics and mathematical models of thermal fusing are described along with the critical parameters in fusing steps. In the later part of the course, the most common fusing technologies are discussed, covering the critical parameters and failure modes that govern each fusing methodology. The course also covers the scientific and engineering challenges that are faced during both the technology and product-development cycles of a fuser. Common tests for image permanence are discussed along with the available options to enhance print physical performance.

Benefits

This course enables an attendee to:

- Identify and comprehend advantages and disadvantages of different fusing technologies that have been developed and used throughout the industry.
- Analyze the critical parameters that define the fusing process and latitude for common fusing technologies.
- Determine the critical failure modes, and the critical parameters that govern them, for conventional fusers.
- Measure image permanence and discuss available steps for improving fusing quality of images on various substrates.

Intended Audience: scientists, engineers and technicians directly or indirectly involved in the selection, analysis, and evaluation of the numerous fusing technologies used in today’s electrophotographic engines. The course is also beneficial to those working in other areas of the EP system, so that they have a better understanding of fusing process and materials requirements. A basic understanding of the EP process is assumed; familiarity with the basics of heat transfer and mechanics is beneficial, but not required.

See bio under SC04: Toner Materials—Engineering and Print Relationships, page 10.

SC15: Advanced Materials for Printed Electronics — NEW

When: Sunday 13:30 – 15:30 (2 hours)

Instructor: Kock-Yee Law, Research and Innovation Solutions

Track: 3D/Digital Fabrication Technology

Level: Advanced/Specialist

Advanced functional materials are needed to continuously fuel the development of new and better printed electronic devices, which are expected to penetrate deep into our society and play an important role in our future daily life. The trends for these devices are: flexible, light weight, smart, green, and sustainable. Key material systems included—but not limited to—in the course are: indium tin oxide replacement materials and approaches, low cost materials for electrodes and conductive tracks, and high performance materials for organic field effect transistor.

Benefits

This course enables an attendee to:

- Benefit by the timely review of key materials technology for printed electronics. For scientists, engineers, managers, and executives who are not working on printed electronics, the broad scope will allow them to become familiar with the field quickly.

Intended Audience: scientists, engineers, managers, and executives from both industry and academia.

See bio under SC10: Overview on 2D and 3D Printing, page 14.

15:45 – 17:45

SC16: Role of Inkjet in Commercial and Industrial Printing Applications

When: Sunday 15:45 – 17:45 (2 hours)

Instructor: Ronald Askeland, HP Inc.

Track: Digital Printing Technology and Applications

Level: Overview

Printing products from HP, Canon, Epson, FujiFilm, Xaar, Kyocera, Ricoh, Memjet, and Kodak are scrutinized and compared. The suitability of inkjet print systems for markets beyond the home and office is evaluated and contrasted with electrophotographic, offset, flexo, screen, and rotogravure printing in those markets. Thermal, piezo, and continuous inkjet printhead performance parameters and ink/media interactions are examined for applications in large format, publishing, direct mail, photographic, package, and textile printing. UV, solvent, aqueous, latex, and textile inkjet inks are described. Recent product introductions and future trends in commercial/industrial printing are discussed.

Benefits

This course enables an attendee to:

- Compare the pros and cons of electrophotographic, inkjet, and analog printing technologies in commercial/industrial applications.
- Describe key differences in piezo, continuous, and thermal inkjet printhead performance characteristics.
- Understand the differences between UV, solvent, aqueous, latex, and textile inks.
- Be aware of future directions in digital printing beyond the home and office.

Intended Audience: those somewhat familiar with inkjet printing technology who would like a better understanding of inkjet's role in the analog to digital conversion process.

Ronald Askeland is a system architect in the Advanced Technology and Platform Solutions division of HP in San Diego, where he has been since 2016. He has 32 years of experience in inkjet technology and has been awarded more than 60 US patents on inkjet inks and printing systems. Askeland received his PhD in analytical chemistry from Colorado State University. Previously he worked for HP in San Diego, CA (1984-2011) and Barcelona (2012-2015). Askeland is the author of Inkjet Print Engines in The Handbook of Digital Imaging (edited by Michael Kriss ©2015 John Wiley & Sons, Ltd.).

SC17: Fabrication Materials & Processes of Inkjet Printheads

When: Sunday 15:45 – 17:45 (2 hours)

Instructor: Hue Le, Le Technologies Inc.

Track: Inkjet Technology

Level: Advanced/Specialist

In recent years, enormous progress has been made in the design, fabrication, and commercialization of inkjet printing systems. This course describes the materials and processes that have been used to produce various inkjet printheads, which are the core component of the printing systems. Methods of forming inkjet nozzle, anti-wetting coated nozzle surface, ink channel and chamber, and various bonding methods are then reviewed. Materials of thin film resistor (for thermal inkjet) and piezoelectric ceramic (for piezoelectric inkjet) are also reviewed. The course concludes with insights into the potential material interactions between the more complex jetting fluids and the printhead structures in several emerging applications such as bio-printing and printed electronics.

Benefits

This course enables an attendee to:

- Understand the basic science and technology

in manufacturing methods of various types of thermal and piezoelectric inkjet printheads.

- Assess the current development in fabrication materials and processes of inkjet printheads.
- Evaluate insights into the potentials and limitations of different types of printheads.

Intended Audience: scientist, engineers, product managers, and other charged with development or manufacture of inkjet printing systems.

Hue Le is an inkjet printing technologies consultant at Le Technologies Inc. From 1997 to 2011, he formed and worked at Pico-Jet Inc., which designed and manufactured fluid jetting devices and systems for industrial printing applications. Prior to PicoJet, Hue was director of technology development for Tektronix, Inc.'s Printing and Imaging Division. He has more than 32 years of experience in developing and commercializing inkjet printing systems and holds 21 US patents. Le received a BS in chemistry, University of Iowa (1979) and MS in chemistry, New Mexico State University (1981).

SC18: Surface Ink Interactions and Surface Characterization

When: Sunday 15:45 – 17:45 (2 hours)

Instructor: Kock-Yee Law, Research and Innovation Solutions

Track: 3D/Digital Fabrication Technology

Level: Advanced/Specialist

Fundamental understanding of how inks wet, spread, de-wet, and pin on a print surface is important to the quality of the print output, but it is even more crucial to modern printed (or flexible) electronics manufacturing, where print resolution and device functional performance are paramount. This course starts with a tutorial on surface characterization and wetting fundamentals. Discussion includes the understanding of measurement tools for surfaces and coatings, wetting dynamics, and the meanings of these measurements. The importance of understanding and controlling ink wetting, spreading, and evaporation in digital manufacturing is illustrated. The mechanism for the formation of the “coffee ring” stain is overviewed and countermeasures are discussed.

Benefits

This course enables an attendee to:

- Learn how to upgrade their measurement tools and procedures.
- Expand their knowledge in ink-surface interactions and be ready for future challenges.

Intended Audience: the course covers a wide range of topics, from surface fundamental to the application of these basic concepts to solve problems in

digital printing. Surface scientists/engineers and researchers in digital fabrication will benefit from the overview of the state-of-the-art wetting fundamentals and concepts, as well as its applications in digital printing. Managers and executives from both industry and academia should also find it beneficial by learning the importance of fundamental to problem solving in general.

See bio under SC10: Overview on 2D and 3D Printing, page 14.

Tuesday, November 7, 2017

SC19: Introduction to 3D Printing of Metals

When: Tuesday 10:30-12:30 (2 hours)

Instructor: Jason Jones, Hybrid Manufacturing Technologies

Track: 3D/Digital Fabrication Technology

Level: Introduction

3D printing, also known as additive manufacturing, has recently emerged from niche engineering and hobbyist use, to be a mainstream strategic technology across a broad range of applications. Two recent developments have helped catalyse its recent growth: low cost polymer printers and high-end metal printers. The internet is saturated with information about low-cost printers; however, finding reliable information about metal printing is more difficult. Furthermore, the deposition of metal using digital printing techniques is just beginning to receive significant attention.

This course provides insight into the existing techniques for producing metal parts directly and indirectly using 3D printing technologies, including an assessment of their relative strengths, weaknesses, and costs. Additionally, the fundamentals of material preparation, how oxidation is avoided, and post processing methods are addressed. Key market players, applications (including aerospace, dental, medical, and printed electronics), and standards activities are identified. Perhaps most importantly, trends for future growth, including opportunities for digital printing are highlighted.

Benefits

This course enables an attendee to:

- Understand the state-of-the-art in metal additive manufacturing processes.
- Become conversant with the fundamentals and issues of additive metal approaches.
- Appropriately match techniques (based on their pros/cons) with a variety of applications.
- Gain a sense of the direction of future development and potential for this technology, as well as future opportunities for digital printing.

Intended Audience: those interested in gaining early-intermediate exposure and understanding of the 3D printing of metals. Also those who want a frame of reference for comparing larger scale metal printing practices with conventional digital fabrication practices (for example comparing the production of aerospace parts with printing conductive tracks). There are no pre-requisites for this course.

Jason Jones is co-founder and CEO of Hybrid Manufacturing Technologies, a 3D printing company equipping CNC machines for additive manufacturing (AM). Jones has a PhD in 3D printing from the University of Warwick and

has led millions of dollars of AM research and authored numerous publications and patents during the last decade. He has investigated 3D printing/digital fabrication techniques for multi-material functional parts and hybrid processing approaches for metals. Jones was a founding member of the ASTM F42 committee for AM where he serves as a task group chair and has led the development of several standards (including ISO/ASTM 52921). He also serves as a leader for SME's Additive Manufacturing Community (the largest professional 3D printing community world-wide). This short course has been prepared with Associate Professor Greg Gibbons of the University of Warwick, a 20-year veteran in the field of Additive Manufacturing.

Hotel and Travel Information

With its stunning backdrop of the Rocky Mountains, Denver, The Mile High City, and capitol of Colorado, hosts the Printing for Fabrication 2017 conference. The Grand Hyatt Denver, located in the heart of the city, hosts this year's meeting.

Grand Hyatt Denver

1750 Welton Street
Denver, CO 80202
+1 303 295 1234

Rate: Single/Double \$199 plus 14.75% tax

Rate availability: The discounted rate is available for November 3–10 based on availability. Early reservations are assigned on a priority basis to conference attendees provided they are received by October 13. To guarantee a room, a credit card number or deposit equal to one night's housing must accompany the reservation request.

Reservations Deadline: October 13, 2017

Online reservation link:

<https://aws.passkey.com/go/P4F17>

Phone reservations: +1 888 421 1442 /

Reference: 2017 Printing For Fabrication

Check in/out: 3:00 pm/noon

Cancellation Policy: 48 hours prior to arrival to avoid one night plus tax penalty.

Travel Notes

Denver Int'l Airport (DEN) is 23 miles from downtown. It serves 187 destinations including more than 20 international cities in nine countries. For more information visit www.flydenver.com/

Getting to Hotel from Airport (7 miles)

By Commuter Rail

- Take the A line commuter rail to Union Station. One-way fare: \$9 Time: ~37 minutes. From Union Station take a taxi to the hotel or catch the free 16th Street Shuttle that leaves you a block from the hotel. See imaging.org/print4fab for links to rail info.

Via Taxi

- Charge is \$55.57 flat rate to the hotel. Be sure to ask for the flat rate.

Via Shuttle

- SuperShuttle: one way fare is \$25. Reservations can be made online.
- ABC Shuttle: one way fare is \$35. Reservations can be made online.

Weather

Early November weather can range from a high of 54°F/12.2°C to a low of 23°F/-5°C. Snow or rain can be expected. Dress warmly!

About Denver

See details, page 8.

CONFERENCE REGISTRATION + MEMBERSHIP OPTION

Register for the conference and become a member for the same rate as non-member registration.

See details, page 20.

PRINTING FOR FABRICATION 2017 REGISTRATION

Register online at www.imaging.org/print4fab

First/Given Name _____

Last/Family Name _____

Title/Position _____

Company _____

Complete Mailing Address _____

Telephone _____ Fax _____

Email _____

Conference registration includes: admission to all technical sessions, including the Technologies in Digital Photo Fulfillment program; proceedings abstract book + full papers on USB flash drive; entrance to the exhibit; coffee breaks; and the Welcome and Conference Receptions. **Separate registration fees are required for short courses.**

Print Gallery and Demonstration Session (see page 5 for details)

- ☐ I would like to reserve a 2' x 4' space for a print gallery sample.*
- ☐ I would like a half-table to demonstrate a program/product related to the talk I am giving.*
(Session and Paper Title): _____
- ☐ I am not an author, but would like information on reserving space to demonstrate a program/product*

Conference Registration (CHECK ONE)

Please check **ALL** that apply. I am a:

- ☐ speaker ☐ session chair ☐ committee member ☐ IS&T member ☐ ISJ member

Please note: To better serve your needs, IS&T is offering conference registration options that include membership for the same price as a non-member fee. If you select a registration category with membership, please also choose between an online subscription to the Journal of Imaging Science and Technology (JIST) or Journal of Electronic Imaging (JEI).

	REGULAR		STUDENT	
	until Oct 8	after Oct 8	until Oct 8	after Oct 8
___ Conference registration: current IS&T/ISJ Member	\$795	\$895	\$160	\$210
___ Conf. registration (+ new or renewing membership + JIST)** Membership begins within 2 weeks of registration and expires 12/31/17.	\$895	\$995	\$185	\$235
___ Conf. registration (+ new or renewing membership + JEI)** Membership begins within 2 weeks of registration and expires 12/31/17.	\$895	\$995	\$185	\$235
___ Conference non-member registration	\$895	\$995	\$185	\$235
___ One-day: <input type="checkbox"/> Tues <input type="checkbox"/> Wed <input type="checkbox"/> Thurs <input type="checkbox"/> Fri	\$445	\$495	\$150	\$200
___ Short course only (check and proceed to short course selection area)				
___ Technologies in Digital Photo Fulfillment ONLY includes all tech sessions Wednesday + the Conference Reception, but no Print4Fab proceedings book. TDPF proceedings will be available online for free download.	\$350	\$450	\$100	\$150

Registration Subtotal \$ _____

Extra Proceedings

Registration includes proceedings abstract book + full papers on USB flash drive.

Hardcopy proceedings book (full papers) _____ @\$125/each \$ _____

Extra abstract book + USB flash drive _____ @\$150/each \$ _____

Extra USB flash drive _____ @\$100/each \$ _____

Page Subtotal \$ _____

* You will be contacted by IS&T staff with further details.

** If you choose this option, you may register for Short Courses at the Member rate.

continued on next page

PRINTING FOR FABRICATION 2017 REGISTRATION CONT'D.

We recognize that changes in the imaging industry have put some of our loyal attendees in strained financial situations. If you are currently unemployed, but would still like to attend this year's meeting, please contact dsmith@imaging.org to discuss your situation.

Short Course Registration (see page 5 for course descriptions)	until Oct 8	after Oct 8	
2-hour course Member registration	\$165	\$215	\$ ____
2-hour course Non-member registration	\$200	\$250	\$ ____
2-hour course Student registration	\$65	\$115	\$ ____
Check all that apply: <input type="checkbox"/> SC01 <input type="checkbox"/> SC02 <input type="checkbox"/> SC03 <input type="checkbox"/> SC04 <input type="checkbox"/> SC05 <input type="checkbox"/> SC06 <input type="checkbox"/> SC07 <input type="checkbox"/> SC08 <input type="checkbox"/> SC09 <input type="checkbox"/> SC10 <input type="checkbox"/> SC11 <input type="checkbox"/> SC13 <input type="checkbox"/> SC14 <input type="checkbox"/> SC15 <input type="checkbox"/> SC16 <input type="checkbox"/> SC17 <input type="checkbox"/> SC18 <input type="checkbox"/> SC19			
SC12 4-hour course Member registration	\$260	\$310	\$ ____
SC12 4-hour course Non-member registration	\$295	\$345	\$ ____
SC12 4-hour course Student registration	\$95	\$145	\$ ____

OR
Take three or more classes and receive 10% off the total price
(enter three or more two-hour courses, fill in member or non-member fee next to each, add together, and multiply by .90 to get your price, representing 10% savings; add additional lines if needed; students may not take advantage of this offer)
SC____ \$ ____ + SC____ \$ ____ + SC____ \$ ____ = \$ ____ x .90 = \$ ____

Student and Young Professional Event (see page 2 for details)
☐ I would like to take part in the Student and Young Professional Get Together. (You will be contacted with details closer to the event.)

Extra tickets for guest/spouse for receptions
____ Extra Welcome Reception Ticket (Name: _____) \$45 \$ ____
____ Extra Conference Reception Ticket (Name: _____) \$75 \$ ____

Membership (see also conference reg options)	US Address	Non-US Address	
new membership (begins now, expires 12/31/18)	\$95	\$105	\$ ____
annual membership renewal (expires 12/31/18)	\$95	\$105	\$ ____
student membership (begins now, expires 12/31/18)	\$25	\$25	\$ ____
for all memberships select one: <input type="checkbox"/> JIST online <input type="checkbox"/> JEI online			

join now and calculate fees based on member rates

Subtotal from previous page \$ ____
Wire transfer fee, if applicable (\$25) \$ ____
GRAND TOTAL \$ ____

Payment Method: ☐ AmEx ☐ MasterCard ☐ VISA ☐ Discover ☐ Wire Transfer ☐ Check
Card#: _____ Exp. Date: _____
Name as it appears on card: _____
Authorization Signature: _____

Return this form with signed credit card authorization to IS&T, 7003 Kilworth Lane, Springfield, VA 22151
or fax to +1 703 642 9094. We do not encourage sending via e-mail.
Contact registration@imaging.org for wire transfer information.

Note, \$25 must be added to the Grand Total for wire transfer payments to cover bank costs.
Please note: To cover bank charges and processing fees, there is a cancellation fee of \$75 until
October 8, 2017. After that date, the cancellation fee is 50% of the total plus \$75.
No refunds will be given after November 9, 2017. All requests for refund must be made in writing.

Printing for Fabrication 2017 (NIP 33)



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