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DIA Awards Archive

The Display Industry Awards are the display industry’s most prestigious honor, given annually since 1995 by the Society for Information Display to recognize the best display products or applications introduced to the market during the previous calendar year.

Here are the award winners listed from 2014 and prior years.

2014 Award Winners

Display of the Year

Gold Award: Samsung Display's 5.68-in. Curved (Flexible) AMOLED Display

The Samsung 5.68-in. FHD curved AMOLED display represents a major milestone for the entire display industry – the world's first truly flexible full-fidelity display technology to be mass produced and adapted for use in a mass-market product. Now being produced on a plastic substrate, the new Samsung display panel enables smartphones such as the Samsung Galaxy Round to be curved, significantly improving a user's grip. Smartphone users will be able to comfortably hold a larger-screen version of the panel with just one hand. The smartphone has a curvature of 400 mm, while human hands have a natural curvature of about 300–500 mm. Also, the display enables a more visually immersive mobile experience with a “landscape view” aspect ratio of 1.88:1, comparable to the Vista Vision technology (1:83:1) now used in most movie theaters. In addition, the curved screen is more readable thanks to a significant reduction in light reflectance. Samsung's new curved display will later evolve into bendable and foldable displays that will further revolutionize the use of smartphones and other mobile-product form factors. The Samsung 5.68-in. FHD flexible display used in the Galaxy Round is fabricated on a special type of plastic that is capable of withstanding high processing temperatures to ensure adequate mobility, Vth, and other TFT characteristics. The plastic substrate is fabricated on carrier glass, and after TFT processing and organic material deposition, the substrate is removed from the carrier glass using a proprietary liftoff process.



Silver Award: LG Display's 55-in. FHD Curved OLED TV Panel

LG's curved OLED TV was introduced last year, bringing a new kind of viewing experience into the home. The TV uses LG's WRGB OLED technology with an oxide TFT backplane, the company's technical solution of choice for large-sized OLED panels. The panel is slim – only 4 mm thick with side bezel widths of 11 mm. At 19.2 pounds, the TV is also substantially lighter than competitive products. At the same time, it offers superior picture quality, achieving remarkably rich and natural colors through 8.3 million subpixels with the addition of white subpixels – 2 million more subpixels than competitive panels. The panel also delivers clear images with less than a 0.001-msec response time, 5,000 times faster than most LCDs. Most notably, LG Display's curved OLED TV panel can realize deep and dark blacks with the capability of reproducing a wide spectrum of blacks, allowing for an optimal contrast ratio. In addition to the vivid and enhanced picture-quality experience, the curved structure of the new OLED TV panel offers viewing comfort. The curvature mimics a human's normal line of vision, known as the “horopter line,” which makes it more eye friendly and allows viewers to feel less fatigue even when watching the screen for long periods of time. Users will also enjoy a more theater-like viewing experience because the curved screen has a wider and brighter field of view. The IMAX-like curvature of the screen minimizes visual distortion and loss of detail. LG Display's curved OLED TV panel also incorporates the company's acclaimed FPR 3-D viewing technology, which minimizes eye and body muscle strain during 3-D viewing. The added FPR 3-D film on the curved OLED TV panel offers better depth as well as a clearer 3-D effect.



Display Component of the Year

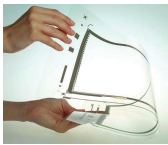
Gold Award: UDC's Green Phosphorescent Universal PHOLED Emitter Material

OLED displays gained a large energy efficiency boost in 2013 when Universal Display Corporation (UDC) began shipping commercial green Universal PHOLED emitters to panel makers for incorporation into mobile products. UDC's proprietary green phosphorescent OLED (PHOLED) emissive system can reduce an OLED display's power consumption by approximately 25%, while providing excellent color in mobile displays. Adding green PHOLEDs to displays has increased OLED's competitiveness with LCDs for mobile applications, and this new material is expected to be a key driver in the commercialization of OLED TVs. Through years of R&D work and achievements, UDC has produced UniversalPHOLED materials that provide record-breaking energy efficiencies, vibrant colors, long operating lifetimes, and manufacturing versatility. The green PHOLED emitter builds on the successful commercialization of UDC's red Universal PHOLED emitter, first launched in commercial passive-matrix display products in 2003. PHOLED materials are expected to drive wider adoption of OLED technology and greater growth in the display and lighting markets because they significantly reduce power consumption and lower heat emission compared to prior fluorescent green OLED materials. Based on these advantages, UDC believes that all OLED products, including smartphones, tablets, TVs, and lighting panels, will benefit from the use of its green Universal PHOLED materials.



**Silver Award: Canatu Oy's
Carbon NanoBud (CNB) Film**

Canatu Oy's Carbon NanoBud (CNB) Film provides superior optical performance for flat, flexible, or formable touch screens, displays, and touch-sensitive surfaces. This transparent conductive film is used in capacitive touch sensors for portable devices such as mobile phones, tablets, and digital cameras, and in automobiles that require excellent display readability in outdoor and bright indoor environments. With near-zero reflectance (less than 0.2%) from the CNB touch layers, CNB touch sensors improve contrast by up to 40%, and thus enhance display readability compared to incumbent touch solutions. In portable applications, the high contrast further enables the use of lower backlight power to increase battery life by up to 20%. CNB films have the highest transmission of any carbon nanomaterials, with 96% transmission at a 150-Ω/□ sheet resistivity, practically zero haze, and almost perfect color neutrality. CNB films are also applied in capacitive touch sensors for flexible wearable devices such as smart watches and flexible and foldable mobile phones and tablets. The films are highly foldable down to a bending radius less than 1 mm over more than 100,000 bending cycles. Another application of CNB films is in 3-D formed capacitive-touch surfaces in smart watches, home-appliance control panels, automobile center consoles and dashboards, and mobile phones. The films and sensors are stretchable up to 100% (twice their linear dimension) and can be thermoformed and overmolded with standard industrial processes such as film insert molding or in-mold decoration. Carbon NanoBud material is made from carbon nanotubes and fullerenes. Being carbon based, it absorbs light as opposed to reflecting as with commonly used ITO and other transparent conductive materials such as silver nanowires and metal meshes. This is the reason why CNB sensor layers have almost zero (<0.1%) haze and almost zero (<0.2%) diffuse and specular reflectance. When deposited on a substrate, CNB material forms a random network that is highly flexible and stretchable. Canatu's CNB manufacturing process is environmentally friendly and cost effective, with CNB film produced from common carbon gases in a single process step at room temperature, on rigid or flexible substrates, and in sheet or roll-to-roll form.



Display Application of the Year

**Gold Award: LG Display's G
Flex**

LG Display's G Flex smartphone incorporates a flexible OLED panel that is based on a plastic substrate instead of glass. By applying film-type encapsulation technology and attaching the protection film to the back of the panel, LG Display made the panel bendable and unbreakable. Compared to an OLED display panel based on glass, the flexible OLED panel is lightweight, thin, unbreakable, and features design flexibility. This allows for a design that naturally fits the contour of a smartphone user's face. The G Flex's OLED panel is vertically concave from top to bottom with a radius of 700 mm and only 0.44 mm thin. What's more, the panel is also the world's lightest, weighing a mere 7.2 g even with a 6-in. screen, the largest among current smartphone OLED displays. Plastic OLED panels are made in a process similar to that of glass OLED panels; however, the former uses a plastic substrate and a different "sealing" material. First, an organic matter called Polyimide (PI) is coated on the glass substrate. A proprietary, specially developed form of multi-layered organic and inorganic film is used to encapsulate the OLEDs and protect them from moisture. In the final process, to achieve flexibility, it is necessary to separate the glass and PI layer to remove the glass from the lower board, which can be achieved by applying a special layer. The board is naturally weaker once the glass is removed, so the back plate is then attached to the part where the glass was removed to ensure sturdiness. In the future, LG plans to make this process applicable to the production of large-sized devices, including personal laptops, monitors, and televisions, as well as eReaders and more.



**Silver Award: Google's
Chromebook Pixel**

Chromebooks are built for the way that people use computers and the Web today. They make computing faster, simpler, and more secure – for everyone. The LCD on the Chromebook Pixel is stunning, providing users with a rich, immersive experience. The 12.85-in. touch screen had, at launch, the highest pixel density of any laptop (239 ppi), and the 3:2 photographic format is specifically designed for using the Web (reducing the need for scrolling). Other statistics include a maximum brightness of 400 nits, a 60% color gamut, a wide (178°) viewing angle with IPS technology, and a 0.55-mm layer of touch-enabled glass fused directly to the screen (to preserve picture clarity). For users, text is crisp, colors are vivid, touch interactions are smooth – and each of the 4.3 million pixels seems to disappear into one spectacular picture. Google used a-Si TFT technology for the pixel to reduce the cost of the glass panel. The transmissivity of its high-ppi a-Si TFT panel was lower than panels fabricated with oxide transistors or low-temperature polysilicon. To attain low power consumption using a-Si, the company optimized the remaining components (including LEDs, optical films, and light pipe). The stack-ups can be seen in Fig. 1. The company's goal is to continue to push the laptop experience forward, working with its entire ecosystem of partners to build the next generation of Chrome OS devices.



2013 Award Winners

Display of the Year

• **Gold Award:** *Sharp and Semiconductor Energy Laboratory's IGZO LCD used in the AQUOS Smartphone*

The scope of connected applications for handheld devices is ever growing, as is the demand for information devices such as smartphones that enable us to see an enormous amount of rich content anytime, anywhere. The penalty we pay for this great performance has traditionally involved high-power demands and short battery life. In an effort to alleviate the need for this tradeoff, Sharp Corporation and Semiconductor Energy Laboratory (SEL) jointly developed a new IGZO technology that imparts crystallinity in an oxide semiconductor composed of indium (In), gallium (Ga), and zinc (Zn). This IGZO enables a display with both high resolution and ultra-low power consumption, characteristics that have in the past needed to be balanced against each other. In addition, the IGZO incorporates a touch panel, and represents the first time an IGZO panel has been integrated into a smartphone. Sharp and SEL succeeded in aligning the crystallizing IGZO layer in the c-axis direction, which results in higher reliability of the device, in addition to enabling higher definition, lower power consumption (1/5–1/10), and high performance of the touch panel due to miniaturization and high performance of the thin-film transistor. The AQUOS PHONE ZETA SH-02E from Sharp can be used for 2 days without charging batteries because of its low power consumption and can be used 4.8 times longer than conventional units when displaying a static image, thanks to the IGZO. Improved recognition accuracy and response speed of the touch panel enable a better user interface as well. Pen input is also supported. IGZO can also be applied to other, larger displays such as monitors, TVs, etc., since it corresponds to the same manufacturing processes of large motherglass substrates equivalent to a-Si. It can also be applied to displays other than LCDs; for example, organic electroluminescent displays. IGZO will also enable development of applications for non-display uses such as sensing devices. Sharp and SEL researchers believe that IGZO will become the core technology of displays in the future.

• **Silver Award:** *Shenzhen China Star's 110-in. 4K x 2K 3D TFT-LCD TV*

Shenzhen China Star Optoelectronics Technology Co., Ltd. (CSOT) has successfully developed a 110-in. LCD TV that is the largest of its kind in the world. The 110-in. TFT-LCD integrates many innovations in LCD technology. It has a reported dynamic ratio of 50000:1, an ultra-high brightness of 1000 nits while consuming less than 1100 W, and highly saturated color reproduction with a color gamut of about 92% of NTSC. Moreover, through the effective use of shutter glasses technology in 3-D mode, the left to right eye crosstalk ratio is less than 2.5%. CSOT's goal was to develop an attractive display with an extraordinary visual quality that would enable entertainment applications such as gaming, movie, and multi-user communication. Such a TV will play an important role in bringing families together. Accordingly, the company wanted to develop a TV with a large LCD panel, high resolution, and 3-D functionality. The 110-in. LCD was designed and fabricated in CSOT's Gen 8.5 facility. To meet the above visual reality and entertainment requirements, 4K x 2K resolution (3840 x 2160) and shutter glasses 3-D functionality were implemented. During development, the major challenges were panel uniformity, power consumption, visual quality, and the creation of an electric and optical and mechanical (OM) system for the ultra-high-definition LCD. It is well-known that large-sized LCDs can suffer from a lack of panel uniformity when resolution and frame rate are upgraded for playing films or pictures. In order to suppress mura and to enhance panel uniformity, CSOT improved its manufacturing processes in several ways. High transmittance technology, high transmittance vertical alignment (HVA), and local dimming with a 288-area LED backlight were utilized to reduce power dissipation. To support the 3-D mode with 120 Hz, fine stereo performance (FSP) technology was implemented in the driving system, which greatly improved both 2-D and 3-D quality. Since the ultra-high-definition interface is not mature in the market, the image-process system was assembled with an FPGA-base unit by CSOT. This 110-in. panel can receive any format of 4K x 2K video and is compatible with commercial transmission interfaces such as HDMI and DP. In addition, the large-sized panel accommodates the entire viewing angle of the human eye. Besides the TV application, this 110-in. TFT-LCD can be used for advertisements and educational and office displays. Another area of focus for the company is to replace the LED boards commonly found in public-information-display (PID) systems with a much more colorful, complex, and detailed messaging medium afforded by this new development.

Display Application of the Year

• **Gold Award:** *Apple's iPad with Retina Display*

By using an organic passivation technology for the first time in a 9.7-in. display with an amorphous-silicon TFT, Apple engineers and their technology partners were able to fit four times the number of pixels into the same 9.7-in. (diagonal) screen found on earlier iPad models. The resulting pixel density of the iPad Retina display – 264 ppi – makes text and graphics look smooth and continuous at any size. This 2048 x 1536-pixel display has set a new standard for mobile-display resolution in a panel this size. The third-generation iPad, as with each iPad since the original, uses technology called mobile in-plane switching (IPS) to achieve a viewing angle that has established the benchmark in the tablet category. It enables users to hold the iPad in almost any position they want and still see a high-fidelity image. The consistency of gamma over viewing angles provides an enhanced viewing experience to end users in consumer, business, and education applications; from web surfing, photo-sharing, and gaming to medical research, business analysis, and elementary and higher learning applications. The custom cell design is optimized for maximum transmittance, which, in combination with a custom driver IC and backlight, enables high resolution with industry-leading low power consumption.

• **Silver Award:** *Nokia's Lumia 920 Smartphone*

The Nokia Lumia 920 smartphone is known for innovative imaging, wireless charging, and advanced touch technology. The phone has a PureMotion HD+ screen that represents Nokia's latest innovation to radically improve display capabilities. The PureMotion HD+ 4.5 in. 332-ppi screen offers crisper graphics and less blurring while users are scrolling, navigating, and playing games. Nokia's PureMotion technology addresses the inadequate moving-image quality of other mobile displays, allowing it to better leverage the high-speed rendering capabilities of its internal graphics engine. One of the ways the Nokia Lumia 920 prevents blur on a screen is with a response time faster than 16.7 msec. On average, it takes about 9 msec for transitions on the screen of the Nokia Lumia 920. This phenomenal transition speed was achieved by boosting the voltage to each LCD pixel – overdriving the panel. With overdrive-enhanced LC response, PureMotion display pixels finish their transition well before the update of the next frame for any pixel needs to start, resulting in a less blurry image. The Nokia Lumia 920 is the first Nokia smartphone to have a super-sensitive touch display that works with fingernails or even gloves. This new ability is the biggest leap forward for capacitive touch screens since multi-touch gestures were introduced. The technology is adaptive, reacting to any conductive object that is touching the screen. In practice, the screen will automatically adjust sensitivity to provide the best possible touch-screen experience, making touch usage faster, more natural, and accurate. Super-sensitive displays have also been featured in other Nokia Lumia smartphones like the Lumia 720 and 520. The Nokia Lumia 920's PureMotion display also introduces a new level of outdoor viewing experience in mobile displays. In addition to the very low reflectance, which largely improves dark tone rendering in ambient light, PureMotion adds high luminance mode for backlight LED-driving and image contrast enhancement, on top of superb optical stack design. Together they improve the overall contrast and therefore sunlight readability. In an extremely

bright environment, the Nokia Lumia 920 PureMotion display takes advantage of its backlight luminance reserve and becomes the smartphone WXGA (1280 × 768) display with highest peak luminance. This high-luminance mode works automatically, based on the data received from an ambient-light sensor.

Display Component of the Year

• **Gold Award:** *QD Vision's Color IQ Optical Component*

Color IQ optical components are advanced light-emitting semiconductor nanocrystal products developed by QD Vision, Inc. They are the first product to utilize quantum dots for commercial displays. These breakthrough components enable LCDs such as TVs, monitors, and all-in-one computers to achieve significantly wider color gamut with a far more natural and vivid viewing experience than that of conventional white LED systems. While most LCDs offer color quality that might reach 60–70% of the 1953 NTSC standard, LCD products utilizing Color IQ optical components can achieve 100% of the NTSC, Adobe, and sRGB color performance standards. Designed as a drop-in solution, Color IQ optical components may be easily integrated into conventional side-illumination LCD backlight systems. The components are delivered as a fully packaged, sealed solution, made of a glass optical tube containing red and green quantum dots (QDs) that are combined, tuned, and optimized to achieve a customer-specified on-screen white point. Designed for very-high-volume LCD applications, Color IQ products deliver color performance meeting or exceeding that of OLED and direct-lit RGB LED systems, while maintaining the cost structure of side-illumination systems for mainstream LCD TVs. After a number of years in development, Color IQ optical components have been rigorously qualified and tested to meet the stringent product reliability and lifetime requirements of mainstream consumer-electronics applications. Systems with Color IQ optical components use highly efficient blue LEDs instead of white LEDs as the excitation source that stimulates the optical component to emit red and green and transmit blue light. Color IQ optical components harness the unique light-emitting properties of a new class of nano-materials called quantum dots to emit narrow bandwidth light, which is ideal for LCD systems, delivering pure saturated colors to the front of screen. QDs allow for independent control of emission color and composition, with their nanoscale dimensions controlling the semiconductor bandgap. Their combination of efficiency, reliability, saturated emission, and color tunability are unmatched in any known material set.

• **Silver Award:** *Sharp's Moth-Eye Technology*

Sharp's AQUOS Quattron 3D XL9 LCD TVs use "moth-eye panels" to suppress the reflection of ambient light and to realize deep black imagery. Moth-Eye technology incorporates a nanoscale design that is inspired by the eyes of the common night-flying moth. These Moth-Eye panels help to emphasize Sharp's "four primary colors technology," which enhances the quality of color displays, and also helps make imagery visible even in a bright room. These sets (AQUOS Quattron 3D, XL9 series, including 80-, 70-, 60-, 52-and 46-in. models) have a high contrast ratio to the level of 100 million:1 and images composed of approximately 8.3 million subpixels. Sharp Corporation succeeded in the first-ever mass production of Moth-Eye technology using a nano-imprint process incorporating a large-sized seamless drum stamper. In the field of the optical films, low-reflective (LR) films coated monolayer-on and anti-reflective (AR) films deposited multi-layer-on are popular. An LR film can be produced at a low cost, but does not provide a sufficiently low reflectance. An AR film can provide a low reflectance, but entails high costs for production. Therefore, there are strong demands to make both ends of optical properties and costs meet. The Moth-Eye technology is a solution because it has a single-layer film of UV curable acrylic resin on a base film, even though it works as a multi-layer film optically. A single-layer film has merits in terms of material and process costs. In the meantime, the drum stamper is also produced in a cost-effective and industrially easy way that utilizes a combination of anode oxidation and etching of aluminum. With this method, 100-nm-size structures are formed spontaneously in a large area by merely controlling anode oxidation voltage, rather than by an overly sensitive photolithography process that makes it difficult to achieve uniformity in a large area. The biggest benefit obtained by Moth-Eye technology is that it provides users with clear and high-quality images in bright places both indoors and outdoors. In terms of power consumption, Moth-Eye technology can conserve electricity with no loss of image quality since it is not necessary to increase the brightness of the backlight as much as you would with a lower contrast panel. In the future, applications for Moth-Eye need not be limited to electronic displays. It can be used, for example, in the glass of a picture frame at a museum or for a showcase at a jewelry shop.

2012 Award Winners

Display of the Year

Gold Award: *AU Optronics's 55-in. 4K x 2K 2-D/3-D Switchable Glasses-Free TV Display*

AU Optronics's 55-in. 4K x 2K 2-D/3-D switchable glasses-free TV incorporating AUO's proprietary display made its debut in Japan in December 2011 and is currently the world's first 4K x 2K TV display, as well as the largest glasses-free 4K x 2K 3-D TV display commercially available.

This TV's LC display offers an exceptional viewing experience in extreme comfort. The display features a 4K x 2K (or "quad-HD") resolution of 3840 x 2160 for vivid and lifelike 2-D images. Meanwhile, a simple switch by the viewer converts the image instantly into 3-D format, with 3-D support for up to nine positions based on the TV's built-in face-tracking camera. Virtually no dead zones exist, ensuring the highest viewing quality possible. This lenticular-lens 3-D technology eliminates the need for 3-D glasses in order to view outstanding 3-D images. Viewers can now choose their preferred viewing positions to enjoy a pleasant and comfortable experience free of added eyewear or dead zones. For AUO's partners, the glasses-free 3-D solution also allows for ease of incorporating the new panel technology into their current systems. This compatibility heralds the growing commercialization of 4K x 2K 2-D/3-D switchable glasses-free TV displays.

Silver Award: *Qualcomm's mirasol Display Technology*

Qualcomm mirasol display technology from Qualcomm MEMS Technologies (QMT) is designed to deliver color and interactive content that can easily be viewed in a variety of lighting environments, including bright sunlight, without sacrificing battery life.

The first device featuring a mirasol display, the Kyobo e-Reader, arrived on the market in November 2011. Three more e-Readers quickly followed, and additional products are expected in the coming months. Beyond e-Readers, however, mirasol displays have potential application in a range of commercial and consumer devices.

The core building block of mirasol displays is the iMOD element, a simple MEMS device composed of two conductive plates. One plate is within a thin-film stack on a glass substrate. The other is a reflective membrane suspended over the substrate. The human eye perceives color as certain wavelengths of light amplified with respect to others. The iMOD elements in a mirasol display can switch between color and black by changing the position of the membrane. This is accomplished by applying a voltage between the conductive plates. When a voltage is applied, electrostatic forces cause the membrane to deflect. The change in the spacing between the plates results in a change in the

wavelengths of light that undergo constructive interference. In the open state, the membrane is positioned to create constructive interference in either the red, green, or blue wavelengths. In the closed state, the membrane is positioned to create constructive interference outside the visible range, causing the element to appear black. A full-color display, meanwhile, is assembled by spatially ordering side-by-side iMOD elements reflecting red, green, and blue wavelengths respectively while in the open state.

The mirasol display is also capable of video. Since visible-light wavelengths operate on the nanometer scale (i.e., 380–780 nm), the deflectable iMOD membrane only has to move a short distance – a few hundred nanometers – in order to switch between two colors. This switching occurs extremely fast, on the order of tens of microseconds, and directly translates to a video-capable display.

The above properties give mirasol significant advantages. Since the display is reflective, the brightness of the display scales naturally with the ambient light level. This results in a consistent and comfortable viewing experience across a wide range of lighting environments, including direct sunlight. To extend the viewable range into dark ambient conditions, an integrated front light is incorporated into the display module. Additionally, the display is bistable, meaning it consumes near-zero power in situations when the display image is unchanged.

Today, consumers are relying on mobile devices for functionality previously addressed by other devices: playing games, reading books, and watching movies – and they want to be able to do these activities anytime, anywhere. All require more display use, which puts greater strain on the battery, and with today's technology, most mobile devices are limited to indoor functionality. Qualcomm mirasol displays offer both outdoor viewability and longer battery life with minimal performance compromises.

Display Component of the Year

This award is granted for a novel component that has significantly enhanced the performance of a display. A component is sold as a separate part destined to be incorporated into a display. A component may also include display-enhancing materials and/or parts fabricated with new processes.

Gold Award: Nanosys's Quantum-Dot Enhanced Film (QDEF)

The recent take off in the popularity of powerful mobile devices such as tablets and smartphones offers a tremendous opportunity for display makers in the coming decade. It has become clear that consumers want a richer, more lifelike experience from their devices, and color performance is one area where large gains can be made immediately to meet that demand. The industry has focused on improving nearly every other characteristic of the screen over the years – luminance, contrast, thickness, resolution – often to the detriment of color performance. Color is the next major differentiator in the display market and will bring a stunning new visual experience to the consumer and a great new value proposition to the manufacturer.

The color performance of an LCD screen is determined by two parts of the display: the backlight and the color filters. Nanosys addresses the color issue by offering a new backlight for LCDs. A standard LCD backlight creates white light using a yttrium aluminum garnet (YAG) phosphor. The YAG phosphor produces a two-color light spectrum, dominated by blue accompanied by a broad, yellow component. It lacks strong red and green elements. QDEF uses the unique properties of quantum dots to create a pure-white backlight that is designed specifically for LCDs. This light, made up only of narrow spectral peaks in red, blue, and green wavelengths, allows for wide color-gamut performance when mixing these primary colors at the pixel level. It does this with great efficiency, allowing for a bright display without requiring higher power consumption, thus saving battery life. A quantum dot, which is about the size of a water molecule, can emit any color of light at precise wavelengths. QDEF combines red- and green-emitting quantum dots in a thin, optically clear sheet that emits white light when stimulated by a blue LED light source.

The result is vivid color. High-color displays will allow consumers to enjoy more visceral and truer to life content. And high- color performance displays will make the digital viewing experience of photos, movies, and video games more realistic. Filmmakers and video-game developers will be able to more accurately bring their creative vision to life.

Nanosys invested about a decade of R&D to ensure its quantum dots are of the highest quality and reliability. More than 100 patents have gone into the design of QDEF, and it has been tested to meet industry standard lifetimes for TVs – 50,000 hours or more of use. But engineering the quantum dots to meet display-industry specifications was not enough to offer a powerful product for the LCD market. The dots needed to be easily integrated into current manufacturing operations with minimal impact on display system design. For this reason, Nanosys worked with major display manufacturers to design a simple, drop-in product that does not require line retooling or manufacturing-process changes. QDEF is a replacement for an existing film in LCDs called the diffuser sheet. Manufacturers who have invested billions in equipment for LCD production can simply slip QDEF into their manufacturing process, change their "white" LEDs to blue, and start producing LCD panels with OLED-like color performance and better energy efficiency, at only a fraction of the cost.

Silver Award: LG Chemical's Film Patterned Retarder Incorporating Merck's Proprietary Reactive Mesogen (RM) Layer

A film patterned retarder (FPR) is an optical component attached to a 3-D LCD TV's front polarizer to convert left- and right-eye images to left- and right-circular-polarized light, allowing viewers to enjoy 3-D images through passive-polarized glasses. The FPR consists of a substrate, alignment layer, and a patterned reactive mesogen (RM) film. The novel photoaligning polymer has very high UV sensitivity and a heat stability that is suitable for film process.

The reactive mesogen film used for LG Chemical's FPR is made using Merck KGaA licrivue materials. These RM materials are designed to be coated on a variety of substrates to produce well-aligned birefringent films. For FPR, the licrivue materials are formulated for coating onto flexible plastic substrates by a roll-to-roll coating process. The coated licrivue RM materials align and follow the pattern of the photoalignment layer. This alignment is preserved by UV polymerization of the RM film to form the patterned retarder.

LG Chemical commercialized this FPR for the first time in the world in 2010. LG Chemical's FPR, which incorporates Merck KGaA licrivue materials, is 10 times thinner and 20 times lighter than glass-based patterned retarders, can be easily mass-produced, and makes enjoyment of 3-D content more convenient. LG Chem has developed various key technologies such as a novel photoaligning polymer, non-contact-type roll-to-roll continuous patterning, and management of the dimensional stability of FPR – all of which help realize superior performance in 3-D displays.

Display Application of the Year

This award is granted for a novel and outstanding application of a display, where the display itself is not necessarily a new device.

Gold Award: Samsung's Galaxy Note

Combining the features of a smartphone and a tablet, the Samsung Galaxy Note offers a large screen and new user input technology, while retaining a pocketable design that allows users to capture, create, and share in new ways. It utilizes AT&T's 4G LTE network to enable a premium user experience.

The Galaxy Note is a portable communication device designed with a 5.3-in. display featuring HD Super AMOLED technology. Its high-resolution (800 x 1280 pixels) screen provides a dynamic, colorful, and comfortable viewing experience for content such as videos, photos, documents, and Web sites. Super AMOLED can depict more dynamic images since it has deeper blacks than LCDs and covers 95% of all natural colors. Also, depending on the screen's white area, AMOLED display adjusts its luminance for eye comfort.

The Galaxy Note includes a creative tool called the S Pen, which delivers fast, responsive, and precise control to create fine lines and detail on the device display, much like an ink pen and pad of paper. The Note also features S Memo, a multimedia application designed to capture all forms of user-created content generated by the S Pen. Pictures, voice recordings, typed text, handwritten notes, or drawings can all be combined via a single application, converted to a 'memo' and shared as desired. An easy screen-capture function also allows users to instantly save any screen. The screens can be personalized with the S Pen before being saved or shared.

The Note comes equipped with a 1.5-GHz dual-core processor, making it extremely fast, with a smooth and seamless user interface. Meeting extra rigorous security criteria, the Galaxy Note is categorized as a "Samsung Approved for Enterprise" (SAFE) device. The addition of SAFE certifications ensures that any organization's mobile work force can be remotely managed and securely connected to corporate applications and data.

Samsung has also included a smart professional planning tool that makes full use of the device's large screen. The calendar integrates the phone's to-do list and schedule; and control and navigation are intuitive. The Galaxy Note is outfitted with a premium accessories portfolio including a desktop dock. A spare-battery-charging system allows for a convenient backup charging solution.

The Samsung Galaxy Note's large screen and unique input technology enable mobile communications in a more personal, creative way.

Silver Award: Perceptive Pixel's 82-in. Projected-Capacitive Unlimited Multi-Touch and Stylus LCD

Over the last 5 years, multi-touch input, particularly via projective-capacitive sensing, has become ubiquitous for mobile and slate devices. This approach, when implemented properly, can sense an unlimited number of fingers with zero-force sensitivity at high sample rates while preserving excellent display fidelity. Although there are many other types of touch sensors implemented in other types of devices, for better or for worse, the user base has come to expect the "feel" of projective-capacitive touch sensing, and, similarly, developers have come to count on recognizing gestures produced by such devices.

However, projective-capacitive sensing is notoriously difficult to scale to larger displays, so it has been rare to see pro-cap devices larger than 24 in., and these have only been achieved by distancing the sensor glass so far from the display, with such a thick sensor glass, that theresulting parallax makes the device unusable for serious applications, let alone with a stylus. Display characteristics also suffer from such a stack-up due to inter-reflections.

In August of 2011, Perceptive Pixel introduced the first large-scale pro-cap interactive display that achieves the level of fidelity and performance necessary for real productivity. It is the world's largest projective-capacitive multi-touch and stylus display, featuring true full-frame unlimited-finger touch and precision stylus sensing at 120 Hz across a proprietary sensor that is optically bonded to an 82-in. LCD panel. The display utilizes novel state-of-the-art projective-capacitive controller electronics with an unprecedented signal-to-noise ratio (SNR), specifically designed for application at these large dimen-sions and in optically bonded sensor stack-ups.

This controller is also designed to track multiple (four in this model) high-precision active styluses tracked truly simultaneously along with an arbitrary number of touch contacts on the same sensor substrate. These styluses are true digitizer-class devices, with features such as subpixel precision, pressure sensitivity, hover sensing, and barrel switches. This is only the second controller ever introduced with this capability.

The unit utilizes a proprietary transparent conductor sensor that Perceptive Pixel manufactures in its Portland, Oregon, facility, constructed on a thin 2-mm Gorilla Glass substrate. Perceptive Pixel then optically bonds the giant 82-in. sensor onto the LCD cell, again in its own facility. Though there are incidental benefits in display fidelity, optical bonding was deemed critical to this product's construction because a professional user experience demands an ultra-low parallax between the display plane and the interaction surface, especially when a precision stylus is utilized. This process also greatly enhances the ruggedness of the system, serving as a protective cover glass to the cell against the focused force of a stylus tip.

The Perceptive Pixel 82-in. pro-cap display feels exactly like a mobile touch device, only greatly scaled up. Perhaps, more importantly, all applications designed for mobile devices work. Perceptive Pixel utilizes a unique system architecture that integrates the raw, richer sensor information at a much tighter level with the software frameworks above it, allowing much more sophisticated gesture and contact classification along with a dramatic reduction in latency.

The combination of both multi-touch as well as precision stylus-sensing capabilities opens up new user-interface paradigms that human-computer interaction (HCI) researchers are only beginning to harness. Touch is great for its intuitiveness, power, and non-intrusiveness, but it is not effective for sustained productivity or for precision work, which is why it has not achieved significant penetration beyond consumer markets.

Similarly, as compared to pen-only interfaces, the combination of these two modes in a truly simultaneous manner (not alternating between one and the other) results in a synergistic division of labor between a users' two hands, leading to measurable increases in user efficacy.

This device may allow users to realize a digital replacement for the old analog whiteboard. Perceptive Pixel's 82-in. display can be frequently seen on CNN as well as other networks being used to cover this year's historic presidential primaries and election.

2011 Award Winners

Display of the Year

*Gold Award: **Apple's iPhone 4 Retina Display***

By developing pixels only 78 μm wide, Apple engineers and their technology partners were able to pack four times the number of pixels into the same 3.5-in. (diagonal) screen found on earlier iPhone models. The resulting pixel density of the iPhone 4 Retina display – 326 ppi – makes text and graphics look smooth and continuous at any size. The 640 x 960-pixel display set a new benchmark for mobile-display resolution. The iPhone 4 Retina display uses technology called mobile in-plane switching (IPS) to achieve a viewing angle superior to that of conventional mobile LCDs, enabling users to hold the iPhone 4 in almost any position they want and still get a high-fidelity image. The consistency of gamma over viewing angles provides an enhanced viewing experience to end users in applications such as gaming and photo-sharing. The LTPS-TFT backplane design is fully customized, including organic passivation and optimized pixel design for maximum transmittance. Combined with a custom driver IC, this enables high resolution with industry-leading low power consumption.

*Silver Award: **Samsung Mobile Display's On-Cell Touch AMOLED***

Samsung Mobile Display developed the revolutionary On-Cell Touch AMOLED (OCTA) display for use in mobile applications. The OCTA display has an integrated touch sensor that eliminates the need for an additional touch-screen overlay. Until now, touch-capable mobile displays have utilized an input sensor fabricated onto a separate glass substrate, which is then laminated as a separate subassembly onto the display. This extra glass layer has resulted in additional weight and product thickness. Furthermore, the extra sensor-to-display interface layer causes a loss of display luminance and is a source of internal reflections that degrade display performance, especially in high-ambient lighting conditions, such as outdoors. The OCTA display was developed to meet the ever-increasing performance and industrial design demands of today's modern mobile devices. The touch sensor integrated onto the display glass uses projected-capacitive touch-detection technology to deliver multi-touch input capability with the highest possible sensing performance. Additionally, because AMOLED displays are self-emissive, they do not require the thickness, added weight, and expense of a backlight. As a result of this new design approach, the Samsung OCTA display delivers excellent performance and exceptional quality with a highly accurate and sensitivity-optimized touch input in a module that is less than 2 mm thick. The Samsung OCTA has nearly 100% light transmission and outstanding outdoor visibility due to Samsung's elimination of the extra interface layer. Also, its multi-sensor input capability enables gesture recognition for the most advanced mobile devices.

Display Component of the Year

*Gold Award: **E Ink's Triton***

Color e-paper displays enabled by E Ink's Triton color imaging technology deliver high-contrast, sunlight-readable, low-power performance designed to further close the divide between paper and electronic displays. With the E Ink Triton color configuration, a thin color-filter array (CFA) is added in front of the black-and-white display, which is based on E Ink's Pearl electrophoretic technology. The CFA consists of four subpixels – red, green, blue, and white – that are combined to create a full-color pixel. The result is a low-power, direct-sunlight, readable color e-paper display. Triton enables color applications markets including e-books, e-newspapers, e-magazines, e-textbooks, and digital signage.

*Silver Award: **ITRI's Flexible Substrate for displays***

The Silver Award was given to the Industrial Technical Research Institute (ITRI) for its novel flexible substrate technology that is compatible with existing TFT infrastructures and processes. ITRI's Flexible Substrate is an inorganic dominated silica/polyimide (PI) hybrid film in which the silica content can be increased as high as 60 wt.%. The film is suitable for the fabrication of flexible displays in both batch and roll-to-roll processes. The existence of networks between silica particles in a PI matrix has been confirmed by 3-D tomography. The novel inorganic silica/polyimide (PI) hybrid technology for flexible substrate is a significant step forward in the display field. For batch-type processes, the flexible substrate is easily prepared by coating a PI solution on glass carriers, followed by fabricating TFT devices on the said substrates. The surface roughness of PI/silica hybrid film as measured by atomic-force microscopy (AFM) is less than 5 nm. It is therefore good enough for the manufacture of flexible displays. Moreover, the adhesion properties of PI/silica film with silicone oxide, silicone nitride, and ITO are very good without any other primer or surface treatment process needed. The Tg of the PI/silica hybrid film is higher than 400°C due to the inorganic silica dominated phase. Furthermore, the high inorganic content of silica/PI reduces the coefficient of thermal expansion (CTE). The silica content of the film can be increased as high as 60 wt.% while still reaching the desired optical properties. For the roll-to-roll fabrication process, the ITRI flexible substrate attains a variety of attractive properties, such as low CTE (20 ppm/°C, high transmittance (around 90%); within a wavelength range of 400–700 nm), excellent flexibility, and high Young's modulus (4.3 Gpa). Additionally, a flexible color-filter active-matrix electrophoretic display (AMEPD) and a flexible touch film were made on ITRI's flexible substrate. The novel inorganic dominated silica/PI hybrid technology is a significant step toward the realization of flexible active-matrix displays.

Display Application of the Year

*Gold Award: **Apple's iPad***

Apple's original iPad shipped in April 2010. Industry experts were initially unsure how the new tablet computer, which was larger than a smartphone and smaller than a laptop, would be received by consumers, but nearly 15 million sold worldwide that first year (<http://www.apple.com/pr/library/2011/01/18results.html>). The iPad's mobile in-plane switching (IPS) LCD, combined with a multi-touch user interface and iPad system design (it runs on the same iOS as the iPhone) turned out to mark a new era of tablet computing. The iPad display provides a superior viewing experience, with a minimized gamma shift over viewing angles by using advanced mobile IPS technology. By working closely with display partners on all technical aspects, Apple has customized the design to achieve a total optimization of display pixel structure, LED, backlight, electrical circuits, and software management to maximize the power efficiency. The iPad is able to achieve 9 hours of battery life for 3G Web surfing and 10 hours for WiFi Web surfing by combining this custom-designed LCD with an innovative product design and power management system – all with an ultra-thin profile.

Silver Award: *Samsung's Galaxy S*

In June 2010, Samsung Mobile launched its first-ever premium portfolio of smartphones in the company's 15-year history in the U.S. The vibrant display on each device attracted the attention of both media and consumers and allowed the Galaxy S portfolio to succeed in the smartphone market. Samsung Galaxy S smartphones provide a premium viewing experience with a brilliant 4-in. display powered by Samsung's Super AMOLED touch-screen technology. Super AMOLED technology design yields thinner displays, delivering some of the thinnest, most responsive full-featured smartphones in the industry. Due to its advances in color reproduction, contrast ratio, response time, and viewing angle, Samsung's innovative display technology makes watching movies, viewing videos, and playing games come to life like never before, even in bright light and outdoor environments. Samsung's Super AMOLED screen offers improved color reproduction that is 40% higher than other leading displays. That means the user sees an incredibly close match between the color quality on the mobile phone and that of the original content source, whether it be film, video, or digital images. Super AMOLED also delivers a contrast ratio of 100,000:1, which is more than 100 times the quality of other leading displays and the closest comparison to HDTV standards. That means the Galaxy S will show the very brightest whites and the very darkest blacks for unmatched vivid colors and clarity. In terms of response time, Super AMOLED is 2500 times faster than the leading display standard, clocking in at one-hundredth of a millisecond.

2010 Award Winners**Display of the Year****Gold Award: *LG Display's 47-in. 3-D LCD Panel***

LG Display's 47-in. 3-D LCD Panel is the first commercially available TFT-LCD module for 3-D televisions in the mid-40-in. range. The panel works with polarized glasses to provide bright, high-quality 3-D imagery (and vivid 2-D imagery as well) that is comfortable for viewing, without the crosstalk or flicker that can cause dizziness and eye strain. To create the 3-D LCD, the company developed a new patterned retarder and its own special process of glass lamination. The patterned retarder separates the polarization states between the odd and even lines so that right- and left-eye images can be seen completely separately. Right-eye images are presented by the odd lines and left images by the even lines. Viewers' right and left eyes, therefore, see different images with the polarized glasses, making the images appear three dimensional. The retarder, in combination with the special glass lamination process, enables a low surface reflection with no moiré pattern, greatly improved luminance, and crosstalk-free imagery. The panel also uses in-plane switching (IPS) for superior viewing. It employs LG Display's proprietary technology to realize clear imagery and is the brightest of any currently available 3-D LCD panels that use glasses. Moreover, the 3-D viewing works with low-priced polarized glasses.

Silver Award: *Pixel Qi's 3Qi Multimode LCD*

Active-matrix liquid-crystal-display (AMLCD) technology is the technology of choice for many applications, from mobile devices to large HDTVs. But there are areas where today's LCD is lacking: it is power hungry, particularly when the display is optimized for high luminance; it is not easily viewable in brilliant ambient light; and it is not considered an ideal medium for comfortable, long-term reading. These are the challenges tackled by Pixel Qi, a California and Taipei start-up company founded in 2008 by Dr. Mary Lou Jepsen. Jepsen previously co-founded the One Laptop Per Child program, for which she developed an earlier generation of the 3Qi screen. Today's version builds on her experience in delivering sunlight-readable screens for children in less technologically developed countries – from Peru to Nigeria to Nepal. In developing the newer 3Qi multimode LCD technology, Pixel Qi added another requirement: the display had to be manufactured in existing LCD fabs. The use of standard manufacturing processes and materials enabled rapid ramp-up to volume production of reliable displays at competitive costs: Pixel Qi has been making strides as a genuinely fab-less screen developer. The 3Qi display has all the advantages of a standard backlit LCD: rendering quality, full-color images and full-motion video, and high screen luminance using regular backlights. But unlike standard displays, in high ambient light levels such as in an office or home, the 3Qi display's reflective mode contributes to the rendered image, allowing the backlight to be turned down or off, which delivers significant power savings and makes for an attractive screen and comfortable reading experience – with exceptionally high resolution. Outdoors, the 3Qi display really shines: its reflective mode renders a crisp image with the look of the best electrophoretic displays.

Display Component of the Year**Gold Award: *N-trig DuoSense Solution (for pen and multi-touch)***

Touch is one of the primary channels through which we experience our world and manipulate the objects making up our environment. In order to create a way for people to interact more naturally with their computers, N-trig created the DuoSense Solution, a dual-mode pen and true multi-touch capacitive digitizer, combining all forms of input into a single device for performing tasks with a wide variety of personal-computing devices. Users can employ the pen to annotate on the screen or engage with two or more fingers to manipulate objects directly on the computing device. N-trig's dual-mode digitizer uses both pen and zero-pressure capacitive touch to provide the company's true hands-on computing experience for mobile computers with a single device. It consists of ***The DuoSense Digitizer***, a customized capacitive sensor module, mounted on top of the LCD, which enables direct on-screen manipulation using pen and multiple simultaneous touch inputs, and enhances the overall user experience; and ***The DuoSense Pen***, which enables users to annotate, draw, and point to objects directly on the screen, complementing the inherent multi-touch capabilities. The DuoSense pen is available as either an electrostatic battery-less pen or a battery-powered Digital Pencil, both of which correspond to the same unique hardware.

Silver Award: *RealD XL Cinema System*

The RealD XL Cinema System is an efficient polarization modulator that mounts externally to a digital-cinema projector. It works in concert with passive, circular-polarizing eyewear to produce cinematic-quality 3-D images. The product was inspired by the need to present 3-D images on larger screens. Single projector 3-D systems, at the time (around 2006) removed large portions of the available light by using absorbing linear polarizers or spectral division. The XL surpassed competing technologies by employing polarization recovery to double the light throughput of 3-D presentations. A single digital-cinema

projector with XL is capable of showing 3-D movies at screen sizes up to 80 ft. in width. The XL design was required to double the polarized light output of the system and, additionally, perform under the conditions of digital cinema. The system is robust in high optical flux (>30,000 lm), as considerable time was spent on process development for each component and subassembly. To maintain cinematic resolution, a careful optical implementation overlays images to extremely tight pixel tolerances. Simple and intuitive overlay adjustments minimize installation time. Once aligned and locked, the system does not require readjustment over its lifetime.

Display Application of the Year

Gold Award: **Nikon COOLPIX S1000pj**

The COOLPIX S1000pj is the first compact digital camera to feature a built-in projector. With a simple touch of a button, the camera projects photos or movie clips at up to 40 in. in size on any flat surface. Pictures can be projected individually or as slide shows complete with music and added effects that enhance the experience. The pico-projector unit, which was minimized in order to be integrated with the digital camera, is based on white-LED illumination optics and incorporates polarizing beam-splitters, a reflective liquid-crystal-on-silicon (LCOS) microdisplay, and projection optics. In order to utilize the light efficiently, Nikon developed optimized illumination optics that include a type of free-form-surface optical element.

Silver Award: **NVIDIA 3D Vision**

A transition to 3-D across all major digital media and entertainment platforms is happening now. With its NVIDIA 3D Vision technology, consisting of software and wireless active-shutter glasses, NVIDIA is helping to bring this technology to consumers, delivering ultra-realistic games, high-definition video playback, a rich movie experience, and crisp photos – all in 3-D with ultra-wide viewing angles. 3D Vision has been designed with top-of-the-line optics that are used in conjunction with 120-Hz LCD panels to enable two 1080-pixel full-resolution images per eye in 3-D mode running at 60 Hz per eye. They are comfortable to wear and modeled after modern sunglasses, offering a lightweight alternative to conventional 3-D glasses. 3D Vision eyewear is a fully untethered solution, enabling free range of motion and up to 40 ft. of wireless 3-D viewing. 3D Vision works with any 120-Hz certified display, including the newest 3-D HDTVs, computer LCDs, notebook computers, and 3-D projectors. The included NVIDIA software automatically converts over 450 games to work in 3-D stereo out of the box, without the need for special game patches. 3D Vision is also the only stereoscopic 3-D gaming solution to fully support NVIDIA SLI, NVIDIA PhysX, and Microsoft DirectX 11 technologies.

2009 Award Winners

Display of the Year Award

Gold Award: **Samsung's 240-Hz LCDs**

Samsung has broken new ground with the introduction of its 40-, 46-, and 52-in.-diagonal full-high-definition (FHD, 1020 x 1080) 240-Hz LCD panels. These panels deliver unprecedented motion-image performance for LCD TVs, enabling superlative image quality even for fast-action high-speed moving images. Recent increases in LCD resolution, luminance, contrast ratio, viewing angle, color gamut, and color depth have all brought LCD-TV picture quality to new levels, but motion-image performance has been widely considered to be the final obstacle between LCD TV and the ultimate viewing experience. Samsung's 240-Hz LCD panels have now removed that obstacle with a highly innovative pixel-cell structure and a new driving architecture that overcomes hold-type driving limitations inherent in LCDs and other matrix-addressed displays. NTSC video streams provide a new frame of data 60 times per second. In Samsung's new 240-Hz panels, a motion-estimation motion-compensation (ME/MC) engine creates three interpolated frames for every one incoming frame. The three interpolated frames are inserted between each two incoming frames. Therefore, the viewer sees four times as many frames as with conventional TV, which reduces by a factor of 4 the frame-to-frame image-holding time that causes motion blur. Motion performance of displays is characterized using the motion-picture response-time (MPRT) metric. LCDs refreshed at 60 Hz typically deliver MPRT values at about 16 msec. This level of MPRT performance results in significant motion blur for fast-moving image sequences, especially on larger screens. In 2007, Samsung was first to market with 120-Hz panels, delivering MPRT scores of 7-8 msec, similar to that of plasma-display-panel (PDP) screens. Samsung's new 240-Hz panels deliver MPRT results on the order of 4 msec, which is a performance level comparable to that of a CRT. This type of "CRT-like" motion-image performance was previously considered unattainable on LCDs and other matrix-addressed displays. Key technologies that enable Samsung's 240-Hz system include an advanced ME/MC interpolation architecture, new embedded-clock interface technologies to handle the higher data bandwidth between the timing controller and source boards, a new LCD panel architecture based on half-gate double-data (hG-2D) driving, and a novel pixel structure based on charge-shared super-patterned ITO vertical alignment (CS S-PVA). Samsung's CS S-PVA structure is a key enabling technology that effectively doubles the available pixel charging time, in turn allowing the 240-Hz panel's data lines to be driven cost effectively with a single bank of column drivers.

Silver Award: **Texas Instruments' DLP Products - DLP Pico Chipset**

Texas Instruments DLP Products has developed a way of offering large-scale viewing of the increasing amount of mobile content consumers have at their fingertips with the first generation of the DLP Pico Chipset. This new technology is so small that device manufacturers can embed DLP projectors into mobile phones and accessories, enabling enhanced viewing on the go. DLP pico technology allows users to project enlarged images, video, and Web browsing onto any flat surface. A coffee shop becomes a boardroom, a camping tent becomes a theater, and the classroom wall transforms into the newest backdrop for share-and-tell. By utilizing unconventional light sources such as LEDs, DLP pico technology features an aperture ratio of more than 92%, tens of thousands of pixel elements, switching speeds of less than 20 µsec, and TI's DarkChip native-contrast-ratio process technology. In addition, the chipset is capable of displaying the widest color gamuts possible. Images are produced using the same technology that goes into all DLP products. Over 100,000 tiny hinge-mounted mirrors are used to project up to 50-in. diagonally in size. The initial concept for DLP pico technology emerged about 3 years ago. With a value proposition of projecting the biggest image from the smallest box, an opportunity to expand into new categories became apparent. The DLP team looked at cell phones, handhelds, and laptops and identified limitations in screen size and viewing capabilities. For example, when checking e-mail from a smart phone, users cannot see an attachment.

Display Component of the Year

Gold Award: Corning's Jade Glass for Advanced Display

In January 2008, Corning launched Jade glass for advanced display, a fusion- formed glass with high thermal stability, designed for the high-end feature-rich mobile-device market. Jade works with two display technologies - low- temperature polysilicon (LTPS) applications and organic light-emitting diodes (OLEDs) - to solve some of the challenges facing the mobile-device industry. Jade is the first glass substrate optimized for LTPS. Beyond this application, Jade provides capabilities that may enable the scaling of OLEDs to large-sized TVs. The amorphous-silicon (a-Si) process is used in the manufacture of LCDs for TVs and monitors, while the LTPS process is used by makers of displays for small devices. Compared to a-Si, the LTPS process is much more demanding in terms of temperature, surface, and dimensional requirements, and while it may seem a contradiction to talk about a high- thermal-capability glass for a process described as "low temperature," that is precisely what is needed. The LTPS process requires the glass to be very stable and not change shape. Throughout the process, the glass must also maintain a pristine surface quality. The keys are uniformity and consistency. The primary distinction between Jade and other polysilicon glasses is that Jade needs no secondary heat treatment or polishing to meet the demanding surface and thermal stability requirements of the LTPS and OLED manufacturing processes. Previously, fusion manufacturers (including Corning) needed to heat-treat a-Si glass in order to stabilize it so that it could withstand the process - in effect, pre-shrinking the glass. Not only does this pre-treatment make the entire process more complex, it also creates the potential for the glass to change shape under high temperature, and the extra handling can degrade the surface quality of the glass. Polysilicon has always had the promise to deliver higher-performance devices, but the limitations of LTPS technology have confined it to a small portion of the marketplace. Jade will now help move LTPS technology forward, providing increased flexibility for innovation in performance and scalability.

Silver Award: Merck's PS-VA Mixtures

Polymer-stabilized vertical-alignment (PS-VA) is a novel LCD technology that enables displays with very fast switching and very high contrast, as well as high transmission. Thus, backlight brightness can be significantly reduced, which prolongs battery lifetime in mobile devices and reduces power consumption in TV sets - making both these products "greener." Lower backlight power, as well as the PS-VA-specific LCD-electrode layout, also provide a cost benefit to LCD makers. PS-VA technology needs very specific LC mixtures and also a specific panel-manufacturing process: in the PS-VA mixture, a small amount of polymerizable LC (reactive mesogen) is the key component. During the PS-VA process step at the panel manufacturer, that reactive mesogen is polymerized by UV light while a voltage is applied to the LCD panel. For well-chosen liquid- crystal mixture formulations, display layouts, and process conditions, a local, small deviation of the LC orientation from the vertical direction, or "tilt," is generated, which brings about the above-mentioned significant enhancements in LCD performance. From a practical point of view, incorporating a tiny, but well-defined amount of reactive mesogen into an LC mixture is not a trivial matter, as modern displays demand the utmost purity in all materials. "Normal" LCs are basically inert, but due to the reactivity of the new component, special large-scale LC-mixture production processes and equipment as well as new quality-control methods need to be employed (while also minimizing any drawbacks in takt time and yield).

Display Application of the Year**Gold Award: Amazon.com's Kindle 1**

The Amazon Kindle is a revolutionary portable reader that wirelessly downloads books, blogs, magazines, and newspapers to a crisp, high-resolution electronic-paper display that is designed to look and read-like real paper, even in bright sunlight. Kindle uses a display technology called electronic paper that provides a sharp black-and-white screen that works by using ink, just like books and newspapers, but displays the ink particles electronically. It reflects light like ordinary paper and uses no backlight, which helps eliminate the eyestrain and glare associated with other electronic displays such as computer monitors or PDA screens. Amazon's stated goal is to offer the world's best purpose-built reading device. The company's long-term vision for Kindle is to have every book ever published, in any language, in print or out of print, all available in less than 60 sec. It started out with 90,000 available books in 2008 and today offers over 260,000 books, plus newspapers, magazines, and blogs.

Silver Award: iZ3D's 3-D Monitor

In 2005, Neurok Optics decided that the autostereoscopic solutions it had been developing for monitors lacked the necessary "wow" factor for users. But the company was eager to attract a U.S. game-playing population of 100 million and encouraged by the increasing number of 3-D game titles on the market. It therefore made the decision to compromise its original goal of unaided 3-D viewing with the idea that consumers would find it preferable to wear some vision aid that enabled a 3-D "wow" factor as opposed to autostereoscopic 3-D with limited 3-D effects. Neurok then used the intrinsic electro-optical characteristics of liquid crystals to create its "iZ3D" technology with stacked panels in which liquid-crystal material acts as a polarized light-directing valve. The software algorithm of iZ3D's polarization-based technology creates slightly different images for the left and right eye. But unlike film with fixed polarizer angles for projectors, iZ3D controls left- and right-eye images by dynamically changing the polarity of each picture element (pixel). Left- and right-eye images are addressed and controlled simultaneously. With the software-based iZ3D image-control algorithm, the back TFT-LCD controls the intensity of the transmitted light and the front TFT-LCD controls the polarization angle of the transmitted light. In actuality, iZ3D updates images 60 times per second. However, the change to the required polarization angle is performed subpixel by subpixel. That means that for 1680 x 1050 resolution, up to 600 million subpixels are reoriented every second for each image frame change. The polarizer films on the back LCD panel determine the polarizer axis of the light as it enters the front panel. To dynamically control the light transmission of the back and the front panel, iZ3D takes advantage of liquid crystal's inherent polarizing characteristics: the liquid crystal of the front panel redirects the entering polarized light, according to the degree of the liquid-crystal twist. To control the liquid-crystal twist, an electrical field is applied. Varying the electric field, subpixel by subpixel, results in polarization angle changes for each subpixel. The specific liquid-crystal material in iZ3Ds will respond to electrical-field changes with changes in the polarization angle anywhere between 45 and 135°. This method of simultaneously addressing, controlling, and displaying left- and right-eye images creates flicker-free images for comfortable, prolonged 3-D viewing enjoyment. The 22-in.-wide iZ3D monitor is a 2-D/3-D switchable display bundle that includes passive 3-D glasses and stereoscopic 3-D display drivers. The monitor is designed for work in 2-D and for single- and multiple-player gaming in 3-D. Watching 3-D movies and videos is also supported with the addition of a software stereo player. The LCD panels feature a 16:9 aspect ratio with 1680 x 1050 resolution, 300-nit luminosity, and 5-msec response time. Inputs are dual-video DVI/DVI or DVI/VGA to drive the two stacked LCD panels. The monitor works with all current graphic cards that have dual outputs.

2008 Display Industry Awards

Display of the Year Award**Gold Award: Sony Corp. - OLED TV XEL-1**

The promise of OLED TV has been on the horizon for several years, and Sony won the race to market with its slim XEL-1, changing the form factor of television while delivering excellent picture quality. The 11-in. (measured diagonally) XEL-1 model is about 3 mm thin at its thinnest point and offers picture

quality with extremely high contrast, outstanding brightness, exceptional color reproduction, and a rapid response time. It was introduced Dec. 1, 2007 in Japan and in January 2008 in the U.S. and incorporates Sony's independently developed "Organic Panel. The "Organic Panel" has been under development for more than 10 years. With its light-emitting structure, an OLED display can prevent light emission when reproducing shades of black, resulting in very deep blacks and a contrast ratio of more than 1,000,000:1. The lack of a backlight allows the device to control all phases of light emission from zero to peak brightness. The innovative technology delivers exceptional color expression and detail without wasting power, so it is an exceptional energy-saver. Since OLED technology can spontaneously turn the light emitted from the organic materials layer on and off when an electric current is applied, it features rapid response times for smooth, natural reproduction of fast-moving content such as sports and action scenes in movies.

Silver Award: Samsung SDI Co. Ltd. - 2-in. QVGA Ultra-Slim Low-Power High- Contrast Wide-Color-Gamut AMOLED Module

Samsung SDI's 2-in. QVGA ultra-slim, low-power, high-contrast, wide-color-gamut AMOLED module, which started mass production in August 2007, represents the vanguard in OLEDs for mobile displays. This product is a 2-in. QVGA AMOLED module that is used in the Nokia Prism and Arte collections of mobile phones. It contains applied fine-metal-mask (FFM) evaporation technology on low- temperature poly-silicon (LTPS) substrates. This AMOLED display has a resolution of 240 x 320, a luminance of 180 cd, a viewing angle of 180° (all directions), no visible flickering, 100% color gamut in comparison to NTSC with up to 16 million colors, and a power consumption typically around 120 mA. This model is the strongest entrant yet to compete with TFT-LCDs in the high- end mobile-phone market, thanks to its slim form factor, low power consumption, extra-wide color reproducibility, and extremely high contrast ratio.

Display Component of the Year

Gold Award: Luminus Devices, Inc. - PhlatLight Backlight Unit

Luminus Devices has already made a considerable impact on the display market, having successfully proven its PhlatLight® LEDs as suitable replacements for mercury-arc lamps used in projection TVs and projectors. This experience provided Luminus with the insight and understanding to apply the unique characteristics of its PhlatLight technology to other display applications. The high flux and collimated light output of PhlatLight LEDs have now enabled, for the first time, edge-lit backlight units (BLUs) for very large-screen LCD TVs with diagonals larger than 40 in. The PhlatLight BLU is making the large-screen LED-backlit LCD TVs viable by reducing the price premium of LED backlights and driving the adoption of LED backlighting into mass markets. High-volume production and system scalability to larger and smaller sizes will help bring the performance and ecological benefits of LED backlighting to all types and sizes of TVs, monitors, and digital-signage displays, with LCD TVs incorporating PhlatLight LED backlight units expected in stores by the end of 2008.

Silver Award: FUJIFILM Corp. - WV-EA Film

Before now, TN-mode LCDs were mainly used for monitors smaller than 19 in. In monitors larger than 19 in. and TV sets bigger than 20 in., IPS or VA mode were the norm, but of late, TN-mode LCDs have been appearing in these larger-sized displays as well due to lower cost, the faster response time of TN-mode LCDs, and the improvement of WV film. In particular, the development of "WV-EA" contributes to the size expansion of TN-mode LCDs. "WV-EA" is a new WV film for TN-mode LCDs suitable for large-sized wide-aspect-ratio LCD monitors and LCD-TV sets. The "WV-EA" film that was initially developed in 2005 achieved a further viewing angle expansion (see figure) for monitors, but not for TV applications because of the existence of mura on the coating surface. The thickness mura (non-uniformity or unevenness) in the alignment and polymerized discotic material (PDM) layer occurred with the conventional coating method, mainly caused by the fluctuation of airflow in the drying process. This mura gave rise to optical fluctuation, and it was a critical issue for larger panel sizes. Some additives were used and adjusted to improve the thickness mura. However, it is quite difficult to control both the thickness uniformity and the viewing-angle performance because the additive changed the optical properties of the WV film. The "WV-EA" film introduced in 2007 has succeeded in remarkably improving the thickness uniformity. Here, FUJIFILM has introduced new airflow control technology with the precise control of airflow directions and speed in the drying chamber. In addition, the company has developed a new additive that makes compatible the thickness uniformity with the optical properties. These improvements have allowed the "WV-EA" film to expand in TV applications, which have never been possible with the conventional WV films.

Display Application of the Year

Gold Award: Apple - iPhone

Introduced in June 2007, the iPhone created a frenzy of interest that superceded the buzz for any consumer-electronics device that had come before it. From a display perspective, the iPhone is notable for what Apple calls the Multi-Touch display, a 3.5-in. (diagonal) widescreen display with a 480 x 320- pixel resolution at 163 ppi. The iPhone uses projected-capacitive touch technology in two different implementations as described in Apple's patent application. The first, which Apple calls "self capacitance," is a simple passive array of 24 x 36 sensing electrodes in a single plane. Commonly known as a "matrix" touch panel, this is often used in applications such as industrial control panels, membrane keyboards, and other situations where a limited number of well-defined areas on a surface need to be made touch sensitive. Since it is basically a low-resolution architecture, it is not regularly applied to displays. The second implementation is a more-traditional structure consisting of two sets of parallel rows of transparent conductors, one on each side of a substrate, perpendicular to each other. Apple calls this implementation "mutual capacitance." What makes this remarkable is that Apple's firmware processes and outputs up to 15 simultaneous touches. This gives the iPhone's user interface (UI) a tremendous amount of flexibility in terms of recognizing different types of touches, which is vital since there is no traditional phonepad - the entire display serves as the UI.

Silver Award: RealD - ZScreen and Electronic 3-D Cinema

The ZScreen was developed by StereoGraphics Corp. of San Rafael, California, which was purchased by RealD in 2005. The team that created the ZScreen was lead by Lenny Lipton and included Art Berman and Lhary Meyer. Its original application was as a modulator for CRT monitors used for stereoscopic viewing of molecular modeling images for Evans & Sutherland workstations. The same team also designed the CrystalEyes product that has been the standard for scientific and engineering visualization for almost two decades. The ZScreen was developed into a projection device used with CRT projectors and then with DMD projectors. The modulator itself consists of a sheet polarizer in optical series with two pi-cells that are driven out of phase. The technology was first suggested by James Fergasen as a communications device, and he worked with Lipton to perfect its application to moving image projection. The ZScreen was applied for the theatrical application at RealD by a team lead by Josh Greer with Matt Cowan, who developed the cross-talk reduction process. The future looks bright for the stereoscopic cinema, which is experiencing a creative renaissance as filmmakers explore the new medium. This rebirth of the cinema is being enthusiastically greeted by audiences all over the world.

2007*

*Note: The year of the awards was changed in 2007 to reflect the year in which the award was given out - hence, there is no 2006 award.

Display Component of the Year

Gold Award: Corning Inc. Eagle XG™ Glass Substrate

Launched in 2006, EAGLE XG™ Glass Substrate is the industry's first LCD glass substrate that contains no added heavy metals and halides-traditionally, glass production has required the use of arsenic, antimony and/or halides to prevent bubbles in the glass. EAGLE XG is currently the most environmentally friendly substrate available. Its revolutionary new glass composition provides added value while retaining all of the enabling attributes of the previous industry standard, Corning EAGLE2000™ substrates, including density, durability, thermal properties and a pristine surface optimized for the manufacture of large, high-resolution displays. At the end-of-life for an LCD with EAGLE XG, the absence of hazardous materials increases the options for recycling and makes disposal less of an issue.

Silver Award: Luminus Devices PhlatLight LEDs

PhlatLight™ LEDs (light-emitting diodes) are an advanced solid-state light source based on Luminus Devices' patented photonic lattice technology. PhlatLight LEDs have an embedded, sub-wavelength microstructure that radically influences the way light is emitted out of the LEDs. Luminus has leveraged its expertise in photonic lattice technology to develop the proprietary PhlatLight product family for use in a variety of applications, including projection TVs and other advanced, high-definition displays. PhlatLight technology optimizes light extraction by suppressing the lateral propagation of photons inside the chip of LEDs. The photonic lattices direct the photons to the front surface of the LED, emitting substantially more light and in a narrower, collimated beam that is more readily collected and delivered to its target than with traditional LEDs. The photonic-lattice technology in PhlatLight products is what sets them apart as an entirely new category of LEDs.

Display of the Year

Gold Award: Samsung Electronics Co. Ltd.: High Contrast, Wide Color Gamut, LED-Backlit LCD TV (LE40M91B)

The Samsung LE40M91B 40-inch LED backlit TV lead the pack of LED-backlit TVs that entered the marketplace in force for the first time in 2006. This thin-film transistor liquid-crystal display (TFT-LCD) TV combines superior brightness and maximum image fidelity to deliver a high-quality high-definition (HD) viewing experience. Featuring a dynamic contrast ratio of 10,000:1-the highest available today-the sleek, new LE40M91B allows for exceptionally dark blacks against the brightest whites. By re-mapping the complete range of primary colors through a mercury-free LED backlight, Samsung has extended the wide color gamut to an industry-leading 145% of the EBU standard. Its high- definition 1366x768 pixel resolution accentuates the panel's subtly understated black sheen appearance with richly textured wide-screen panoramas in a 16:9 aspect ratio. Other significant visual achievements include the incorporation of 10-bit gray-level fidelity, elimination of motion judder, and prevention of smearing along the edges of the picture that can occur on flat screens during fast-moving scenes. With a response time of less than 8 milliseconds, the LE40M91B is virtually free of motion-picture blur with no false contouring. The display's refresh rate of 100Hz (EU), 120Hz (NTSC) produces an extremely clear picture with virtually no ghosting. In normal TVs, a new visual frame appears every 1/50th of a second (EU) or 1/60th of a second (US). Hold-type driving used in flat displays at this rate can result in the appearance of blurred images. By interpolating a new frame to be inserted between each set of incoming frames, the tendency toward motion-blur artifacts appears to have been virtually eliminated based on early reviews.

Silver Award: Matsushita Electric Industrial Co.: World's First 103-Inch Diagonal 1080p Plasma Display

When it comes to displays, bigger is often better, and the sheer size of Panasonic's 103-inch diagonal 1080p Plasma TV is certainly an attention- grabber-it is the largest plasma display in the world. However, the performance of the TH-103PF series of plasma TVs was the reason for its selection as the 2007 Display of the Year Silver Award winner, not just its size. With industry leading 16-bit color reproduction, the TH-103PF series provides a wide-screen progressive display featuring full high-definition (HD) pixel resolution of 1,920 horizontal x 1,080 vertical, a contrast ratio of 5,000:1, and 4,096 equivalent steps of color gradation, delivering clear, crisp and dramatic fast-action video images. This 1080p display's screen resolution, which amounts to about 2 million pixels, equals twice the resolution of high-definition televisions that are commonly available today. It boasts an effective display area of approximately 89 inches wide by 50 inches high, which is equivalent in size to four 50-inch Panasonic plasma displays. A contrast-management system optimizes the contrast for each individual portion of the image displayed, while a high-precision Motion Pattern Noise Reduction circuit adjusts the image to enhance picture quality by detecting motion patterns that generate noise. Panasonic overcome numerous technical hurdles by developing a new rib structure and phosphor for these super large panels. The 103-inch 1080p plasma panel features consistent and uniform discharge, delivering the same accurate images from the center to every corner of the screen and brightness as the current 50 -inch HD model.

Display Application of the Year

Gold Award: Actuality Systems Inc.: PerspectaRAD

PerspectaRAD is a significant step forward in the display field because it is the first time a high-resolution volumetric 3-D display is in pre-clinical studies for cancer treatment. It is the first display technology to deliver high-resolution, real-time animated medical imagery to clinicians in true autostereoscopic 3-D (3-D without "goggles"). PerspectaRAD is a combination of cancer-treatment software, a volumetric 3-D display, and a 3-D haptic interface-it connects to existing Philips Medical radiation therapy work stations to give radiation oncologists improved tumor coverage with high accuracy. The traditional method of radiation oncology is problematic because doctors are performing a complex 3-D procedure on 2-D displays. PerspectaRAD solves these problems, allowing physicians to view the CT scan in a true volumetric 3-D display: the Perspecta Spatial 3-D Display. It creates a floating, hologram-like 3-D image that can be seen from any angle. It instantly lets the doctors see the location of the tumor and organs in relation to each other. The Perspecta Display includes software and hardware that take 3-D data, such as a CAT scan, and "slices" it into 198 pieces around a central axis, like slicing an apple. The sequence of slices are relayed by several-fold mirrors and focused by spinning projection optics onto a diffuse screen that rotates at 900 rpm. The imagery and the screen are synchronized, and in aggregate create a walk-around 3-D image 10 inches in diameter composed of 100 million voxels (volume pixels). It is the highest-resolution volumetric display ever built, and is run off a single Windows XP PC.

Silver Award: Motorola MOTOPHONE F3

Motorola's Motophone F3 handset employs a revolutionary ClearVision display that addresses the concerns that have made cell phone adoption in many emerging nations an issue, specifically cost and power usage. This the first time that a bistable display technology has been used in a high-volume product.

The Motofone F3's ClearVision display leverages low-cost, low-power electrophoretic-display (EPD) technology from E Ink Corp. to provide users with a 2-inches-diagonal, highly readable screen viewable even in bright sunlight. The Motofone F3 is one of the few entry-level mobile phones that incorporates significant technology innovations including the EPD, dual antenna, single transducer and other SW improvements into a highly affordable device.

2005

Display Industry Awards

Gold Award:

The Philips 3D Solutions 42-in. 3D Intelligent Display is perhaps the most comprehensive 3D solution on the market today. It is tailored to professional markets including digital signage, a growing area of interest for 3D displays, which can attract more attention than traditional 2D signs. The 42-in. LCD with slanted multi-view lenticular lens technology is based on Philips WOWvx technologies, and provides autostereoscopic 3D images with full brightness (460 cd/m2), full contrast (1000:1) and true color representation. The display is based on a 1920x1080 high-definition (HD) panel, enabling great picture quality in both 2D and 3D mode. It allows multiple users to view 3D content at the same time within a large comfort zone.

Silver Award:

Sharp Corp. and Sharp Laboratories of Europe Ltd.'s Two-Way Viewing Angle LCD, the world's first mass-produced display capable of showing different information simultaneously to two different users. It initially rolled out in July 2005 as a 7-in. w-VGA LCD based on Sharp's parallax barrier 3D technology. A parallax barrier is superimposed on a thin-film-transistor (TFT) LCD, causing light from the backlight to separate into right and left directions. This allows the two images to be separated by a wide angle, with each viewing position enjoying considerable viewing freedom and minimal cross talk (or image mixing). The product was initially targeted for the automotive market, allowing the driver to view a GPS screen or safety information while the passenger can watch a DVD or, eventually, digital TV. Sharp believes the market for this technology extends beyond the car, and says it can be applied to any display technology, including emissive displays, and for any screen size, from the smallest mobile phone display to a 65-in. screen.

Display Product of the Year Awards

Gold Award:

SmartDisplayer Technology Co. Ltd.'s Smart Card with Embedded Electronic Paper Display is a flexible, 0.25mm-thin, ultra-low-power bistable display. SiPix Imaging Inc.'s Microcup® Electronic Paper distinguishes this smart card, allowing for increased security, control and personalization. This is the first flexible display panel to be embedded into an ISO-compliant payment card. The DisplayCard was developed by Innovative Card Technologies and authentication expert nCryptone. Due to the challenging requirements for the DisplayCard, Innovative Card Technologies/nCryptone chose SmartDisplayer's flexible display for several reasons: flexibility, low power consumption, impact-resistiveness, and extreme thinness. SiPix Microcup® Electronic Paper met all these requirements, with the added benefit of display-image retention even with the power removed.

Silver Award:

Samsung Electronics Co. Ltd.'s Pocket Imager (SP-P300ME) is the world's first market-launched projector with a light-emitting-diode (LED) light source, offering unparalleled brightness (25 ANSI lumens) and contrast ratio (1000:1) when compared to other similar-sized projectors. The Pocket Imager measures 12.7 cm x 9.3 cm x 5.7m and weighs 700 grams. The unit features a digital light projector (DLP) light engine with a novel LED light source. The display is a .55-in. digital micromirror device (DMD). A special cooling system reduces the heat coming out from many points with only one fan, which helps this product attain low audible noise (under 25dB) during operation. It can project images at various screen sizes, ranging from 12 in. to 63 in., without affecting contrast at a resolution of 800x600 pixels. The adaptable focus range is .4m to 3m.

Display Material or Component of the Year Awards

Gold Award:

Dai Nippon Printing Co. Ltd.'s Crystal Illusion Screen is a transparent optical front-projection screen on which bright, crisp images can be reproduced in a bright room. The reproduction of sharp, large-sized images floating in mid-air makes it possible to open a new projection display market. High-contrast pictures can be displayed even in bright rooms because the new screen uses cholesteric liquid crystals (CLCs). With a peak gain of 2.0 and 50% transparency, the Crystal Illusion Screen is available in sizes of up to 75 inches in a 16:9 format.

Silver Award:

3M Optical Systems Division's Vikuiti™ () LCOS Optical Core (the "Optical Core"), which is lead- and cadmium-free in compliance with EU RoHS regulations, enables a high-quality television image with the lowest possible Liquid Crystal On Silicon (LCOS) projection light-engine cost and reduced light-engine component count. The key enabling technology in the Optical Core is Multilayer Optical Film ("MOF") Polarizing Beam Splitter ("PBS") film. This film comprises many hundred layer-pairs of two polymers, one of which is uniaxially birefringent while the other is homogeneous. By matching the index of the homogeneous layers with the ordinary index of the birefringent layers, light polarized perpendicular to the extraordinary axis is transmitted through the film unimpeded. However, light polarized along the extraordinary axis is partially reflected at each inter-layer interface. Forming a quarter-wave stack of these layers, so light can be separated into two orthogonal polarization states with high extinction, enhances this reflection. This is important for producing high-performance television images. Optical Core performance is industry leading, including contrast values typically exceeding 6000:1 with much higher transmission efficiency than other systems. The PBSs have been shown to have over 30% higher transmission than MacNeille or wire-grid PBS designs (c.f. Philips' paper 64.1 at SID '05). Incorporation of this technology into brighter systems, such as front projectors for home theater and conference rooms, is under development. Implementation of other approaches is also in process to simplify imager compensation, achieve new levels of ANSI Contrast, and further decrease engine costs.

2004 Display Industry Awards

Gold Award: LG.Philips LCD's LC550W01-A5 LCD Module, the first commercially available thin-film transistor liquid-crystal display (TFT-LCD) module for

television sets in the mid-50-in. range. With the development of the LCD module, LG.Philips addressed the challenges of designing large TFT-LCD modules for television applications with a variety of innovative technologies.

Silver Award: Nemoptic BiNem®'s Bi-Stable LCD, a bi-stable variation on the classic supertwisted nematic (STN) LCD that made the technology compatible with existing STN manufacturing lines. Nemoptic's black- and-white, VGA version of the display was manufactured and integrated into eBooks by Nemoptic licensee Picvue, earning Nemoptic the 2004 Display of the Year Silver Award.

Display Product of the Year Awards

Gold Award: Sony's LIBRIé eBook reinvigorated the eBook category by integrating a bi-stable, electrophoretic, "electronic paper" display from the team of E Ink and Philips. The Display Industry Awards Committee bestowed Sony Corp. with the 2004 Display Product of the Year Gold Award for incorporating novel display technology in the design of an eBook that is more appealing to consumers and bringing the eBook closer to fulfilling its potential.

Silver Award: Motorola's RAZR V3 Cell Phone. From its 13.9 mm- thick anodized aluminum case and an all-up weight of only 95 grams, to the chemically etched keypad created from a single sheet of nickel-plated copper alloy, the two state-of-the-art displays, and its long list of features, Motorola's RAZR V3 was sleek and stunning. For raising the ubiquitous cellular telephone to new levels of elegance and functionality, the awards committee honored Motorola with the 2004 Display Product of the Year Silver Award.

Display Material or Component of the Year Awards

Gold Award: E Ink's Microencapsulated Electrophoretic Front-Plane Laminate (FPL) for Paper-Like Displays showed substantial innovation in the science and technology of electrophoretic front planes. E Ink solved a number of difficulties with electrophoretic displays and, working with partner Philips, commercialized a display that exhibited two levels of gray in addition to black and white, with all levels being stable when power is removed.

Silver Award: Lumileds Lighting LLC's Luxeon LED Module for Backlights pioneered practical LED backlight modules for liquid-crystal displays.

2003 Display Industry Awards

Gold Award: LG.Philips LCD's 20.1-in. UXGA TFT-LCD panel with copper bus lines. As active-matrix liquid-crystal displays (AMLCDs) get larger, the high resistivity of aluminum alloy bus lines results in flicker and non-uniform images across the panel. Increasing the width of the lines reduces the resistance but worsens aperture ratio, which reduces brightness or increases power consumption. Copper is a much better conductor than aluminum alloy, but copper can be a contaminant for downstream processes. In its 20.1-in. UXGA AMLCD, LG.Philips LCD developed a way of using copper bus lines that does not affect downstream processes; in addition, the copper process results in one less deposition step and two fewer etch steps. The copper-bus display's flicker was 25 dB down, with a luminance of 250 nits and power consumption of less than 30W.

Silver Award: Hitachi Ltd.'s polysilicon-TFT displays made with a low-temperature process on 730x920-mm glass substrates. By developing a low-temperature (450EC) process for making polysilicon TFT-LCDs, which eliminates the need for pre-annealing the glass substrate, Hitachi Ltd. made it possible to produce relatively low-cost polysilicon displays on relatively large glass substrates. In 2003, the company was manufacturing two small, full-color, low-power TFT-LCD displays using the process. Hitachi said the process should be capable of fabricating LCD and OLED panels up to 20 inches on the diagonal on glass substrates without pre-annealing. *Display Product of the Year Awards*

Gold Award: Mitsubishi Electric Corp.'s ultra-thin, single-DMD™, XGA rear-projection monitor. With its tour-de-force optical system, the LVP- 60XT20 (VS-60XT20U outside of Japan) provided a 60-in. display in a package only 10.2 inches deep. This allowed rear-projection monitors to be considered as direct alternatives to flat panels in many public information and advertising applications.

Silver Award: Eastman Kodak's EasyShare LS633 digital still camera, the first consumer product ever to incorporate a full-color active-matrix OLED display. Kodak integrated the AM550L full-color OLED display it made with Sanyo into the Kodak EasyShare LS633 digital still camera.

Display Material or Component of the Year Awards

Gold Award: Universal Display Corp. and PPG Industries' new generation of red and green phosphorescent OLED materials and device structures with three to four times the efficiency of conventional fluorescent materials. The phosphorescent materials permitted Samsung SDI to build the first prototype OLED cell-phone display that is more efficient than an equivalent AMLCD.

Silver Award: NXT's SoundVu® Distributed Mode Loudspeaker (DML) technology, in which actuators on the periphery of a panel turned the entire panel into a speaker that produced high-quality, stereo sound. The apparent source of the sound could be made to coincide with the location of the image that is "originating" the sound, so sound-vision synchronicity, which has been an important part of commercial cinema since the 1940s, could now be incorporated in desktop and laptop PCs, and in flat-panel TVs. The technology has been used by NEC, Sharp, and others.

2002 Display Industry Awards

Gold Award: Eastman Kodak's AM550L organic light-emitting-diode (OLED) display. At a time when the first OLED products to appear in consumer products were simple monochrome or "area color" alphanumeric displays, Kodak and manufacturing partner Sanyo ramped up volume manufacturing of this full-color, active-matrix, video-capable OLED with vibrant, saturated colors. The AM550L, which had a 2.16-inch (5.48-cm) diagonal and 521x218 pixels, produced a bright image, consumed 450 mW of power (typical), and weighed just 8 grams. It was intended for applications such as cell phones, PDAs, digital still cameras, DVD players, and automotive and industrial uses.

Silver Award: Samsung Electronics' 40-in. wide-XGA TFT-LCD module. Already seen in various forms for several years, the "40-inch" became commercially

available less than a year before the 2002 DYAs. As the first TFT-LCD module to break the 30-inch barrier, this device demonstrated that LCDs could compete with PDPs in the markets for public information displays and large-screen TV. That same year, larger prototypes were announced by Samsung and rival LG.Philips Display.

Display Product of the Year Awards

Gold Award: Samsung Electronics scored another win for its 43- and 50 -in. rear-projection HDTV monitors. These were the first mainstream rear- projection HDTVs using Texas Instruments' DLP™ microdisplays. Samsung's field-sequential color projection engine used one microdisplay for economy, and with initial prices beginning at less than \$4,000, the company entered the market at a competitive price point.

Silver Award: Sony Corp.'s KF-60DX100 Grand Wega 60-in. rear- projection LCD HDTV incorporated several new technologies in 2002. These new technologies included a 1.35-in.-wide-XGA (1366x768-pixel) high-temperature- polysilicon (HTPS) LCD panel, a dot-line inversion drive scheme, and a three-panel optical engine that featured corner-to-corner high resolution and a user-replaceable UHP lamp.

Display Material or Component of the Year

Gold Award: Optiva, Inc.'s Thin Crystal Film™ Polarizers, which represented a fundamentally new way of making polarizers based on a molecularly engineered nanomaterial. When applied to a glass or plastic substrate, the company's TCF™ polarizing material self-assembled into a supramolecular liquid-crystal structure. The result was a polarizing film less than 1 micrometer thick, compared to 200 micrometers for a traditional polarizer. The new polarizer was highly customizable, much cheaper than traditional polarizers, and could be applied to the inner sides of LCD substrates, protecting them from scratches and abrasions, and thus creating more rugged LCD displays.

Silver Award: DuPont Holographics' holographic reflectors, which inexpensively and dramatically improved the visibility of portable, reflective liquid-crystal displays.

2001 Display Industry Awards

Gold Award: Rainbow Displays for its Model 3750 37.5-inch AMLCD panel, which seamlessly - invisibly - tiled three 21.4-in. AMLCDs in a one-by-three array. Seamless tiling had proven to be surprisingly difficult; Rainbow was the first company to successfully implement the technology in a commercial product.

Silver Award: IBM Research Laboratories for its Model T220 9.2- megapixel AMLCD - 3840x2400 addressable pixels on a 22.2-in.-diagonal screen for a pixel density of 204 ppi (80 pixels/cm). The T220 was the product of years of research by IBM exploring the technology and benefits of LCDs with nearly photographic quality.

Display Product of the Year Awards

Gold Award: Minolta, for pioneering the use of a liquid-crystal-on- silicon (LCoS) microdisplay as the viewfinder in a digital still camera, replacing the optical viewfinder that had not changed in principle since its use on 35-mm film cameras of the 1930s.

Silver Award: Not presented in 2001.

Display Material or Component of the Year Award

Gold Award: Alien Technology's Fluidic Self-Assembly (FSA) process automatically placed small encapsulated integrated circuits called NanoBlocks™ into matching depressions in a display's backplane. This innovative approach to packaging display (and other) electronics showed potential for making very rugged and inexpensive devices.

Silver Award: MOXTEK's ProFlux™ polarizer, made of a very-fine- pitch wire grid. The wire-grid polarizer tolerated the high light intensities and temperatures found in projectors, and was capable of contrast ratios much higher than those produced by conventional polarizing beam splitters.

2000 Display Industry Awards

Gold Award: eMagin Corp.'s OLED-on-Silicon microdisplay, uniquely combined two of the industry's most exciting technologies: organic light- emitting diodes (OLEDs) and display-on-silicon microdisplays.

Silver Award: Ise Electronics Corp.'s carbon-nanotube (CNT) FED high- brightness lighting element was the first commercial product to use CNT field-emission technology.

Display Product of the Year Awards

Gold Award: inViso's eCase incorporated its OptiScape II LCOS microdisplay module for a hand-held viewer that could be synchronized with a PC. This allowed the user to carry documents while on the go and to view them at approximately the same resolution and color depth as on a desktop monitor.

Silver Award: Sharp Corp. and Semiconductor Energy Laboratory Co., Ltd. for Sharp's LC-R60H DU 60-inch high-definition rear-projection video monitor, the first commercial product using LCD imagers with thin-film transistors made from continuous-grain silicon (CGS). The monitor presented SXGA images with the very high luminance of 1000 cd/m2 and a contrast ratio of 400:1.

Display Material or Component of the Year Awards

Gold Award: DigiLens' Application-Specific Integrated Filter (ASIF™), which applied a new electrically switchable Bragg grating technology to make a solid-state replacement for the mechanical color wheel used to obtain full color from a one-panel projection display.

Silver Award: Toppan Printing Co. Ltd. for its EBU-CF matrix color filter, which featured new pigments and dispersing parameters matched to new phosphor specifications for the backlight used with the filter. The result was the first color filter that allowed LCD TV sets and computer monitors to render colors as well as their CRT-based competitors. The filter was the first to comply with European Broadcasting Union (EBU) color-reproduction standards.

1999 Display Industry Awards

Display of the Year Award

Gold Award: Toshiba Corp.'s family of direct-view, low-temperature polysilicon (LTPS) TFT-LCDs with integrated drivers. Low power consumption and higher durability made these 4", 8.4" and 10.4" LTPS TFT LCDs ideal for portable applications. Toshiba's aggressive development and commercialization of LTPS TFT-LCDs provided system designers with thin, light-weight displays that did not require external LCD drivers, resulting in more reliable displays that were more resistant to mechanical stress.

Silver Award: MicroOptical Corp.'s Clip-on & Invisible Monitor™, an eyeglass display that put a microdisplay in the ear piece of a superficially ordinary pair of eyeglasses, and reflected the image into the eye with a virtually invisible prism embedded in the eyeglass lens. The result was a one-ounce virtual display that provided a clear, sharp virtual image in front of the user. The quarter-VGA model weighed only 100 grams and added only about \$250 to the cost of a prescription pair of eyeglasses.

Display Product of the Year Awards

Gold Award: Sharp Corp.'s 20-in. LCD Color TV was, at the time, the world's largest-screen, commercially available direct-view AMLCD TV. The 640x480-pixel display had a viewing angle of 120° horizontal and 100° vertical, and an enhanced color filter that combined with the bright backlight to produce substantially enhanced color purity and a 40,000-hour lifetime.

Silver Award: Silicon Graphics Inc.'s 1600SW digital, wide-screen professional LCD monitor. The 1600SW featured a 17.3-in. SuperWide™ screen with a 16:10 aspect ratio and 1600x1024 pixels. The monitor combined wide viewing angles of 120° horizontal and +45 /55 vertical, with a response time fast enough for viewing video and interacting with 3D models, making it ideal for content creators, engineers, and financial professionals.

Display Material or Component of the Year Awards

Gold Award: Pixelworks Inc.'s PW364/264 Single-chip ImageProcessor™ Display Controllers were the world's first single-chip flat-panel display controllers. The chip - the first 0.25-micron system-level- integration ASIC with embedded DRAM - contained half a million gates of random logic, a 32-Mb SDRAM core, and an on-board integrated 16-bit processor running at up to 133 MHZ. With this product, Pixelworks made a giant step toward reducing the size and cost of LCD controller boards and toward bringing LCDs into the monitor mainstream.

Silver Award: Digital Display Working Group's Digital Video Interface (DVI). The DVI is a digital interface standard that was developed by a group of industry leaders including Compaq, Fujitsu, Hewlett Packard, IBM, Intel, NEC, and Silicon Image, and earned the general acceptance of the display and computer industries. The standard specifies a single plug and connector that encompasses both the digital and legacy VGA interfaces, as well as a digital- only plug and connector, answering the industry need "for a common digital connectivity specification for digital displays and high-performance PCs while allowing for existing analog support." DVI handles bandwidths in excess of 160 MHZ, and thus supports UXGA and HDTV with a single set of links. At the time of the DYAs, DVI was expected to accelerate the trend to routine support of digital displays by PC-based controllers, thus reducing the cost of digital liquid-crystal monitors.

1998 Display Industry Awards

Display of the Year Award

Gold Award: Tohoku Pioneer's Organic Electroluminescent Display. Tohoku Pioneer produced a production version of its 256x64 dot-matrix OLED device and incorporated it into Pioneer's GD-F1 FM Multiplex Automotive Receiver for receiving text messages from the FISC traffic-information system. The OLED's high luminance and contrast made the messages readable in most daylight conditions. This green device was the world's first and only commercially produced OLED. In presenting Tohoku Pioneer with the 1998 Gold Award, the DYA committee acknowledged Tohoku and Pioneer's solution of the many technological problems that stood between a promising electro-optical material and practical display devices.

Silver Award: Fujitsu's 15-in. Multi-Domain Vertical Alignment (MVA) TFT LCD. With its FLC38XGC6V/6V-01 module, Fujitsu combined a novel LC mode with a multi-domain structure for a combination of wide angle (160° both horizontally and vertically) and very fast switching time (25 ms, on + off) based on the structure of the display itself, i.e. without external compensation. In addition, the multiple domains were created without rubbing. Fujitsu exhibited a 21.3-in. demonstration unit in Japan, which was shown displaying a motion picture, suggesting the possibility of a wall-hanging TV. But in 1998, the awards committee found the 15-in. MVA-TFT module, which was being delivered at a rate of several thousand a month, the most exciting development. With a luminance of 200 cd/m², a contrast ratio of 300:1, a four-tube backlight, and a choice of an LVDS or CMOS digital interface, the committee deemed this display a particularly attractive CRT replacement for monitors.

Display Product of the Year Award

Gold Award: Hughes-JVC's D-ILA™ Digital Graphics G1000 Projector incorporated their recently developed Direct-Drive Image Light Amplifier (D- ILA™) in the first projector to use the highly effective reflective light-valve technology. Unlike the CRT-addressed ILA® devices developed previously by Hughes-JVC, the LC-on-CMOS device was digitally addressed. At 0.9 in. on the diagonal, it was much smaller and lighter than the CRT-addressed devices. The projector used

three of the D-ILA™ devices working through a single lens to produce a maximum screen resolution of 1365 x 1024 pixels with a luminous flux of 1000 ANSI lumens and a contrast ratio of more than 250:1. The projector handled a full SXGA image without scaling or loss of quality, scaled smoothly for lower screen resolutions, and could handle 1000 TV lines for full HDTV compatibility. With a weight of 28.6 lbs., the projector was intended to be transportable and to offer easy set-up. With the 1998 Gold Award, the Committee acknowledged a quarter century of dedicated light-valve development at Hughes and Hughes-JVC.

Silver Award: Alcatel's One-Touch Com™ use a 40 x 80-mm backlit LCD to combine the functions of a GSM digital cellular phone, a personal organizer, a wireless Internet e-mail communicator using SMTP and POP3 protocols, a short-message (SMS) communicator, and PC companion. A specially formatted SMS message sent to the One-Touch Com™ could update the calendar automatically. PC synchronization could be done via the PC's serial port or wirelessly through the integrated IrDA infrared port. The key to getting all of this into a compact 240-gram package was the relatively large display, which could present a GUI, interactive data screens appropriate to the various functions, a soft keypad for dialing phone numbers, and a soft alphanumeric keyboard that was actuated with a stylus. Alcatel created a sophisticated multi-functional product that could open Internet e-mail to a wide range of users, without any need for computer equipment or expertise. The product was based on a highly intelligent design that was enabled by display technology and a thoughtful user interface.

Display Component or Material of the Year Awards

Gold Award: Silicon Image's PanelLink™ was the first implementation of transition-minimized differential signaling (TMDS), setting the stage for substantially less-expensive digital flat-panel monitors (FPMs) and universal controller cards that economically supported both TMDS and traditional analog monitors. PanelLink™ implemented TMDS with a transmitter-receiver chipset, with the chip residing on either a single-purpose TMDS or universal graphics controller card. A twisted-pair cable up to 5m long connected the two chips. Dai Nippon also won a Gold DCMA award in 1998 for its Ultra-Contrast Screen. Conventional double-lenticular "black stripe" screens, used with Fresnel lenses in television and other rear-projection applications, had been very effective in providing high screen gain with low reflection of ambient light for high contrast. But the pixel pitch of these screens couldn't be reduced much below 0.3mm, making them unsuitable for SXGA and HDTV applications. At these higher screen resolutions, it was possible to use single-lenticular screens, but the lack of black stripes on these screens meant reflections were higher and contrast lower. The addition of a contrast-enhancement filter would have provided increased contrast, but at the cost of screen luminance. Dai Nippon Printing Company helped resolve that problem with its ultra-high contrast screen (UCS), a lenticular screen with 0.14-mm pitch that incorporated an internal ambient-light absorption system (ALAS) that provided improved contrast without an external black matrix or contrast-enhancement layer. As the first high-gain enhanced-contrast solution for single-light-source (LCD, DMD, etc.) rear projectors, UCS was widely accepted.

1997 Display Industry Awards

Display of the Year Award: Jointly awarded to Fujitsu and NEC for their 42-in. Color Plasma Display Panels. Fujitsu Ltd. was first with its 42- in. PDPs and dominated the still-small market in 1997. NEC Corp., another Japanese company, had also made strides in the market by 1997, and showed an impressive panel at SID '97 in Boston. Fujitsu and NEC were the only two companies to have PDPs commercially available before the cutoff date for the 1997 DYAs, and the awards committee chose to honor both companies for their achievements and the industry as a whole for its farsighted commitment to plasma technology.

Honorable Mention: Sony's Super-Flat FD Trinitron® CRTs caused a stir at SID '97 with their 16:9 aspect ratios, beautiful CRT images, and completely flat screens. Flat-screen CRTs had been produced in the past in small quantities by Tektronix for military and government customers, and by Zenith in somewhat larger quantities for premium computer monitors. But Sony was the first to produce a large wide-aspect-ratio flat-screen for television and the first to use Trinitron® taut-wire technology in a flat-screen CRT. The result was a striking difference in what viewers saw when they watched a CRT-based television receiver. Sony used the designation WEGA for Japanese- market receivers based on the FD Trinitron®.

Display Product of the Year Awards

Display Product of the Year: Clarity Visual Systems' LCD Rear- Projection Point-of-Purchase Displays showed the company could apply rear- projection LCD technology to a specialized but large market and optimize it for videowall, kiosk, and dynamic-signage applications. Units had viewing areas ranging from 40 to 58 in. on the diagonal, depths starting at 18 in., weights beginning at 90 lbs., and an average white luminance greater than 200 fL. Clarity's models were designed to be used singly, arrayed horizontally in "banners," vertically in posts, and both horizontally and vertically in video walls. Design goals included even luminosity across each screen, excellent consistency of luminance and color from unit to unit to enhance videowall-type applications, and easy accessibility and set-up. Clarity impressed the 1997 awards committee with its ability to focus on a class of customers and their needs and to tailor display system integration and development efforts to specifically answer those needs.

1996 Display Industry Awards

Display of the Year: Hitachi's 13.3-in. Super TFT-LCD with In-Plane Switching. Although other companies followed in its footsteps, Hitachi was the first to utilize in-plane switching (IPS) in a practical display. In doing so, Hitachi created a true desktop replacement for cathode-ray tubes (CRTs), with large horizontal and vertical viewing angles and with no color change at any viewing angle. IPS, which Hitachi called "Super TFT," made a major change in the TFT-LCD panel architecture. Traditional TFT-LCDs had had electrodes on the front and backplates, and applying a voltage to these electrodes tilted the liquid-crystal molecules from the plane of the plates to a plane that was perpendicular to the plates. This turned the LCD pixel from OFF to ON, but did so in such a way that the optical characteristics could vary greatly with angle. Super-TFT put both electrodes on the bottom plate so that when the liquid-crystal molecules were twisted from the OFF to the ON state, they were always oriented parallel to the bottom plate, resulting in optical characteristics that were remarkably constant with viewing angle. The process for implementing this new architecture was simpler than the traditional one. The only tradeoff arose from the fact that the Super-TFT approach put opaque metal electrodes on the bottom plate. The result was a somewhat smaller aperture ratio, so Super-TFTs were not suitable for battery- operated applications.

Honorable Mention: PixTech's () 52-in. Field-Emission Display (FED) was the first commercially available FED. The ¼-VGA monochrome display came in a 70-nit 1-W (typical) version with a green phosphor, and had horizontal and vertical viewing angles of 160°. PixTech opened the door for manufacturers of FEDs, and with its PixTech Alliance invited other companies - including Futaba, Raytheon and Motorola - to walk through that door with them.

1995 Display Industry Awards

Display of the Year: Texas Instruments' Digital Light Processing (DLP) Engine. Incorporating TI's Digital Micromirror Device (DMD™), this unique approach used individual hinged micromirrors fabricated on a MOS IC that contained the drivers for the mirrors. Each mirror represented a pixel, which was turned on and off depending on whether the mirror was tilted so that the light it reflected was directed through a lens onto a screen or out of the lens' range. TI's unique approach to the challenges of projection-display technology was marked by technical innovation, a long-term commitment to working out the engineering details, and a clear and consistent business model based on Canon's success in building laser-printer engines that OEMs incorporated into end-user projection products.

Honorable Mention: Fujitsu's 21-in. Color Plasma Display. Fujitsu was the first company to bring a "full-color" plasma display to market, and the company's model FPF21C8060UA was, in 1995, the only the only commercial "full- color" (262,000 colors) PDP. Upon Fujitsu's receipt of the 1995 honorable mention, the awards committee noted the company's PDP was "clearly the first of many commercial large-screen color PDPs" and that these panels would "dramatically alter the face of entertainment, computation, presentation, industrial control, and communications products by making direct-view large-screen color displays practical."

Display Product of the Year Awards

Display Product of the Year: Casio's QV-10 LCD Digital Camera was the first digital still-image camera to be enhanced with a liquid-crystal display (LCD) The camera weighed 6.7 ounces (plus the weight of four AA batteries), stored up to 96 JPEG images and featured a 1.8-in. TFT active-matrix LCD for use as both a viewfinder and playback monitor. With the camera in record mode, the LCD monitor allowed the viewer to look at the image on the viewfinder and adjust the exposure interactively. The camera could send its images in NTSC video format directly to a video tape deck, a standard television set equipped with a video-input jack, a picture phone, or a video printer. With an optional personal-computer adapter kit, the images could be uploaded to a Windows-based PC or Macintosh computer for storage, manipulation and/or printing. The edited images were then capable of being transferred back to the camera. In play mode, four or nine images could be displayed on a single screen, and users could enlarge selected portions of a single image. By incorporating a color display, Casio transformed the general-purpose digital still camera into a tool of vastly expanded uses, pricing it at under \$1,000 to make it possible for many consumers to explore those uses.

Honorable Mention: Sharp's Hi-8 Viewcam. Following the company's own lead in creating compact consumer camcorders using a relatively large color LCD as a combination viewfinder and playback monitor, Sharp created the VL-H420UP viewcam for professional applications. The unit used a 4-in.-diagonal LCD with enhanced resolution and a reflectivity of only 1% for better contrast and viewability in brightly lit conditions. The Viewcam offered a 16:9 wide-screen mode, digital image stabilization, fade-in/fade-out capability, a high-speed motorized zoom that went from full wide angle to full telephoto in 2 seconds, and an instantaneous 20X digital zoom.

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