SID 2000 REVIEW ISSUE

Information DISPLAY

September 2000
Vol. 16, No. 9

SID

Official Monthly Publication of the Society for Information Display

The International Display Industry Met at SID 2000

- ***SID 2000 Review***
  - ***Overview • Microdisplays***
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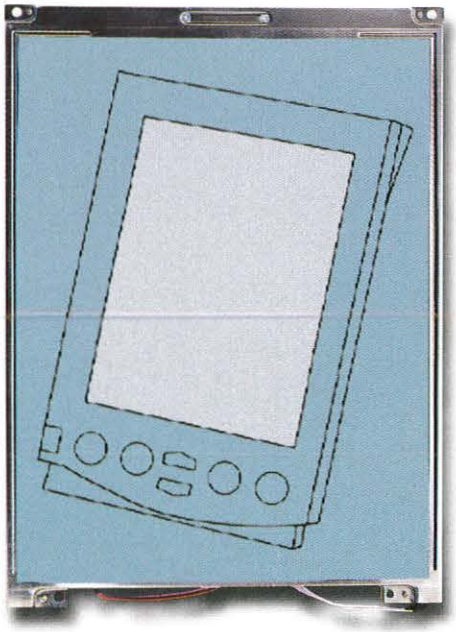

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BPA INTERNATIONAL

COVER: A SID 2000 exhibitor said it: "The SID technical sessions are always strong, but the trade show this year seems to have risen to a whole new level." This issue is devoted to extensive coverage of the event, and the technologies, products, and industry news our contributing editors uncovered.

John Robinson for SID

For more on what's coming in *Information Display*, and for other news on information-display technology, check the SID Web site on the World Wide Web: **http://www.sid.org**.

Next Month in *Information Display*

Flat-Panel Issue

- Replacing the Color Wheel
- Analog *vs.* Digital Interfaces for LCDs
- Computex Taipei Review (23-in. AMLCDs)
- INFOCOMM Review

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Information DISPLAY

Sony Announces New Approach to Digital CRT Monitors at PC Expo

PC Expo – held this year June 26–29 at, as always, the Javits Convention Center in New York City – follows hard on the heels of the SID International Symposium and INFOCOMM. The three shows, and their audiences, are very different. SID is both the principal technical conference of the international display community and a major OEM-oriented trade show. INFOCOMM has a series of tutorial seminars and professional training sessions, but it is primarily a trade show – a substantial one, drawing over 26,000 this year – aimed at audio-visual dealers and contractors. It is a bit of a simplification to say that INFOCOMM is a projector show, but projectors big and small are the most obvious products you'll see there.

PC Expo is a general computing show keyed to both corporate and individual users. It's the kind of show at which professional presenters wearing head-mounted mikes compete with each other for audio mindwidth (you can usually hear several of them, loudly and simultaneously) as they throw rolled-up T-shirts into their respective audiences and where you will learn more than you ever wanted to know about Web sites that let you share your family photographs *via* on-line photo albums. But displays are everywhere, and invariably, interesting display-related developments are to be found at PC Expo. This year one of them was extremely interesting indeed.

Sony introduced its Diginex™ architecture for digital CRT monitors as a technology demonstration and showed it in the expansive Sony booth. Rather than essentially slap a DVI interface on a standard multisync monitor and convert from digital to analog early in the signal's journey through the monitor, Yoshihisa Narui, Manager for Technical Planning at Sony Display Systems of America in San Diego, rethought the monitor's architecture for a digital environment. Narui's approach is to keep the signal digital until the last possible stage, when it must be converted to analog to drive the CRT. But prior to this stage, Narui uses a digital frame memory, which allows Sony to use a single-frequency-scan tube and yoke. Any image format or refresh frequency sent by the video card leaves the frame memory converted to the format and (high) refresh that the tube expects to see.

Not only does this approach optimize the image, but it embodies a smart strategy for manufacturing. Ultimately, digital electronics manufactured in high volume becomes cheap. And making a single-frequency tube allows the use of simpler yokes and deflection circuits and simplifies the assembly of yokes to CRTs, which is relatively time-consuming.

Said Hiro Ishizuka, who has taken over from Tei Iki as President of Sony's Display Component & Device Company of America: "While many thought FD Trinitron® technology and its flat screen surface was the last frontier for CRT displays, ... there is yet another new frontier for this proven, resilient display technology. The development of Diginex technology holds tremendous promise for the future of computer displays."

Sony has joined the Digital Display Working Group and is working to accelerate the adoption of DVI by system and graphics-card makers. Ishizuka told *ID* that the current installed volume of DVI platforms does not yet justify a roll-out

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Information
DISPLAY

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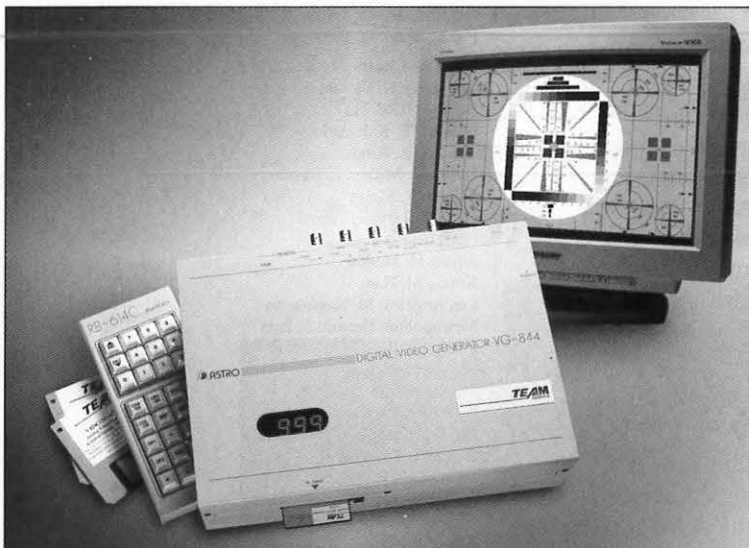

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a view from the hilltop

The Best Product at the Lowest Price ...

by Aris Silzars

It was a late Thursday afternoon at the Long Beach Convention Center. The bright overhead mercury arc lamps in the empty exhibition hall were illuminating a vast expanse of bare, gray concrete flooring. A few pieces of cardboard and styrofoam were strewn here and there. The room conveyed the feeling of desolate emptiness. It seemed that at any moment one could expect a tumbleweed or two to come bounding by.

A few hours earlier, Jay Morreale, Symposium Coordinator, and I had stood near the entrance door and watched as the exhibition of the Year-2000 SID International Symposium had come to an end and the rapid dismantling began. For the previous two-and-a-half days, the Long Beach Convention Center had been a bustle of activity as the venue for yet another successful SID Symposium with a record number of booths, and with exhibitors showing the full gamut of the latest displays and display-related products. Now all the activity was focused on dismantling, packing, and moving out – for shipment back to the factory or perhaps on to the next show.

The speed with which all this took place was quite amazing. The left-over sales literature quickly found its way back into the thoughtfully retained cardboard boxes. The working displays were unplugged, disassembled, and repacked into their custom-designed crates. Other products, signs, and visual aids also disappeared with urgent efficiency. And somewhere in this process, the recently carpeted floor reverted back to its hard gray concrete.

Is this the modern-day high-technology version of a circus coming to town? Months of promotion, planning, and preparation all culminating in three days of frenzied activity – activity focused on presenting the latest and greatest display-related products to a worldwide technical community.

During their heyday, around the beginning of the twentieth century, circuses had mixed reputations. While serving the purpose of bringing novel entertainment experiences and occasionally even providing acts of skill and daring to a population that was far less mobile than today's, they were also known for over-promotion and occasionally even for misrepresentation. A few perpetrated outright fraud in the sideshows and carnival areas that accompanied the main-ring events. Eventually, even with limited long-distance communications, the word got out and at least the worst offenders were forced to tone down their claims. Of course, as the years passed, as people began to travel more, and as locally available entertainment in the form of movies and the new electronic medium called television became more prevalent, most of these circuses did not survive. Only the few that could adapt to the higher entertainment standards to which people were becoming accustomed were able to survive.

Promoting, selling, advertising – really, who needs them! If I have a great product, people will find me and buy it. And if I have created this great product and can sell it at the lowest price, then why would anyone need a "sales pitch?" Promotion and advertising should only be necessary for those who have poor products or those who want to run a circus. Right?

Well, a few years ago I visited a microelectronics factory in one of the republics of the former Soviet Union. The factory was badly in need of some

continued on page 50

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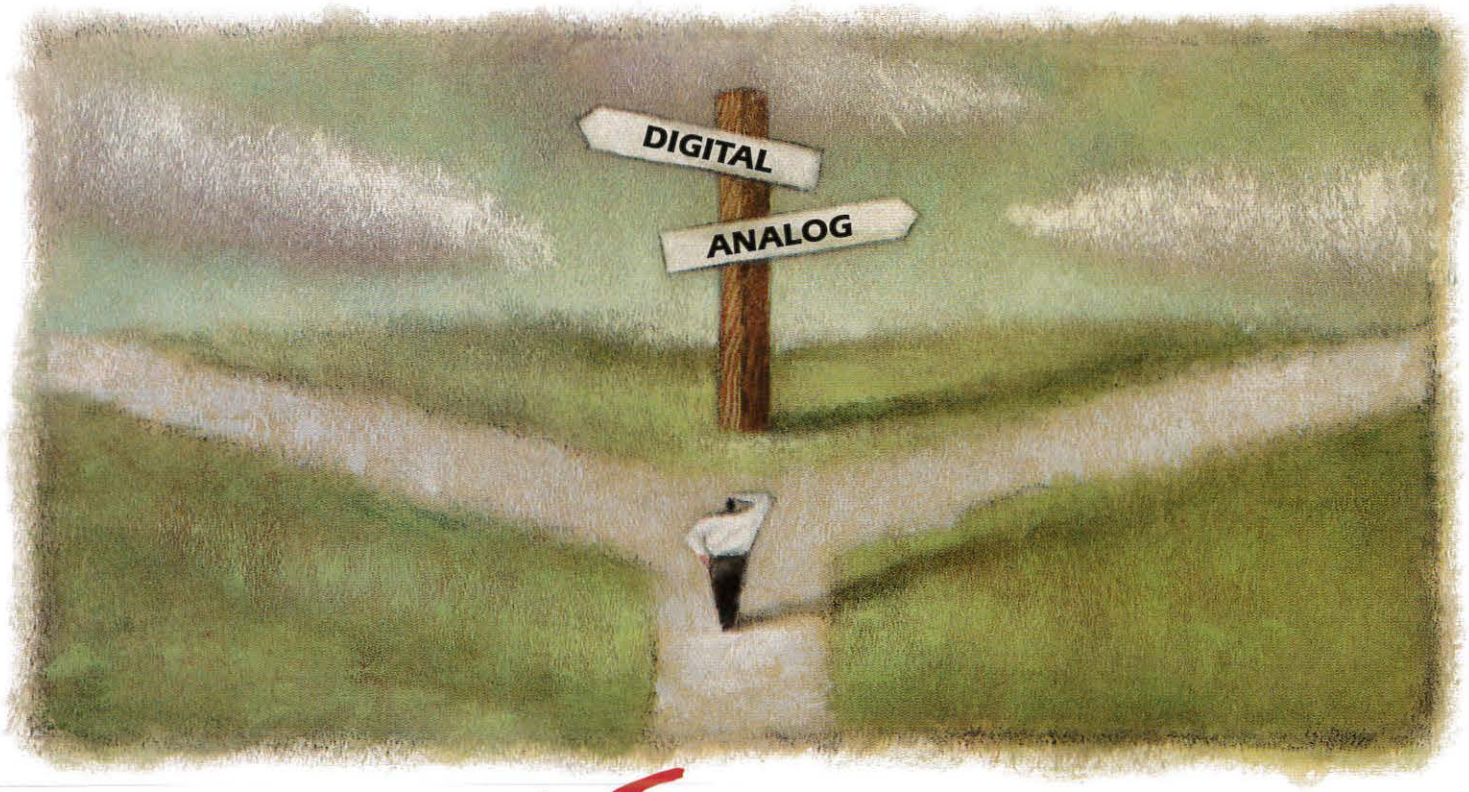

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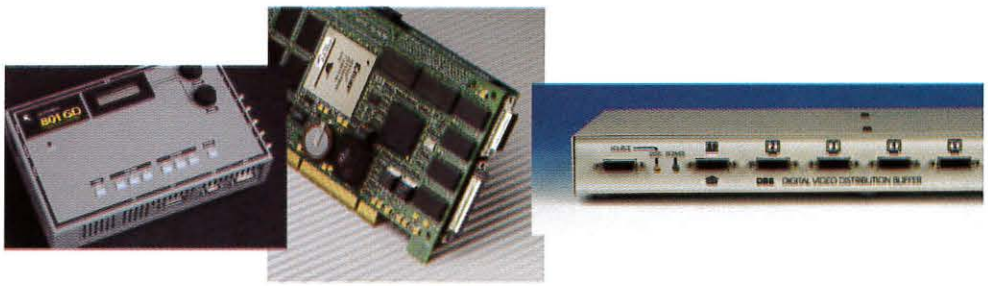

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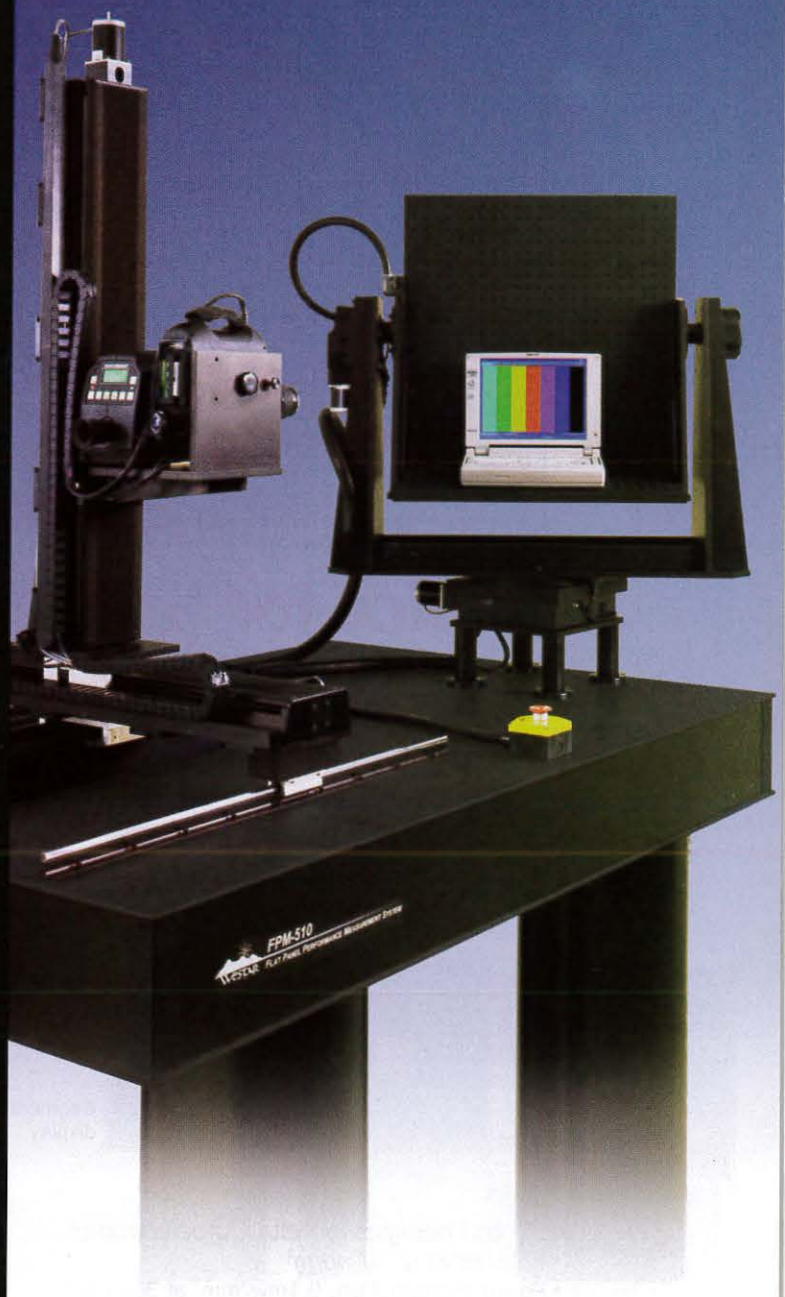

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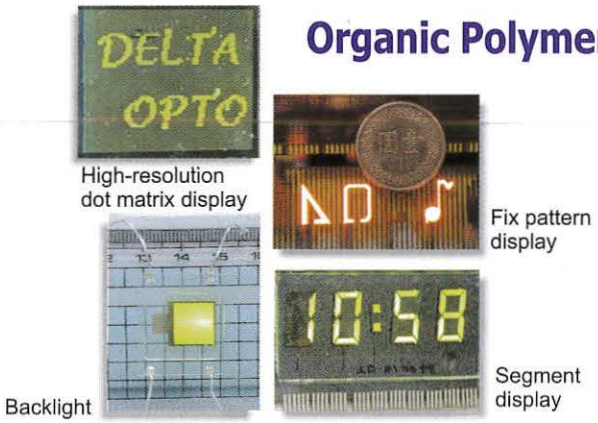

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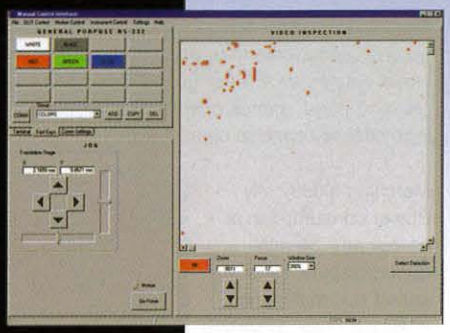

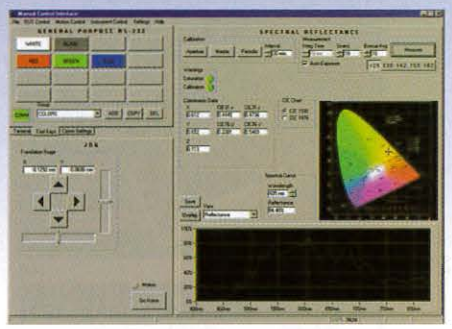

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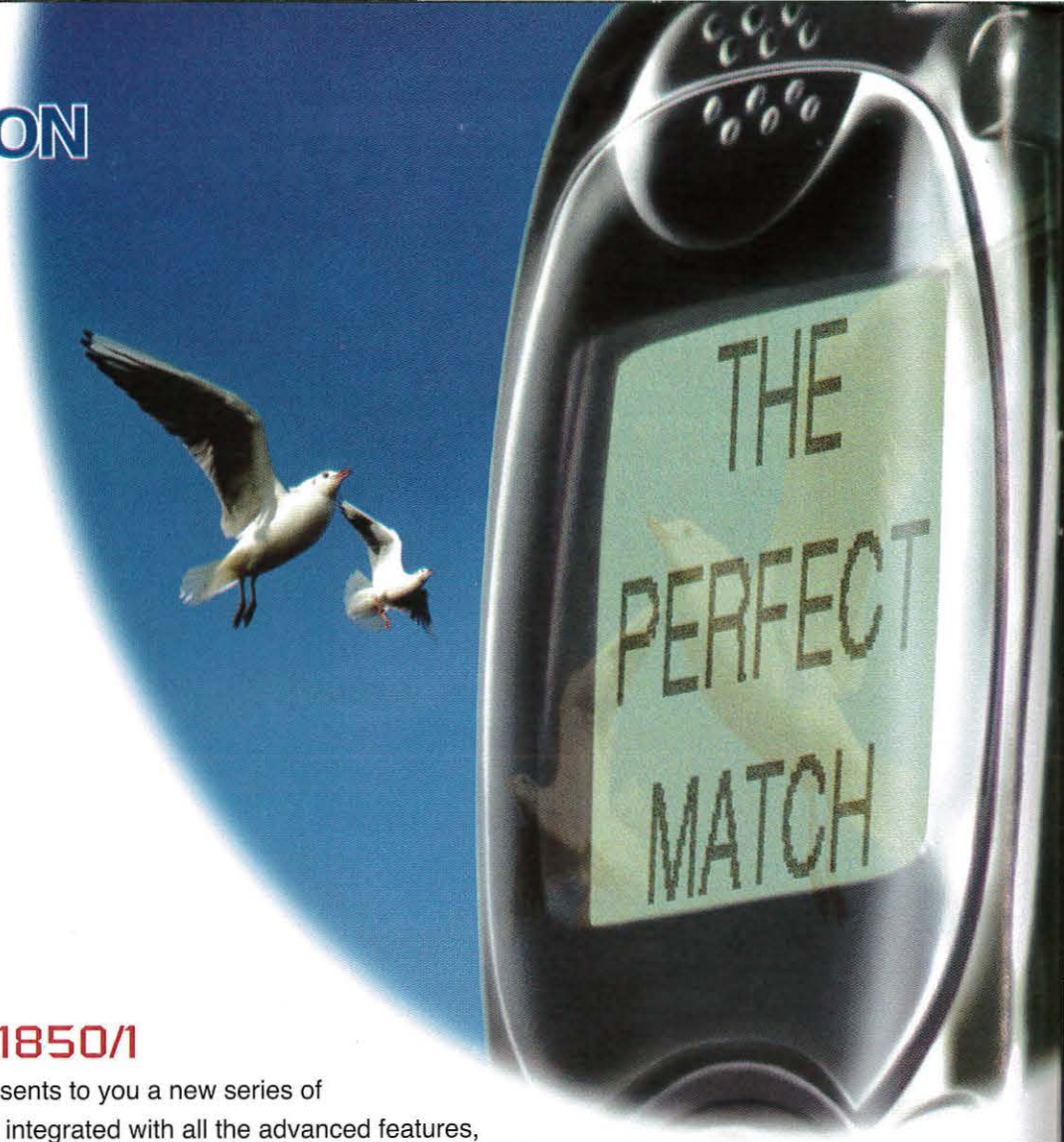

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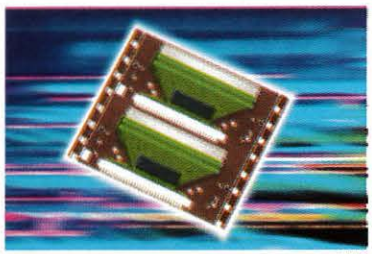
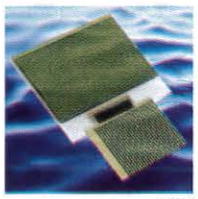


TAB

Part Number	Resolution
SSD1820	128x64, Monochrome
SSD1821	128x80, Monochrome
SSD1850	128x64, 4 level gray scale
SSD1851	128x80, 4 level gray scale



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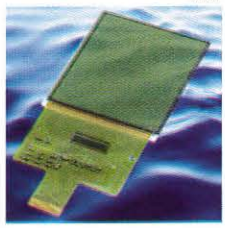

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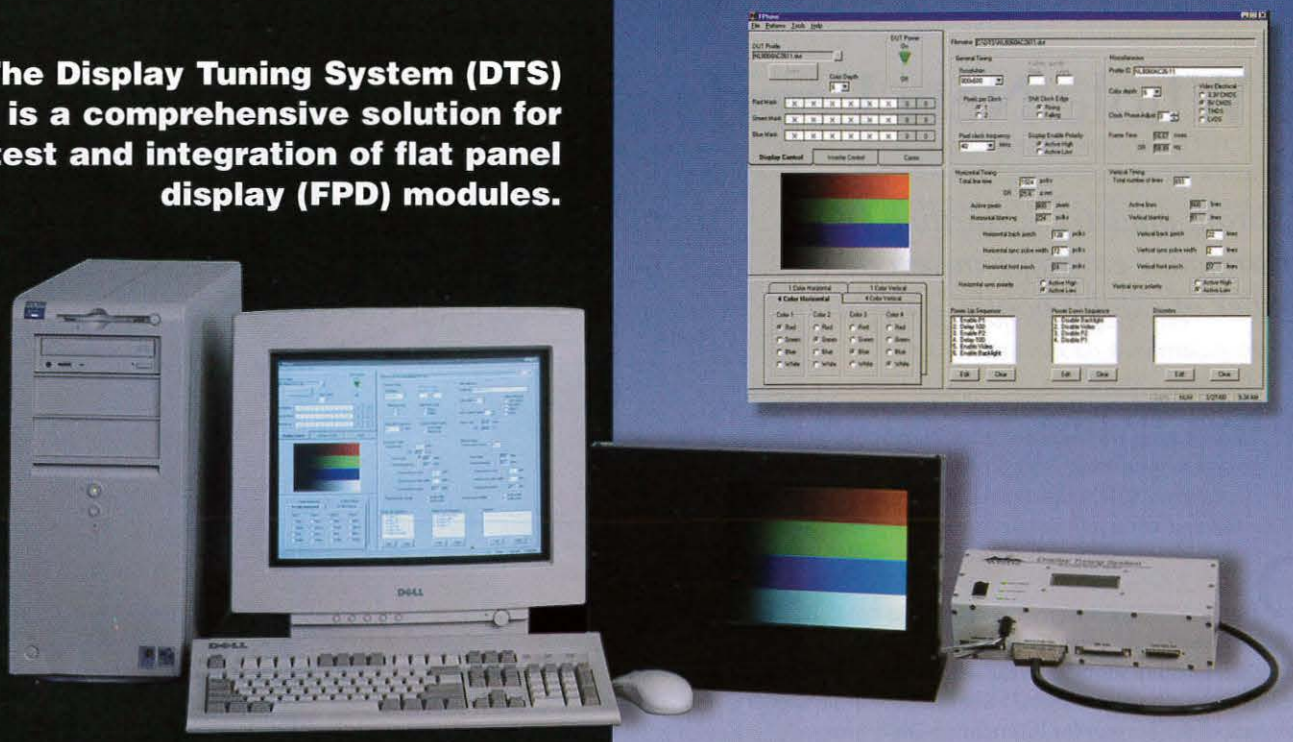

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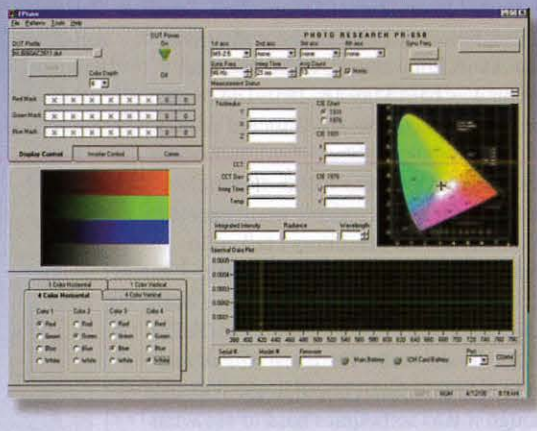

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A Whole New Level

A vibrant industry, a startling OLED demonstration, expansion of the LCD performance envelope in several directions, the LCoS roll-out, and a record number of exhibit booths gave SID 2000 an air of champagne effervescence.

by Ken Werner

DISPLAYTECH'S Kelly Goranson said it: "The SID technical sessions are always strong, but the trade show this year seems to have risen to a whole new level." She was talking about the Society for Information Display's annual International Symposium, Seminar & Exhibition (SID 2000), held this year May 14–19 in Long Beach, California (the exhibition was held May 16–18). The overall attendance matched last year's record of 6600 at San Jose, and the number of exhibit booths rose to 435 from last year's 402. Traffic seemed brisk, serious contacts were reportedly plentiful, and all the exhibitors I talked to were happy – some approaching ecstatic.

The most exciting exhibit had to have been the 5.5-in. quarter-VGA active-matrix OLED (AM-OLED) shown by ***Eastman Kodak*** and ***Sanyo*** in Kodak's small booth in the 900 aisle – although it was sometimes hard to see what was there over the heads of the surrounding crowd. The switches in this OLED's active matrix are made of polysilicon, which was also used to fabricate on-board row and column drivers. The result was a brilliant image coming from a thin glass sandwich held in the air by a work-holder, and the display was connected to its host system only by a 25-conductor ribbon cable. A 2.4-in. prototype, which was also shown in the booth, was described in an invited paper (40.1). (See "OLEDs Dazzle at SID 2000" by Alan Sobel in this issue.)

Here, clearly, was an important part of the display future knocking on our communal door, but apparently not loudly enough for Kodak's own product people to hear it with any noticeable sense of urgency. Plans are to use a 1.8- or 2.0-in. quarter-VGA version of the OLED as the viewfinder/monitor in Kodak digital cameras appearing in the stores for Christmas 2001. That seems like a leisurely roll-out for a technology that looks so good now. Shakespeare had it right as usual: "Wake Kodak with thy knocking! I would thou couldst!"

Judging from the press kit, Kodak seems more interested in selling its proprietary OLED materials to other display manufacturers. (In June, Kodak announced that it was licensing its passive color and monochrome OLED technology to RITEK Corp., the Taiwanese company that is the world's largest maker of storage media, with a focus on stamped, recordable, and rewritable optical discs.)

Let's not deny that commercial roll-out is difficult. It took the liquid-crystal–on–silicon (LCoS) microdisplay folks years to get from ones and twos to hundreds of thousands per month – but this is the year. In their booths and suites, and at the Microdisplay Round-

John Robinson for SID

Due to improvements in the registration procedure for SID 2000, long lines were no longer evident in the registration area at the Long Beach Convention and Entertainment Center.

Ken Werner *is editor of* Information Display Magazine.

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John Robinson for SID

RITEK, the world's largest maker of CD, CD-R, DVD, DVD-RAM, etc., media, has been working on OLEDs for the last 2 years, and this year had a handsomely designed booth at SID. Following SID, RITEK and Kodak announced a licensing agreement for Kodak's passive OLED technology.

table – an annual event for press and analysts – leading microdisplay companies eagerly cited chapter and verse about current and projected monthly shipments, and some were happy to announce customer relationships. ***Displaytech***, for example, showed the Samsung rear-projection 43-in. TV receiver (using three Displaytech microdisplays) that was to be sold by Circuit City and other retailers beginning in July, and ***Colorado Microdisplay*** (***CMD***) showed the CMD-containing SVGA Olympus PC Eye-Trek™ headset that is packaged with IBM's new Wearable PC.

LCDs

The AM-OLED and the LCoS roll-out were major stories, and they served to distract people from significant events that would have been front and center in almost any other year. Notably, the LCD performance envelope was increasing in several directions at once. ***Toshiba*** was offering an impressive range of low-temperature-polysilicon (LTPS) AMLCDs to OEMs in quantity (for which the company had received a SID/*Information Display* Display of the Year Award), was showing some nice reflective versions, and was featuring a 10.4-in. UXGA display with a high pixel density of 192 pixels/in.

In fact, reflective LCDs were making clear progress generally, with ***Sharp*** showing a lovely 11.3-in. TFT SVGA version. The introduction of non-standard pixel formats was also notable, with ***Samsung*** and others pushing SVGA+ (1400 × 1050), while ***Mitsubishi*** introduced Quad VGA (1280 × 960) in an industrial module.

NEC showed an innovative AMLCD architecture (and described it in invited paper 48.2), in which the matrix color filter (MCF) was fabricated on the rear TFT plate instead of the front plate (more on this and on LCDs in general in the LCD review article in this issue).

Kent Displays has apparently found the holy grail of cholesteric LCDs: a full-color display – well, 4096 colors, anyway. Quarter-VGA and VGA versions were scheduled for full production by July. ***Optrex***, the 800-lb. gorilla of custom display makers, also showed its first cholesteric display.

What Light Through Yonder Window Breaks?

We're talking emissive displays and backlights here. ***Candescent Technologies*** showed an extremely impressive 13.2-in. SVGA field-emission display (FED). (My only reservation is that the display did not appear very bright, despite a claimed luminance of 200 cd/m^2. The accompanying 5.3-in. quarter-VGA was bright, but I didn't notice any luminance figures posted.) The 13.2-in. puts to shame the very rough, low-pixel-count 15-in. "work in progress" that PixTech has been showing for the last couple of years. But PixTech was not to be seen this year, nor was Futaba, nor Motorola. Indeed, in the exhibit hall only Candescent was holding the FED torch aloft. The Candescent folks were not entirely happy with that situation since they had been hoping for a broad showing of FED successes to validate the technology, which has suffered reverses during the last couple of years following a period of great optimism.

Samsung

Displaytech showed a prototype version of this Samsung 43-in. high-definition (720p) rear-projection TV receiver which uses three of Displaytech's LCoS microdisplays.

But if support was not to be found on the show floor, it could be found in abundance just a few feet away in the technical sessions, where at least 15 papers on FEDs were being delivered by authors from the likes of ETRI (the Korean research institute), ERSO (the Taiwanese national electronics research organization), Samsung Advanced Institute of Technology, Motorola, Fuzhou University, the Korean Institute of Science and Technology, Kyung Hee University, Candescent and Sony, Ise Electronics, and Mie University. If there was a common theme, it was finding alternatives to Spindt tips, which require demanding manufacturing processes. Carbon nanotubes and printed structures were popular approaches. With this high level of activity in Korea and Taiwan – and, to a lesser extent, in Japan – Candescent may soon be getting the company it was looking for at SID. The International Display Manufacturing Conference in Seoul during the first week of September might be a good place for them to look.

Both ***Teledyne*** and ***Philips*** were making remarkably bullish comments about the potential for LED backlights not only to compete with CCFTs, but to replace them entirely (more about this in the accompanying LCD story).

In the Beginning ...

In the relative calm of Tuesday morning before the frenetic activity of SID 2000 had fully revved up, the conference was inaugurated with two keynote addresses, both excellent, one of which actually heated the blood of some members of the audience.

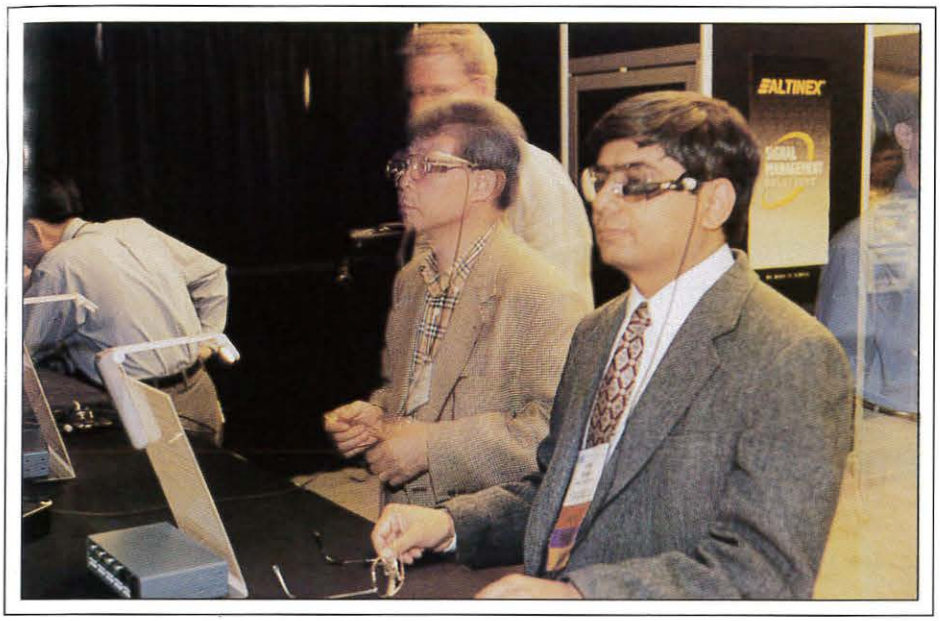
In "The Future of Cinema: Is It Digital," Jerry Pierce, V.P., Universal Studios, presented a professional's thorough and tough-minded analysis. The good news for the display community is that D-Cinema will be the way Hollywood films are distributed in 15 years, probably in 10. But there are lots of hurdles to be overcome, with technology now being among the easiest.

Digital projectors, said Pierce, are now close to being good enough for cinema. Black levels must improve and motion artifacts must be reduced. The digital image must be able to match the quality of 35mm answer prints in color, texture, brightness, and motion – as a start. Current digital projectors aren't there yet, but "it's definitely going to be doable."

The great attraction of D-Cinema is that a simpler, more reliable, more flexible process can be built around it than is possible with film. The difficulties are that it must satisfy the artistic needs of the Hollywood creative community and the financial needs of studios, distributors, and exhibitors. The trick is that the benefits flow to the studios and the distributors, while the exhibitors (theater owners) have to bear the intimidating capital costs of conversion. The industry realizes that some way needs to be found to share costs and benefits so that the exhibitors will find conversion attractive, but there isn't a workable proposal on the table yet. Along the way to creating a workable financial and technical system, a whole suite of file, display, and media standards will have to be created.

Pierce concluded his presentation by assuring the audience that Hollywood is moving toward digital cinema, and that the industry takes it as gospel that the movie theater must continue to provide an experience that is dramatically superior to home presentation. "D-Cinema is not the first step, but the last step in the digital chain," he said. "D-Cinema will come, but not too quickly."

Bob O'Donnell, research manager for PC monitors and projectors at International Data Corp. (IDC) (Mountain View, California), won the hearts of the CRT contingent in the audience and the antagonism of everybody else when he gave the second keynote, "PC Monitors: A Look Ahead." The source of this polarization was a user study performed by IDC that concluded that most users prefer the images on CRT monitors to those on LCD monitors independent of price, and less than 1% are willing to pay current price differentials.



John Robinson for SID

During SID 2000, people frequently lined up to view the microdisplays at the Display Technology Showcase.

Other data and conclusions were appreciated equally on both sides of the aisle. One hundred million monitors were shipped last year, said O'Donnell, with healthy growth projected. LCD monitors are projected to go from 3% of stand-alone (unbundled) monitors in 1999 to 15% in 2003 in spite of the lack of user enthusiasm found in IDC's study.

Average monitor cost is rising gradually because people are tending to buy larger, more capable monitors. From 1999 to 2003, monitor cost is projected to rise from 15 to 35% of system cost, which has interesting ramifications. The monitor will increasingly become the "hook and differentiator" for the PC system. Although cost will still be critical, the monitor as hub becomes an increasingly important issue. Look for an acceleration of the trend to include speakers, microphones, USB hubs, video cameras, and even TV tuners (as done recently by Samsung in some SyncMaster models) in monitors. When a user group was asked what features the users wanted in their next monitor, the answers (in order of frequency) were: a camera, a USB hub, 16:9 aspect ratio, and (particularly for business users) higher resolution.

O'Donnell noted that by the end of 2000, flat tubes will dominate in CRT monitors; flat square tubes will hang on only in economy models. He noted also that LCoS rear-projection models will arrive late this year, and that they will be both big and pricey. "If they are too pricey, it will be tough for them to survive."

Side by Side

In the Display Technology Showcase (DTS), SID's annual side-by-side comparison of different displays and technologies, the big and better-than-ever plasma displays from ***Pioneer***, ***Plasmaco***, and ***NEC*** again drew lots of attention, with Plasmaco's excellent 60-in. being the largest. (There were reports from Korea that Samsung had shown a 63-in. PDP and that LG had a 70-in. in the lab, but these displays have yet to be seen at SID or DTS.)

A steady stream of attendees waited on line to see the near-to-eye microdisplays by ***Inviso***, ***Colorado Microdisplay***, ***Three-Five Systems***, and ***MicroOptical Corp***. Two otherwise identical monitors from ***U.S. Electronics*** had analog and digital interfaces, although, unfortunately, they were not showing the same images.

Supporting technology gets more and more impressive. ***STMicroelectronics/Arithmos*** showed video scaling chips (in LCD monitors) with dual analog and digital inputs and context-sensitive scaling. ***Sage***'s controller chip supported picture-in-picture. ***Genesis Microchip***'s scaling engine integrated a TMDS receiver and a dynamic phase checker. ***Pixelworks***'s highly integrated image processor incorporated a TV tuner and picture-in-picture. And ***Silicon Image*** demonstrated a DVI transmitter–receiver pair that implemented high-bandwidth digital-content protection (HDCP) in a 24-in. Sony CRT monitor.

DTS is intended to be a professional-level educational event. In comparing different technologies side by side, DTS often provides a shock or two, even to professionals in the field. Last year, the shock was how good CRT television looked in comparison to plasma. This year the shock was how far LCD television still has to go to compete with plasma and CRT. ***Sharp*** outrageously displayed its 19.7- and 28-in. AMLCD TV receivers, which are striking packages. The relatively low luminance compared to the nearby PDPs was expected, but the extent of smearing with moving images was extremely disappointing.

Sharp has made it a major corporate initiative to convert its entire TV line to LCDs by 2005. The lesson of DTS is that they – together with others that would expand the role of LCD TV – have a lot of work to do.

Introduction

This overview is an introduction to the other nine articles in this SID 2000 review issue of *Information Display*. These articles describe, summarize, analyze, and provide expert opinion on what could be seen, heard, and learned at the display industry's premier international technical conference and trade show.

Since SID 2000 is so central to the cycle of display development and technical communication, this issue also serves as an annual round-up of display-technology, display-manufacturing, display-marketing, and display-integration issues. We hope you find it valuable, and we encourage you to tell us if you would like more coverage – or less – of any particular area. ■

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Microdisplays and Manufacturing Infrastructure Mature at SID 2000

Microdisplays are now being made at the rate of hundreds of thousands per month, and every month there are more products into which they are integrated.

by Chris Chinnock

THE BIG NEWS in microdisplays at SID '99 was the push to get liquid-crystal–on–silicon (LCoS) manufacturing issues solved so that products could be introduced. A year later, most manufacturers are shipping displays and are in various stages of ramp-up.

But solving microdisplay-manufacturing problems has proved to be only one part of the commercialization puzzle. For projection products, new architectures and optical devices for three-panel and single-panel engines have had to be developed in parallel. The number and variety of projection engines on display at SID 2000 indicate that the entire manufacturing infrastructure is maturing rapidly. As a result, front- and rear-projection systems for high-definition television and computer monitors have already started to enter the marketplace. Near-to-eye products such as video headsets and viewfinders are also starting to reach the market. If LCoS-based products can capitalize on their promise of good performance at lower cost, consumers will be pleasantly surprised to see very nice products at very attractive prices over the next few years.

In projection engines, ***OCLI*** (Santa Rosa, California) presented a new three-panel opti-

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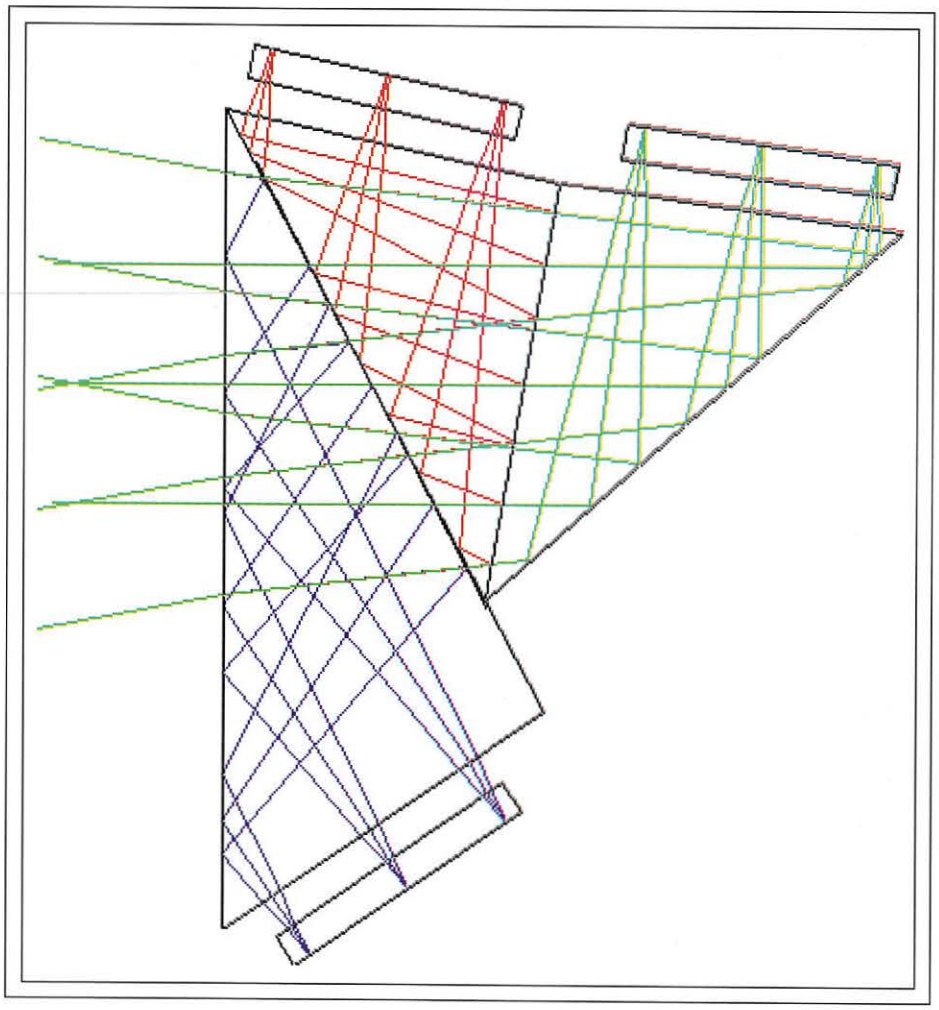

The well-known coating company OCLI presented a modified Philips-prism configuration for LCoS projection engines that offers lower weight and manufacturing cost.

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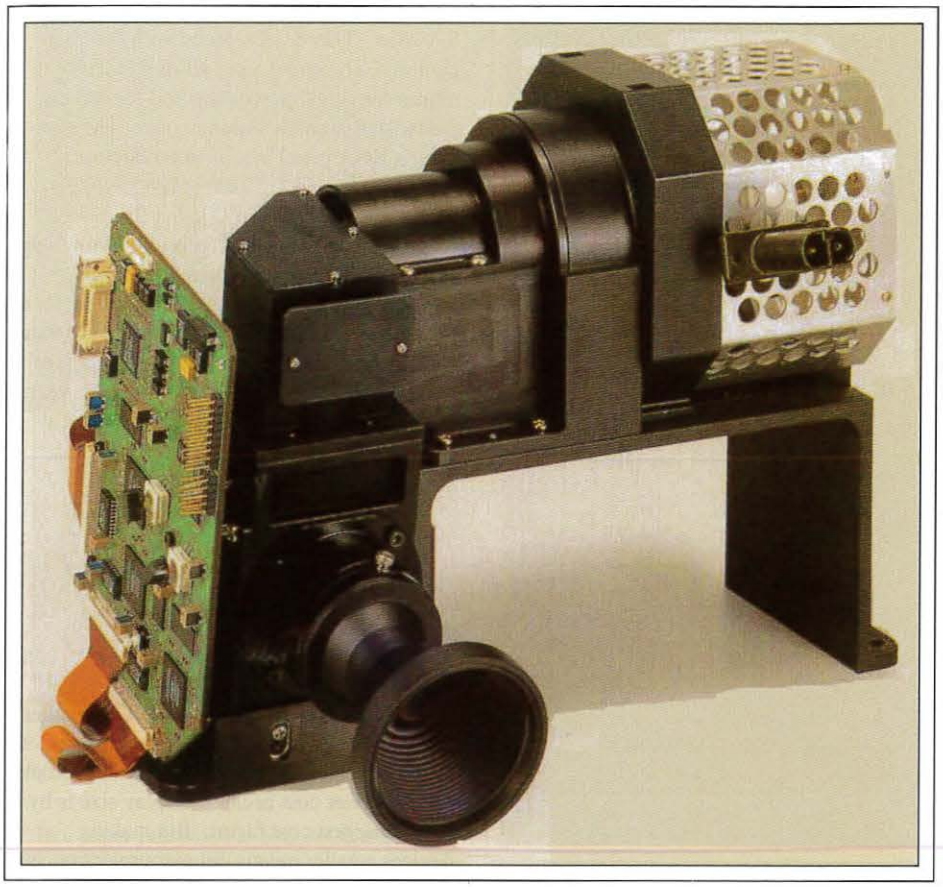


Advanced Optical Engineering

Advanced Optical Engineering's LCoS projection engine will be manufactured by Samsung, and could end up in a 25-in. monitor within a year.

cal architecture which they called the OCLI Prism. It is a modified Philips-prism configuration that incorporates two identically shaped prisms and one somewhat larger prism, and is designed for use with reflective LCoS panels. This design offers the advantages of lower system mass and weight and reduced manufacturing cost.

Interestingly, the engine from ***Nikon Corp.*** (Tokyo, Japan), which was on display in the ***Three-Five Systems*** (Tempe, AZ) booth, had exactly the same architecture. Nikon developed its engine architecture to support the 0.9-in. Digital Image Light Amplifier™ (D-ILA™) panels from JVC, but is now redesigning the optical components for the 0.78-in. SXGA panels from Three-Five Systems. The primary target will be rear-projection computer monitors and/or televisions in the 25-in. range.

Also in the Three-Five booth was an SXGA projection engine developed by ***Advanced Optical Engineering*** (***AOE***) (Westlake Village, California). It will be manufactured by Samsung Electro-Mechanics Company, Ltd. (SEMCO) (Suwon City, Korea). Color separation and recombination is accomplished in a proprietary three-element system that SEMCO wants to keep under wraps for the time being. This engine could end up in 25-in. monitors with a street price of $2500–3000 within a year.

Aurora Systems (San Jose, California) roared into SID 2000 with two new projection engines. The Horizon engine features on-axis illumination; the Stratus engine features off-axis panel illumination. Both were demonstrated in rear-projection configurations. The company was also promoting their Nova engine for use in front-projection systems. This design may turn up in a front-projection product by year's end. If the Nova engine sounds familiar, it's because the engine was designed and promoted by now-defunct S-Vision. (S-Vision's demise had nothing to do with the quality of its technology. Aurora acquired substantial IP and equipment from S-Vision's liquidators, and hired several of former staff members. Three-Five Systems also acquired IP.)

The Stratus engine was demonstrated in a 24-in. rear-projection monitor that is only 9 in. deep. This is the shallowest rear-projection monitor design we know about. On-screen performance features a contrast ratio (CR) in excess of 450:1 (full field) and luminance of 350 cd/m^2 with a unity-gain screen.

Although they were not at SID, Primax Electronics, Ltd. (Taipei, Taiwan) says they are now developing an SXGA engine that uses JVC D-ILA panels and a single X-cube architecture. The company is promising to show a projection prototype at INFOCOMM that weighs 8.9 lbs. and outputs 1000 ANSI lumens using a 120-W lamp.

One-panel LCoS projection systems are also under development. ***DisplayTech*** (Longmont, Colorado), which demonstrated an early prototype at SID '99, showed a much improved version this year. The main challenge with the one-panel system is to get the brightness up without sacrificing other aspects of performance. On a 35-in. screen, DisplayTech achieved a CR of 150:1 with an on-screen luminance of about 120 cd/m^2. While these numbers are still a bit low, the company is offering evaluation kits to developers and quoting for mass production.

Other companies, such as ***Philips Components*** (San Jose, California) and Hansol Electronics (ChoongBuk, Korea), are also working on single-panel systems. Another year of development is probably necessary before these companies are ready for commercial roll-out.

There was also progress in products intended for near-to-eye applications. These include DVD headsets, computer accessory headsets, viewfinders for camcorders and still cameras, and, eventually, smart phones and other hybrid products. Of particular note was the eShades headset developed by ***Inviso***. This device contains twin SVGA displays and is meant to interface with a computer or portable DVD player. The design is stylish and light in weight. In fact, the flex that holds the displays and electronics is a clever four-fold design that is some of the best packaging we have seen. The company is ready to begin production in Q4 '00.

Aurora Systems

Aurora Systems demonstrated its new Stratus microdisplay projection engine in this 24-in. rear-projection monitor that is only 9 in. deep.

MicroOptical Corp. (Westwood, Massachusetts) showed how their EyeGlasses™ headsets could be integrated with a cellular phone by using the Compact Card slot to acquire display information. ***Planar Systems*** (Beaverton, Oregon) showed their AMEL display with optics that allowed the image to be seen at a surprisingly long distance from the eye. ***MicroDisplay Corp.*** (San Pablo, California) showed how their color SVGA displays will be used in a headset from a Korean manufacturer.

There was also a notable shift this year in the markets that near-to-eye developers are going after. Last year, entertainment and computer headsets were big. This year, viewfinders are getting a lot more attention. Although most of these are lower-resolution QVGA displays, they are used in established products with significant production volumes.

Kopin Corp. (Taunton, Massachusetts) has been most successful here and is now ramping to a production rate of 200k/month. ***DisplayTech***, ***Colorado Microdisplay*** (***CMD***) (Boulder, Colorado), and Display Research Labs (Los Gatos, California) have now all joined in the hunt. DisplayTech, for one, says it expects its displays to be in digital cameras by Christmas.

There was also a lot of news concerning microdisplay devices themselves. CMD debuted its latest display, a QVGA device targeted for viewfinder and mobile Internet-terminal applications. This device is basically a scaled-down version of their SVGA display but measures only 0.19 in. on the diagonal. It comes with a companion LED controller ASIC and, together with the LED illuminators, is said to have the lowest power consumption of any QVGA microdisplay (90 mW). Evaluation kits should be available by Q3 '00, with production in Q1 '01.

Aurora Systems reports they are working on a redesigned SXGA panel that improves upon a similar design they licensed from S-Vision. This device, along with the companion XGA model, uses all-digital techniques for signal processing and for driving the twisted-nematic liquid crystal. The company's XGA panel is now in production, while the new SXGA panel (1365 × 1024) should be ready by Q3 '00.

SpatiaLight (Novato, California) is now shipping its SXGA panel, which the company terms a DisplASIC because it integrates a lot of functionality into the display's silicon backplane. The company reported it would reach a 10k/month production rate by the end of the year.

JVC has decided to offer their D-ILA displays to OEM customers for integration in front- or rear-projection products – a move that could help establish LCoS technology. The company also announced the development of a QXGA device (2048 × 1536) for digital cinema and a new SXGA device that reduces pixel pitch from 13 to 10 μm.

The digital-cinema chip is expected to compete with systems that use an SXGA DLP® chip from Texas Instruments. JVC's smaller SXGA device (now 0.7 in.) represents one of the most important ways that LCoS developers can lower cost because display size is by far the biggest cost factor. But making devices smaller means dimmer projection systems unless corresponding improvements in lamp and optics technology can keep pace.

eMagin Corp. (East Fishkill, New York, formerly FED Corp.) showed its white-emitting active-matrix OLED display. Despite several design attempts, the device is still not quite right. Availability will be delayed until the end of the year, when a color SVGA version will also be ready.

Semiconductor Energy Labs (SEL) (Kanagawa, Japan) also reported on an active-matrix OLED device: a 0.7-in. VGA display. SEL fabricates its OLED layers on a poly-Si active matrix; eMagin uses a bulk-silicon-backplane process. The SEL device achieves 6 bits per color and has a 38% fill factor.

Sharp Corp. (Osaka, Japan) revealed that their Continuous Grain Silicon (CGS) microdisplay technology was making headway. This process, which converts a-Si to a high-quality form of poly-Si, has used high-temperature processing to date. As a result, the substrate material has had to be quartz. To really lower costs, Sharp needs to refine their process to lower the temperature and allow the use of flat-panel glass substrates.

MicroOptical Corp.

MicroOptical Corp. would like us to wear a microdisplay for our cellular phone.

In a paper presented at SID 2000, the company described how they have managed to get the process temperature down to around 550°C, but they also use laser annealing. Until this process is perfected, CGS technology would appear to be much too expensive. (A 60-in. HDTV the company now sells uses three 2.6-in. CGS panels, but the set sells for a whopping $60K.)

Sony Electronics (Tokyo, Japan) also reported on their development work with ferroelectric-based LCoS panels. They described a 1920 × 1080 panel that has very good performance but is not yet ready for commercialization.

All in all, SID 2000 was very good for microdisplay developers and system integrators. The technology now appears to have turned the corner, and it is clear that products will reach market. But the longer-term question of the technology's ability to find profitable segments in the projection and near-to-eye market space is still an open issue. It is going to an exciting year, so stay tuned. ■

Fusille, Rigatoni, and Linguine — Sometimes with Backlights

LCDs, the pasta of flat panels, are really a dizzying number of different technologies that share the same name – and the varieties continue to multiply.

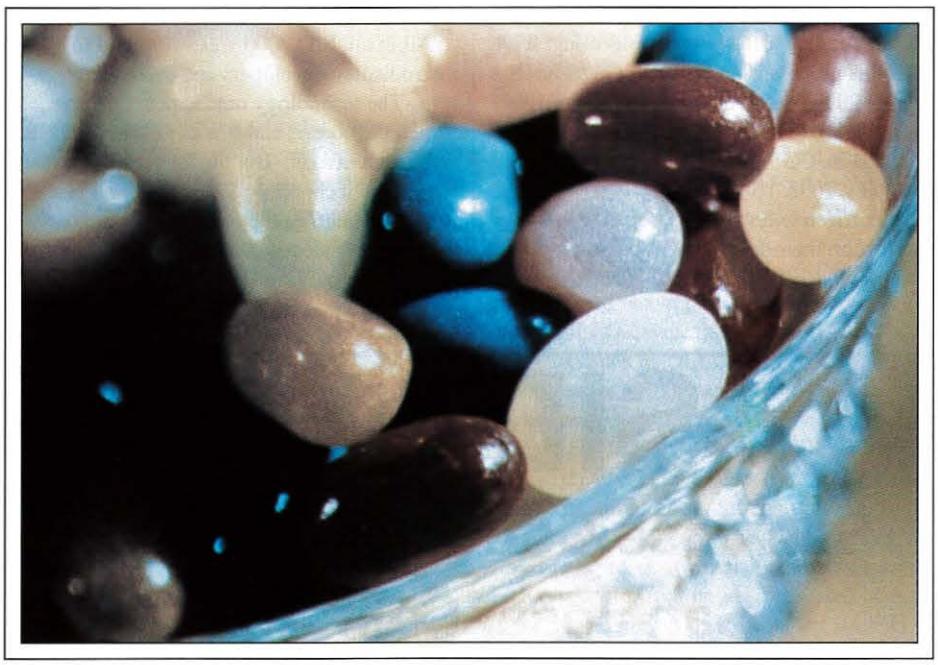
by Ken Werner

EXCEPT for the "venerable CRT," a frustrating moving target that refuses to sit still and be picked off by the LCD industry's sharpshooters, liquid-crystal displays (LCDs) rule the information-display roost. The technology's strengths include its flexibility. Other than relying on a liquid-crystal material – and there are many of them, with differing characteristics – the differences among many types of LCDs are likely to be more striking than their similarities. To some extent, it's a matter of perspective. Does one look at all these display technologies and lump them together under one name (like "LCDs" or "pasta"), or does one focus on their substantial differences ("polysilicon" and "LCoS"; "linguine" and "rigatoni").

This richness of LCD solutions and opportunities is impressive. So, although there was much interest at SID 2000 in OLEDs and PDPs, to most people in the LCD community the former is just a wisp of smoke over the horizon and the latter is, at least for now, a niche technology that is complementary rather than competitive. This leaves the different varieties of LCDs to compete among themselves, where appropriate, and to multiply – filling every imaginable ecological niche that is opened up by product planners.

For instance, liquid-crystal–on–silicon (LCoS) microdisplays might be used in smaller rear-projection monitors that could compete directly with direct-view LCD monitors (although not yet). Toshiba, the undisputed leader in low-temperature-polysilicon (LTPS) TFT-LCDs energetically touted the benefits of greater pixel density in virtually all sizes of direct-view LCDs, which is one of the things LTPS makes possible. NEC, taking Toshiba's line seriously, countered with a clever architecture that permits higher pixel densities in traditional amorphous-silicon (a-Si) TFTs.

Terry Scheffer, shifting the resources of his Hilo Research Laboratory to Colorado Microdisplay from In Focus Systems (with which he still retains a cooperative relation-



Toshiba America Electronic Components

Reflective displays are getting better, and quite a few of them could be seen at SID 2000. This 4-in. VGA reflective polysilicon AMLCD from Toshiba features 202 pixels/in.

***Ken Werner** is editor of* Information Display Magazine.

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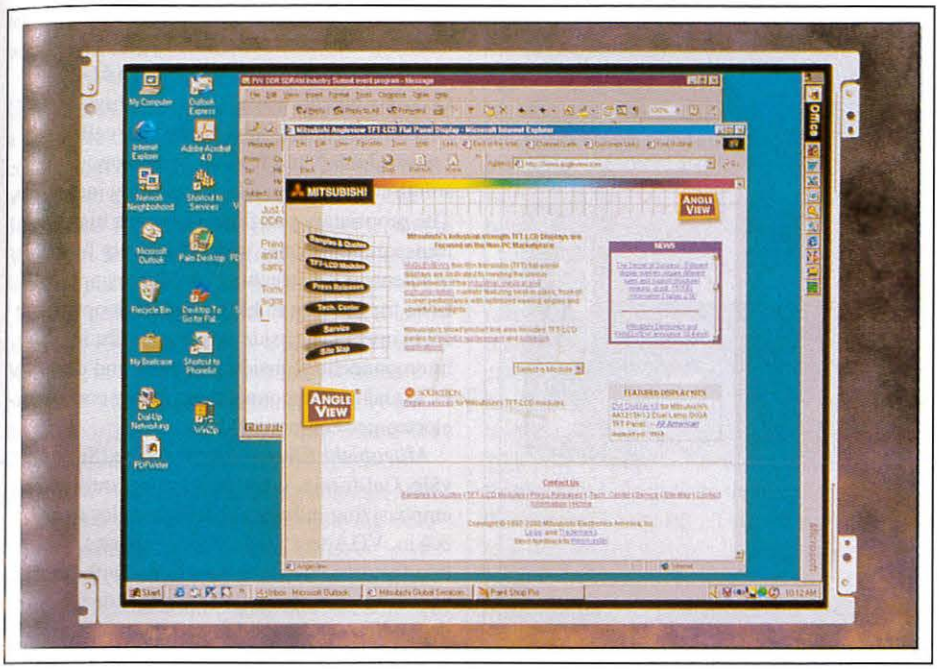


Mitsubishi Electronics America

Mitsubishi's 12.1-in. XGA AMLCD module has a luminance of 150 cd/m², a thickness of 5.5 mm, and a weight of 390 grams. It is optimized for notebook-PC applications.

ship), sees a healthy future for active addressing and its variations in enhanced PDA and smart-cellular-phone displays, where improved performance is desperately needed but TFTs absorb too many parts dollars (or won or yen) and too many of the battery's milliwatt-hours.

The keynote address by Bob O'Donnell, Research Manager for PC Monitors and Projectors at market researcher IDC, didn't please the LCD contingent when it reported on an IDC user study that concluded that most users of computer monitors prefer CRT images to LCD images at any price. But it did not induce any noticeable doom or gloom either. After all, O'Donnell confirmed the numbers produced by other market researchers which indicated that the penetration of LCDs in the stand-alone monitor market will grow from 3% in 1999 to 15% in 2003.

Medium and Large LCDs

Toshiba America Electronic Components (Deerfield, Illinois, www.toshiba.com/taec) had a major presence at SID 2000 to promote the availability of its LTPS LCDs in quantity. This was the technology that earned the SID/*Information Display* Display of the Year Gold Award, and Toshiba was displaying the crystal award and a large graphic in its expansive booth. Business Development Director Steve Vrablik said that LTPS yields are now becoming comparable to a-Si, and the new Generation-3 Fukaya works makes the production of 15-in. displays feasible. The plant is capable of producing 30,000 400 × 500-mm substrates per month. A new line that can produce 25,000 550 × 670-mm substrates per month is scheduled to become operational in Q2 '01.

In a conversation with *ID*, Vrablik described an unanticipated problem that is confronting Toshiba and other makers of high-resolution (130–200 ppi) LCDs: typical end users don't understand the benefits of higher pixel density and are therefore hesitating to pay a premium for it. "What," asked Vrablik, "is the best metric to use for consumers?" All of this is far from an academic exercise because one of the things that LTPS does is make higher-resolution displays feasible. Is there any way to be convincing other than by showing the benefits in a side-by-side comparison? (If you have any ideas, send your e-letters to the editor to kwerner@sid. org. We'll publish those that are of general interest.)

LTPS does carry a price premium, which is narrowing. But direct price comparisons are not too relevant at the moment because LTPS displays are going into new applications rather than existing ones, said Vrablik. Most sales are for 3- and 4-in. displays, where the application requires a smallish display with higher resolution than has traditionally been available. The 4-in. model is a nice-looking reflective VGA display with 202 ppi that consumes 400 mW and has a total optical response of 40 msec (sample price, $500). Other displays in the "200-ppi Series" are a 6.3-in. XGA model and an impressively sharp 10.4-in. UXGA version. SVGA and XGA versions of the 10.4-in. are used in the new Sony Vaio SR Series of thin notebook PCs. All of the 10.4-in. models are mechanically interchangeable. The product line is extensive, going up to a 15-in. UXGA unit – which looked good even in bright light. A 20.8-in. QUXGA (3200 × 2400) was shown at JES, Vrablik said. A newly announced 5.8-in. 800 × 480 (160 ppi) unit for DVD players was shown in the booth, as was a newly announced 8.4-in. SVGA model producing 350 cd/m² from 7.2 W. This unit, which has a dual-tube backlight, is intended for industrial applications.

Toshiba is also half of DTI, the IBM-Toshiba LCD-making partnership. Competition? Not directly, said Vrablik. DTI is devoted to a-Si AMLCDs, while the Toshiba-only effort is exclusively LTPS.

There are, of course, a variety of system-level benefits to LTPS beyond improved pixel density and aperture ratio, and although Toshiba has a head start in the technology, it's not alone in developing it. Sony-Toyoda, LG, and Samsung have announced production capability, and Compal (Taiwan) is working toward it. And Sharp has continuous-grain silicon (CGS), which is a variation on the concept.

Omid Milani, Senior Marketing Manager at ***NEC Electronics*** (Santa Clara, California, www.necel.com), didn't know I had previously spoken with Toshiba's Steve Vrablik, but when I visited the NEC booth he launched himself on the same topic, almost as if the two men were debating each other in the same room. "You don't have to use polysilicon to get over 200 ppi," Milani said. And to prove it he showed me a fascinating technology demonstrator: a 9.4-in. UXGA AMLCD with 211 ppi and a-Si TFTs. The display attains a 52% aperture ratio by fabricating the color-matrix filter (CMF) on the TFT plate – a

Solomon Technology Corp.

Solomon Technology Corp. introduced its "Rainbow Line" of small LC modules with an integral LED backlight and a choice of colors.

process that NEC somewhat confusingly calls "COT" (and described in paper 48.2). The benefit arises from the fact that the margin of alignment error that must be allowed for can be substantially lower when the CMF is precisely aligned on the TFT plate. The result is a larger aperture ratio.

Milani noted that the U.S. industrial display market is growing at 30% per year. This is a market that NEC has been serving for several years, and is now offering a wider range of products, with greater luminance, wider viewing angles, and long-lived bulbs with lifetimes up to 50,000 hours.

Among the offerings were SXGA monitors in sizes from 15.4 to 20.1 in. Interestingly for NEC – which has been a staunch hold-out for analog interfaces – all of these monitors are available with a choice of analog or digital (LVDS) interfaces. Said Milani: "NEC is moving ahead from its analog-only philosophy because a consensus is forming around interfaces, and the data source is now more frequently digital. The market has determined that digital interfaces are desirable."

A 21.3-in. UXGA monitor was on display and is going into production in Q3 '00. This will be the only high-end monitor not available with a digital interface because, said Milani, reliable digital interfaces are not yet available for large UXGA displays. EMI and the attenuation of fast signals are among the problems. NEC wants to offer the UXGA monitor with a digital interface as soon as feasible.

The 18-, 20-, and 21.3-in. panels use in-plane switching with an optical response of 60–70 msec. The next generation, which will appear in 2001, will have a response of 30 msec.

Optrex America (Plymouth, Michigan, www.optrex.co.jp), the large maker of custom and standard industrial displays, showed a wide range of products, including several new-product introductions. Among these was the company's first standard (not custom) color automotive LCDs, which include a backlight and heater. Brand new were some STN color reflectives (2.5-in. diagonal and 160 × 120 pixels) and a 3.8-in. QVGA transflective with about 33% reflectivity. These displays, intended for the next generation of PDAs and smart phones, looked very nice in bright ambient light. The same transflective technology was being used for 480 × 240 pseudo-analog gauges and other graphics for automotive instrument panels.

And, a first for Optrex, were segmented and 160 × 160-dot cholesteric LCDs in various colors. The displays have a 0.8-sec page refresh rate.

Finally, ***Asahi Glass Company*** (***AGC***), Optrex's parent, was presenting a high-bandwidth optical-waveguide film called LucinaGuide® as a low-cost interconnecting solution for high-resolution-display interfaces. The proprietary per-fluoro film is a highly transparent polymer with a precisely formed gradient-index structure. AGC sees applications for the film in high-resolution optical LCD interfaces inside notebook PCs, in other interconnections inside notebook and desktop PCs, and in interconnections inside consumer-electronics equipment.

Mitsubishi Electronics America (Sunnyvale, California, www.angleview.com) was emphasizing industrial LCD modules from 8.4 in. VGA to 15.0 in. XGA versions. The line features dual-tube backlights with luminances ranging from 250 to 400 cd/m^2, depending on the model, and the tubes are replaceable. One module was being shown in an H-P Infinium oscilloscope. All except the 15-in. displayed 262,000 colors.

Mitsubishi was showing the handsome SGI 1600SW wide-screen monitor (with Mitsubishi's 17.3-in. 1600 × 1024 AMLCD) that won the SID/*Information Display* Display Product of the Year Silver Award – along with many other awards. Another Mitsubishi display that expanded upon the standard repertoire of formats was an industrial 15.0-in. quad-VGA (1280 × 960) producing 250 cd/m^2 thanks to a four-CCFT backlight. The display exhibited good-looking color, excellent viewing angle before color shifts set in, and some smearing on fast video.

Also shown was a 10.4-in. SVGA portrait display used by Honeywell in avionics instrumentation. The display is broadly used, I was told, in aircraft such as the Cessna Citation and certain Embraer models.

Samsung Semiconductor (San Jose, California, www.usa.samsungsemi.com) was using its large, elaborate booth and a banner hung in the registration area to promote the new Wiseview™ brand for its line of TFT-LCDs. Samsung was pushing the "SXGA+" (1400 × 1050) format. The idea is reportedly to offer better performance than plain-vanilla SXGA without having to deal with all the costs and complexities of UXGA. A 15-in. version with 180-cd/m^2 luminance, 25-msec response time, 250:1 contrast ratio (CR), and 120 (horizontal) viewing angle

looked very nice, as did a 16.5-in. version with 180 cd/m^2.

Also on display were a very nice 15-in. UXGA unit with a luminance of 150 cd/m^2, a response time of 40 ms at 25°C, and 262k colors, and a lovely 17-in. SXGA model with a luminance of 200 nits, a response time of 30 msec at 25°C, a 160° viewing angle, and a 300:1 CR for high-performance monitors and EWS applications. A 24-in. wide UXGA (1920 × 1200) display with 500:1 CR, a luminance of 400 cd/m^2 (max), a response time of 30 msec, and a 16:10 aspect ratio showed beautiful still images but smeared badly on fast video. A 21.3-in. UXGA unit with 250:1 CR, a luminance of 200 cd/m^2, a response time of 60 msec, and a viewing angle of 160° (horizontal and vertical) was displaying beautiful map imagery. A 14.1-in. SXGA+ model with 262k colors, 250:1 CR, a response time of 40 msec, and a luminance of 150 cd/m^2 was using a two-channel LVDS interface and showing beautiful CAD and graphics images.

Although I didn't see it on display, Samsung's press kit noted that potential customers are currently testing 2-in. reflective polysilicon 720 × 240 displays with on-board driver and peripheral circuits for the new IMT-2000 cellular phones. Commercial IMT-2000 service is scheduled to start in the U.S. and Europe next year. Third-generation IMT-2000 will offer wireless multimedia services, including real-time video. Samsung expects this to fuel a growth in the world market for mobile handsets from 360 million this year to 1.6 billion in 2005, 370 million of which will have TFT-LCDs.

Philips Flat Display Systems (San Jose, California, www.philips.com) showed an 18.1-in. SXGA display with a 250:1 CR and a luminance of 200 cd/m^2 at the relatively low power consumption of 32 W; and a very-nice-looking 22-in. 1600 × 1024 display with a luminance of 180 cd/m^2 from 40 W, 16.7 million colors, and a 250:1 CR. There was also an assortment of 15- and 18-in. Brilliance® monitors and standard 15.1-in. modules with a luminance of up to 400 cd/m^2. Philips doesn't talk much about its long-running avionics-display program, but the fact that a Philips display was going up in the Space Shuttle being launched the day I was in the booth had to be mentioned.

Once one knows how to make a-Si TFT arrays, the temptations to use them as sensor arrays, as well as pixel-switch arrays, seems almost irresistible. Finding a commercially viable product to which the technology can be applied has proven more difficult, but Philips, together with partner Who?Vision, has come up with a promising fingerprint identifier called the e-thenticator™. The sensor, which is thin and the size of a postage stamp, has been incorporated in a PCMCIA.

The Who?Vision part of the device uses a pressure-sensitive polymer that luminesces in response to a finger's pressure; a Philips a-Si matrix senses the light. Electronics, in this case incorporated into the PCMCIA that houses the entire unit, transfers the data to the host notebook PC. As demonstrated at SID 2000, the unit produced a very clean image of fingerprints, which were then matched to those stored in the PC. The unit provides a straightforward way of allowing only authorized individuals to have access to a portable or fixed PC. The product should be commercially available by Q3 '00.

LG.Philips LCD (Seoul, Korea, www.lgphilips-lcd.com), the joint venture between Philips FDS and LG that is now the world's second-largest producer of LCDs (after Samsung), had its own extensive exhibit area, where it was promoting its wide product range. The displays range in size from a 6.5-in. to a 22-in. 1600 × 1024 model with a PanelLink interface and to a just-announced 20.1-in. LCD module for digital and analog TV that is just 20 mm thick and delivers a luminance of 500 cd/m^2. Also featured was a 15.7-in. SXGA display for desktop-monitor applications that is intended to have a cost comparable to 15-in. XGA LCDs and the image content of a 17-in. SXGA display. The company was touting its UV alignment system that does away with rubbing and improves viewing angle, the company said.

Sharp Microelectronics (Camas, Washington, www.sharp-world.com) showed an assortment of reflective LCDs, including an 11.3-in. SVGA TFT prototype with 18-bit color that was nice under ambient show lighting and positively beautiful under a halogen lamp. The battery life of a typical notebook goes to 12 or 14 hours in this display, instead of 2 or 3 hours in a backlit display. A very

John Robinson for SID

LCDs come in many varieties and are integrated into many products. Any random view of the SID 2000 show floor would probably include at least one or two of those display varieties and products.

nice 3.9-in. reflective TFT was shown in a Sharp Zaurus PDA, which contains a digital camera. The product, which is not available in the U.S., was very attractive in its slim metal case.

Also shown was 6.5-in. transflective TFT-LCD with 400 × 240 pixels intended for automotive and outdoor applications. The unit has earned a couple of design wins for automotive GPS systems, and will appear in cars in a year or two. The units for automotive applications were all designed for the automotive temperature range from –35 to +85°C under operating conditions from –40 to +95°C in storage.

Also on display were new UXGAs for the desktop-monitor market. A 19.6-in. unit with a 300:1 CR, 0.149-mm pixel pitch, 24-bit color, and a luminance of 200 cd/m^2 looked very good, as did a 15-in. version with a luminance of 200 cd/m^2 and a 300:1 CR.

Kent Displays (Kent, Ohio, www.kentdiplays.com) was proudly announcing its achievement of the long-sought full-color cholesteric display. Products were scheduled to be in full production by the end of July, and will include QVGA 5.625-in. and VGA 6.25-in. units with a per-page refresh rate of 2.5 sec and 4096 colors. Shown prominently in their unusually elaborate booth were the company's Infosign™ message centers. Lawrence Taylor was ebullient about the success of the show for Kent, but there was something he wasn't telling me. Contributing to the high spirits at Kent was the company's expectation of an imminent reversal of the previous decision in Kent's long-running legal battle with Advanced Display Systems (ADS) – a decision that had gone against Kent. That reversal came the week following SID 2000, and one can read about the dispute on Kent's and ADS's Web sites.

Meanwhile, ***Advanced Display Systems (ADS)*** (Amarillo, Texas, www.advanceddisplay.com) was talking up its recent agreement to license the company's Fast Multistable Liquid Crystal Display (FMLCD) technology (its version of cholesteric LCD) to Avery Dennison for the development of display products on flexible substrates. The company was showing a smart card in one of its displays driven by an Alien Technology NanoBlock™.

Small Displays

In addition to its microdisplays, ***Three-Five Systems*** (Mesa, Arizona, www.threefive.com) was showing a reflective LCD of about 1.5 × 2.5 in. for advanced cellular phones. There weren't a lot of pixels, but the display looked pretty good under a bright spotlight.

In a suite, Alien Technology (Morgan Hill, California, www.alientechnology.com) showed a few simple displays, including a five-digit PDLC driven by eight of the company's NanoBlocks™. The point was not the displays themselves, but that NanoBlocks are being made and that the innovative packaging approach works. CEO Jeff Jacobsen said the company will have NanoBlock displays in smart cards at Cartes (the smart-card show) in Paris in November. He also said that a major production order will soon be announced, to be filled from the company's new 21,000-square-ft. facility in Morgan Hill.

Alien's Roger Stewart has designed a 1000-transistor NanoBlock, Jacobsen said, which has attracted the interest of OLED people because they need multi-transistor pixel-switching networks.

Seiko Instruments (Torrance, California, www.seiko-us-ecd.com) was showing its compact Vitrium™ COF displays. New are low-power STN color reflective and transflective versions. A 128 × 128 display was being shown, with larger configurations scheduled for this fall and the spring of next year. Product Marketing Manager Mick McLachlan said that lots of new work is being done on reflectives, with more products coming in 6–12 months from all vendors.

Hunet (Tokyo, Japan, www.hunet.com/english/LCD.html) was showing its 1.5-in. field-sequential-color (FSC) display with Dynamic Excite Drive and 320 × 240 pixels for cellular phones. New are the 260,000-color capability and the ability to switch the display to monochrome for lower power consumption. A version with 4096 colors would require less video RAM; the Japanese market is now using 256 colors, with a response time of 2 msec; 2- and 3-in. versions were scheduled for July availability, said CTO Masaya Okita.

Solomon Technology (Kaohsiung, Taiwan, www.solomonlcm.com.tw) introduced its "Rainbow Line," which integrates the LED backlight onto the display's own circuit board for reduced thermal resistance and improved life. The devices display 16 characters by 2 lines, and are available in several colors. In addition, the company showed its large selection of small character and graphic modules.

Supporting Technologies

LEDs continue to increase in popularity for backlighting small LCD modules, but two purveyors of LED backlights were remarkably aggressive in their predictions that LEDs would soon begin to replace CCFTs for backlighting larger LCDs in mainstream applications.

George Panagotacos, Director of Engineering at ***Teledyne Lighting and Display Products*** (Hawthorne, California, www.teledynelighting.com) said there is substantial interest in replacing the CCFTs in standard 3ATI avionics modules. The LEDs are now 2–3 times more efficient than CCFTs, and the military likes the instant "cold on." The breakthrough was a moldable compound that has 98% reflectivity. This, said General Manager Barry Wrenn, permits an overall efficiency of 88%. The result is that some customers who do not need the extra luminance have asked the company to depopulate their Alphalight lamps, which cuts costs. The only downside compared to CCFTs is the initial price, said Panagotacos, but the situation is getting better as more companies produce high-brightness LEDs.

The 3ATI backlight has generated lots of interest, said Wrenn. It delivers 3500 fL at 6.6 W using 80 LEDs. It's only 1/4-in. deep, is dimmable, and operates well in cold weather without heaters. Smith's Instruments and Korry Electronics are interested.

Philips Flat Display Systems was showing some of the LumiLed™ backlights it makes under a joint venture with Agilent for monitor and TV LCDs. The backlights are directly controllable for color temperature, and prototypes are being shown. The approach is to use R, G, and B to make white, with the primaries tuned to the colors in a color-matrix filter (CMF). Engineering samples will be available to potential customers this year. Edwin Van Lier predicted the LED backlights would be competitive with CCFT in 3 years. An 18-in. LumiLed sample was producing 150 cd/m^2 from an LCD module; a 15-in. sample in an LCD module produced 250–300 cd/m^2. When only the R, G, or B LEDs were turned on for my benefit, the colors were very intense and saturated. Non-traditional possibilities for color displays come out of all this, but LumiLed will start with a white composite light and a traditional CMF. Brad Fuller said to expect volume production by early 2001. Incidently, LumiLed is also interested in mak-

ing LED lamps to replace incandescents and fluorescents in domestic and office lighting.

Lumitex (Strongsville, Ohio, www.lumitex.com) keeps refining its Microlens™ molded backlights. The company showed a prototype of its new 32 × 32-mm backlight with one white LED in the corner. The illumination was remarkably even. The company has programs with Fluke, Seiko Instruments, and Global, and has two new cellular-phone projects in progress. Said a Lumitex executive, "This is the best show we do. On a scale of one to ten, this is a twelve."

Diguang Electronics (Shen Zhen, China, www.asiansources.com/diguang.co) showed CCFT and LED backlights in a variety of configurations.

Cliff Morris, Director of Marketing for ***Sheldahl*** (Northfield, Minnesota, www.sheldahl.com) said that the movement from glass to flexible displays is opening opportunities for companies that have done vacuum coatings on polymer films. Sheldahl buys film and deposits substances such as ITO on it to meet specifications traditional for glass. They do laser etching and roll-to-roll photolithography.

B. F. Goodrich's Joe McDaniel was in the booth, and he noted that Goodrich was working on new film for displays under a USDC grant. Dimensional stability is the key component of the USDC contract, said McDaniel. The issue is getting a flexible film that has a higher melting point. The Goodrich film has a 300°C melting point, and is compatible with many standard glass-based processes. But Goodrich makes polymers, not films. How they will ultimately participate in the display industry is undecided, but perhaps the ADS –Avery Dennison announcement points the way.

Conclusion

It was clear at SID 2000 that in the complex and multifaceted world of LCDs, there are new products, new players, new paradigms, and new opportunities. Business was brisk. Of course, we have another "crystal cycle" to go through late this year or early next year, but there is hope that the increasing diversity of LCD applications and technologies will make this dip far less painful than the previous one.

It may well be that when SID 2001 rolls around next June 3–8 in San Jose, the temper will once again be as enthusiastic and optimistic as it was at SID 2000. ■

Manufacturing, Materials, and Components

At least 20% of the exhibitors were showing manufacturing equipment, testing equipment, materials, or components, making SID 2000 a sizable display-manufacturing show.

by Alfred Poor

THIS YEAR, 240 exhibitors occupied a whopping 435 booths at the 2000 SID International Symposium, Seminar & Exhibition in Long Beach, California, which is a 7% increase over the booth space used at last year's conference. If one were present from the initial opening moment on Tuesday morning through the close on Thursday afternoon, one would have been able to spend just 3 minutes at each booth in order to cover the entire floor. And trying to speed up the process by stopping only at the booths that had displays would have meant missing some of the most interesting exhibits of all: a wide range of new manufacturing-related items, from films for rear-projection screens, to manufacturing equipment, to test and measurement devices.

The show is now long over, and all the exhibits have been packed up and shipped back home, but let's put on our running shoes for a virtual dash through the hall to find out about some of the new manufacturing, materials, and component products that were presented there. There isn't enough room here to mention every exhibitor, but here's a representative sample of what was on display.

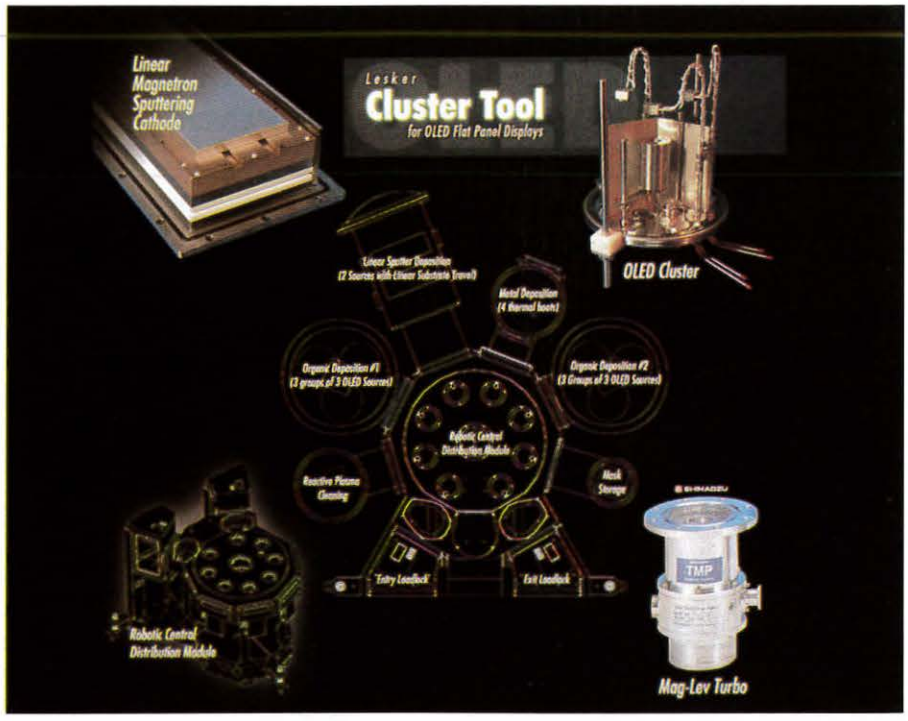
Manufacturing Products

Some of the products are intended to be of use before a display is even built. LCD Master from ***Shintech*** (Yamaguchi, Japan, www.uujnet.or.jp/shintech/lcdm/English) is a software tool used to model and evaluate LCD designs. It can be used to predict performance attributes such as transmissivity, reflectivity, and viewing cone before the displays are built.

When it comes to building displays, a number of companies had equipment designed to help with different aspects of the manufacturing process.

Microdisplays were one of the hot topics at SID 2000, and ***MicroJoin*** (Poway, California, www.microjoin.com) had new equipment for this market. The company was showing its new Model 7200 integrated assembly system for microdisplay manufacture, which uses the company's Ceramic Hot Bar Technology (CHBT) for precision bonding of anisotropic conductive film (ACF).

Organic light-emitting-diode (OLED) displays were another hot topic, and the ***Kurt J.***



Kurt J. Lesker Company

Kurt J. Lesker Company showed its cluster-tool system for OLED/PLED R&D and pilot production, the closest thing to turnkey OLED manufacturing.

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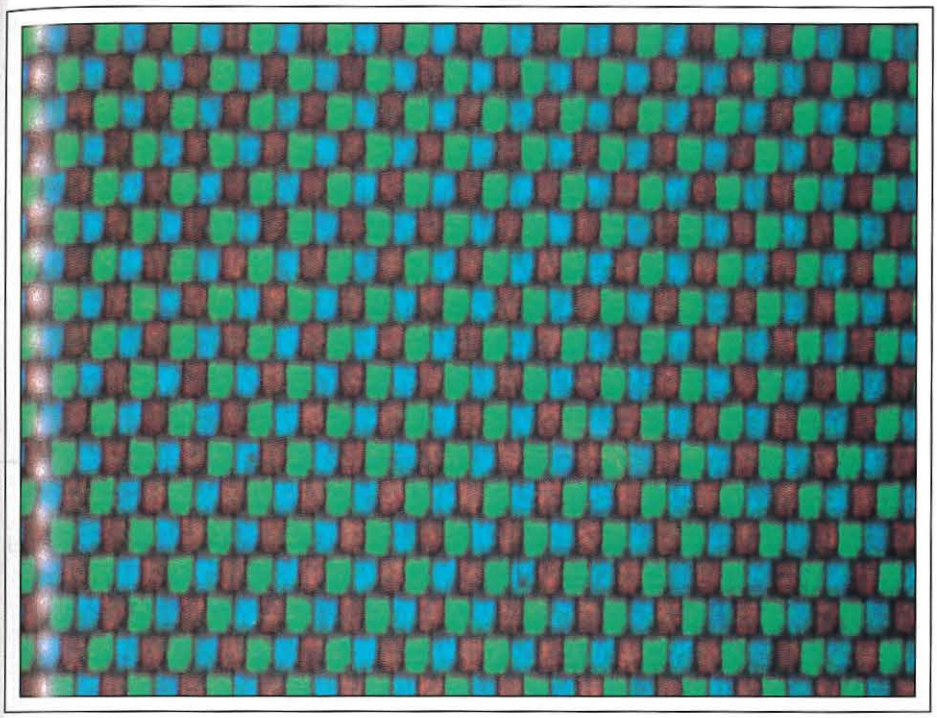


DuPont

A micrograph of the DuPont holographic reflective color-filter prototype. Each sub-pixel is 100 × 150 μm. Unlike standard filters, which work by absorbing light, such a color filter could contribute to a more efficient color LCD module and longer battery life in laptop PCs.

Lesker Company (Clairton, Pennsylvania, www.lesker.com) had a new cluster tool designed for the manufacture of OLED flat-panel displays. This is the closest one can get to turnkey OLED manufacturing in R&D or pilot-production quantities. A high-volume machine is under development.

TLC International (Phoenix, Arizona, www.tlcinternational.com) is a new entrant in the glass-scribing market; their new Phoenix 600 high-accuracy glass scriber is built to handle substrates up to 600 × 600 mm, at a speed up to 500 mm/sec.

Applied Films Corp. (Longmont, Colorado, www.appliedfilms.com) has a new ATX700 in-line sputtering system that offers a small footprint, low particulates, and simple tooling for low-cost, reliable production.

Physical Components and Services

It takes many components to manufacture a display, and the exhibitors offered a wide range of choices. Perhaps one of the most intriguing components was the holographic color filter from ***DuPont*** (Wilmington, Delaware, www.dupont.com) that splits white light from the projection lamp into red, green, and blue, making the display more efficient and brighter.

Front- and rear-projection components were also highly visible in the exhibit hall. ***LuminOz*** (Culver City, California, www.luminoz.com) demonstrated a series of high-gain wide-viewing-angle rear- and front-projection screens, including a dramatic three-dimensional face that looked animated when a moving image was projected behind it. ***Dai Nippon Printing Co., Ltd.*** (Tokyo, Japan, www.dnp.dk) showed a variety of rear-projection display screens, including the new holographic Crystal Illusion screen that mounts on a window so that the viewer can see the projected image, yet still see through the window as well. And ***Fresnel Optics*** (Rochester, New York, www.fresnel-optics.com) makes rear-projection screens using microstructured optical elements, novel materials, and special coatings. The company was also making note that last March, the U.S. Display Consortium awarded it a contract to develop screens for desktop displays up to 32 in. on the diagonal. ***Physical Optics Corp.*** (Torrance, California, www.poc.com) was showing their light-shaping diffusers and rear-projection display screens.

To protect direct-view displays such as LCD panels, ***CYRO Industries*** (Rockaway, New Jersey, www.cyro.com) offers abrasion-resistant plastic sheets. ***Panelview*** (Portland, Oregon, www.panelview.com) showed a range of products designed to enhance the image of flat-panel displays by reducing glare and making images brighter. For CRT products, ***Techneglas*** (Columbus, Ohio, www.techneglas.com) offered glass and frit for CRT picture tubes.

Synaptics (San Jose, California, www.synaptics.com) produces touch-sensitive products, including ClearPad which offers 90% light transmission and a single layer of ITO without an air gap. This solid-state design, which is based on the non-transparent touch pad the company has made for millions of notebook computers, has no moving parts and a sensitivity up to 1000 points/in.

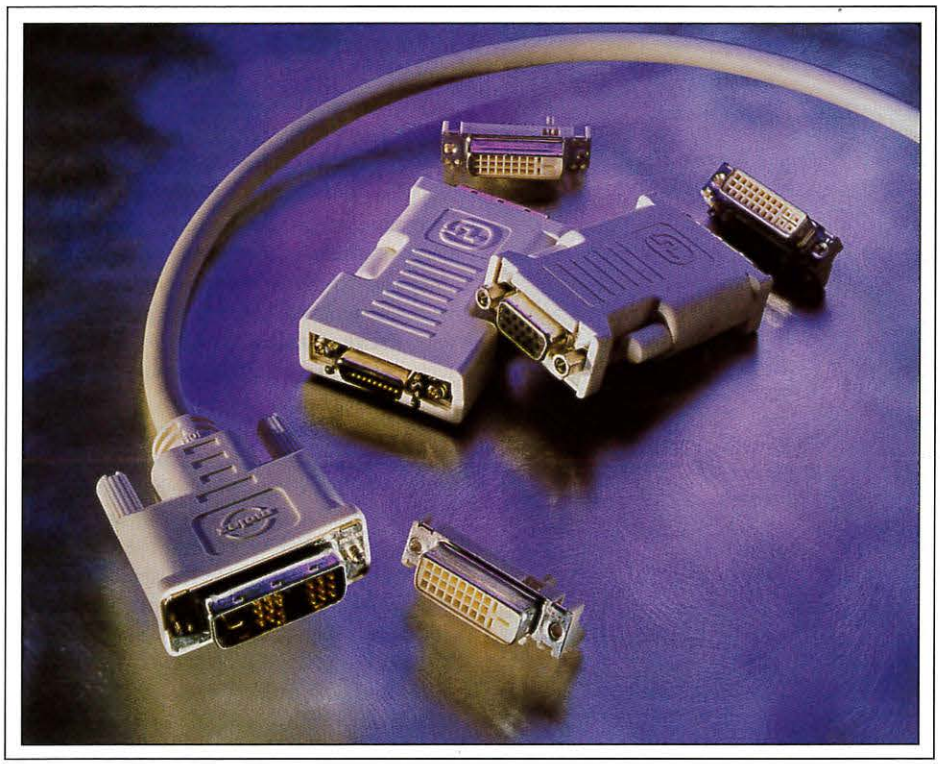
Multi-Fineline Electronix (Anaheim, California, www.mflex.com) offers flex circuit-board manufacturing and assembly, which is an important part of the puzzle for portable displays.

Adhesives Research (Glen Rock, Pennsylvania, www.adhesivesresearch.com) featured optically clear pressure-sensitive adhesives. ***Fujipoly*** (Kenilworth, New Jersey, www.fujipoly.com) showed their SARCON silicon rubber with advanced thermal conductivity for thermal-management applications; the shape-conforming material helps dissipate heat.

Terapixel (Espoo, Finland, www.terapixel.com) creates laser-scanned photomasks for displays, in sizes up to 450 × 450 mm.

There were many exhibitors offering materials and coating services for indium tin oxide (ITO) layers – the clear conductive layer that plays a part in many display technologies. New display designs require novel materials, however, and ***NeoVac*** (Santa Rosa, California, www.neovac.com) specializes in applying ITO to flexible substrates including PET, polycarbonate, and other plastic films.

One key set of components in any display design are the cables that move the signal from one point to another. The advent of digital interfaces for desktop monitors and a host of other display and computing devices have made connectors and cables a critical component. ***Molex*** (Lisle, Illinois, www. molex.com) has taken a position of leadership in this



Molex, Inc.

Molex showed its line of MicroCross DVI connectors for implementing the Digital Display Working Group's Digital Visual Interface, which received one of ID*'s Display Material or Component of the Year Awards.*

area, with the MicroCross connectors that meet DVI specifications for combined analog and digital signals, including the high-resolution dual-channel digital connections. The company also provides adapters for other digital interfaces – including DFP and VESA Plug and Display – that make it easy to connect new DVI-compatible devices to others with the older interface connectors.

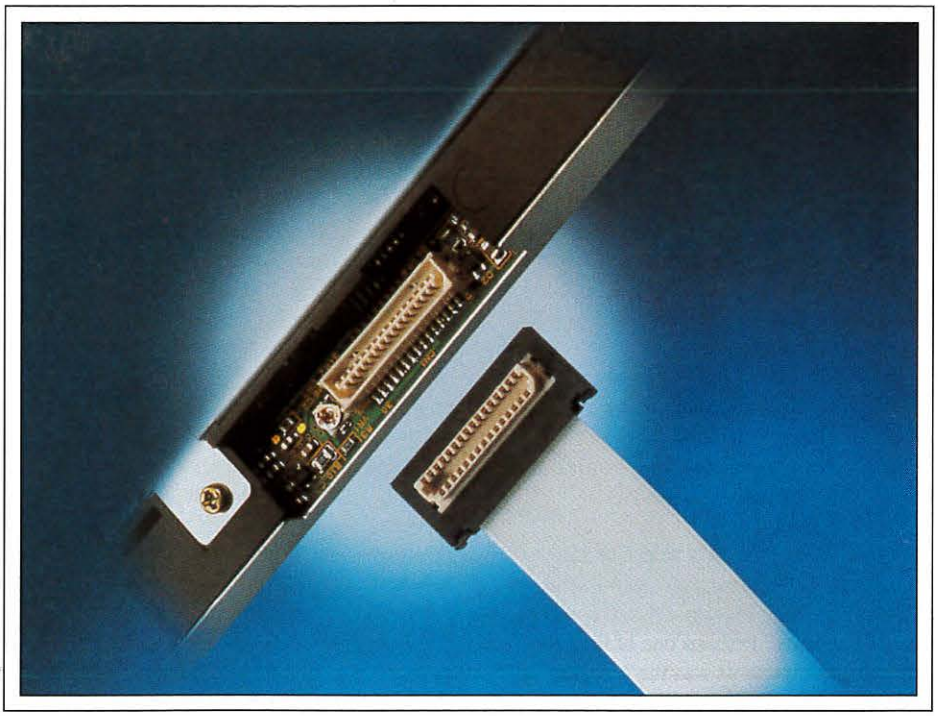
For cabling within a display, ***Axon' Cable*** (Mount Prospect, Illinois, www.axoncable.net) showed the new AXOLINK line of flat-cable assemblies for displays which use 0.5-mm flat flexible cable with 31 or 41 conductors. ***Meritec*** (Painesville, Ohio, www.meritec.com) offers a variety of custom cable assemblies with a choice of connectors, cable type, and number of conductors.

Another important but unseen component in many display systems are the sophisticated films that play critical roles in improving image quality.

Nitto Denko (Fremont, California, www.nitto.com) introduced their award-winning film that is designed to enhance LCD brightness by 50–60%. This material reflects and recycles light from the backlight that would otherwise be lost. As a result, power consumption is decreased and battery life is extended.

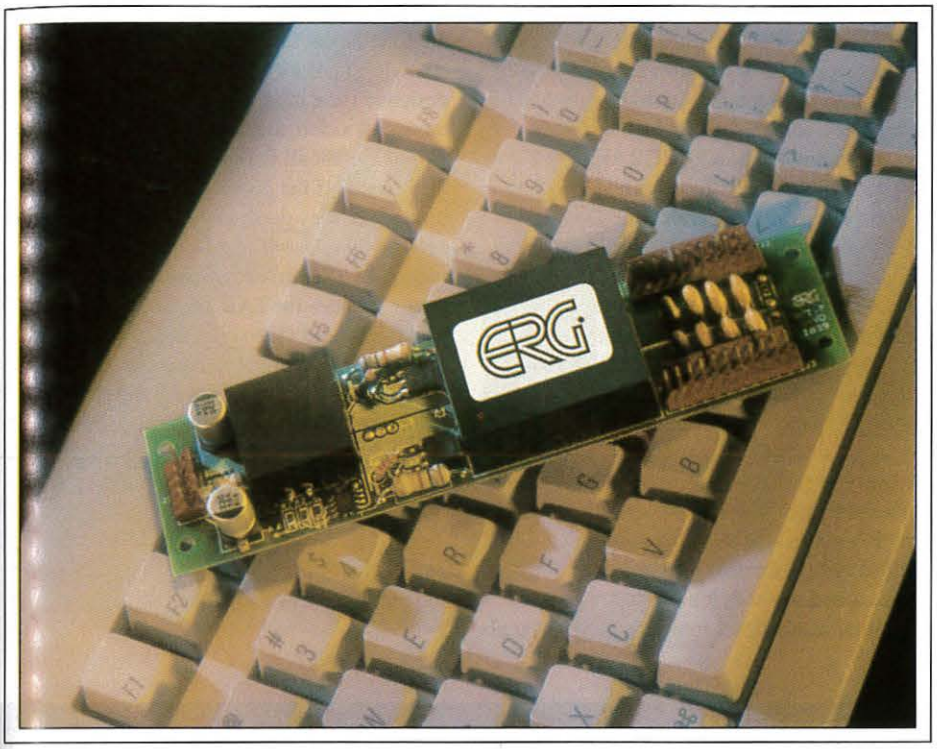
3M Optical Systems (St. Paul, Minnesota, www.3m.com) unveiled the new Vikuiti brand for its display films, designed to improve display efficiency and reduce glare. The company's popular BEF film, and other favorites, are now under the new brand. ***Optical Coating Laboratory Inc.*** (***OCLI***) (Santa Rosa, California, www.ocli.com) offers protective and glare-reducing layers for flat-panel displays, and ***Tekra Corp.*** (New Berlin, Wisconsin, www.tekraatg.com) showed the company's Terrapin hardcoated films designed to make display devices more durable.

Some materials in a color display are not noticeable. For example, ***OSRAM Sylvania*** (Towanda, Pennsylvania, www.sylvania.com) introduced a new deep red phosphor for use in color plasma-display panels. The small particle size and good stability of this new formu-



Axon' Cable

Axon' Cable's AXOLINK-FDC flat-cable assemblies for board-to-display connections is shown. The flexible cables are only 0.5 mm thick.



Endicott Research Group

ERG showed its range of CCFT inverters for LCD backlights, some of which are smaller than previous models and some of which are designed to drive large numbers of CCFTs. This MB unit is both: it can drive up to 10 CCFTs.

lation is designed to provide increased brightness and better color.

Electronic Components

In addition to the physical parts and materials, there are also electronics that must handle a variety of sophisticated tasks. ***Silicon Image*** (Sunnyvale, California, www.siimage.com) – known for developing the PanelLink digital interface – showed the SiI 851 single-chip controller solution. This chip contains a number of functions, including PanelLink receiver, on-screen display (OSD), scaling, and power management, all in one chip. The one-chip approach reduces board-space requirements and lowers parts and manufacturing costs.

Pixelworks (Tulatin, Oregon, www.pixelworks.com) showed their award-winning line of highly integrated interface chips for flat-panel displays, including on-screen display for configuration, automatic image optimization, and scaling. At the Display Technology Showcase (DTS), they demonstrated a transmitter–receiver pair that implemented high-bandwidth digital-content protection for DVI. Another controller maker, ***Sage*** (San Jose, California, www.sageinc.com), had a variety of digital display controllers on hand, including the new Jag-D with ActiveColor management, which supports up to three simultaneous signal inputs including support for a video window. ***Faroudja Laboratories*** (Sunnyvale, California, www.faroudja.com) showed off new ASIC controllers designed for video decoding, de-interlacing and line doubling, and video enhancement with an OSD generator.

Seiko Instruments (Torrance, California, www.seiko-usa-ecd.com) featured their iChip for hand-held products, which is designed to make it easy and inexpensive to add dial-up Internet connectivity for Web access and for remote access or diagnosis of appliances or other products.

Highlighting the interest in OLEDs, ***Clare Micronix Integrated Systems*** (Aliso Viejo, California, www.claremicronix.com) showed column drivers for OLED displays. ***Chip Supply*** (Orlando, Florida, www.chipsupply.com) is in the business of designing and building custom display-driver products in both prototype and production quantities.

Drivers for backlights in flat-panel displays are also important. ***Microsemi Corp.*** (Santa Ana, California, www.microsemi.com) has RangeMAX backlight inverter modules with digital dimming, high efficiency, and a small form factor; these factors help extend battery life in devices such as color hand-held devices. ***Taiyo Yuden*** (USA), formerly Xentek Power Systems (San Marcos, California, www.xentek.com), announced new dual-lamp inverters for cold-cathode fluorescent lamp (CCFL) backlights, with dimming control over a 10–100% range. And ***Endicott Research Group*** (***ERG***) (Endicott, New York, www.ergpower.com) announced new inverters for backlights that are designed to handle larger displays with multiple CCFLs.

Another component available to support display products is from ***Applied Data Systems*** (***ADS***) (Columbia, Maryland, www.flatpanels.com), which is offering an Intel StrongARM-powered embedded-system board that supports the Linux operating system.

Test Equipment

A wide range of exhibitors offered equipment and services designed to measure and test display products. One of the growth areas is test equipment for microdisplays. ***Integral Vision*** (Farmington Hills, Michigan, www.iv-usa.com) has a new pixelQ device for microdisplays that can provide analytic tools such as luminance contours and pixel-area histograms. ***DisplayCheck*** (Mystic, Connecticut, www.displaycheck.com) makes vision-based test and inspection equipment for small displays, including the MicroDisplay Tester for microdisplays that identifies pixel and line defects, detects blemishes, and measures absolute brightness. ***Westar Corp.*** (St. Louis, Missouri, www.westar.com) also has new microdisplay test and inspection systems.

On a larger scale, ***Photon Dynamics*** (San Jose, California, www.photondynamics.com) has a new fourth-generation ArrayChecker-2000 that works with larger substrates, smaller pixel features, and low-temperature-polysilicon process technology. It can handle substrates up to 730 × 920 mm and can analyze features as small as 60 µm.

Many exhibitors had instruments designed to measure the output from finished panels. ***Leader Instruments*** (Happauge, New York,

www.leaderusa.com) introduced their LT 9213 LCD Flicker Checker and LT 1663 Flicker/Balance Checker units. ***Tricor Systems*** (Elgin, Illinois, www.tricor-systems.com) showed their Model 822 video photometer, which has a 12-bit pixel depth and a 1024 × 1024-pixel resolution. ***LMT*** (Berlin, Germany, www.lmt-berlin.de) makes easy-to-use tristimulus colorimeters with short measuring times, and ***Hoffman Engineering*** (Stamford, Connecticut, www.hoffmanengineering.com) makes photometric and radiometric test equipment.

Instrument Systems (Ottawa, Ontario, Canada, www.Display Testing.com) showed the DTS140 with a CCD array spectroradiometer and offering enhanced sensitivity and a fiber-optic interface.

For portable applications, ***Quantum Data*** (Elgin, Illinois, www.quantumdata.com) showed their new 600 Series battery-powered video-test-signal generators. Their new Model 822 video test generator supports signals up to 600 MHz, including 18 HDTV signal formats. ***TEAM Systems*** (Santa Clara, California, www.team-systems.com) makes stand-alone and PC-based video test generators, including the new UNIGRAF UNI VG-1108pc which is a PC-based product with digital outputs supporting both PanelLink and LVDS.

As digital interfaces become more important and widely available, there are special application needs such as connecting more than one display to a single output. ***Extron Electronics*** (Anaheim, California, www.extron.com) has a new digital direct distribution amplifier for DFP/DVI interfaces that distributes one input to four outputs. And ***Altinex*** (Brea, California, www.altinex.com), which designed the signal distribution and control system for the Display Technology Showcase, has a solution for the cable snarl that often results from routing all those signals to advanced multimedia display systems: a multimedia cable with seven coax cables and six twisted pairs in a single PVC jacket designed for a mixture of computer video, broadcast video, and audio signals.

Finally, not all flat panels are perfect when they come off the production line – and even if they are, they don't always stay that way. ***Incline*** (Newbury Park, California, www.incline-LCD.com) provides flat-panel-display repair services for TAB drivers, shorted TFTs, backlights, and video circuitry.

We have only mentioned about one-fifth of the total number of exhibitors, and other exhibitors have products and services that fall into the categories that have been discussed. The only way to find out about all the exhibitors in these and other areas at SID 2001 is to come to San Jose and make sure that plenty of time is allocated for walking through the exhibit hall. ■

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Circle no. 14

A Jolly Good Show

The doomsday mentality is gone as the surviving makers of CRTs and components realize they have a lot to offer a world in which flat panels do not provide the best solution to all problems.

by Joe Hallett

SOMETIMES, when one walks into a place, there's something intangible in the air that affects one's mood. Maybe it's threatening; maybe it's comforting. But a common ingredient is the lack of a specific reason for the feeling. That's the way it felt to this old CRT hand at the SID 2000 exhibition. It would be easy to blame the feeling on nostalgia. There were fewer CRT-related companies, a natural result of changes in the CRT industry's infrastructure. And giants from the past came to celebrate and remember the old times. But that's the way it was last year and the year before.

Could it be that consolidation has run its course? Could it be that the CRT industry finally has re-stabilized itself around the realities of today's marketplace? Whatever the reasons, there seemed to be signs of a new optimism, with planning for the future replacing fear of the future. Perhaps it was the collective confidence that those remaining may be survivors – a notion that was reinforced by the sight of industry pioneers in the crowd whose experience spans half of the CRT's 100-year existence. We saw John Constantine, Sam Cristaldi, Peter Seats, and others who helped display technology emerge from electronics laboratories after World War II, riding the waves from radar to television, from cockpits to computers.

The yoke manufacturers have their own view of the CRT business. Gardner Marcy, CEO of ***Syntronic Instruments***, sees strength in projection displays and flight simulators, but weakness in other areas: "Military and some other applications are moving toward flat panels. But helmet-mounted displays (using CRTs) have an uncertain future." Bill Holt of the ***WinTron Division of Video Displays Corp.*** offers a similar view, noting that the firm's new yokes are doing well.

Of course, there were the big announcements, just before the show opened. First up, on May 3, ***Video Display Corp.*** said it would add ***Lexel Imaging Systems*** to its portfolio of display businesses. Then on May 16, Lexel announced it would acquire the electro-optical division of ***Imaging and Sensing Technology***. Behind these two announcements lies a significant part of the CRT's history. Lexel began life as the Allan B. DuMont labs in the 1930s. (DuMont was one of the true pioneers of the CRT, first applying the technology to instrumentation and later to television.) The

John Robinson for SID

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labs were acquired by Fairchild Camera in 1962, by Thomson-CSF in 1972, and by Hughes in 1988. Hughes added Projectron, Inc., in 1987 and Westinghouse-Horseheads' Direct View Storage Tube product line in 1989. The combined operations were renamed Hughes Display Products in 1991, adding Litton's Photo Recording product line in 1994, when the name changed again to Lexel. It's a long and tangled web ... and the saga continues.

In development at ***Brimar Ltd.*** are applications such as new 4- and 7-in. CRTs for digital photography. The tubes print directly to photo paper, bypassing the need for a film negative. According to Brimar, the technique is applicable to "mini-labs," school photography, collages, and picture enhancement. And there is the Brimar "light engine," which uses a conventional CRT bulb and screen to produce more than 50,000 fL on a 57 × 43-cm area for the rear illumination of an LCD panel.

At one of the evening panel discussions, "Flat Panel Television: An Oxymoron?" competitors' comments about the CRT ranged from grudging admiration to annoyed acceptance: "... an unbelievable increase in quality and drop in cost ... I hope CRT cost-performance is finally saturated after 100 years ... the CRT is like a greased pig, tough to control ... Volume speaks! Any technology could be cheaper than the CRT with enough volume ... I'm not sure if we have to catch up! ... A shark in the fish tank keeps the fish quite lively." Maybe they finally realize that the CRT continues to be a moving target for competing display technologies, earning respect as a worthy competitor that is perhaps past its prime, but still able to play a good game.

In high-volume applications, which were under-represented on the show floor but still visible in the technical sessions, CRTs seem to be holding on to most of the small-screen portable-TV business, although threatened at very small sizes by LCDs. And CRTs still dominate the larger screen sizes up to around 36 in., helped by innovations in manufacturing that have made it feasible to mass-produce flat-faced and wide-aspect-ratio tubes. Digital signal processing, which is required to produce high-quality images on flat-panel displays, also benefits CRT displays. As Sony has demonstrated with its high-end consumer TV sets, consumers will pay more to get good-quality pictures on flat-faced displays. And the CRT may continue to deliver in this area at a price significantly lower than an equivalently sized flat panel.

Dave Rigdon, ***Philips Electronic Components*** (Ann Arbor, Michigan) said, "We are showing three 'Real Flat Cybertube' CRTs, a 32-in. with a 16 × 9 aspect ratio is due this fall. The others have 4 × 3 aspect ratios, a 27V (viewable diagonal) due early next year and 32V sizes to follow." (All use beam-pitch modulation, described in a paper by T. G. Spanier, Philips Display Components, Eindhoven, in the technical sessions.) "Real Flat is making an impact. It's linked to digital TV. The question is 'Will it be the only style of CRT in a few years?'"

A highlight at the show was ***CELCO***'s 50th anniversary, an event that brought three generations of the Constantine family to the show floor. CELCO founder John Constantine and longtime CRT- industry veteran Peter (Sam) Cristaldi were caught on the show floor. Could their combined experience of over 100 years be used to predict the future of the CRT? Cristaldi: "They said way back in the '50s that CRTs would be obsolete in 1958, but they're still using them." Constantine said, "I hear comments that in certain applications the CRT has it hands down, with much better performance, better resolution, smoother look ..." Cristaldi said, "The CRT still has a long way to go. It gives a continuous display without the digital jumps."

Will the CRT still be around in another 50 years? Constantine said, "Absolutely!" Cristaldi said, "Yes!" It would be wrong to say that there's nothing new in this industry. Constant replenishment of people and ideas has allowed this crusty old technology to survive. Concern about the future of the CRT seems to be waning as the CRT business continues to grow in its areas of strength. For Honeywell's affable John O'Donnell it was and is "a jolly good show." ■

OLEDs Dazzle at SID 2000

There was a lot of emissive technology to see at this year's SID International Symposium, but an active-matrix OLED prototype brought forth gasps of amazement – and envy.

by Alan Sobel

IN AN ORDINARY YEAR, the bigger, brighter, and better-looking plasma displays, Candescent's impressive 13.2-in. FED, or iFire's next evolutionary step toward thick-film dielectric electroluminescent (TDEL) television would have provided a solid lead to this story about emissive-display developments at SID 2000.

But to varying degrees, all of these were eclipsed by what, for me, was the stand-out of the show: ***Kodak/Sanyo***'s organic light-emitting-diode (OLED) display with its active matrix of low-temperature-polysilicon (LTPS) thin-film transistors, 320 × 240 pixels, 5.5-in. diagonal, and 150-cd/m^2 luminance. The contrast, color saturation, and overall picture "punch" knocked my socks off. It will be a while before this kind of performance is available in a production display, but as an indicator of what OLED technology can do, it is a most favorable omen.

There were other OLEDs on display as well. ***Philips***, which prefers the term PLED (polymer LED), had smaller displays with a more limited color gamut. ***eMagin***, formerly FED Corp., had a very interesting green 1280 × 1024 0.77-in.-diagonal OLED on a silicon substrate, which incorporates all of the signal processing required to go from digital video input to 200-cd/m^2 real-time monochrome video. The company was also showing other OLED microdisplays.

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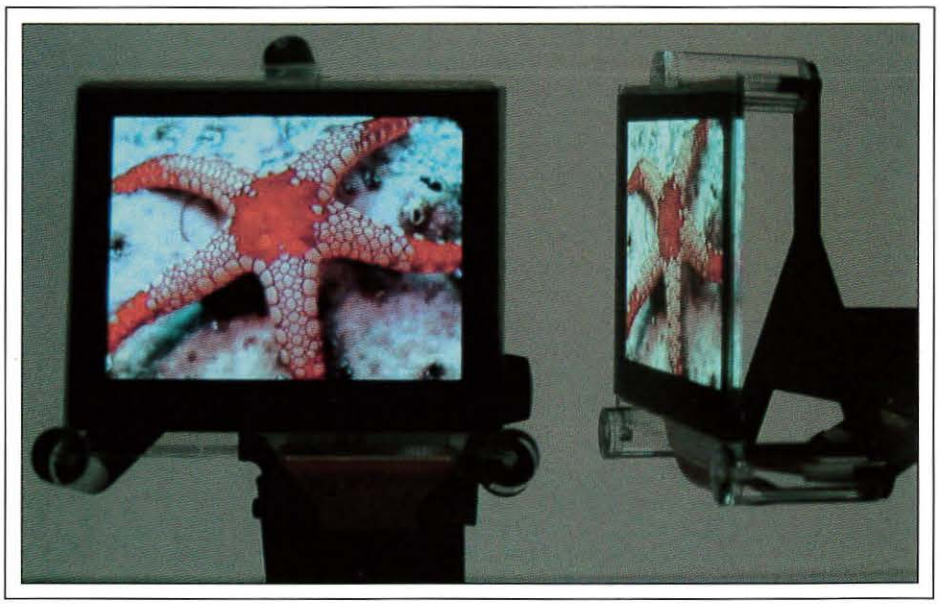
Other OLED and OLED-related exhibitors were ***DuPont***, which plans to supply components for OLEDs and has recently acquired Uniax; ***Covion***, an alliance of several OLED companies including Cambridge Display Technology; Lite Array; and Ritek. None of these companies are yet able to show displays that match those from Kodak/Sanyo, eMagin, and Philips.

Light-Emitting Diodes (LEDs). Conventional inorganic LEDs were not represented as pixelated displays, but rather as fast-switching backlights and indicators. This technology is well-represented in Las Vegas in spectacular signs, but their manufacturers are more likely to exhibit at electric-sign conventions than at SID.

Field-Emission Displays (FEDs). A few years ago, this was the technology that would challenge the LCD for notebooks and the like. It has proved to be a much more difficult technology to master than its proponents thought. The only contender present at Long Beach was ***Candescent Technologies***, in partnership



Eastman Kodak

Kodak/Sanyo's startling active-matrix OLED had its polysilicon drivers on board, so the thin glass sandwich needed only a single 25-conductor ribbon cable to connect it to the outside world.

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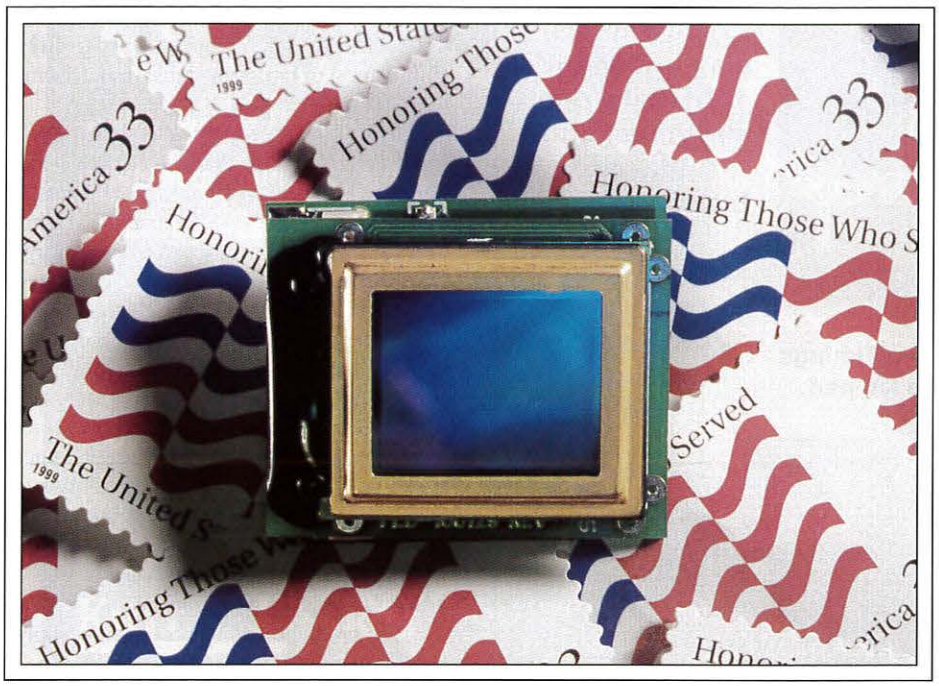


eMagin Corp.

eMagin's 12C10M is the first commercial OLED-on-silicon microdisplay. The SXGA monochrome device attracted substantial interest in eMagin's booth.

with Sony. The impressively large – for an FED – 13.2-in. SVGA display looked very nice, but not as bright as the company's good-looking 5.3-in. QVGA display, which was showing real-time video. Several papers in the technical sessions reported on the progress of Sony/Candescent and other researchers.

Vacuum Fluorescent Displays (VFDs). This elderly and durable technology is still very much in evidence, especially in automotive and appliance applications. The technology just keeps chugging along – no breakthroughs but continuous incremental progress. ***Noritake*** showed their 1-in. (approximately) monochrome CRTs used in stadium-type spectaculars; this technology is also used by Mitsubishi and Sony in similar applications.

There are similarities to FEDs, but Futaba, one of the few vendors in this field – and one that has shown FEDs in the past – did not have any FEDs on display this year.

Plasma-Display Panels (PDPs). This art keeps moving along. ***Plasmaco*** is up to 60 in. on the diagonal, with a resolution of 1366 × 768 and a luminance of 550 cd/m^2. Both ***NEC*** and Plasmaco showed 50-in. panels. Several companies, including ***Pioneer*** and ***Fujitsu,*** showed smaller ones. The displays are looking better. The moving-image artifacts that have plagued PDPs have been reduced to minor annoyances. Cost is still the major issue. The magic number of $2000–3000 for a TV set is still far out of reach, despite energetic efforts.

There were a number of papers at the symposium on various aspects of PDPs, including efforts to understand the device phenomena in more detail. The aim, at least in part, is to improve efficiency. There is much good work going on in Asia and the U.S. Plasma-addressed LCDs (PALCs) were not in evidence on the show floor, although there was at least one paper on the subject.

Electroluminescent Displays. Electroluminescence (EL) comes in several flavors. Old-fashioned powder EL is still being used for some lighting and backlighting applications, and is finding limited use in alphanumeric displays. Thin-film EL (TFEL) is still alive and well, both in large displays and in microdisplays. ***Luxell***, ***Lite Array***, and ***Ritek*** showed large displays; ***Planar*** demonstrated both large displays and microdisplays in monochrome and in color. ***Sharp***, the first producer

John Robinson for SID

Fujitsu color PDPs are not the largest available, but they are probably the best selling. Many PDP monitors bearing the names of major electronics companies are built around Fujitsu panels.

Circle no. 16

Circle no. 17

emissive displays

of TFEL, was not showing displays based on the technology. The company is apparently putting most of its considerable resources into LCDs.

iFire, off the show floor, was showing a 17-in. color prototype that looked quite good. Their thick-film EL is claimed to be potentially less expensive than "conventional" thin-film EL, and to be readily extendable to larger sizes, but there are clearly technical problems yet to be solved.

Progress in hardware generally does not move at Internet speed. Rather, there are many incremental tweaks in design and manufacture, punctuated by occasional major changes, and even those major changes don't appear in products instantaneously. This is a good thing. We all expect that the new products we purchase will have been adequately tested for reliability over a reasonable time frame.

These profound statements certainly apply to what was on display at Long Beach. The recent major new devices, FEDs and OLEDs, show two facets of this. FED manufacturers are back in the lab, solving mostly manufacturing problems, while OLED developers are still working on both research and manufacturing problems and making dramatic progress on both fronts. ■

Circle no. 18

Circle no. 19

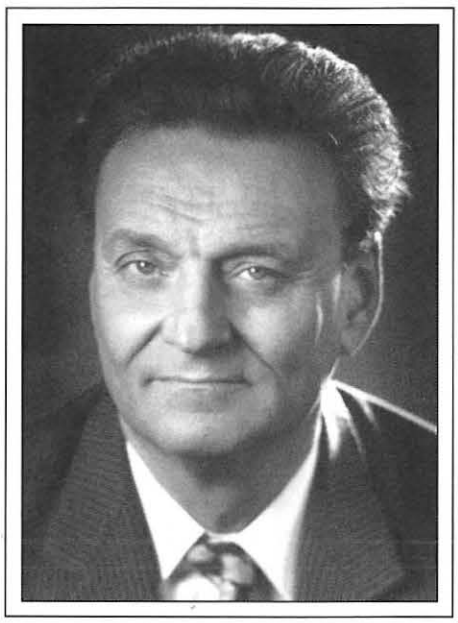
LCDs and OLEDs: One Technology Too Many?

LCD development is vibrant, and the technology is successfully providing displays for today's many new applications – but OLEDs have found an immediate niche that will grow substantially over time.

by Ernst Lueder

SPECIALISTS in LCD research long accustomed to success have been rudely awakened by their first serious competition, the organic light-emitting diode (OLED). As again evidenced at SID 2000, polymer LEDs (PLEDs) have made surprisingly fast progress, now reaching an efficiency of 15 lm/W for yellow at 3 V, with a life of 20,000 hours. PLEDs can even serve as backlights for LCDs, an application in which they already approach the efficiency of a fluorescent light source. The further development of OLEDs based on polymers or on small molecules has now left research laboratories for chemical companies with expertise in the handling of purified materials with inorganic residuals in the low ppm range.

The LCDs, however, are fighting back with a variety of appealing applications, and they even showed some convincing novelties at SID 2000. Reflective displays operating with ambient light will always have the advantage over emissive displays, such as OLEDs, of zero power consumption for illumination. As a result of the tight light budget for reflective displays, colors realized with additive filters are not yet very saturated – but improvement is possible. Further, color generation with stacked trilayers holds great promise. Hot candidates are reflective films realized as guest-host displays or as holographic polydispersed LCDs (PDLCDs). Portable reflective displays with an A4 format have the potential to become the heart of mass-produced paper-white consumer products. Together with memory chips carrying the contents of books, these displays open up the prospect of reading at freely selectable places – under palm trees at the beach, for instance – without dragging along a heavy bundle of books.



Placing the display on unbreakable lightweight plastic substrates is a definite possibility supported by presently emerging low-temperature processes for thin-film components. One can even envision rolled-up displays resembling a papyrus scroll.

LCDs, in general, and especially those in consumer goods, are rendered less expensive by replacing vacuum manufacturing processes by printing. Even printing of liquid-crystal layers with the appropriate alignment has been successfully demonstrated.

Besides the well-established and hard-to-beat a-Si TFT-addressed LCDs, the more recent LCoS technology will provide very attractive projection systems, including TV applications. Virtual displays for monocular viewing and their extension to binocular 3-D displays are further arrows in the LCD quiver.

Holographic PDLCDs exhibit the potential for multi-use devices such as electronically addressed optical switches between the reflective and the transmissive mode, bandpass filters, and electronic color wheels and lenses, and they merit further materials research.

Because of all these developments, LCDs will not relinquish their ubiquitous position, but they will have to face competition from OLEDs, first in the market for low-information-content displays, but then creeping slowly up to the active-matrix panels. ■

Prof. em. Dr. Ernst Lueder *has long been associated with the Institute of Network and Systems Theory at Stuttgart University, where he earned a worldwide reputation for his work on PDLCDs, LCD addressing, and low-temperature processing for plastic substrates. He now divides his time between Stuttgart, Germany, and Scottsdale, Arizona; e-mail: Ernst.Lueder@ins.uni-stuttgart.de or e.lueder@worldnet.att.net.*

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PDPs: A Big Wave under the Water

The plasma-display business may seem like a calm inlet, protected from the violent currents that roll (and enrich) other parts of the display industry – but the tide is rising.

by Shigeo Mikoshiba

THE electronics industry expects to sell 10 million digital TV receivers within 1000 days of the start of commercial digital TV broadcasting, and makers of plasma-display panels (PDPs) certainly see this as a great opportunity for introducing their products into the home-use market. An even more aggressive forecast has been made by Nomura Research Institute: The hang-on-the-wall-TV business will grow into a US$170 billion market in 2025. The key display device will undoubtedly be the PDP.

In spite of these encouraging forecasts, the PDP technical sessions were relatively calm at the SID 2000 International Symposium, Seminar & Exhibition. There were 17 oral and 13 poster presentations, compared to 12 and 8 last year, respectively, an increase of 50%. Of the total of 30 plasma presentations given this year, 13 were from Korea (with a 14th paper having one Korean co-author), seven from Japan, and four from the U.S. I was surprised that the number of Korean papers exceeded that from Japan, indicating that extensive research work is being pursued in Korea. Nevertheless, this does not mean that Japan has ceased PDP activities. In the week following SID 2000, there was a PDP Technical Meeting in Japan, which attracted 240 people. This meeting was not an academic one, but one oriented toward practical developments – finding solutions to today's issues.

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Japanese engineers are heavily involved in reducing the cost of PDPs, and perhaps too busy for their managers to encourage them to present papers at conferences such as SID. The engineers believe that the quality of PDPs is commercially acceptable, but the price is prohibitive. This is in line with the idea pointed out by David Mentley of Stanford Resources in his SID 2000 Monday Seminar (M-1), "Just adequate is good enough if the price is low enough."

In the meantime, Korean engineers are looking into new technologies which may surpass existing technologies, most of which have been patented by Japanese organizations. One such example is a low-temperature co-fired ceramic-on-metal (LTCC) technique presented by LG Electronics (paper 31.3) and Daewoo, Orion, and Sarnoff (paper 31.2), which utilizes a titanium metal plate instead of the commonly used soda-lime glass for the rear substrate. Another example is the addressing-while-displaying (AWD) drive scheme presented by LG Electronics (paper 31.1) and Samsung (paper LP-6), which does not use the widely adopted address-display period-separation (ADS) drive scheme.

In the exhibition, Plasmaco displayed a 60-in.-diagonal PDP (described in paper 27.1), which attracted a considerable number of attendees. Although it was not exhibited, LG Electronics introduced a 60-in. PDP (paper 31.1), Samsung SDI announced a 63-in. PDP in Korean newspapers, and Dr. Shinoda of Fujitsu Labs discussed dreams and technical issues relating to an 80-in. PDP at the PDP seminar.

PDPs are marching towards even larger diagonals. Several PDP sets exhibited beautiful TV images at the Display Technology Showcase. Recent trends in the reproduction of attractive images are to eliminate motion artifacts, enhance peak luminance, and increase gray-scale capability at low luminance levels (but with a sacrifice of spatial and temporal resolution). These advances will only require minimal increases in the cost of sets. In spite of Mr. Mentley's comment, I hope that PDP picture quality will become comparable to that of CRTs in the near future, and that common test patterns will be used to make direct comparisons of reproduced images between the various displays, as has been done at the Display Technology Showcase. ■

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Discussing the Non-Existent: Flat-Panel Consumer Television

I walked in thinking that flat-panel consumer television was an oxymoron, as the panel topic suggested; then the panelists redefined "flat panel."

by Joe Hallett

I used to think it was fun to drag myself over to an evening panel session after getting up at six in the morning for early meetings, bouncing between exhibits and technical sessions all day, and then "relaxing" at the exhibitor's reception. With luck, Carlo Infante would be there, guaranteeing a lively discussion no matter what the subject. But issues have changed and people have changed.

Now the evening-panel room reminds me of a big-city train station after rush hour is over. A few people in one corner of the room seem agitated about something. Voices that nobody can understand are coming from the PA system. Scattered individuals for whom a 14-hour day is enough are already dozing, waiting for stimulation.

Hear this, SID 2001 organizers: Put the evening sessions into smaller rooms that fit the expected audiences! Nothing would boost attendance more than having a few "standing room only" sessions. And maybe the audience wouldn't be caught napping.

Having said that, the topic for Evening Panel Discussion E-2, "Flat-Panel Consumer Television: An Oxymoron?" promised to be interesting. As we enter the new millennium, two generations have been taught to expect thin, flat TV sets, waiting only for the natural progression of enabling technology. The future is now, but must TV be both thin and flat? And does anyone want the picture to be on the wall?

As the evening wore on, the discussion became broader and more elusive as the panelists described, defined, redefined, and summarized the reasons why their companies understood the market and provided products better than anyone else's. More importantly, we heard how changing markets, applications, and infrastructure confound anyone's effort to predict the future. Here are some highlights.

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What *Is* Flat-Panel TV?

Everyone knows the answer, but all the answers are different! Does a CRT with a flat faceplate qualify? What about a front-projection system? It quickly became obvious that flat didn't necessarily mean either thin or direct-view – at least not to the panelists. In other words, anything goes.

Dave Eccles (Sony Electronics) said "There's nothing that says it must hang on the wall." But some agreed that, given the choice, most consumers would prefer to look down at a low piece of television furniture rather than up.

From the audience someone noted "an unbelievable increase in CRT quality and drop in cost." The venerable cathode-ray tube isn't going away. Comments by competitors ranged from grudging admiration to annoyed acceptance. But CRTs are unlikely to be contenders above 36 in., where plasma gains its strength. At some larger size, projection takes hold.

There was a comment from the audience that "A shark in the fish tank keeps the fish quite lively." Rear projection may overlap the CRT in smaller sizes, as shown on the show floor by Aurora Systems' 21-in. tabletop display. TFT-LCDs are strong and growing in small, portable TVs, but OLEDs and FEDs may still move into small-screen low-power applications.

Dave Eccles said "Maybe none of the new technologies has to displace another ... the issue is how consumers see displays." The CRT is a contender because it can take advantage of the new DTV standards and digital signal processing to improve picture quality. Sony has shown that such a TV set can be priced higher than conventional sets because the customer perceives better pictures.

Jun Souk of Samsung said "Volume speaks! Any technology could be cheaper than the CRT with enough volume." High yield should mean lower cost. Souk spoke eloquently of efforts to reach low manufacturing costs for larger sizes of TFT-LCD flat panels. But new manufacturing facilities carry a high price tag. These costs must be paid. " ... I'm not sure if we have to catch up with the CRT." A wave of new applications is moving in, where computer-like functions and TV may be combined in products that are different from anything that is now available.

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The display community should be careful not to promote today's solutions to yesterday's problems, but instead should adapt to changing infrastructures, interactive appliances, and household appliances connected to the Internet.

The panel consisted of Dave Eccles (Sony Electronics, replacing Tei Iki); Arun Johary (Sage, Inc.); Peter VanKessel (Texas Instruments DLP Home Entertainment, replacing Gary Sextro); Jun Souk (Samsung Electronics); and Bill Whalen (Pioneer Electronics). ■

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It's in the Electronics

Some attendees grumbled when the panelists wandered off the advertised topic, but the resulting conversation on field-sequential color was lively and kept most listeners interested.

by Richard Blaha

THE PANELISTS for Tuesday evening's Panel Discussion E1, "Display Electronics for High Image Quality," included Gwyn Edwards of Faroudja Laboratories, Mark Flynn of Kaiser Electronics, James Larimer of NASA Ames Research Center, Rainer Malzbender of Displaytech, and Julie Mapes Lindholm of Lockheed Martin Technology Services. Panel moderator Russel Martin of Silicon Image opened the panel by asking each panelist to discuss an issue in image-processing algorithms that impacts image quality.

Mark Flynn started by listing the trade-offs between electronic and optical solutions to correct image problems such as keystone distortion. Electronic solutions are flexible and cheaper but can reduce the MTF and can't refocus. Optical solutions can refocus easily, but cheap optical solutions can add artifacts such as chromatic distortion and reduce MTF.

Russel Martin stimulated the panel discussion by challenging Mark Flynn that he underestimated the resolution loss in keystone correction – as keystone is corrected the pixels are no longer square. It was agreed that first-generation electronic keystone-correction solutions are not the best and must mimic optical solutions. Electronic keystone correction may also be difficult to implement because sampling and scalar electronics distort the pixels.

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Is keystone important? Nikhil Balram cited a *PC Magazine* survey that found that most business projector users chose to live with keystone instead of correcting it. But Mark Flynn thinks home movie viewers are less tolerant of geometrically distorted images.

Rainer Malzbender discussed the challenges of incorporating field-sequential-color (FSC) schemes into existing non-FSC graphics controllers, and presented three solutions: integrating the FSC electronics into the existing controllers, integrating the electronics into the product, and increasing the frame rate. Economics determines which one is used. Designers of high-volume low-cost products such as viewfinders will modify the graphics controller, but designers will integrate the FSC electronics into higher-cost products. The third solution to increasing frame rates is not often used because it demands increased bandwidth.

James Larimer continued the FSC discussion by citing color break-up as a key issue. The discussion became lively when Jim proposed that color break-up is improved by adding a white segment in color wheels. Besides improving the luminance by 50%, the added segment reduces the frame times and changes the luminance at edges in the image where color break-up is especially noticeable. The improvement in brightness was not disputed, but was countered with the disadvantages of added cost, reduced color saturation, and gray scale.

The panel also discussed using temporal multiplexing chroma schemes such as color shutters and rotating prisms to reduce bandwidth demands by drawing the red, green, and blue images simultaneously line by line. There are many multiplexing schemes. The one to use depends on system architecture and cost, and each must be evaluated within the system timing constraints.

From the audience, Pete Baron commented that the color break-up resulting from saccadic eye movement (the color flash effect, or CFE) – as opposed to color break-up resulting from object motion – is a significant, and frequently the dominant, artifact in FSC. Formal testing of a statistically significant population sample indicates that the susceptibility to CFE as a function of either object luminance or object contrast with respect to background varies over a wide range (up to 20:1). This variability does not appear to be age-dependent.

Additional tests based on viewing a wide range of static images showed that the CFE artifact is strongly image-dependent: object size, contrast with the near-field background, and characteristics of the overall image (contrast range, colorfulness, and spatial-frequency characteristics) are all important variables, as is ambient light. Other factors such as a dark ambient and frequent and large eye movements can severely aggravate CFE.

Julie Mapes Lindholm continued the color break-up discussion from her experience with fast-moving targets depicted by flight simulators. Displays will distort FSC images in space and time. The effects stem from a combination of the object motion, the low sampling rate, the pixel persistence, and the inability of the human visual system to see

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high temporal frequencies. Lindholm showed snapshots of measurements of fast-moving objects that demonstrated increased feathering or blurred edges with increasing object speed. Increasing the vertical line width reduced feathering.

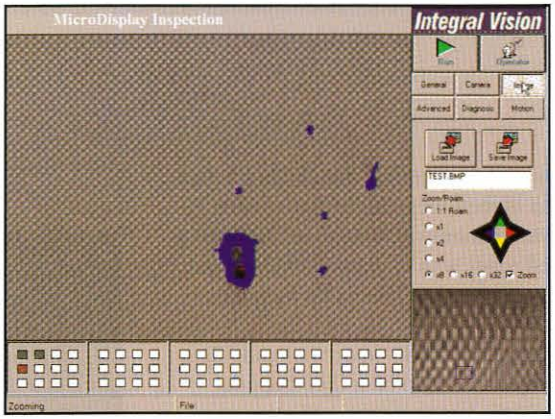
The distortion of FSC images on an LCD is more complicated than on a CRT because LCDs hold the image longer – 16 msec or so. The typical color CRT, with its millisecond phosphor-decay time, matches the human visual response better. A comment was made, however, that the image quality of an LCD could be made to equal that of a CRT by pulsing the LCD backlight.

Gwyn Edwards changed the subject by discussing the challenges of converting interlaced video into acceptable images on pixelized displays. De-interlacing is easy to do badly and complicated to do well. The best solution is to incorporate adaptive motion-compensation algorithms that simply add the interfaced fields when there is no motion and compensate for motion when motion is detected. No fixed algorithm works well for all sources, so each source must be treated differently. For example, video derived from film with a 3-2 video pull-down must be compensated differently from video generated by a video camera.

The panel was informative and Russel Martin worked hard to try to make it lively. A few participants were surprised that the majority of time was spent discussing FSC problems instead of image-quality algorithms as advertised. Perhaps FSC can be the subject of a future panel. ■

SharpEye™ Inspection Station

Inspection of Small Flat Panel Display Technologies



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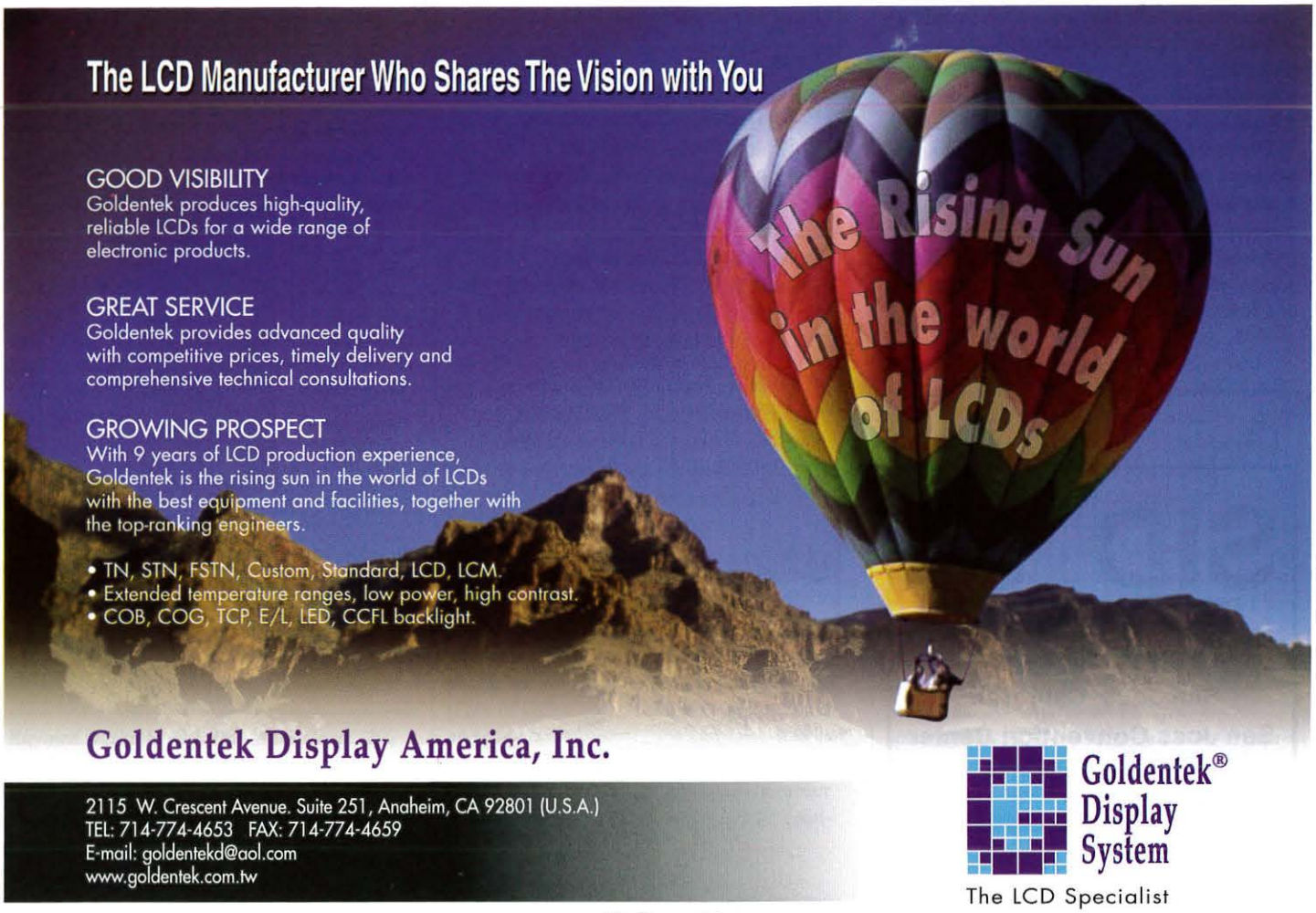

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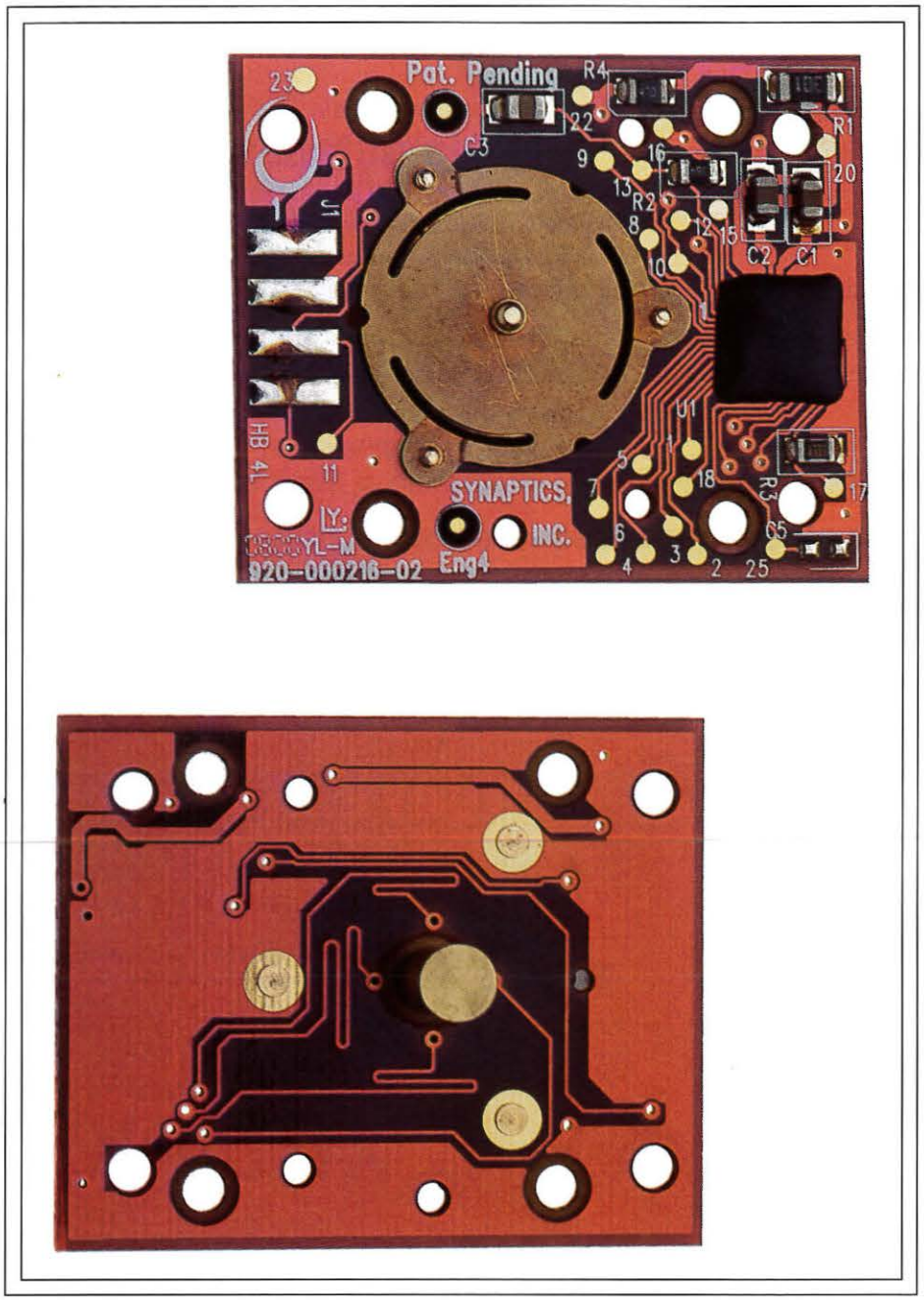


Synaptics

Synaptics' capacitive TouchStyk™ uses many fewer components than traditional laptop-PC pointing sticks, and can be used simultaneously with a touch pad. The device supports tapping on the end of the stick for selection.

of Diginex monitors, but that he excepts Diginex products to be available in 2001.

Dramatic as it was, this was not the only news from Sony, who announced that effective immediately, all CRT computer displays produced by Sony would have completely flat screens. (Sony is careful to say "virtually flat" because its flat screens are very slightly "higher" in the center to help provide a subjectively flat image plane.)

Sony also introduced the impressive GDM-FW900, a 24-in. flat-screen monitor with a 16:10 aspect ratio for displaying two full-size pages side by side, the company's widest Trintron® display. The maximum screen resolution is 2304 × 1440 pixels at an 80-Hz refresh rate. With an audience of graphics professionals, animators, and CAD engineers in mind, Sony has not used the standard PC putty color for this monitor, adopting instead a metallic silver bezel and dark gray cabinet.

Eizo showed a sharp-looking 19.6-in. LCD monitor, and it should look sharp with 1600 × 1200 pixels. The price is not yet set, but it is likely to be between $4000 and $5000. ***Sceptre***, which often seems aggressive in its pricing, showed an 18-in. SXGA LCD monitor for $2699, but had a special show price of $2199 for buyers of a single "evaluation unit."

Synaptics, maker of 20 million touch pads incorporated in notebook computers, introduced its capacitive pointing stick. The TouchStyk™ uses only seven components, compared to 30 or so for conventional pointing sticks, which use resistive strain-gauge technology. All the components fit on the TouchStyk's modular circuit board (see photo), while some of the components for the conventional approach must be incorporated on the PC's motherboard. Unlike conventional pointing sticks, the TouchStyk™ can co-exist with a touch pad, with both devices active simultaneously. And the system handily detects taps on the top of the stick. In combination with the ClearPad™ clear touch pad and Spiral™ low-cost inductive pen-sensing system for portable information devices – both introduced at SID 2000 – Synaptics is on a roll.

Franklin launched its eBookMan®, a PDA device with MP3-playback capability. But Franklin is pushing the device as an e-book reader. To that end the device will ship with Microsoft Reader when it becomes available this fall, and Franklin has put the appropriate content-provider partnerships in place. Franklin is trying hard to give the claim that their device can actually be used to read e-books some level of credibility. The display is 200 × 240 pixels – compared to the standard PDA display's 160 × 160, and Franklin states the display has "enhanced contrast." Indeed, the contrast is good and the display is large enough to put a reasonable number of words on the screen. But there simply are not enough pixels to go around, so the text is malformed and hard to read for any length of time. Franklin is making a good effort,

though. The text can be read in either portrait or landscape mode, and text size can be adjusted. And the price is attractive: $129.95 to start; $179.95 to move up to an enhanced and backlit display with more bundled aps and content offerings; and $229.95 to move up to 16 MB of RAM from 8 MB and to get more content downloads. And you can add up to 64 MB with a multimedia card.

This is surely an interesting device at the price, but it is hard to believe that users will spend a lot of time reading books with it until the display gets much, much better. Today's problem is that the cost of a small, high-quality display is simply not compatible with the required MSRP of a device such as the eBookMan – but today's problems are surely tomorrow's opportunities.

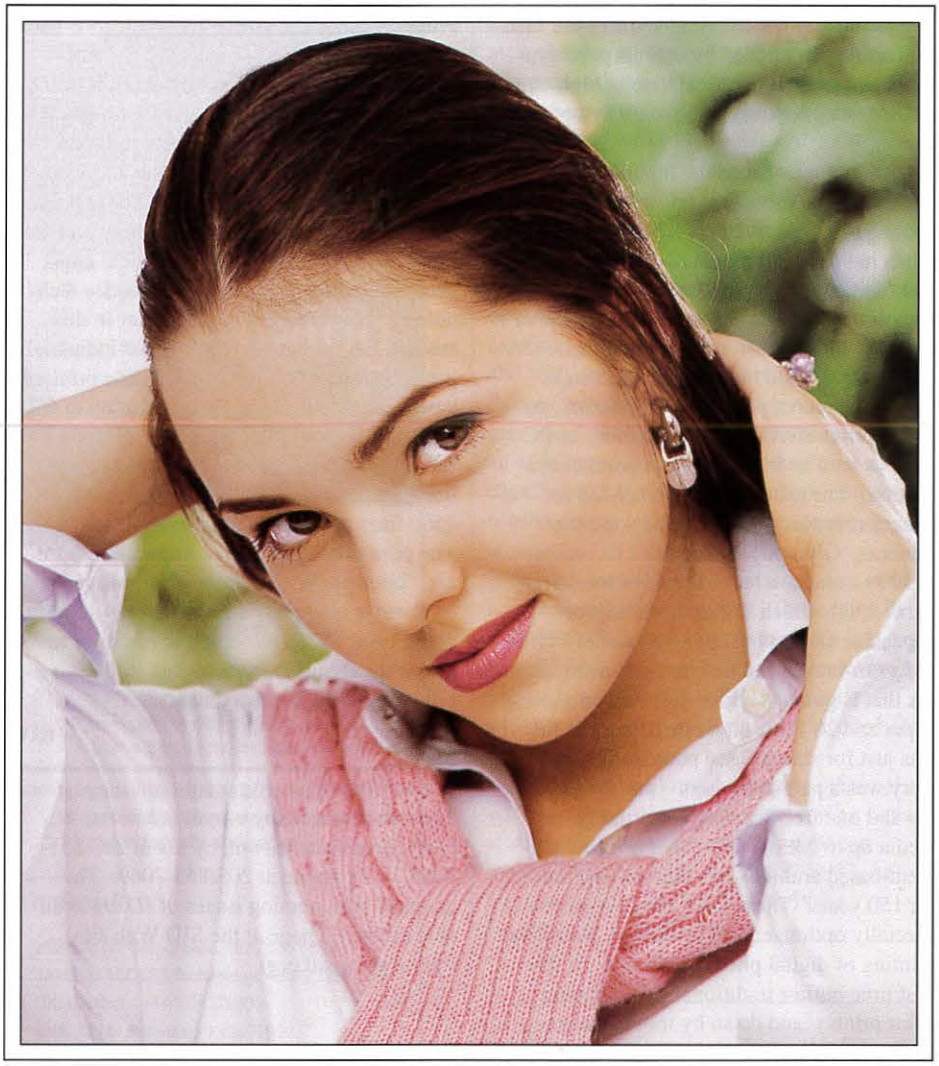
PixelVision, which installed the first Fujitsu PDPs at the New York Stock Exchange, has merged with ***Cybex***, which is about to merge with its leading competitor. The new name for the new company was to be announced the Monday following PC Expo.

The company's focus is to provide solutions for the formidable computing and display problems encountered on trading floors. To oversimplify a technically complex and interesting set of problems, a traders desk (and there may be close to a thousand on the floor) may have several displays on top of it and two or three computers below, all connected to servers in a back office. Thirty percent of the traders are new, move, or leave each month, which makes re-routing cables and reconfiguring the network a nightly nightmare, and which makes help-desk support difficult. Cybex's strategy is to move forward from its advanced matrix-KVM switches to techniques that give each individual computer and display its own IP on the network, which would make reconfiguring and support relatively easy. The network technology becomes Cybex's product; the PixelVision displays, which are now LCDs, become part of the package, not the major element in the sale.

Proxima, in addition to showing its new 5-lb. ultra-portable projectors with single DMD engines (the more expensive of which throws 1100 lm and has a DVI connection), was proudly exhibiting its Projectionlink™. This consists of a transmitter, which receives a wide range of typical projector inputs from one or more presenters, and a receiver that delivers RGB and/or video (with accompanying mouse and audio) inputs to the projector. The transmitter and receiver are connected with up to 300 ft. of CAT5 Ethernet cable. The product makes "installing and configuring projectors as easy as pulling a network cable." This is a more modest (and less expensive) approach than that put forth by several vendors at INFOCOMM, in which each projector was a node on a network. Presentations and video were delivered to one or more projectors on the network as digital files. These approaches worked with anybody's projector. Proxima's is proprietary and is designed as a point-to-point solution. But Proxima's approach makes the audio-visual contractor's job easier without being threatening, while the more general approach requires contractors to rethink the way they do business. If "courage is the willingness to abandon proficiencies," Proxima's approach requires less courage and is therefore likely to be more successful in the short run.

Printing and Scanning (and a Little Photography)

The interface between soft- and hardcopy remains a somewhat awkward one, which is why so many companies are working so hard to provide ever more elegant solutions.



Chu Fujiwara for Epson

Desktop photographic printing has come a long way. This image, originally 8 × 10 in., was printed at 1440 dpi on a $299 Epson photo printer using glossy photo paper. To the naked eye, it was virtually indistinguishable from a traditional photograph, and its quality was substantially better than we can reproduce in this magazine with halftone printing.

editorial

Hewlett-Packard introduced the HP ScanJet 5370C, a scanner with 1200-dpi optical resolution and 42-bit color depth expected to sell for $299. The scanner includes a slide/film/transparency carrier and a lighthouse that is placed on top of the transparencies. The results looked good, and the scanner comes with software that makes it easy to insert the scanned images into various applications or Web documents. Contributing Editor Alfred Poor commented that Agfa has adopted a similar approach, but has included the toplight within the scanner lid – a mechanically more elegant solution. H-P also showed its relatively new high-end Photo-Smart 912 digital camera, which offers some of the manual controls demanded by serious photographers and present for some time in high-end models from the likes of Nikon, Olympus, and Canon.

Olympus introduced the high-speed P-400, the first dye-sublimation printer to sell for under $1000. An 8.25 × 11.7-in. (A4) photo prints in 90 sec for a total media cost of $1.90. The time compares to the several minutes usually required by ink-jet printers. The printer is intended for professional photographers, serious amateurs, and imaging professionals. Like other recent photographic printers, the P-400 prints directly from a memory or PC card, as well as from a USB or parallel connection. The printer is recommended for images recorded with 2-Mpixel-or-better cameras. Olympus also showed its recent C-3000 camera, a less-expensive version of the C-3300, which differs from its more expensive sibling by having a smaller buffer.

Epson introduced new printers using photo ink that is guaranteed for 10 years on glossy paper and 26 years on matte paper, but that was just for starters (see photo). The real story was a pair of printers – one for the desktop and one free-standing for printing on media up to 24 in. wide – that use new pigment-based archival inks that are guaranteed for 150 years. These inks, which require a specially optimized ink-jet design, permit the printing of digital photographs that for the first time outlast traditional photographic color prints – and do so by more than a century! Now combine that technological advance with this datum, shared by InfoTrends Research Group at its ImageScape 2000 event held in conjunction with PC Expo. By 2003, half of the installed U.S. photographic minilabs will be digital. Bring in your film, and the minilab will scan it and print it digitally. Of course, the lab could also supply you with a Photo CD of your images. Presumably, such labs could also produce prints or burn CDs directly from a digital camera's flash memory card.

All of this augurs well for a vast increase in digital photography at all levels of sophistication. (Only 3–4% of U.S. households currently have a digital camera, according to InfoTrends.) That implies great opportunities for displays with higher pixel counts and better sunlight readability for back-of-camera viewfinder/monitors and electronic near-to-eye viewfinders. But, like the display Franklin needs but doesn't have for its e-book, the cost must be low.

Finally, we hardly ever talk about it in *ID*, but there is a substantial market for high-speed line printers that crank out millions (perhaps billions) of mass-market address labels and barcode labels daily. These printers use dot-matrix impact technology and are more interesting for their mechanical engineering than for their hardcopy display technology. Now ***Tally***, a major player in this market, has produced a high-speed industrial ink-jet printer to do what impact line printers have traditionally done. It prints at up to 600 lines per minute with permanent ink for a third of a cent per page. (High-end impact line printers, including Tally's, print at up to 1500 lines per minute at an even lower cost.) The print quality is, unlike impact line printers, "laser-quality," and the printer is quiet.

There is obviously a lot of display activity going on at PC Expo – even if you have to dodge the flying T-shirts to find it. And, yes, I did get one (a T-shirt, that is).

– KIW

We welcome your comments and suggestions. You can reach me by e-mail at kwerner@nutmegconsultants.com, by fax at 203/855-9769, or by phone at 203/853-7069. The contents of upcoming issues of *ID* are available on the *ID* page at the SID Web site (http://www.sid.org).

a view from the hilltop

continued from page 4

new production equipment but otherwise still had decent capability to produce low-complexity analog ICs. Up until the collapse of the Soviet Union, they had always built to a demand that was set by a central planning committee. These committees decided which products needed to be built, in what quantities, and which factories would build them. Since shortages were the norm, anything that could be produced was always accepted by the customers – in this case, various electronic-equipment factories. Selling, advertising, and promotion were neither necessary nor even understood as concepts. The government committees also decided where specific factories would be located, what they would produce, and who would be the recipients of their products.

During my visit, I tried my best to explain the basics of marketing and selling, and how worldwide competition determines the acceptable price and quality of the goods that customers select for purchase. After several hours of discussion, my hosts told me that while they greatly appreciated my explanation and could comprehend the theory behind what I was trying to convey, the strategy that they would follow would be to act like a spider that spins a web and then waits for a fly to stumble into it. As far as I know, several years later, they are still waiting for that first client-fly.

No matter how excellent the product or how attractive the price, the information that describes the benefits must reach potential customers. And since many others are seeking to accomplish the same goal, the process becomes a challenging one.

Selling products – high-tech or otherwise – is demanding work. Most of the time, it is not at all obvious that a given product is the best one or has the lowest price. Even when there is an optimum match with a particular customer, other customers will most likely have different needs and will have to make compromises.

Computers, wireless communications, and the Internet have not made the product-selection process significantly easier. They have provided the tools for faster communications and for the ability to access a wider user base, but the basic process of identifying customers' needs and meeting them with excellent products has not changed. It is still necessary to disseminate the information to as wide a customer base as appropriate. Brand identities and company reputations are as important as

they ever were. Perhaps the lack of personal service and sales expertise that the Internet and mail-order shopping inherently impose place even greater importance on a company's reputation.

For a technical client community, such as represented by SID, what better opportunity does a company have to show its products or capabilities than at an exhibition such as the one in Long Beach? In this setting, operating samples can demonstrate a product's full capabilities, the best technical experts can be made available to answer the most challenging questions, and personal relationships can be built that will lead to future opportunities for mutually beneficial business interactions.

None of this can be done as effectively on the Internet. How can we effectively demonstrate a new display product using a remote display terminal of another kind? How many e-mails does it take to locate the appropriate expert to answer a difficult technical question? How long is it likely to take by e-mail to develop a close business friendship – as close as from sharing just one meal together?

For these reasons, I am not all that enthusiastic about e-commerce or the many dot-com companies that have recently sprung up. I think there is more to buying and selling than the convenience of electronic order entry. Product demonstrations in "real" stores, personal service, and the ability to easily return a disappointing product are not such bad ideas after all.

For us in the technical community, the benefits of personal relationships and the need to carefully evaluate display products up close and with our own eyes will not go away. In fact, as we continue to develop new technologies and diversify existing technologies with an ever-broadening set of products, we can expect to see the annual SID exhibition and related events take on even greater importance.

Selling a technology, a product, or a service is indeed a challenging task. There is no better way to do it than in person with a live sample. For this reason, I extend my welcome to you to join me at future SID exhibitions, which will be even grander than the one held this year in Long Beach.

To discuss this topic further, or others of your choosing, you may contact me by e-mail at silzars@attglobal.net, by telephone at 425/557-8850, by fax at 425/557-8983, or by regular mail at 22513 S.E. 47th Place, Issaquah, WA 98029. ■

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SID Installs New Officers at Long Beach

At the Board of Directors Meeting held in conjunction with the Society for Information Display's annual International Symposium (SID 2000), the election results for the new officers of SID International were announced, and the officers were formally installed at the SID Business Meeting on Tuesday, May 16th.

Aris Silzars, after two years as President-Elect, succeeded Tony Lowe as President (see photo). Silzars, President of Northlight Displays (Issaquah, Washington), currently helps companies large and small take new display technologies to market. ***Allan R. Kmetz*** (Lucent Technologies, Liberty Corner, New Jersey) was installed as President-Elect; ***Robert L. Wisnieff*** (IBM T. J. Watson Research Center, Yorktown Heights, New York) became Treasurer; and ***Shigeo Mikoshiba*** (University of Electro-Communications, Tokyo, Japan) was installed as Secretary. Regional Vice Presidents are ***James Larimer*** (NASA Ames Research Center, Moffett Field, California) for the Americas; ***Akito Iwamoto*** (Toshiba Corp., Kawasaki, Japan) for Asia; and Andre Van Calster (University of Ghent, Ghent, Belgium) for Europe.

Each new President of SID nominates new committee chairs. President Silzars made it clear that he wanted committee chairs who would be activists. The chairs are ***H. Uchiike*** (Academic), ***K. C. Park*** (Applications), ***D. Dumont*** (Archives), ***E. Lueder*** (Bylaws), ***H. Hoffman*** (Communications and Publicity), ***P. Heyman*** (Conventions), ***B. Needham*** (Chapter Formation), ***G. McGuire*** (Definitions and Standards), ***A. Lakatos*** (Honors and Awards), ***T. Iki*** (Long-Range Planning), ***R. Seery*** (Membership), ***T. Lowe*** (Nominations), and ***D. Mentley*** (Publications). Contact information for most of the chairs is on the SID Web site (www.sid.org). Committee chairs will be pleased to receive your suggestions and offers of participation, Silzars said.

– Ken Werner

Thirty-five Years of PDP Research Earns Larry Weber High Honors at SID 2000

This year, the Honors and Awards Committee of the Society for Information Display (SID) bestowed high honors on the man considered by many to be one of the fathers of ac plasma-display-panel (AC-PDP) technology. ***Larry Weber*** received the Karl Ferdinand Braun Prize honoring his pioneering contributions to PDP technology and its commercialization at the SID 2000 Awards Banquet held on May 15th in Long Beach, California.

Weber began his research on PDPs at the University of Illinois, where in 1966 he demonstrated the first successful AC-PDP. He continued his research at the University as an Associate Professor, demonstrating a number of enhancements, including a method to dramatically reduce the required power consumption dramatically and an addressing scheme that reduced the number of drivers by 50%.

Weber was quick to point out that the inventors of the AC-PDP were his professors, Bitzer and Slottow, to whom he expressed his sincere appreciation. A pivotal event occurred in 1987 when IBM decided to discontinue its commercial PDP development.

Weber, with the help of University of Illinois students, bought IBM's PDP manufacturing equipment and related technology and started Plasmaco, Inc., in a former apple-juice factory in upstate New York. Less than a year later, Plasmaco demonstrated its first new panel at the 1988 SID Symposium. In the ensuing years under Weber's technical leadership, Plasmaco – now a wholly owned subsidiary of Matsushita – has continued to pioneer PDP technology, including a full-color 20-in. panel in 1994 and its industry-leading 60-in.-diagonal HDTV panels shown at SID '99 and SID 2000.

The Johann Gutenberg Prize, SID's other major technology award, was given to ***Seung Ho Baek*** and ***Charles DeBoer*** who together were recognized "for the conception, design, and development of laser thermal-dye-transfer color-imaging systems." Baek and DeBoer both worked at Eastman Kodak Research Laboratories, where they conducted a significant body of research into laser thermal-imaging technology, photosensitive polymers, and related science. Their efforts led directly to the commercialization of this technology in Kodak color-printing and photographic-proofing systems.

Baek attributed some of their success in commercializing the technology to the recent availability of high-power low-cost diode lasers, which dramatically reduced the cost and weight of production systems. Seeing this new printing technology first-hand is the only way to truly appreciate how exciting it is.

SID also named four new Fellows of the Society:

Ken Werner

Newly installed SID President Aris Silzars (right) receives the ceremonial gavel from outgoing president Tony Lowe.

- ***J. William Doane***, co-founder of Kent Displays, Inc., "for research and development of dispersed polymer and bistable cholesteric-texture displays."
- ***Setsuo Kaneko***, NEC Corp., "for contributions to the research and development of a- and poly-Si TFT technologies and TFT-LCD monitors."
- ***Hiroyuki Ohshima***, Seiko-Epson Corp., "for contributions to the development of poly-Si TFT-LCDs."
- ***A. A. S. Sluyterman***, Philips Display Components, "for innovative contributions to CRT technology, deflection systems, and novel CRT systems."

Special recognition awards were given to ***Joseph A. Castellano*** (leadership in display technology and market assessment and forecasting), ***Nobuki Ibaraki*** (development of a- and poly-Si TFTs and TFT-LCDs), ***Shoei Naemura*** (R&D in liquid-crystal materials), ***Tsunehiko Sugawara*** (development of flat and light-weight glass bulbs for CRTs and advances in the mechanical reliability of CRTs), ***Teruo Tohma*** (development and commercialization of multicolor organic electroluminescent devices), and ***Shin-Tson Wu*** (invention and commercialization of mixed-mode TN-structure reflective LCDs).

– Stephen P. Atwood

Jim Hurd, Flat-Panel Industry Leader and Mentor in U.S., Dies

Jim Hurd, the founding CEO of Planar Systems, passed away on June 14, 2000, after a year-long battle with leukemia. Jim, who led Planar Systems to become one of the largest flat-panel-display companies in the U.S. and Europe, was a pioneering technical and business leader in the U.S. flat-panel industry. He was actively involved at the national level in influencing governmental policy on flat-panel displays in such areas as trade, the National Flat Panel Initiative, and in the formation of consortiums to address critical issues concerning the flat-panel-display industry.

Jim was an active business leader in Oregon, serving as the Chair of the Oregon Council of the American Electronics Association. During his term in 1992, he led the development of the Oregon Technology Benchmark annual survey and conference. He was also active in supporting technical educational thrusts in Oregon and was a member of the board of trustees of the Oregon Graduate Institute. For his service to industry and community, the American Electronics Association and the Boy Scouts of America awarded him Oregon's Technology Executive of the Year in 1993.

James M. Hurd was born May 12, 1948 in Spokane and grew up in Kennewick, Washington. He received a bachelor's degree in physics from Lewis & Clark College in Portland in 1970, where he met his wife Alice. Jim joined Tektronix soon after graduation, where the initial focus of his work was on the surface science of phosphors. At Tektronix, he was eventually promoted to be Manager of Solid State Research. The research activities in the Solid State Research Labs that he managed eventually led to the formation of two successful companies: Triquint Semiconductor (GaAs devices) and Planar Systems (EL Displays). In 1983, Jim left Tektronix to cofound Planar Systems with Chris King and John Laney. After Planar became a successful company, Jim lent his wisdom to help other start-up companies achieve similar success by serving on the board of the Oregon Resource and Technology Development Fund, which is a state-sponsored venture-capital fund.

Jim was a great friend to those who had the opportunity to know him. He was able to balance his successful business life with an active private life that included mountain climbing, running, bicycling, tennis, scuba diving, and a love of auto racing. He is survived by his wife Alice and his sons Owen and Peter.

The family suggests remembrances to Portland Mountain Rescue, P.O. Box 5391, Portland, OR 97228 or Lewis and Clark College, 0615 S.W. Palatine Hill Road, Portland, OR 97219.

– Chris King

calendar

Twentieth International Display Research Conference (IDRC '00). Sponsored by SID. Contact: Ralph Nadell, Palisades Institute for Research Services, Inc., 212/460-8090 x203, fax -5460, e-mail: Rnadell@newyork.palisades.org.
Sept. 25–29, 2000 Palm Beach, FL

Seventh Annual Symposium on Vehicle Displays. Sponsored by the SID Detroit Chapter. Contact: V. Cannella; 248/540-7830.
Oct. 3, 2000 Dearborn, MI

Second Annual Display Industry Conference: Commercializing OLEDs. Contact: Intertech, 207/781-2150, fax -9800, email: info@intertechusa.com, www.intertechusa.com
Oct. 11–13, 2000 San Diego, CA

The Sixth Asian Symposium on Information Display (ASID '00) and Information Display China 2000. Sponsored by the SID Asia Region, ITE, IEICE, and XJTU. Contact: Prof. C. Liu, Xi'an Jiaotong University; +86-29-2668657, fax -2668659, e-mail: chlliu@xjtu.edu.cn.
Oct. 18–20, 2000 Xi'an, Shaanxi, P.R. China

The Sixth International Conference on the Science and Technology of Display Phosphors. Sponsored by DARPA and SID. Contact: Mark Goldfarb, Palisades Institute for Research Services; 212/460-8090 x202, fax -5460, e-mail: mgoldfar@newyork.palisades.org.
Nov. 6–8, 2000 San Diego, CA

Eighth Color Imaging Conference: Color Science, Engineering Systems & Applications. Sponsored by IS&T and SID. Contact: Dee Dumont, SID HQ, 408/977-1013, fax -1531, e-mail: office@sid.org.
Nov. 7-10, 2000 Scottsdale, AZ

Electronic Information Displays (EID 2000). Sponsored by SID. Contact: Trident Exhibitions, +44-(0)-1882-614671, fax -614818, e-mail: info@trident exhibitions.co.uk.
Nov. 21-23, 2000 London, UK

The Seventh International Display Workshops (IDW '00). Sponsored by ITE and SID. Contact: IDW '00 Secretariat; +81-3-3423-4180, fax -4108.
Nov. 29–Dec. 1, 2000 Kobe, Japan

The 17th Annual Flat Information Displays Conference. Sponsored by Stanford Resources. Contact: Laura Barretto at 408/360-8400, e-mail: sales@stanfordresources.com.
Dec. 12–14, 2000 Monterey, California ■

SID Conference Calendar

Next Show!

The 2000 International Display Research Conference (IDRC '00)

The 20th edition of the International Display Research Conference will be held at The Breakers Hotel, Palm Beach, Florida, September 25–28, 2000. This year's conference is comprised of papers from Asia, Europe, the U.S. and Canada. The presentations reflect the current thrust of flat-panel research on organic LEDs, virtual displays, and light valves on Si for projection, printing replacing vacuum processes, and reflective displays with color or multiline addressing.

25 SEPTEMBER 00

20th International Display Research Conference (IDRC '00)

PALM BEACH, FLORIDA
SEPTEMBER 25–28, 2000

- An international conference on display research and development aspects of:
  - Display Fundamentals, Display Devices
  - Hard Copy & Storage, Input Systems
  - Integrated Devices and Applications
  - Image and Signal Processing,
  - Color Perception, Human Factors

6 NOVEMBER 00

Sixth International Conference on the Science and Technology of Display Phosphors

SAN DIEGO, CALIFORNIA
NOVEMBER 6–8, 2000

- An international conference on the future prospects of phosphors for:
  - OLEDs – ELDs – FEDs
  - CRTs – Plasma Displays
  - PL Devices – LC Backlights

7 NOVEMBER 00

8th Color Imaging Conference: Color Science, Engineering, Systems & Applications

SCOTTSDALE, ARIZONA
NOVEMBER 7–10, 2000

- An international multidisciplinary forum for dialogue on:
  - Creation and capture of Color Images
  - Color Image reproduction and interchange
  - Co-sponsored with IS&T

3 JUNE 01

SID '01

SAN JOSE, CALIFORNIA
JUNE 3–8, 2001

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- An International Symposium Seminar and Exhibition – Featuring
  - Technical Sessions – Poster Session
  - Author Interviews – Evening Panels
  - Short Courses – Applications Seminars
  - Technical Seminars – Applications Sessions
  - Product Exhibits – Display Technology Showcase

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