Format and Submissions Requirements: Technical Summary

Submissions must consist of two separate parts. The first part should consist of a single page containing a 35–50 word abstract. The second part should contain a 4-page technical summary that follows the outline below. Please follow the instructions below for the preparation of the Abstract and Technical Summary.

35-50 Word Abstract: Your submitted 35-50 word abstract, highlighting the key details of your paper, will be published in the Program if your paper is accepted. The abstracts are usually edited to accommodate the program format.

Technical Summary: Include the first author's name and the title of the paper on each page. Please include the information listed below in the Technical Summary.

(1) Objective and Background: Briefly describe the goals and intent of your project. and give background factors that led to the new results.

(2) Results: Describe the specific results that will be presented at the Display Week 2016 Symposium. Please provide a technical description of how the results were achieved. Sufficient detail (quantitative and/or graphical data) should be included so the Program Committee can properly evaluate your submission.

(3) Impact: Discuss the significance of your work and compare your findings with previously published work.

(4) References: List a few main references covering projects in related areas.

(5) Prior Publications: Generally, Symposium papers must be original contributions. If your organization has published or presented material on similar work in English, please explain how the present material differs. The only exception to this rule is that papers submitted to the Applications Subcommittee need not be original.

The Technical summary must be no longer than four pages. Material beyond four pages will not be considered in evaluating the paper.

All authors are required to upload their Abstract and Technical Summary to http://www.sheridanprinting.com/pcm/sid/sid.cfm

Additional information must be provided in the online submission form.

Authors must

    (A) Indicate if you wish to have your paper considered for oral or poster presentation, if you have a preference.

    (B) Indicate the closest matching and Symposium Topic from the list provided

    (C) Include the 35-50 word abstract

    (D) Include a minimum of three keywords for the submission;

    (E) Indicate whether the presenter of the paper is currently a student; and

    (F) Include the names of all authors with their affiliations, addresses, telephone numbers, and e-mail addresses. Please underline the name of the presenter when there are two or more authors.

If you need further information, please contact Bill Klein at wklein@pcm411.com.

Timetable

The deadline for receipt of abstracts and technical summaries is December 1, 2015. Notification of acceptance will be e-mailed by February 8, 2016 (The deadline for late-news papers is January 20, 2016; notification of acceptance, February 15, 2016). Authors of accepted papers will be directed to an online "Authors Kit" with instructions for the preparation of the paper to be published in the Symposium Digest. The paper shall consist of four pages, including all illustrations, and is due March 1, 2016 (March 15 for Late-News papers).

Points of Contact

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Format of Presentations

Oral presentations will conform to a 20-minute format (15 minutes for presentation and 5 minutes for questions and answers). This year's Poster Session will be held late Thursday afternoon, May 26, between 5:00 and 8:00 pm. Accepted papers will be assigned to either oral or poster presentation at the discretion of the program committee.

Student Travel Grants

A limited number of student travel grants, up to $1000 each, will be made available to student presenters of accepted papers. A student travel grant must be requested upon submission of abstracts by checking off the appropriate box on the online submission site. A questionnaire will automatically be generated. Please complete the questionnaire. Only students who submit the questionnaire will be eligible to receive a student travel grant. The deadline for the submission of abstracts is December 1, 2015; January 20, 2016 for late-news submissions. Students receiving travel grants will be informed via the acceptance letter.

Late-News Papers

A portion of the Symposium schedule will be reserved for Late-News Papers. These papers should describe the results of late-breaking and significant developments that merit special consideration for attention at the Symposium.

The deadline for Late-News Papers is January 20, 2016. Late-News Papers must follow the format described for regular submissions to the Symposium (see page 1). Additionally, authors should include a statement describing why their paper deserves late-news status. **Only a limited number of late-news papers will be accepted.** Authors of accepted presentations must also submit a paper for inclusion in the SID Digest. Papers accepted for oral presentation will have 10-minute slots (8 minutes for presentation, 2 minutes for discussion).

Poster Session

Poster sessions present the opportunity for a more interactive dialog between authors and the audience. A successful poster paper should be a high-quality innovative paper where the poster presentation format would promote the exchange of detailed information between specialists. Papers where the demonstration of a new technology, concept, or phenomenon can complement the presentation are particularly suitable for the poster format and are encouraged.

Submission requirements and review criteria are the same for both oral presentation and poster formats, and these two formats receive equivalent publication in the SID Digest of Technical Papers. As indicated under "Format of Submissions," authors may state their preference for a poster or an oral paper presentation; however, the final assignment of accepted papers will be at the discretion of the program committee. Poster presenters are requested not to distribute handouts other than business cards.

Deadlines and Key Dates

Technical Summary. . . . . Dec. 1, 2015

Late-News Technical Summary . . . . Jan. 20, 2016

Accept/Reject Letters . . . . Feb. 8, 2016

Late-News Accept/Reject Letters . . . . Feb. 15, 2016

Digest Paper Submission . . . . Mar. 1, 2016

Late-News Digest Submission . . . . Mar. 15, 2016

Display Week 2016 . . . . May 22 – 27, 2016

Sunday Short Courses . . . . May 22, 2016

Monday Technical Seminars . . . . May 23, 2016

Business Conference. . . . . May 23, 2016

Investors Conference. . . . . May 24, 2016

Exhibition / I-Zone . . . . May 24–26, 2016

Vendor Forum . . . . May 24–46, 2016

Symposium . . . . May 24–27, 2016

Market Focus Conferences. . . . . May 25 & 26, 2016

Special Technology Tracks for 2016

The Display Week 2016 Symposium will be placing special emphasis on six Special Technology Tracks to address the rapid growth of the field of information display in the following areas. Submissions relating to these special topics are highly encouraged.

1: AUGMENTED AND VIRTUAL REALITY

This special topic will cover the technologies and applications in the emerging area of augmented and virtual reality (AR/VR). The sessions will bring together scientists, engineers, business professionals, market analysts, and industry leaders involved in AR/VR technologies, products, applications, advanced developments, and emerging trends.

- **Augmented and Virtual Reality Systems and Applications**
- **Head-Mounted, Near-to-Eye, and Wearable Displays**
- **Depth Sensing and 3D Imaging Technologies**
- **Multi-Sensors and Display Integration**
- **Localization, Tracking, and Navigation Techniques**
- **Mapping and Rendering of Virtual Objects onto the Physical World**
- **Inputs, Interfaces, and Interactions**
- **Object, Human, and Scene Capture, Reconstruction, Recognition, and Understanding**
- **Biometrics and User Authentication**
- **Usability and Human-Factors Considerations**
- **Emerging AR/VR Market and Business Trends**

2: DIGITAL-SIGNAGE DISPLAY SOLUTIONS

New enabling innovations and applications of existing and new display solutions are enhancing large-area and seamless tiled displays featuring areas >1000 ft.^{2}, pixel resolutions ranging from 3 to 30 ppi, full-color capabilities, high contrast ratio with brightness solutions ranging from 500 to >5000 nits, and indoor and outdoor capabilities. Papers relative to the technology and applications of these displays for curved, compound curved, and flat formats in any aspect ratio are solicited. Technologies and applications include, but not limited to,

- **LCDs/Modules**
- **Discrete Packaged RGB LED and Modular Arrays**
- **Backplane and Unique Interconnect Technologies (flip chip, COB)**
- **OLED Materials, Processing, and Displays (RGBW) for Integrated Solutions**
- **Wide-Area/Field Color-Filter Solutions; Color Uniformity and Calibration**
- **Down-Conversion Materials (Phosphors, Quantum Dots)**
- **Novel Implementations in Data Flow and Interconnect (Data and Power)**
- **Emerging Applications/Unique Visualization Solutions**

3: LIGHTING:

All aspects of solid-state lighting with focus on advances in materials and devices, visual and non-visual effects of lighting, smart lighting and intelligent luminaires, as well as implementation and application of color changing or CCT tunable luminaires.

- **Materials and Devices for Solid-State Lighting**
  - **Notable Developments in LED and OLED Sources: Breakthroughs in Efficacy, Color Rendering, Reliability, Lifetime, and/or Manufacturing Efficiency**
  - **Critical Components in Solid-State Lighting: Substrates, Optics, Lighting Extraction, Thermal Management, and/or Color-Conversion Materials**
- **Visual and Non-Visual Effects of Lighting**
  - **Quality of Light, including Color Rendering, Flicker, and Glare, for Indoor and Outdoor Applications**
- **Biological and Psychological Impact of Light and Related Health Effects**
  - **Visual Neuroscience Behind Lighting or Display Design**
  - **Visualizing Lighting on Displays**
- **Color Changing and/or CCT Tunable Luminaires**
  - **Control Systems, Strategy and Algorithm for Color Changing or CCT Tuning**
  - **Application or Case Study of These Luminaires**

4: TFTs AND DISPLAY CIRCUITS ON PLASTIC SUBSTRATES

The flexible display is emerging as it provides another degree of freedom for system design. Papers related to TFTs and its circuit either built directly on a plastic substrate or transferred from a glass substrate are solicited. Submissions include:

- **a-Si, Oxide, and LTPS TFTs on Plastic Substrates**
- **TFT Characterization and Display Circuits on Plastic Substrates**
- **TFT Panel Transfer or Releasing Process**
- **Plastic Substrate Material Interaction with TFTs and Display Circuits**
- **TFT Process Interaction with Plastic Material**
- **Display-Module Integration with Plastic Panels**
- **Plastic Substrate Bending Interaction with TFTs and Display Circuits**

Special Technology Tracks *(continued)*

5: VEHICLE DISPLAYS AND USER-INTERFACE TECHNOLOGY TRENDS

This special topic covers all aspects of automotive and related HMI issues, including market aspects, display and lighting technologies, head-up displays, application issues with automotive displays, and advanced technologies for displays and touch screens in vehicles. Papers in the following areas are solicited:

- **Usage of and Trends in Automotive Displays, Interfaces, and Applications**
- **Customer Acceptance and Feedback on Different Technology Displays and Interfaces**
- **Regulation and Trends Related to In-Vehicle Interfaces**
- **Display and Lighting Technologies Applicable to Vehicular Applications**
- **Optical Components for Automotive Applications**
- **LEDs, OLEDs for Lighting, Signaling, *etc*.**
- **Human–Vehicle-Interface (HMI) and System Solutions;**
- **Display Legibility, Visual Performance, Driver Distraction, *etc*.**
- **Touch-Screen and Haptic Technologies for Automotive Displays**
- **Driver/User Interfaces (User-Centric Design, Devices, Human Factors, *etc*.)**
- **Displays and HMI for Driver Assistance Systems (Navigation, Collision Warning, *etc*.)**
- **Head-Up Displays (HUDs), Augmented Reality, Night-Vision Systems/Components**
- **Vehicular Infotainment and Projection Displays**
- **Application Issues with Vehicular Displays, Lighting, and HMI**
- **Optical, Mechanical, Electrical, Thermal Performance**
- **Modeling and Simulation**
- **Advanced Technologies for Displays and Touch Screens**
- **Touch-Input Devices (In-Cell, Water Resistant, Chemical resistant) for Automotive Displays**
- **Flexible, Curved, and High-Resolution (Low Power, Sunlight Readable) displays**
- **Motorbike Displays and Applications**
- **Aeronautic Displays and Applications**

6: WEARABLE DISPLAYS

This special track will cover all aspects of wearable displays including product and process design, user applications, wearable system integration, and display technologies. Benefiting from low-power RF, MCU, advanced displays, and a well-established mobile infrastructure, wearables have emerged as one of the most active fields in the technological world. Being the most mobile and personal form of technology to the users, wearable devices present many possibilities, but at the same time many uncertainties. This special track will provide a platform for researchers, designers, engineers, and anyone involved in wearable displays to share recent advancement and challenges. The topics covered include, but not limited to, the following:

- **Wearable Product Design and Concepts**
- **Wearable Applications**
- **Wearable Display Requirements including Readability and Extreme Environmental Durability**
- **Wearable Display System Implementation including Sensors, Power Management, User Interface, and Others**
- **Advanced Displays for Wearable Applications including Low Power, Flexible, Stretchable, Textile, and Others**
- **Wearable-Display Processes**
- **Directive-View Wearable Displays**
- **Head-Mounted Displays and Microdisplays**
- **Fashion and Wearable Displays**

Symposium Topics

As growing and multi-faceted fields, work relating to the special topics can fit under a number of different symposium topics, including Active-Matrix Displays, Applications, Applied Vision/Human Factors, Display Electronics, Display Manufacturing, Display Measurement, Display Systems, Emissive Displays, e-Paper and Flexible Displays, Lighting, Liquid-Crystal and Other Non-Emissive Displays, OLEDs, Projection, Touch and Interactivity, and Vehicular Displays and HMI Technologies. While the special topical sessions will be arranged in a unified program for the benefit of attendees, authors should indicate the appropriate symposium topic for their abstract in addition to the special-topic designation (if appropriate).

The Society for Information Display (SID) encourages the submission of original papers on all aspects of the research, engineering, application, evaluation, and utilization of displays. Display Week 2016 will feature special topical sessions that focus specifically on selected issues or key developments. Paper submissions are welcome for any of the general symposium topics or any of the specific topical sessions.

The Society plans to include coverage of every aspect of display technology and applications, especially the emergence of Wearable and Vehicle Displays. Special attention will also be given to all aspects of novel input technologies for displays. Papers are solicited in all aspects of motion-image technology, including device technology (LCD, OLED, projector, *etc.*) and related system technology. Papers are also solicited in the area of technology development that enables lower-power-consumption and higher-performance display devices for mobile devices (smartphones, tablets, e-books, *etc.*).

Active-Matrix Devices: Advances in the innovative development and implementation of active-matrix electronics into displays and other devices. Active-Matrix Devices focus on TFTs themselves and their circuit design and application, including TFTs electrical/optical characteristics, reliability, new structures, and processing.

Applications: Advances in the development, use, and characterization of display technologies, components, and systems resulting in new capabilities, improved performance or better user experience in (i) existing display applications (*e.g.*, consumer, industrial, commercial, security), (ii) novel or emerging display applications, and (iii) non-display applications.

Applied Vision / Human Factors: Current stereoscopic or 3D display technologies and content often provide visual cues that differ significantly from the visual cues in our natural viewing environment. Submissions which discuss the impact of 3D and head-mounted-display technologies on viewer performance, engagement, enjoyment, comfort, and fatigue are encouraged. Included are proposals and evaluations of novel evaluation techniques; novel technologies for improving specific aspects of the human experience; and studies quantifying the effect of display parameters, system configurations, content generation technologies, or 2D to 3D conversion algorithms on user performance when using stereoscopic and 3D displays

Display Electronics: All aspects of circuits (integrated or otherwise) for displays, electronic components for displays and imaging devices, and image- and video-processing algorithms.

Display Manufacturing: Materials, process, and equipment developments for the manufacture of display panels and module assemblies.

Display Measurement: Characterization and measurements of displays and display components.

Display Systems: Novel integration of displays into specialized devices, as well as system-level aspects of electronic displays.

Emissive Displays: All aspects of emissive displays, including PDPs, field-emission displays, light-emitting diodes, quantum-dot displays, inorganic EL displays, and field-emission lamps. Advances in materials and processing of such devices including phosphors, quantum-dot materials, and field emitters are also sought.

e-Paper and Flexible Displays: All aspects of e-Paper, flexible, and wearable display technologies, including flexible, bendable, or foldable displays (OLED, electrophoretic, MEMS, cholesteric LCD, electrowetting, and other novel emissive and reflective displays) and printed electronics (organic and inorganic). Advances in flexible materials (substrates, transparent conductors, TFTs, barrier layers, and adhesives), printing and novel deposition techniques, manufacturing methods (R2R, bonding and lift-off), electro-optical effects, sensor technologies, drive techniques, device performance and reliability, ergonomics, and applications for emerging paper-like, flexible, wearable, or stretchable display technologies are sought.

Lighting: All aspects of solid-state lighting with focus on advances in materials and devices, visual and non-visual effects of lighting, smart lighting, and intelligent luminaires, as well as implementation and application of color changing or CCT-tunable luminaires.

Liquid-Crystal and Other Non-Emissive Displays: Advances in the development of liquid-crystal and other passive-matrix displays, including electro-optical effects, materials, and devices.

Organic Light-Emitting Diodes (OLEDs): Papers are sought on display design and performance of small–to–large-area panels, including OLED displays utilizing poly-Si, a-Si, microcrystalline silicon, CMOS crystalline silicon, and emerging areas of organic TFTs and mixed oxide transistors including ZnO-based materials. Papers that discuss the progress and challenges for OLED display performance and manufacturing issues compared to LCDs are of particular interest. Furthermore, papers on OLED signage and OLED lighting solutions are welcome.

Projection Displays: Papers relating to all aspects of projection technology are sought. Sessions in the past have included innovative projectors, solid-state lighting, microdisplays, components, projection-system innovations and applications, and others.

Touch and Interactive Displays: Advances in touch-screen technologies, applications, driving electronics, system integration, and human interactions. The advanced materials and process technologies associated with touch design and applications will be also covered.

Vehicle Displays and HMI Technologies: Advances in touch-screen technologies, applications, driving electronics, system integration, and human interactions. The advanced materials and process technologies associated with touch design and applications will be also covered.

As part of the technical symposium covering the broad range of information-display topics listed, Display Week 2016 will feature topical sessions which focus specifically on selected issues or key developments. Paper submissions are welcome for any of the general symposium topics or for any of the specific topical sessions described below.

ACTIVE-MATRIX DEVICES

TFTs and Display Circuits on Plastic Substrates
The flexible display is emerging as it provides another degree of freedom for system design. Paper related to TFT and its circuit either build directly on the plastic substrate or transfer from a glass substrate are solicited.

Oxide TFTs and Display Circuits
Oxide-semiconductor technology is emerging as a strong competitor to thin-film silicon for active-matrix backplanes. Developers of oxide semiconductors continue to solve several critical issues related to oxide materials, and these are associated with the overall characteristics of mass-produced devices, including stability (over time, temperature, and light), uniformity, mobility, etc. Papers related to oxide-based TFTs and displays driven by these TFTs are solicited.

LTPS TFTs and Display Circuits
Si-based TFTs have a long history, but LTPS TFTs are still one of the hottest topics in backplane technologies for active-matrix FPDs because of their superior electrical performance. LTPS TFTs are used for various applications including the backplane of LCD and AMOLED displays. Papers related to advances in the development and implementation of LTPS backplane technology and displays driven by these TFTs are solicited.

Sensor-Integrated Active-Matrix Devices
Active-matrix displays with in-cell touch sensors have recently become important. Papers that advance the state of the art of active-matrix displays with integrated sensors are solicited. Moreover, flat-panel image sensors can be manufactured with processes similar to those for active-matrix displays. They are used for medical x-ray imaging and other sensor systems, including embedded sensors (*e.g.*, image sensors integrated inside an LCD panel and an ambient-light sensor using some display pixels). Papers that describe the process, design, pixel circuits, and readout electronics for achieving the required performance and wide dynamic range are solicited.

New Driving Methods for Field-Sequential-Color and 3D Displays
Field-sequential-color displays are of considerable interest because of their high efficiency and low power. Similarly, field-sequential stereo 3D displays are of considerable interest for 3D TV. Both these displays require high-frame-rate driving. Papers on technologies and active-matrix backplane architectures for high- frame-rate driving for field-sequential-color and field-sequential 3D displays are solicited.

Novel TFTs and Processing Techniques
The growing emphasis on higher-quality displays has led to numerous development efforts for devices, driving circuits, and techniques. Papers are invited which address new device structures, active-matrix driving methods, and the resulting improvements in the following display characteristics, including image enhancement, gray scale, power consumption, response time, contrast ratio, lifetime, driver cost, *etc.* Papers addressing a novel pixel structure coupled with a required new driving scheme are especially encouraged.

Ultra-Low-Power Active-Matrix Displays
Ultra-low power consumption is extremely important for any portable displays, including handhelds and notebook PCs. Ultra-low-power technologies include, but are not limited to, super-high-aperture TFTs, high panel transmittance, highly efficient backlighting, dynamic backlighting, low-V_{th} LC material, charge sharing or recycling, step charging, new driving schemes, low digital voltage, bistable display devices, pixel memory, partial updating, highly reflective displays, *etc.* Papers are particularly encouraged in this area.

New AMOLED Pixels and Backplanes
Organic LEDs have been a focal point in the display industry because of their superb image quality and slim form factor. However, AMOLEDs must overcome the following obstacles in order to achieve high-volume production: differential aging, image burning, power consumption, backplane consistency, manufacturability, and cost. Progress is being made on many of these fronts and on improving maximum brightness for daylight readability. Papers related to AMOLED technologies, such as pixel structure, circuitry, and driving scheme, with an emphasis on its backplane advances, are solicited.

Active-Matrix TV and Flexible Displays
Active-matrix displays produced with low-temperature processes on flexible substrates can provide increased durability, better shock resistance, decreased weight and thickness, and unique product shapes. Active-matrix-display contributions are sought on low-temperature a-Si:H, poly-Si, oxide-semiconductor, and organic TFT devices on flexible-substrate material. These contributions may include process issues such as chemical compatibility or dimensional-tolerance control due to shrinkage, compaction and/or warping, substrate material, and cost.

Active-Matrix Mobile Displays
Active-matrix displays are enjoying rapid growth in smart phones, e-Readers, tablets, and other handheld applications. Special requirements for mobile displays include low power consumption, sunlight readability, slim form factor, image quality, and video performance. Papers on advancements in active-matrix mobile displays using all types of display media including AMLCDs, AMOLEDs, electrophoretic displays, electrowetting displays, photonic crystal pixels, and MEMS pixels are solicited. Contributions are particularly sought on novel pixel designs and addressing and integration methods for handheld displays.

System-on-Glass (SOP)
The high performance of new TFT processes enables the monolithic integration of analog and digital display driver circuits as well as other peripheral functions on the active-matrix-display substrate. The resultant display modules have increased display functionality, performance, and reliability. Papers that advance the devices, circuits, or systems that allow for integration of row and column drivers, controllers, D/A converters, dc-to-dc converters, *etc.*, into active-matrix backplanes are solicited. Issues to be addressed are yield and performance of these advanced circuits, as well as their integration in display systems.

Novel Emerging Active-Matrix Displays and Devices
Developers of active-matrix displays continue to push the limits of the physical design and manufacturing on both small and large extremes. Many novel displays or devices have been studied by many research groups to solve these limits. Papers are solicited on displays and devices based on novel materials and designs or novel applications.

Mobile Displays (Smartphones, Tablets, e-Readers, *etc.)*

With flat-panel-display technology becoming increasingly mobile, the need for improved energy efficiency and ruggedness also becomes more important. Applications already range from many types of handheld devices (smartphones and tablets) and laptop computers to electronic reading devices (e-Readers) and micro-projectors. Most applications are moving toward higher resolutions and higher performance, creating unique issues to be resolved for small-format displays and virtual-image applications as pressure mounts to create more energy-efficient devices. What are the hottest "emerging" mobile-display applications? What new requirements must be satisfied to drive current displays through their next developmental steps for existing applications at higher added value to customers? What are probable future power requirements per square centimeter by application? How will improved-mobility play out in entertainment and games? How to differentiate displays and avoid becoming a commodity in the future market?

Wearable Display Applications

As we reach the practical limits of data content on our handheld devices and as laptops get smaller for improved portability, a thirst remains for more data content and higher resolution supported by increasing bandwidth, faster processors, and larger memory, driven by the rise of streaming high-definition entertainment. Near-to-eye displays offer a way for users to see large, high-definition images in the smallest format package. The display capabilities of tablets, cell phones, smartphones, and handheld games are expanding rapidly. Full-color improved-performance 3D head-tracking compatibility for surround-view and reduced cost are key display parameters to support the growth of the personal-electronics markets. What technical market and consumer-perception hurdles are needed for near-to-eye applications to move from mostly military and medical applications to become mainstream consumer products?

Virtual and Augmented Reality

Virtual reality (VR) has been thought of as the ultimate display technology for over 30 years. Augmented reality (AR) has the power to overlay data and even animation over your view of the natural world. Both VR and AR are best when combined with visualization, tactile, and other feedback mechanisms. Many attempts have been made, and some reasonable levels of success have been achieved in simulators and head-mounted systems, especially by the military. Still, practical virtual-reality systems for the home PC platform have eluded the typical consumer. What is the status of the technology and what advances are on the horizon? What are the primary barriers to mass-market implementations of VR and AR? What are some of the most likely initial commercial and consumer applications? When might we see market entries? What is the market potential for various less-glamorous near-term applications?

Touch and Interactive Display Applications

Touch screens have become common place from grocery checkouts to handheld phones, covering a broad range of industrial, commercial, and consumer applications. It has been estimated that the market for touch screens has been growing over 10% CAGR. Touch screens are now being adopted in home computers and laptops. Unseen applications might arise outside the current scope. What are some of the likely new market applications, and what not-so-obvious novel applications for touch screens might be coming? What technologies best fit some of these growing applications?

3D, Stereoscopy, and Holography

Three-dimensional display systems are currently in use in medical modeling and CAD applications and are continuing to evolve and seek new markets. Major entertainment studios are currently pushing 3D content, opening the door for a new cinema experience. How is 3D or stereoscopic imaging impacting entertainment and gaming? The television industry is following suit at the heels of the movie industry. What is the likely path by which this technology will be implemented and what are the current barriers to mainstream product applications? What is necessary for 3D to become a "must have"? Holography has also been quietly finding increasing applications over the past several years. What are some of these new instrument and imaging applications, and what are the technology solutions and potential killer applications needed for holography to reach into the mass markets other than non-video images on novelty items and product packages?

Avionics, Military, Automotive, and Ruggedized Display Applications

Demands for greater functionality in automotive military and avionics displays are growing. Other outdoor applications require special displays or ruggedized commercial displays. Full-color wide-screen formats, headset and see-through displays, flexible displays, higher resolution, and increased brightness and contrast, as well as lower costs, are needed to meet these demands. How are we approaching the utilization of new and enhanced display technologies to meet emerging vehicular applications? What applications drive the development of advanced displays for avionics and automotive use? What display technologies are most suitable for harsh conditions? What new applications and environments are and can, in the future, be available for displays when suitably engineered devices are available?

Kiosks, Signage, Transparent, and Tiled Displays

Papers on the application of mid- or large-sized displays for signage, kiosks, or advertising and information messages are solicited. The technology can be LCD, OLED, plasma, projection (rear or front), or any other evolving technology. The application can on one hand involve a monolithic display or a transparent screen, or on the other, several tiled flat-panel displays or projected images. Applications can be for indoor, outdoor, or bright illuminated indoor conditions. Papers on the tiling of displays with seamless abutting for command-and-control rooms, for example, are also solicited. What is coming next to excite us, and how far will electronic signage likely penetrate our supermarkets, malls, buildings, and roadways?

Digital Cinema, Entertainment, Gaming, and TV

The era of e-cinema is upon us, with major studios releasing their features in digital form. The possibility for major cost reductions in digital production and distribution may restructure the entire industry. We are now seeing some of these transmission and media formats being implemented. Flat-panel TVs are now available at affordable prices, and viewing area and performance are steadily improving. What will be the future of entertainment and gaming displays? Which display technologies will share in these markets? How might they be implemented? Which will dominate and in what time frame? Digital cinema is an opportunity to make optimal use of the strengths of digital display technologies. Multiple commercial and home-cinema applications exist. What are the best

solutions to the data transmission and presentation issues? How to improve stereoscopic 3D in future of digital cinema? What new features can be provided to improve the entertainment or communications experience?

Medical Displays

Displays are broadly used in the medical profession to enhance information transfer and to access medical histories, to enable broader use of "telemedicine" and to enhance either diagnostics or therapeutics. The full range of emerging medical-display products and systems, from head-mounted systems to aid in surgery to high-resolution displays for x-ray diagnosis, will be discussed. What are likely formats for utilization of 3D, wearable computing, or holography for tomography imaging, endoscopy, or other medical applications? What new applications with wearable computer imaging and augmented reality will be available in future home or clinical based medical products? What new applications are enabled in medicine by adoption of advanced display and new light-generation technologies?

Multi-Modal Display User Interface (*e.g.,* Auditory Displays)

Displays for mobile applications, tablets, PCs, and entertainment are using interactive man–machine interfaces. Whereas personal information devices (PIDs) use single touch, smartphones and other mobile applications use multi-touch and gestures interactivity such that touch has become the dominant communication means to the devices. Recently, other modes of inputs are progressing such as voice (auditory displays), gestures, and facial expressions (coming soon). Any mode of multi-modal displays, including "out of the box" concepts, will be considered for this category.

Display Software Applications (*e.g.,* Image Enhancement)

Some applications of displays require enhancement of the displays performance. Increasing the number of gray levels and controlling their separation is one way to do that. Methods of dynamic backlight and algorithms of controlling gray levels will be part of these applications. Motion-blur compensation for LCDs and image-enhancement techniques for quasi-static displays are becoming differentiating aspects in mobile markets. Optimization in variable ambient lighting conditions or image-processing methods such as edge enhancement will improve the visual experience. The use of dynamic backlights is a method to improve contrast and save energy, involving different methods and algorithms. Combinations of hardware, firmware, and software to improve image properties are welcome for this category.

Smart Lighting / Solid-State Lighting

The solid-state-lighting market has been gaining momentum and replacing incandescent and fluorescent lighting. It has moved from display backlighting and LEDs to home, office, and street lighting, to automotive headlamps and many other applications. Energy efficiency, minimal heat, and better reliability have been driving these markets despite the higher costs. Furthermore, solid-state-lighting technology advancements are permitting users more choices of illumination spectrum as well as dynamic color-adjustable lighting. Prices have been coming down rapidly, further accelerating market growth. The U.S. Department of Energy has been encouraging solid-state-lighting technology. How will the technical issues of thermal management, improved reliability, and power supplies currently being addressed affect the development and deployment of higher efficiency and lower-cost LED and OLED solid-state-lighting applications? What new product designs and applications will be made practical by super-long-life lighting products (e.g., products not designed for bulb replacement) and how will the CFL, LED, OLED, and other solid-state-lighting technologies likely play out against each other? How can we take advantage of the low-voltage driving to make dynamic, programmable, and other "smart" lighting?

Environmentally Friendly (Green) Displays

Display technology has been advancing to provide better resolution, larger size, and performance for less cost. Energy efficiency becomes especially important for large-screen and, on the other hand, mobile applications. Materials of construction and end-of-life disposal have already created major issues for CRTs already, so how do we make the new displays more environmentally friendly at end-of-life? The continually changing and varied regulations around the world to protect the environment can be challenging. Will shifting from mercury-containing CFLs to solid-state-lighting backlights or OLEDs improve customer acceptance of "green" displays? How will consumers relate product price to energy savings, except as it affects mobile-product battery life? What are the anticipated initial production and end-of-life issues for the display industry and how can these be better addressed? Will there be new display applications to replace non-display means of information dissemination with new, environmentally friendly displays?

Ubiquitous Displays

The convergence of increasingly sophisticated display technologies, wireless communications, miniaturization, and interactive media facilitates evolution from passive desktop-centric computing to a new disruptive ubiquitous display environment. The media and visual content will support a diverse variety of display devices that can enable users to seamlessly interact with information. The display would become an active part of the workspace interacting between the user, data, environment, and other displays. For example, a smart refrigerator may be able to be cognizant of its contents, monitoring freshness, warning of outdated items, and planning menus from food on hand. Personal biometric monitors could imperceptibly modulate heating and cooling, and illumination settings for an individual. Computers could be embedded into wristwatches, clothing, walls, and objects of all sizes to facilitate targeted interactive media. What innovations are required to make the concept of ubiquitous displays a reality? What novel methodologies are being applied to achieve the desired capabilities of ubiquitous displays? What kind of applications are being investigated or envisioned?

Novel and Emerging Applications

Novel, emerging, and/or other unique display-related technology can offer an opportunity to solve issues that many may not even realize as issues until a solution is presented. What unique imaging applications can be brought to reality and what opportunities exist for displays and virtual imaging that have eluded the common path of display technology development? From microdisplays and handhelds to wall displays to projection systems, all sizes and approaches are of interest. All areas of display technology applications from point-of-sale information screens to advanced social media enablers belong in this category. In particular, display-related technologies might have non-display applications, some of which to date have been revolutionary. What new applications are enabled for technologies that stem from display industry?

APPLIED VISION / HUMAN FACTORS

Stereoscopic and 3D Display Perception

Current stereoscopic or 3D display technologies and content often provide visual cues that differ significantly from the visual cues in our natural viewing environment. Submissions which discuss the impact of 3D and head-mounted display technologies on viewer performance, engagement, enjoyment, comfort, and fatigue are encouraged. Included are proposals and evaluations of novel evaluation techniques, novel technologies for improving specific aspects of the human experience, and studies quantifying the effect of display parameters, system configurations, content-generation technologies or 2D–to–3D conversion algorithms on user performance when using stereoscopic and 3D displays.

- Methods for quantifying comfort and eye strain
- Methods for quantifying the usefulness of 3D
- Novel technologies for improving the human experience
- Evaluation of display parameters and system configurations on user performance
- Evaluation of the interaction of display parameters with content generation or 2D–to–3D conversion methods
- Evaluation of human experience on interacting or touching 3-D virtual images
- Evaluation of vision and human factors on holographic displays

Lighting and Adaptation

Submissions are sought which explore the impact of display illumination, interactions of ambient and display illumination, and novel methods for producing luminance from a display on user performance and comfort. Of particular interest are papers that discuss the interaction of a display with the ambient-lighting environment. Submissions should concentrate on the design and evaluation of illumination sources for enhancing the human experience. Included are models and metrics of human perception, novel system designs that demonstratively enhance the impact of these systems on user performance and comfort, and studies quantifying the effect of lighting and illumination conditions on the user experience.

- Perception of displays in dynamic or bright ambient conditions
- Design of display lighting systems based upon user performance models and metrics
- Impact of ambient conditions on display performance
- Evaluation of the impact of display lighting systems on human performance
- Impact of glare on displays for human vision

Display-Centric Interaction

Advances in touch screen, gesture, and haptic systems provide the user the ability to interact directly with displayed information. Submissions are sought which discuss advances in user interaction paradigms and advances in input devices, which improve user performance. This area further includes development and evaluation of interaction paradigms involving the impact of cross-modal display or sensing technologies. Submissions within this area are expected to explicitly demonstrate the impact of the relevant technology on user performance, enjoyment, engagement, or comfort.

- Development or evaluation of user paradigms involving touch, gesture, and haptic input
- Cross-modal interaction (display or sensing of touch/sound/smell with visual information)
- Usability evaluations or comparisons of display-centric input devices
- Human-visual effect with augmented-reality interaction

Display Perception and Image Quality

Papers are sought discussing all aspects of display perception and image quality. Topics in this category include papers concerning color management, models of human tone and color perception, perception of high-dynamic-range displays, image-quality metrics and human-vision models, and impact of video artifacts on display quality.

- Models of human tone and color perception, including color-appearance models
- Quality management in the imaging chain (*e.g.*, from camera to display)
- Color management, including gamut expansion and gamma
- Perception of high dynamic range
- Perception of ultra-high resolution
- Perception of wide color gamut
- Image-quality metrics and human-vision models
- Impact of video artifacts on perceived quality

Vision and Human Factors on Emerging Displays

Not only conventional flat-panel displays, but also more and more emerging new display systems and applications have been developed. Submissions within this area are expected to explicitly illustrate the impact or issues of human vision for any of the emerging displays.

- Wearable displays, including smart glasses and smart watches
- Immersive displays, including curved displays and super-high resolution (> 4K x 2K) displays
- High-reflectance displays, including reflective MEMS and e-paper
- Medical displays and images
- Flexible/bendable/foldable displays
- Transparent displays
- Microdisplays

DISPLAY ELECTRONICS

Electronics and Image Processing for Wearable Displays

Wearable displays are one of the fastest growing areas in both consumer products and technological development. Thanks to advancement in low-power advanced RF technology, advanced microprocessor technology, and advanced display technology, the push for super-mobile applications is increasingly close to realization, especially for applications in augmented reality (AR) and virtual reality (VR). This topic will cover the emerging electronics development in wearable-display products, application, and technologies. Specific topics of interest include:

- Ultra-low-power electronics taking advantage of natural energy harvesting
- Image compression and processing for glass-type near-to-eye systems (including AR and VR)
- Attention-control display technologies
- Flexible display electronics for wearable displays
- Wearable sensing electronics
- Power management of wearable displays

Driving Electronics for Ultra-High Definition (4K x 2K and Beyond)

Displays with resolution that is higher than FHD (1920 x 1080) have been one of the biggest issues for next-generation televisions and mobile devices. A relentless push for super-high-resolution image content is requiring rapid evolution of displays. New issues need to be solved to implement displays with these higher resolutions. Papers are solicited that deal with system architecture, interface design, driving circuits, and algorithms that will enable higher-resolution displays such as 4K x 2K and beyond.

Driving and Compensation Circuits for Curved Displays

One of the key recent trends in display applications is curved display surfaces, ranging from large-format TVs offering immersive visual experiences to small-size displays enabling new mobile form factors and wearable devices. Papers are solicited that address the electronic driving, control, and compensation techniques for curved displays, including both large and small displays, technologies spanning LCDs, OLEDs, other emerging displays, and any special image capture and processing techniques for curved displays.

Electronics for Touch and Interactive Displays

The ways we interface and interact with the visual display content on the computing, communications, and entertainment devices are changing, with natural user inputs based on touch, gesture, voice, and multimodal technologies replacing or augmenting the use of traditional user interfaces based on keyboard, mouse, trackballs, and joysticks. Touch technology is already ubiquitous, especially on mobile devices, with annual shipments of touch screens well exceeding a billion units. We are now witnessing early proliferation of voice interfaces on mobile devices, gesture interfaces on consoles, and other form factors. This transition to natural and intuitive user interfaces is ushering in a new class of highly interactive and exciting applications and user experiences. This topic will include papers on the electronic subsystems for interactive displays, including sensors, algorithms, processing, user interfaces, and applications.

OLED Driving Techniques

AMOLED displays have been greatly improved and impacted mobile applications in recent years. Moreover, panel makers are focusing on large-sized television applications of AMOLEDs. They are facing many issues such as V_{th} compensation, low-power operations, 3D applications, high resolution, large-sized implementation, *etc*. Papers are solicited that deal with system architecture, interface design, and driving circuits and algorithms that will enable advanced AMOLED displays regardless of the panel size.

Display Drivers, TCONs, and New Driving Schemes

Despite the maturity of matrix-driven displays, there is no limit to improvements in the driving convention, particularly with new demands such as high refresh rate and large-area driving, high bit-depth, and crisp rendition of moving images. In addition, emissive displays, such as LEDs, PDPs, and OLEDs, have some major advantages over non-emissive displays, such as LCDs and LCoS displays. However, these displays require different driver performance and driving schemes than non-emissive displays. Papers should cover the advancements in drive schemes, intra-panel interconnects, and novel features, architectures, or circuits of driver and timing-controller ICs required to provide the best image quality for various types of displays.

Driving Circuits integrated on Glass

More and more driving circuitry is being integrated into the panel fabrication itself, specifically for row drivers. Papers in this topic should address the design and performance of integrated drive circuits for flat-panel displays using all types of TFTs including amorphous/poly-crystalline/single-crystal silicon TFTs, organic TFTs, and oxide TFTs, *etc*. Papers dealing with architectural and system-partitioning issues, yield and cost impact, low-power circuit structure, vertical stack-up for less capacitive loading, and performance limitations as well as detailed circuit design approaches are solicited.

High Speed Interface

As the resolution of displays increases especially in mobile and TV applications, required data rate of display interfaces becomes higher and higher. Low power consumption and low RF noise emission are essential requirements for long battery life and wireless connectivity of mobile applications. Papers are solicited that deals with interface between a graphic source and a stand-alone display device, an image processing board and a display panel, intra-panel interface between a timing controller and driver ICs. In addition, transmitters/receivers/transceivers, equalization techniques for off-chip interconnection such as signal channels over multiple PCBs or a panel glass, and image data compression algorithms for interfaces are encouraged.

Low-Power Low-Cost Driving Technologies

The need for lower-power displays has been the major driving force behind the development of many FPD technologies, mainly in the portable/mobile display area. But low power is also gaining importance in large-display applications while display performance requirements are intact or required to be even better. Besides, low-power mobile applications present constraints for display-system design that is entirely different from most other applications. This leads to ICs that are designed specifically for mobile displays, dealing, for example, with different display specifications, a broad application space, optimizations for varying ambient conditions, micro-power circuits for systems with super-low-power reflective displays, and, of course, low cost. Papers are solicited that deal with system architecture, interface design, and driving circuits and algorithms that will reduce display power consumption and implementation cost, as well as the latest developments in mobile-display electronics, ranging from ICs and system integration to specific electronic components.

Image/Video Capture and Processing Techniques

Image quality remains one of the most important market drivers for any display application, with the capture, processing, and display all playing crucial roles. The image quality on the display can be optimized by improving the display as well as by applying suitable image- and video-processing algorithms. This processing depends on the nature of the content captured as well as the characteristics of the display used. Papers are solicited that address capture or display-specific video-processing algorithms and circuits. General processing includes, but is not limited to, MPEG (de)coding, noise reduction, de-interlacing, scaling, contrast, sharpness and color enhancement, and frame-rate conversion. In particular, papers are solicited that go beyond this general video and image capture and processing and address various capture and display specific aspects, such as motion-artifact reduction, viewing-angle improvement, lifetime improvement, *etc.*

3D/Depth Imaging and Augmented/Virtual Reality

While contents based on 2D imaging have formed the backbone of today's display applications, depth-imaging technologies are advancing very rapidly, which are enabling new 3D interactive applications with life-like augmented and virtual reality. These technologies are allowing real-time superimposition of virtually rendered 3D objects on the 3D world. One of the important requirements towards providing compelling user experiences for augmented-reality applications are projection mapping technologies with visually consistent cues. Papers are solicited on the topics of depth-imaging, augmented- and virtual-reality applications, including correct mapping and rendering of augmented objects on the real world.

Manufacturing-Related Advances Enabling Current and Emerging Displays (including Flexible or Curved Devices, 3D Displays, Wearable, Multifunctional Display Architectures, *etc.*).

These sessions will focus on manufacturing related developments enabling new display technologies and form factors, along with the incorporation of added functionalities. This may include 3D displays, transparent displays, sensor-integrated display panels (*e.g.,* touch sensing, optical sensing, *etc.*), as well as novel approaches for manufacturing of existing displays.

Manufacture of OLED and Other Emissive Display Panels

These sessions aim to cover broadly the advances in the manufacture of emissive displays. In particular, papers on enablers of lower manufacturing costs of OLED panels are strongly encouraged – equipment, process, and materials advances as related to TFT backplanes, pixel-array fabrication, high-resolution patterning, packaging solutions, *etc.* More generally, papers relating to the manufacture of other emissive technologies are encouraged, including emerging technologies such as quantum-dot LED based displays.

Manufacture of AMLCDs and Other Non-Emissive Display Panels (including LCOS, MEMS-based displays, other LCDs, etc.)

Papers are solicited on topics related to the manufacture of active-matrix backplanes, including innovations in oxide TFTs and poly-Si, as well as conventional a-Si technologies. Examples of manufacturing innovations include process and equipment optimization, mask/complexity reduction, TACT time or yield improvements, and reduction of materials consumption. In addition, the logistics of substrate handling and processing, and overall factory layout, present significant manufacturing challenges. In addition to the above topics, papers describing advances in the manufacture of other non-emissive displays such as DLP MEMS-based displays are solicited.

Manufacture of e-Paper and Other Reflective Displays

Papers are solicited on topics related to the manufacture of reflective displays, such as electrophoretic, electrowetting, electrochromic, MEMS-based displays, *etc.* Particular areas of interest include pixel-array manufacturing and packaging/encapsulation solutions for rigid and for flexible panels. Additionally, papers describing advances in materials, processes, and equipment that enable high-volume manufacturing for this newer family of displays are encouraged.

Materials including Substrates, Films, Adhesives, and Consumables

The advent of new display types, shapes, and features often require the development of new processing equipment and techniques. These sessions will focus on the development and application of new designs or unique adaptations of equipment for the manufacture of displays. Possible topics include equipment advances in the areas of robotic handling, thin-film deposition and patterning, roll-to-roll printing, flexible films, spacer construction, and/or application. Papers applying printing methods in display manufacturing are encouraged.

Manufacturing Equipment for Front- and Back-End Processing, including Packaging, Encapsulation, Interconnect, Assembly, and Roll-to-Roll Processing

The advent of new display types, shapes, and features often require the development of new processing equipment and techniques. These sessions will focus on the development and application of new designs or unique adaptations of equipment for the manufacture of displays. Possible topics include equipment advances in the areas of robotic handling, thin-film deposition and patterning, roll-to-roll printing, flexible films, spacer construction, and/or application. Papers applying printing methods in display manufacturing are encouraged.

Display Component Manufacturing (*e.g.,* Touch Sensors, Backlights, Optical Films, LEDs, Cover Glass, *etc.*).

Finished display products include a variety of components complementing the display panel in the target application. Papers focused on the manufacture of such components are encouraged, including touch sensors, backlight and frontlight light guides, optical films, protective cover glass, and others.

Display Module Manufacturing including Panel and Module Assembly.

Emissive, non-emissive, LCOS, DLP, OLED, FED, reflective displays, and MEMS, as well as other display types each have individual assembly and packaging requirements. Papers describing display module assembly, including plate-to-plate alignment and encapsulation techniques, interconnect technologies such as ACF, and other flex and chip attach methods will be addressed in this session. Further, papers are encouraged on topics related to materials, processes, and equipment enabling module assembly of display panels and associated components, including touch panels, backlights, cover glass, *etc.*

In-Line Manufacturing Test, Repair, and Metrology.

Papers addressing final assembly, test, repair, as well as in-line testing and production-yield monitoring are of interest for this session. Papers are requested covering technology advances for the manufacture and handling of very large TFT glass substrates and how this relates to both equipment and factory design, impacting test and repair methods and yields. Testing of smaller displays such as for the cell-phone market may have a different set of manufacturing test requirements; advances in these areas for yield improvements, new methods, and cost reduction techniques are also encouraged. Also of particular interest are developments in the areas of automated optical inspection (AOI) and array repair.

Manufacturing Productivity

Papers dealing with a systems approach to manufacturing efficiency improvement or cost reduction will be the focus of these sessions. Possible topics include cost reduction and systems integration, quality management and resource planning techniques, manufacturing economics, cost-of-ownership issues, and the human factors in display manufacturing. Additionally, alternate manufacturing techniques that provide significant productivity enhancements, such as roll-to-roll processing, are solicited.

Green Manufacturing.

Papers are solicited on a broad range of topics related to reducing the environmental impact of displays, such as reducing material and energy consumption during manufacturing, waste management, as well as recycling strategies. Examples include equipment, process, and material innovations leading to improved material utilization and energy efficiency, studies on the design of new display manufacturing sites minimizing environmental impact, as well as papers aimed at the environmental considerations associated with display products end of life.

DISPLAY MEASUREMENT

Characterization of Perceptible Display Phenomena

Different physical and optical properties of various display technologies (*e.g.*, LCDs, OLEDs, projectors, reflective, flexible, curved, *etc.*) make it difficult to design characterization methods that deliver consistent results across manufacturers and technologies. Papers are solicited which propose and evaluate measurement methods and resulting objective metrics for comparing the perceptible display phenomena and performance criteria among display technologies in similar applications in repeatable and understandable ways. Papers on the characterization of motion artifacts, high-ambient contrast and color performance – which are strongly dependent on display technology -- are welcome.

Optical Characterization of Display Materials and Components and Their Effects on System Optical Performance

Many display technologies benefit from advances in optical and functional components, such as light-steering films, diffusers, polarizers, retarders, color filters, front-of-screen elements, touch sensors, and coatings. These components impact optical performance – including luminance, contrast, viewing angle, color, and uniformity. The effects also include changes to display MTF and clarity (*e.g.,* sparkle or haze), depending on component type, surface treatments, coatings, and assembly techniques. Papers are solicited that address the optical characterization of components and their impact at the system level.

Advances in Display Measurements Standards

Organizations such as the ICDM, ISO, IEC, and CEA are constantly proposing new methods and concepts in the field of display measurement to address characterization issues brought about by new technologies and applications. Authors are encouraged to submit papers that explore the performance and correlation of proposed methods from current or future international standards.

Measurement Methods for Near-to-Eye Displays for AR, VR, and Other Applications

Applications such as augmented reality (AR), virtual reality (VR), TV, and medical imaging impose unique demands on the specific display technology and the methods used to characterize their performance. Certain display types such as near-to-eye and projection, for instance, use complex optical systems that require unique characterization considerations. Papers describing methods, experiences and results in this area are welcome.

Optical Characterization and Measurement of Light-Field and 3D Displays

In addition to the traditional display optical characteristics that must be evaluated when describing the performance of light-field and other 3D displays, qualities related to 3D-specific functionality must be measured and described. Authors are encouraged to submit papers that are unique or of special interest to light-field and 3D display characterization.

Calibration and Verification of Instrumentation

The field of display metrology benefits from the growing number of instrument developers and new devices. These benefits come with the challenge of verifying the accuracy and traceability of new instruments, as well as their suitability for a given task. Of special interest are procedures and simple diagnostics for on-site calibration. Authors are encouraged to submit papers which describe their recent work in calibrating, testing, and validating new instrumentation.

Optical Property Modeling of Display Technologies

Numerical optical models are often used to aid the design process for new displays. Papers are solicited which explore the theory of these optical models and correlate the models against measured results. Authors should carefully describe the measurement methods as well as the model details.

DISPLAY SYSTEMS

Display Systems

Display Systems employ a variety of electronic devices to harness a man to a machine via high-bandwidth pathway. The devices are sustained by a wide spectrum of advanced components. Novel developments in display system elevate the quality of communication. Papers on new technologies for display systems, modification or improvements of existing systems, real-time controlling or monitoring of operations, and system evaluations are of interest and solicited.

Novel Displays

New and unconventional display systems of today are building blocks for the products of tomorrow. From microdisplays to hand-helds to wall displays to projection systems, all sizes and novel approaches are of interest. Papers are solicited that describe new-concept display systems and may include novel devices, integration, or image processing.

Mobile Displays

As we move toward an ever-more-connected society, mobile displays with increased size and resolution and improved optical parameters are becoming ubiquitous in smart phones, network-connected e-Readers, a wide range of consumer and enterprise communicators, and mobile Internet devices. All of these applications require low power, low weight, thinness, small overall volume, and increased mechanical durability while improving display visual performance. Unique system designs that improve and/or optimize any or all of these aspects of mobile displays are solicited.

Wearable, Virtual-Reality Displays

In the design of mobile devices, such as cell phones, conflicting criteria are present. On the one hand, there is a demand for increased display size and resolution so more information can be presented, while, on the other hand, there is a pressure to reduce the overall size and weight of devices and to increase battery life. Near-to-eye displays offer a compact and low-power solution that can provide large high-resolution imagery to users. Near-to-eye displays include bring-to-eye displays in advanced cell phones, compact systems for head-mounted displays used in mobile computing, electronic viewfinders for cameras, and personal theater systems. Other applications of near-to-eye displays, such as augmented reality, virtual reality, training/simulation, and computer gaming, demand higher resolution and greater field-of-view than mobile devices, yet reducing the size of these larger head-mounted displays is also a priority. Papers are solicited which address novel image sources, optical system designs, and integration of near-to-eye displays into these various devices.

Ultra-Low-Power Displays

Energy saving is a key issue for display technologies. Decreased energy requirements are vital for mobile applications that run on

limited battery capacity. Lower power consumption is also critical for non-mobile display technologies such as television, to conserve limited environmental resources. Papers are solicited that describe methods of energy saving in displays, reduction of power consumption during display operation, and related topics.

Transparent Displays

As information displays become increasingly ubiquitous, transparent or see-through displays have the potential to enable new and innovative applications. Papers are solicited on transparent display technology and innovative display system designs that effectively integrate transparent displays for new applications

3D, Autostereoscopic, Light-Field, Compressive, Volumetric, and Holographic Displays

3D display techniques enable users to enjoy realistic imagery having depth, which makes it attractive in wide range of applications. Advanced 3D display techniques not simply give depth perception by binocular parallax but physically form optical images at arbitrary depths by reproducing corresponding light-field or wavefronts. This feature enhances the reality of the perceived images, and it can also remove the issues related to the 3D fatigue. Especially, recent development in wearable displays and its application to augmented-reality make 3D display techniques even more important. Papers are solicited across the full spectrum of 3D display technologies including stereoscopic, autostereoscopic, light-field, compressive, volumetric, and holographic display techniques with particular interest in the enhancement of viewing angle/resolution/depth range, removal of accommodation-vergence mismatch, reduction of cross-talk, improved luminance, reduced distortion for multiple viewers, and reduction in system cost as well as approaches to manage the computational load of voxel, light-field, or holographic data. Papers related to the applications of the 3D display techniques to emerging display systems including near-to-eye displays, head-up displays, and eye aberration correcting displays are also solicited.

Ultra-High-Resolution Display Systems

The development and deployment of next-generation TV, cinema, and public display systems have many interesting design challenges and tradeoffs because of the move towards ultra-high-resolution with formats such as 4K and 8K UHD. Papers are solicited that describe the design of ultra-high-resolution display systems for home or commercial use, including the technologies and tradeoffs required to scale to meet volume and cost targets for cost-sensitive markets such as home entertainment. Papers are also solicited that describe critical aspects of the ultra-high-resolution eco-system including data compression and transmission, color encoding, video and audio processing, high-frame-rate processing, stereoscopic and autostereoscopic 3D processing, and overall standards required for widespread adoption.

Digital 2D/3D Signage

The use of digital signage has become prevalent in almost every public area indoors or outdoors. These include TV-size displays all the way up to very large video walls. Papers are solicited on systems and technology developed specifically for digital signage. This may include the use of 3D, contrast and luminance improvement for outdoor application of signage, sunlight-readable signage, wide-range dimming capability, mechanically strong signage to protect from tampering and vandalism, signage with a wide operating-temperature range, effective ways of utilizing a screen for transmission of multiple sets of information, signage operation systems, and related topics.

Backlight/Frontlight Units

A BLU is an indispensable device for transmissive or transflective LCDs. However, employing a BLU results in an increase in the power consumption as well as in the thickness of an LCD module. Papers on the following technologies are solicited: (i) functional light-guide plate (LGP) or light-guide film (LGF) for BLU used in mobile displays, (ii) flexible BLU, (iii) slim BLU for LCD TV and monitor, (iv) power consumption reduction and thermal management, (v) solid-state light sources used BLU with three primary colors or more for field alternative LCD, (vi) dynamic BLU for real-time control of color and luminance over time, and (vii) mono-directional, multi-directional or directional scanning BLU. The reduction of power consumption in a display is an attractive and challenging theme. Reflective displays such as electronic paper (e-Paper), microelectromechanical system (MEMS) or microelectro-optical-mechanical system (MEOMS) based displays, and reflective LCDs have great advantages over the transmissive displays in terms of low power consumption, color gamut, and high contrast under bright ambient illumination. However the optical characteristics deteriorate under a dim environment. Frontlighting a reflective display using an edge-lit light-guide plate is a unique method to modulate the displayed images and recover the optical characteristics under a dim environment. Since a front-light unit (FLU) is an indispensable unit for a reflective display in which the optical matching, efficiency, and the image quality through the unit are of great interest, papers on the FLU technologies and related components are solicited.

Backlight/Frontlight Components

To achieve a slim structure with low power consumption and the wide color gamut of LCDs, advances in backlight-unit components, advent of novel materials, and adoption of more efficient-fabrication process are indispensable. Papers on novel optical components are solicited with particular interest in the following technologies: (i) novel optical components; quantum-dot films, quantum-dot capillaries, LEDs, lasers, light-guide plates (LGPs), prism films, diffuser films, and reflective films that have unique functions, structures, and high performances; (ii) optical-components-based novel materials such as unique phosphors, particles, coating materials, and zero-birefringence polymers; (iii) optical components fabricated by novel methods such as significantly thin LGPs by extrusion processes and integrated backlights by role-to-role processes. As it has been explained for Backlight/Frontlight Systems, the reflective displays have great advantages over the transmissive displays in terms of low power consumption, color gamut, and high contrast under bright ambient illumination. The edge-lit FLU is a unique technology for lighting the reflective displays. Papers on the FLU technologies and related components are solicited.

EMISSIVE DISPLAYS

Quantum-Dot Materials

Quantum dots are an emerging class of materials that are impacting display performance today in LCD backlights, and in the future in emissive displays (QLEDs). Innovations are proliferating at the material, deposition, component, and system levels in this very nascent field. Papers concerning the science and technology of quantum-dot materials, for both LCDs and QLEDs are solicited.

Quantum-Dot Applications

Quantum-dot down-conversion is already impacting LCD performance in LCD backlights by using a variety of implementations. Research and development into the photoluminescent down-conversion or down-shifting applications of quantum dots, their benefits, unique implementations, packaging methods, and optics are accelerating. Papers concerning the implantation of quantum-dot materials in display devices are solicited.

Quantum-Dot Cathodoluminescence and Electroluminescence

With the market success of quantum dots as down-conversion materials for LCDs, their application in future emissive displays (QLEDs) has seen a resurgence of interest within the research community. In addition, the unique properties of QDs have lent themselves to novel research on the cathodoluminescence (CL) properties as well as on their application. Papers concerning the EL and CL characteristics and uses of quantum-dot materials are solicited.

Organic–Inorganic Perovskite (OIP) Electronics

Organic–inorganic perovskites (OIPs) have recently attracted intense interest owing to potentially be good fluorescent and electroluminescent properties. The electronic properties can be easily manipulated by molecular engineering, thus making them valuable as an additional set of materials for applications in displays and FETs. OIPs have been employed in light-emitting devices (OIP-LEDs) in an analogous manner to OLEDs. Papers concerning OIP fluorescence, electroluminescence, OIP-LEDs, and OIP-TFT devices are solicited

Phosphors

PDPs, inorganic EL displays, LEDs, FEDs, and CRTs are all light-emitting devices that use phosphors. Research and development of phosphor materials for these devices are expected to improve the light-generation efficiency, longevity, and reliability of such devices. Papers concerning the science and technology of phosphors for these devices are solicited.

Plasma, Field-Emission, and Inorganic EL Displays

Plasma displays, field-emission displays, and inorganic displays are all mature display technologies that have had varying degrees of market success and remain of interest to the research and development community. Papers concerning the power consumption, panel design, image quality, new driving method, electronics design, manufacturing, novel application, or material innovation within any of these display modes are solicited.

Micro Light-Emitting Diode

Micro-sized LEDs have the potential to deliver extremely high-resolution glasses-free 3D images with holographic capability and large-sized displays with very low power consumption. Papers that describe the science and technology of micro-LED devices, electronic control, materials, and characterization for display applications are solicited.

e-PAPER AND FLEXIBLE DISPLAYS

Electronic Paper

Electronic paper (e-Paper) combines the benefits of ink on paper with the rewritability of an information display. This category includes both rigid and flexible displays employing electrophoretic, electrowetting, flexible Ch-LCDs, MEMS, and other novel reflective displays. Papers submitted in this category may cover topics such as the characterization and measurement of e-Paper display performance, or integration issues specific to e-Paper displays. Backplane electronics, integrated drive electronics, drivers, applications, and user interfaces for e-Paper displays are included in the topic.

Flexible OLED and Other Emissive Materials, Displays, and Devices

Flexible OLEDs and other emissive materials such as quantum dots continue to be of high interest to the display community for more robust, rollable, or even foldable device form factors. Papers describing novel techniques enabling flexible emissive displays, flexible high-efficiency and robust materials, flexible encapsulation/passivation techniques and materials, protective surface materials, manufacturing methods suitable for flexible OLEDs, and stable passive- and active-matrix flexible black and white, gray-scale, and full-color displays are particularly welcome.

EPD, MEMS, and Other Non-Emissive Flexible Displays and Devices

Liquid crystals are the most familiar non-emissive displays. MEMS technology is always important as micromirrors in projection displays, but novel emissive and non-emissive applications for direct-view mobile displays, e-paper, and signage are also under active development. Papers are sought on MEMS, electrophoresis, electrowetting, electrochromism, and other non-emissive technologies, as well as their associated materials for flexible applications.

Wearable and Stretchable Displays and Sensors

Flexible, stretchable, thin, light, and robust displays offer the potential to integrate interfaces into objects in the environment and to wear on the body. While touch has quickly become a preferred method for interaction with displays, other sensors and input modes can enhance the user experience with a more intuitive, seamless, and data-rich interaction. Papers are sought on all manner of flexible or wearable touch and other environmental or bio-sensors, flexible display interfaces, and novel applications or uses for flexible electronics.

Flexible Display Materials Including Substrates, Films, Adhesives, and Barriers

Material developments to support the efforts of flexible-display development are appropriate topics for these sessions. These topics include new substrate materials, properties, and handling methods; flexible barriers, improvements in consumable materials such as photoresist and sputter targets; and performance-enhancing materials such as adhesives, polarizers (including film and coated polymer types), and optical-enhancement films. Assembly, module, and interconnect materials such as adhesives, desiccants, and ACF are included. Papers dealing with flexible films, roll-to-roll materials and processes, and ink-jet printing are solicited.

Organic and Inorganic Solution-Based TFTs and Device Performance

Organic and other printable TFTs show promise as a potential low-cost TFT alternative to Si-based TFTs for a range of display applications, and particularly for flexible-display applications. Active-matrix displays produced with low-temperature processes on flexible substrates can provide increased durability, better shock resistance, decreased weight and thickness, and unique product shapes. To ensure success, these devices must show sufficient mobility, low-leakage currents, acceptable on/off ratio, uniformity, and especially good stability, both environmentally and under bias-stress conditions. Papers relating to printed electronics and integration with display devices are sought including the fabrication and performance of low-temperature a-Si:H, poly-Si, oxide-based, organic, or new array processes, flexible substrate material issues such as chemical attack inertness or dimensional tolerance control due to distortion, compaction and/or warping, substrate material, and processing cost. Contributions are also sought on novel pixel designs, process, high integration, and addressing methods.

Integration, Packaging, Testing, and Reliability for e-Paper and Flexible Displays

As new flexible display technology is developed for e-paper, OLEDs, and novel display technologies, key aspects of their commercialization will be the integration and packaging of these displays, and the reliability to both environment and mechanical stressing. Papers are sought that address these issues including package and driver designs, testing results, tools, procedures, and materials.

Flexible-Display and e-Paper Manufacture of and Equipment for Printed Electronics

As new technologies are maturing, novel equipment and processing methods are being developed to take advantage of new materials and substrates. This topic includes low-temperature processing of materials; roll-to-roll manufacturing, printed, and solution-based processing of electronic materials. Papers discussing advances in tools, materials, devices, and displays are sought.

Applications and Ergonomics of Integrated Flexible Electronics

The integration of displays with other functional flexible electronic components is a key manufacturing challenge for the industry, but often essential to realize new applications for integrated or wearable electronics. The ergonomics of such systems is also a key element for market acceptance. Paper are sought covering comprehensive functional systems produced on flexible substrates including display devices, memories, sensors, batteries, solid-state lighting, photovoltaic or other technologies used in conjunction with an electronic display. Materials, process technology, assembly, functionality, and simulation are welcome. Criteria, demonstrations, or new uses related to the ergonomics of such devices are also sought.

LIGHTING

Materials and Devices for Solid-State Lighting

Papers describing notable developments in LEDs and OLEDs with breakthroughs in efficacy, color rendering, reliability, lifetime, and/or manufacturing efficiency are solicited. Papers on developments in critical components such as substrates, electronics, optics, light extraction, phosphors, thermal management, and packaging and encapsulation are sought.

Visual and Non-Visual Effects of Lighting

Papers describing the quality of light, including color rendering, flicker, and glare for indoor and outdoor applications; the biological and psychological impact of light and related health effects; visual neuroscience behind lighting or display design; and visualizing lighting on displays are solicited.

Smart Lighting and Intelligent Luminaires

Papers describing new developments in lighting networks, sensors, embedded intelligence, visual light communication, and/or novel user interface are sought.

Color-Changing and CCT-Tunable Luminaires

Papers on the control systems, strategy, and algorithms for color changing or CCT tuning are solicited, along with papers on the application of or case study on these luminaires.

LIQUID-CRYSTAL AND OTHER NON-EMISSIVE DISPLAYS

LCDs for Advanced Monitors and TVs

Papers related to large-area high-resolution LCDs for advanced monitor and TV applications, with emphasis on displays or key components, including the backlight, driving, and video-processing technologies for high-contrast ratio, high panel transmittance, wide viewing angle, low color washout, fast response, low moving-image blur, and high video qualities are solicited.

LCs beyond Displays

In addition to displays, liquid crystals have also been widely used in many photonic applications, such as spatial light modulators, adaptive lenses, diffractive optics, lasers, biosensors, thermo-sensors, smart windows, tunable filters, fiber optics, non-linear optics, and microwave and terahertz phase shifters. Meanwhile, many interesting applications of liquid-crystal polymers and elastomers have been demonstrated. Original papers addressing advanced materials, new phenomena, device physics, and new applications are encouraged.

Wearable Displays and Microdisplays

The development of technologies for wearable displays, including microdisplays, viewing optics, electronics, and frame systems, are necessary for the commercialization of consumer products. In addition, the handheld LED-based microprojectors and video goggles have also established a stable market need. This session will focus on recent advances in eyewear displays, LCOS, HTPS, as well as LTPS technologies, including panel design, LC modes, and optics. Papers on LED-based system integration are welcomed.

Color Enhancement in LCDs

The topic will cover application of quantum dots and other technologies such as improved color filters and LEDs to enhance the color and widen the color gamut in LCDs. It provides a low cost solution for a wider color gamut than OLED approach (example Sony TV using quantum dots from QD vision).

Blue-Phase LCDs

Optically isotropic liquid crystals, including polymer-stabilized blue phases, offer several attractive features for next-generation displays, such as submillisecond response time, no need for alignment layer, wide and symmetric viewing angle, and cell-gap insensitivity. However, some technical issues, *e.g.*, high operating voltage, wide temperature range, and hysteresis, remain to be solved before widespread applications can be realized. Papers addressing advanced materials, polymer-stabilization processes, device physics and performances, prototype development, photonic applications, and long-term stability are encouraged.

LCDs for Mobile Applications

Papers on improving the thickness, weight, size, robustness, flexibility, transmittance, contrast ratio, power consumption, sunlight readability, and SOG as well as value-added functions such as touch input, scanning function, direct writing input, TV on the go, and exploratory advances for mobile LCDs are solicited.

LCDs for Automotive Displays

This topic will cover the application of LC-based automotive displays for reliable display[lay performance under all weather conditions. Contributions on a variety of automotive-display form factors are welcomed.

Bistable Displays/LC-Based e-Paper

Papers on bistable displays that offer many advantages of no or low cross-talk, high resolution, and low power consumption are solicited. They are ideal for portable and remote displays. Papers focused on the development and application of BTN, FLC, BCD, and other bistable LC technologies are also solicited.

Reflective/Transflective Displays

With the trend to ever-more portable and low-power electronic devices such as mobile phones, DSC, DVC, PDAs, e-books, games, laptops, small TVs, and DVD players, there is a growing need for reflective and transflective displays with improved visual performance. Many of these applications are demanding full-color video performance. Sunlight readability imposes a big technical challenge to mobile displays, such as cell phones, PDAs, and digital cameras. To overcome this issue, reflective, transflective, and high-brightness transmissive displays with adaptive brightness control have been proposed. However, the viewing angle, contrast ratio, color saturation, and color gamut of reflective displays are still inadequate. Papers are solicited to cover this important field from new device physics and materials, electro-optical effects, bio-inspired anti-reflection coating to touch-screen display systems in which all aspects of the visual requirements are addressed.

Ferroelectric/Antiferroelectric LCDs

Ferroelectric liquid crystals have demonstrated a wide variety of effects ranging from binary, bistable, analog, as well as three-state switching observed in antiferroelectric LCs. The microsecond switching speeds afforded by this class of materials have thus far resulted in the commercialization of time-sequential color displays with 24-bit color, with over 23 million cameras incorporating FLC microdisplays sold to date. Papers on the next wave of new displays and products based on FLC/AFLC technology are of interest. Other modes such as those based on the deformable-helix FLC (DHFLC) and SmA electroclinic effect are also welcomed. Papers that describe the latest advances in device fabrication, new FLC structures, modeling, alignment, other novel effects and driving methods for this promising class of materials are solicited.

Alignment and Photoalignment Technologies

Papers on new alignment and photoalignment materials, processes, characterization techniques, stability issues, mechanism, and modeling are solicited. New materials, methods, and manufacturing processes for AMLCDs, wide-viewing-angle LCDs, and defect-free LCDs are particularly welcomed.

Non-Emissive Displays for Digital Signage

Advertising and signage displays are moving increasingly from printed to digital media. Some technologies such as LED and projection displays are already well established in this area, but liquid-crystal displays designed specifically for signage applica-tions have made major penetration in the last year because of their advantages in power consumption and ownership cost. Submitted papers are invited which address specific aspects of technologies associated with signage such as the ability to operate with adequate color reproduction and readability in both sunlit and zero ambients, optimized reflective and transflective technologies, optimum display and pixel size, the ability to tessellate displays into acceptable viewing surfaces, novel technologies to enable viewer interactivity, power efficiency, *etc.*

Fast-Switching LCDs

Fast optical response is an essential factor to improve the image quality of LCDs; in particular, for those requiring full-motion-video images without motion blur. It is also of great interest for field-sequential-color displays. Faster frame rate is the most practical method to reduce motion-video image blur in LCD TVs. The session discusses all aspects of fast response in LCDs such as LC materials, cell parameters and fabrication, display driving including over-driving schemes, and novel LC modes.

LCD Modeling

Modeling of LCDs often provides insight into the physics of observed display characteristics. This insight can lead to optimized or entirely new types of display devices. The session will focus on modeling methods and their application toward the understanding and optimization of LCDs. Submission of papers in this area are encouraged.

Wide Viewing Angle

Viewing-angle and gray-scale performances can be enhanced and color washout can be reduced by various means, such as new LC modes, cell designs, driving techniques, illumination |management and ray mixing, novel subpixel designs, improved materials, and optical compensation with films or of LC modes, such as TN, IPS, MVA, and OCB. Contributions on these topics are welcomed.

Display Films

Display films used for LCDs provide significant value and differentiation to display systems. Some films, including compensation films, brightness-enhancement films, light-redirection films, polarizers, mirrors, anti-reflection/anti-glare films, and privacy filters, have optical effects. Other films have functions such as static or thermal dissipation, EMI shielding, front-surface protection, and anti-fouling property. Papers on all films that add value to the LCD are welcomed.

LCD Materials and Components

Enormous efforts have been made to develop advanced materials and components, such as liquid crystals, polymer materials, and optical films, to improve the image quality of conventional LCDs as well as to develop novel LCDs. Display image quality is always required to improve further from a variety of aspects. Papers covering recent developments in materials and components for uses in advanced LCDs are solicited.

Nanotechnology for LCDs

The enhancement of the EO characteristics of LCDs by the doping of nanoparticles and the functionalization of surface alignment layers for LCs using nanotechnology are interesting and useful. Papers furthering this new era in LCD technology in terms of nanotechnology are highly welcomed.

Driving Mechanisms

The interaction between a display device and its drive electronics has long been a fruitful focus for research and invention. Clever addressing schemes underlie improved contrast in passive-matrix LCDs, faster updates of bistable displays, and accelerated switching and lower power in AMLCDs. Reports of

new advances in this field are expected and welcome.

Photonics Optical Components for LCDs

Optical components play a very important role in LCD performance and functionality. Papers in the area of optical components that improve LCD performance or enable unique functionality are solicited; for example, retardation film, lens arrays, compensation film, and beam-splitting film.

Polymer Composites

Liquid-crystal/polymer composites have demonstrated very interesting properties, many of which are difficult to achieve with conventional liquid-crystal devices. Examples include large-area displays, flexible displays, and optical effects based on diffraction, light scattering, dichroic absorption, or isotropic to anisotropic transitions. This session will cover recent advances in nematic, cholesteric, smectic, and blue-phase liquid-crystal composite systems.

LC Technologies for 3D

After years of development, 3D displays have become part of our daily lives. Papers on applications of 3D using various LCD technologies, such as fast polarization switching, beam steering, fast shutters, *etc.*, are welcomed. Related topics to 3D goggle design, direct-view displays, and projection displays are also solicited.

ORGANIC LIGHT-EMITTING-DIODE DISPLAYS

OLED TV Mobile and Large Area Applications

OLED-based displays have several unique attributes that continue to drive interest for television applications. As well, the explosion in portable video-capable devices such as tablets and smartphones place high demands for the displays. 3D television application puts a higher demand on display power, response times, and high dynamic range. Papers are sought that describe unique OLED display demonstrations that highlight the unique attributes of OLED architectures. In particular, papers are sought for OLED-based displays with unique attributes that include transparent OLEDs, high-resolution displays on novel active backplanes, large-area displays for TV. Papers covering materials (small molecule and polymer), devices, patterning, and unique drive schemes leading to television applications will be considered.

Novel OLED Materials and Architectures Enabling Emerging OLED Displays

Unique solid-state, low-process temperatures are enabling features for full-color flexible emissive displays. In addition, the OLED ultra-fast response times contribute to vibrant 3D displays. Papers describing enabling device architectures and robust thin-film encapsulation that lead to stable passive- and active-matrix flexible full-color displays are particularly welcome. Papers describing novel OLED architectures that contribute to 3D displays will be an important contribution to OLED sessions. Such device architectures may include top and bottom emitters that uniquely enable OLEDs on flexible substrates.

Active- and Passive-Matrix OLED Display Technology

Papers that discuss the progress and challenges for OLED display performance and manufacturing issues generally applied to active- and passive-matrix displays are of particular interest.

Emerging OLED Displays

Papers in the area of OLED devices with rare and exceptional characteristics such as polarized emission and transparency are sought. Papers addressing novel and robust materials and fabrication techniques are especially welcome. Such paper topics include large-area signage, unique passive addressing.

OLED Device and Materials Fundamentals

Papers in the area of OLED and polymer-OLED materials and device architectures with state-of-the-art performance in terms of color chromaticity, high power efficiency, and long operational lifetime at display level luminance are sought. Papers are solicited for novel techniques which enhance out-coupling efficiency of OLEDs. These include areas of microcavity, index matching, optics, simulation, and design of OLED microdisplays. Of particular interest are deep-blue and white devices with high efficiency, color, and long lifetime.

Injection and Transport Mechanisms, Molecular Engineering and Device Structure

The continued improvements of organic materials via molecular engineering and fundamental studies of dynamics of charge carriers and excited states are important to the OLED industry. Papers treating injection, charge generation, transport, and recombination phenomena in individual materials, interfaces, and complete OLED devices are sought, including modeling and computational chemistry techniques. Of particular interest are contributions that apply to the understanding of device and material fundamentals to design OLEDs with high efficiency, low voltage, long lifetime, and saturated color emissions.

OLED Stability and Degradation Mechanisms

Lifetime of OLED devices is one of the most important factors enabling their display and lighting applications. Papers providing insight into degradation mechanism and describing novel materials and device architectures to substantially increase lifetimes and suppress differential aging and image sticking are solicited.

OLED Applications for Lighting

High efficiency, high CRI, and robust white OLEDs for RGBW displays, color-filter approaches, solid-state lighting, and backlighting for LCDs are of special interest to the display and energy-conscious communities. Papers describing novel materials (fluorescent and phosphorescent) and device architectures that are capable of producing efficient and stable white emissions are particularly welcome.

OLED Manufacturing

Novel full-color OLED fabrication and patterning techniques that are capable of producing high-resolution displays are of high interest for the industry. Papers dealing with recent advancements in areas of thermal deposition, ink-jet printing, nozzle printing, other novel small-molecule and polymer deposition techniques as well as development of solution-processed OLED materials and devices are sought. Particularly, approaches to obtain multilayer devices from solution are highly welcome.

OLED Systems Packaging, Integration, and Cost Reduction

Encapsulation is critical to ensure long operational lifetime of OLED displays. Papers describing packaging and thin-film encapsulation advancements for novel designs such as top-emitting and flexible displays are of particular interest to the community.

Projectors and Projection Technology Overview

Papers are sought relating to all aspects of projection technology. Papers in the past have included innovative projectors, solid-state lighting, microdisplays, components, projection system innovations and applications, and others. Topical areas include:

- Projectors and projection technology
- Projection optics
- Solid-state lighting components for projectors
- Projection for cinema
- Portable projectors
- Projection in near-to-eye displays
- Emerging applications for projection systems
- Human factors in projection systems
- Image processing for projection systems
- Head-up projection displays
- Projection screens
- Projection light-field systems
- Projection mapping
- Digital signage

Electronic Projection Systems Based on Microdisplays, Scanned Lasers, or Other Technologies

Papers related to the systems-level design of projection systems and light engines are encouraged, as are papers related to the design of the image-generating elements. In addition, papers related to the miniaturization of a projection system and the reduction of the power consumption of projectors are welcome.

Pico-/Micro-, Mainstream, and Large-Venue Projectors; Multi-Projector Arrays

System-level papers related to individual projectors or projector arrays are welcome. Electronics to drive multi-projector arrays are included. Projection technology has expanded its reach in recent years at both ends: pico-projectors with low output and intended for only a few viewers are at one end and large-venue projectors with ultra-high output and intended for audiences of thousands are both important to the industry.

Emerging Applications for Projection Systems

Emerging applications often require new technologies and designs for the system to fulfill its intended purpose. Papers on unconventional applications of normal projection systems are solicited. 3D projection is an important emerging application for projection for both professional and consumer use. Papers on head-up displays (HUDs) and other systems that project virtual images are also strongly solicited.

Human Factors of Projection Systems and Projection Applications

Studies on how humans perceive projected images and how these projected images fulfill their intended purpose are welcome. Papers related to electronics to provide improved human factors, such as dynamic-range or color-gamut expansion, are also very important. Papers related to the human factors of 3D applications are especially welcome.

Projection-System Components, Including Image-Generating Components, Light Sources, Optics, Projection Screens, and Electronics

Projection systems are built from an extremely diverse set of optical, mechanical, electronic, and electrical components. Component-level developments are the key to advancing projection technology at the system level. Papers on light sources, including lamps, lasers, LEDs, and other approaches are important. Projection screens are a technology that is under represented in the technical literature. Light-management optics such as filters and polarizers are also important.

Opto-Mechanical Design of Projection Systems and Components, Including Lifetimes, Thermal Properties, and Acoustic Noise

This area of projection-system design is often under represented in the technical literature, and additions to the general pool of knowledge are important. Lifetime of components, including image-generating components, light sources, and light-management components such as polarizers are covered.

Projection Mapping

The use of projection technology for the illuminate non-traditional 'screen' surfaces has increased dramatically in recent years, with projection increasingly being used to bring to life building facades, cars, and other complex 3D geometries and surfaces. The current state of the art for the design and deployment of these experiences is largely manual and confined to 2D methods. Papers on techniques and methods to aid in the development and deployment of highly complex 3D projection mapping experiences are solicited. Topics can span any of the following areas: new projection-mapped content workflows, improved ease of setup techniques, accommodation for dynamic physical geometry, motion tracking, and interactivity

Other Topics Related to the Design, Manufacture, or Application of Projection Systems, Subsystems, or Components

Papers on virtually any topic related to the design, manufacture, or use of projection displays are welcome, even if the topic is not specifically mentioned. System efficiency improvements through co-design of multiple subsystems is a very relevant topic.

Touch Systems, Controllers, Sensor Design, and Signal Processing Algorithms

Papers in this session should describe novel state-of-the-art techniques for sensing multi-touch on a display, with quantitative characterization and discussion of their performance. Topics include:

- Touch controller electronics, AFEs, and driving schemes
- Multi-touch sensor design, stackups, and geometries (*e.g.,* diamonds, snowflakes, bars and stripes, telephone poles, *etc.*), including field studies
- Novel In-cell and On-cell systems
- Novel OGS (one glass solution) systems
- Signal and gesture processing algorithms, including palm rejection
- Processing architecture (host vs. ASIC side)
- Integration with display electronics
- Approaches to reducing latency

Novel Interactive Displays

This session solicits novel papers on interactivity that is fundamentally associated with a display. Examples include:

- Simultaneous Touch + Pen systems (both passive and active)
- Hover sensing (finger and/or touch)
- Pressure/force/strain sensing

- Integrated biometric sensing (such as fingerprint scanning)
- Other sensors integrated into the display substrate

We will not accept papers that describe user input sensing systems merely running alongside a display.

Materials and Process Technologies

The recent rapid evolution of touch-screen technology can be partly attributed to the development of improved materials, processes, and equipment for touch-panel fabrication. Papers are solicited in all aspects of novel material or process technologies for touch screens with improved performance or lower cost.

Materials include:
- Substrates (including novel glasses, flexible films)
- Functional coatings (*e.g,.* anti-scratch, fingerprint resistant)
- Transparent conductors (ITO alternatives, carbon, nanowires, metal-mesh, *etc.*)

Processes include:
- New fabrication processes for touch panels
- Patterning methods for touch-panel materials
- Interconnect processes to the external electronics
- Integration methods with the display (direct lamination/ bonding to the display or to the cover glass or as an even more integral part of the display)

Human Factors and Touch-Performance Evaluation
Methodology and Standardization

Touch-screen technology is now being widely used in almost all applications of displays; this has introduced us to many new touch devices. There are more than 10 touch technologies, more than 100 touch manufacturers, and many thousands of touch products. Accordingly, touch-performance evaluation and standardization has become much more important. Papers are solicited in all aspects of novel evaluation and/or standardization methodology of touch performance and characteristics. Aspects can be considered at the level of the touch panel, the touch module (panel plus controller), and/or finished products that use touch (mobile phones, tablets, notebook PCs, AiOs, IWBs, *etc.*). The evaluation methodology can include evaluation criteria, measurement systems, specifications such as accuracy, response, sensitivity, and internal/external noise immunity, new evaluation methodology for matching actual touch performance, and technology to standardize or quantify the evaluation and measurement methods used by each manufacturer. Methodology of subtle optical characteristics particularly found frequently in touch systems are encouraged. Papers in this session should also explore touch systems from the human perspective; for example, how human factors drive touch-screen specifications, appropriate gestures for different form factors, and user studies in an application context.

This special topic covers all aspects of automotive and related HMI issues, including market aspects, display and lighting technologies, head-up displays, application issues with automotive displays, and advanced technologies for displays and touch screens in vehicles. Papers in the following areas are solicited:

- Usage of and Trends in Automotive Displays, Interfaces, and Applications
- Customer Acceptance and Feedback on Different Technology Displays and Interfaces
- Regulation and Trends Related to In-Vehicle Interfaces
- Display and Lighting Technologies Applicable to Vehicular Applications
- Optical Components for Automotive Applications
- LEDs, OLEDs for Lighting, Signaling, *etc.*
- Human Vehicle Interface (HMI) and System Solutions
- Display Legibility, Visual Performance, Driver Distraction, *etc.*
- Touch Screen and Haptic Technologies for Automotive Displays
- Driver/User Interfaces (User-Centric Design, Devices, Human Factors, *etc.*)
- Displays and HMI for Driver-Assistance Systems (Navigation, Collision Warning, *etc.*)
- Head-Up Displays (HUDs), Augmented Reality, Night-Vision Systems/Components
- Vehicular Infotainment and Projection Displays
- Application Issues with Vehicular Displays, Lighting, and HMI
- Optical, Mechanical, Electrical, Thermal Performance,
- Modeling and Simulation
- Advanced Technologies for Displays and Touch Screens
- Touch-Input Devices (In-Cell, Water Resistant, Chemical resistant) for Automotive Displays
- Flexible, Curved, and High-Resolution (Low Power, Sunlight Readable) displays
- Motorbike Displays and Applications
- Aeronautic Displays and Applications