SID '99 REVIEW ISSUE

Information DISPLAY

SID

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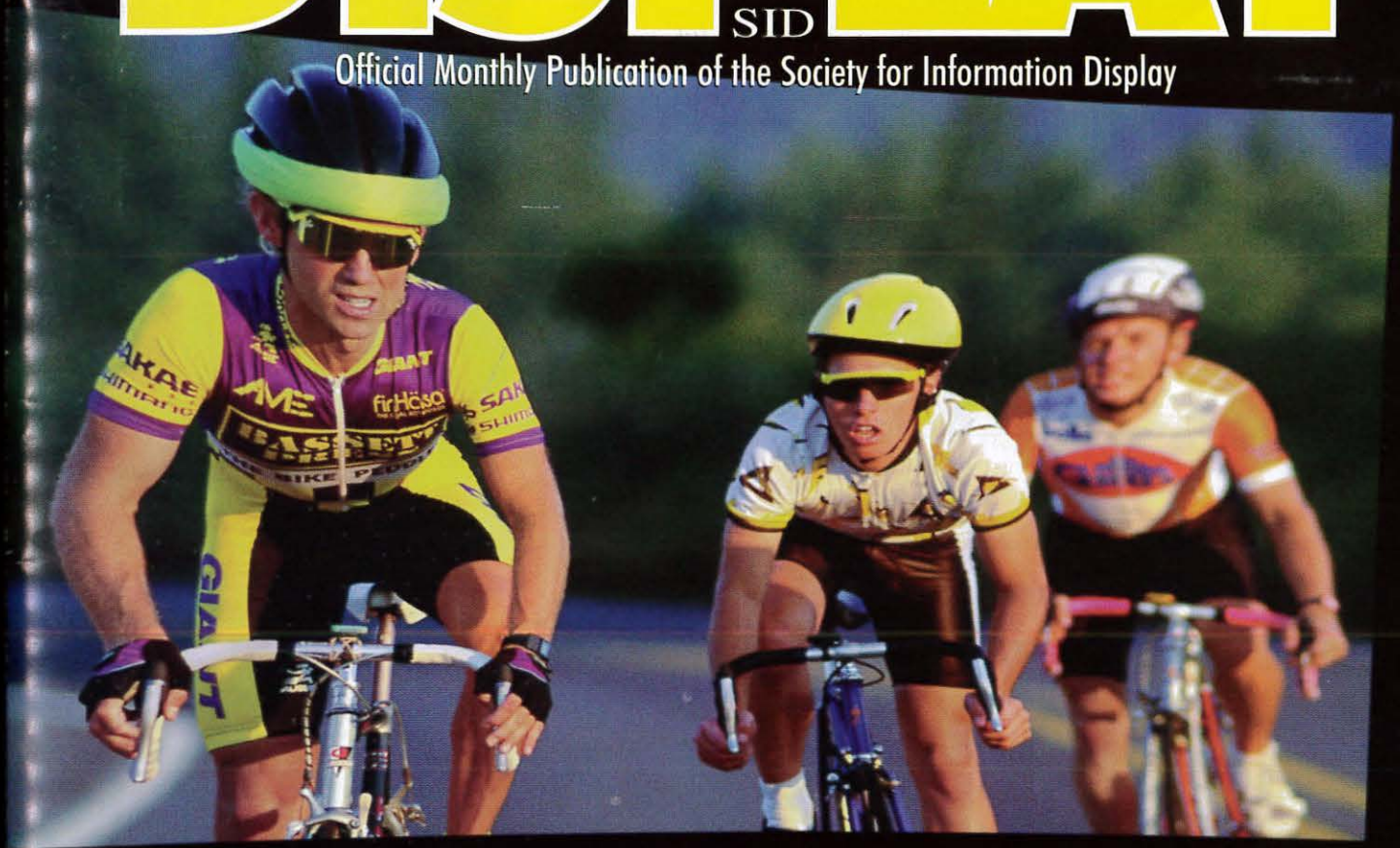

Digital Cinema Arrives at SID '99

SID '99 Review:

- **Overview**
- **Microdisplays**
- **LCDs**
- **CRTs**
- **Emissives & FEDs**
- **Manufacturing**

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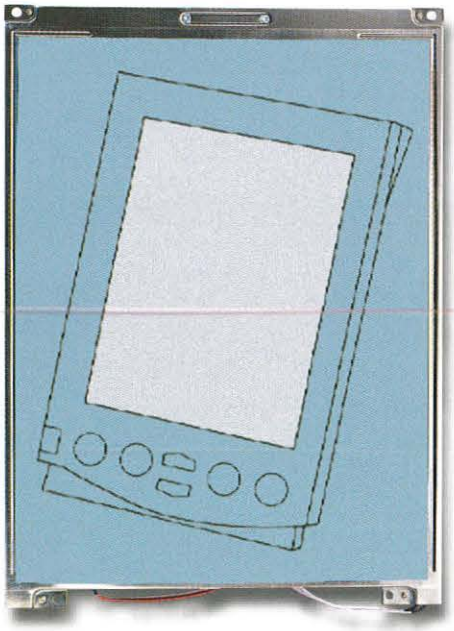
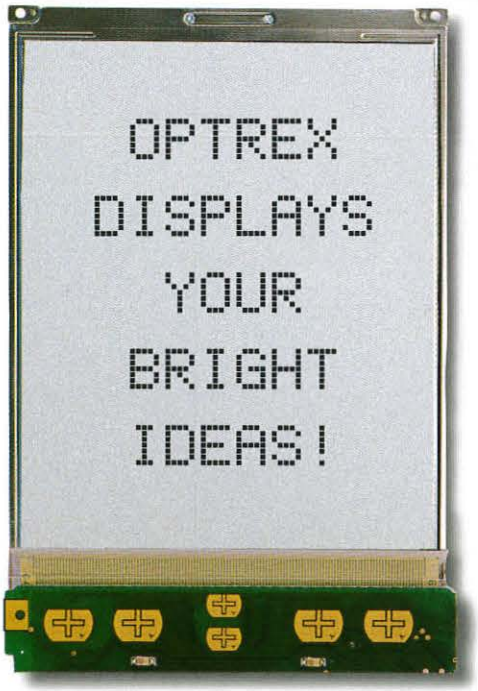
Color Graphics LCD Module



Monochrome Graphics LCD Module



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Information DISPLAY

SEPTEMBER 1999
VOL. 15, NO. 9

COVER: A special comparison of the two leading digital-cinema projection technologies kicked off SID '99 with a sizzle. This composite photo suggests the experience.

Hughes-JVC

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

- Head-Mounted Displays
- Single-Board Computers
- Smart Integration in FPDs
- Computex Taipei '99

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CRTs Go Digital, and Other Display Reports from PC Expo

PC Expo, held this year June 22–24 (just a month after the close of SID '99), is a smaller, less frenetic version of COMDEX – and it has the substantial advantage of being held in New York's Javits Convention Center, which is just an hour away from *Information Display*'s Connecticut editorial offices on the reliable New Haven Line of the Metro North commuter railroad.

It's easy to get distracted by all the hardware, software, and entertaining consumer-oriented trivia at PC Expo, but if one stays focused on display issues it's possible to move through the large halls quite quickly.

The big display news was delivered at a Wednesday morning press conference, where ***ViewSonic*** announced its support of the Digital Display Working Group (DDWG) and its adoption of the Digital Visual Interface (DVI) specification for the company's LCD *and* CRT monitors. In so doing, ViewSonic presented a preview of its digital-only road map for migrating all of its monitors – both LCD *and* CRT – to the digital domain. Marc McConnaughey, V.P. for Technology and Sourcing, said that ViewSonic was the first company to announce digital CRTs, and that the company's intention was to accelerate the adoption of DVI.

McConnaughey said ViewSonic's digital CRT technology, called OptiSync™, will initially add about 15% to the cost of a CRT monitor when it is commercially introduced in January, but the company expects the digital CRT monitors to attain price parity with analog monitors by the end of 2000. By providing a digital pipe between the display and the PC, OptiSync will permit added features, enhanced performance, reduced cost, and enhanced reliability. Fifty percent of the market will be digital by early 2001, McConnaughey said.

Steve Spina, ***Intel***'s Strategic Initiative Manager, spoke as a representative of DDWG, which now has 100 members. Its DVI interface is based on Silicon Image's implementation of TMDS. Intel's objective, said Spina, is rapid digital conversion. Its motivation is the desire to make PC use easier and more enjoyable, as codified in the "Easy PC Initiative" and "Visual Computing Initiative."

ViewSonic was showing its first digital CRT monitor, a flat 19-in. model called the PT795. There will be 50 of them by the end of August. Price parity will be possible, McConnaughey said in response to a question from *ID* because, although "we will be adding silicon ... we will then be able to take out cost in deflection and multi-sync circuits."

ViewSonic Executive V.P. Peter Weedfald commented, "The Internet is a wonderful enabler for display technology." He continued that the LCD-CRT multiple has recently "gone the wrong way," and is now at 3.5 for a 15-in. LCD or a 17-in. CRT. "Three to four years from now, CRTs will still be shipping 100 million per year, but many of them should be digital."

Among the displays in its booth, ViewSonic was showing 15- and 18-in. LCDs that have both digital and analog inputs. They were showing picture-in-picture. The price of the 18-in. version was not yet set, but PR rep Rhonda Grech estimated the price at about $4000.

A variety of exhibitors were showing 18-in. LCD monitors – including ***Compaq***, ***Eizo***, ***Philips***, ***iiyama***, and ***Sony*** – at prices between $3099 and $4000.

continued on page 44

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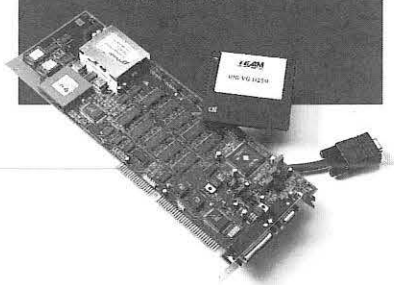

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Circle no. 30

the display continuum

Search and Acquire ...

by Aris Silzars

When kids play in the dirt, we call it "kids playing in the dirt." When adults play in the dirt, we call it "gardening." And when adults play in the dirt using heavy machinery, we call it "a major construction project." Thus, it seems that our frame of reference for a given situation has a strong influence on our interpretation of its significance. Maybe the cost of the toys also has something to do with it.

Some years ago, two of our at-that-time young children had built an elaborate sand castle on the beach. As sunset approached so did the tide. As the first gentle waves surrounded their creation, the moat that had been constructed that afternoon slowly filled with water and served its intended purpose. The sand castle stood in all its glory, with the moat retaining the water even after each wave receded. But the ocean was not to be denied, and soon large chunks began to crumble from the corners of our creation. The oldest child, who was about eight, at first tried to do some repairs, but when that turned into a clearly hopeless task, he became quite distraught. He could see that his hard work was not going to survive what, in his view, had by now become an evil onslaught by the ocean. No parental explanation (that it was time for us to head home anyway) could provide adequate consolation. From his viewpoint, this was a major disaster and parental logic was not going to improve the situation. It took most of the trip home to re-establish the mood of what had otherwise been a terrific day.

Of course, for most of us it is much easier to see these "childish" behaviors in children than it is to see them when they are demonstrated by adults. Hardest of all is to see them in ourselves. When kids play on the family's computer, we call it "kids playing games on the computer." When adults play solitaire or other games on their computers while on a plane flight or in the office, we call it "taking a well-deserved break from important and exhausting business activities." When kids throw a temper tantrum, we call it "kids acting like two-year-olds" - which is often the age that they happen to be. When adults throw a temper tantrum, one of the currently popular descriptive terms is "road rage."

How we interpret a situation can determine how we respond to it and the effect it has on us. As many of you have, I'm sure, discovered, in most cases an optimistic and perhaps even playful attitude is more likely to lead to a good outcome.

Therefore, in this spirit of not taking life too seriously, let's take a look at some of the recent events that are creating great excitement in both the technical and financial sectors. As we all by now know, any new start-up company that puts the @ symbol or a ".com" in its name is deemed immediately ready for an IPO (initial public offering). Whether or not it is ever likely to become a profitable business hardly seems to matter. Right now, the entire financial community seems to be tangled up in the Web.

The Internet, the World Wide Web, or just "the Web," is certainly going to be increasingly important to us in the display community because the more that is done on-line, the more new displays are going to be needed. If we are able to understand the nature and the location of these on-line activities, we should be better positioned to respond with the right kind of display technologies - current or yet to be invented. For us, that old marketing adage for business success

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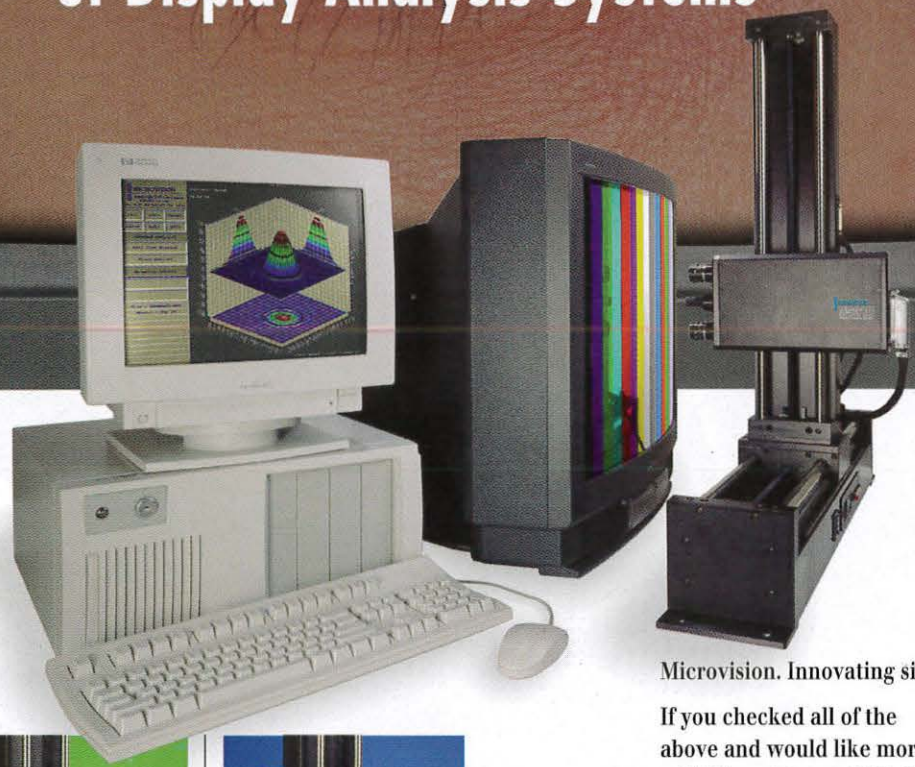

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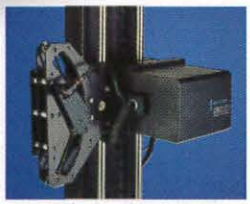

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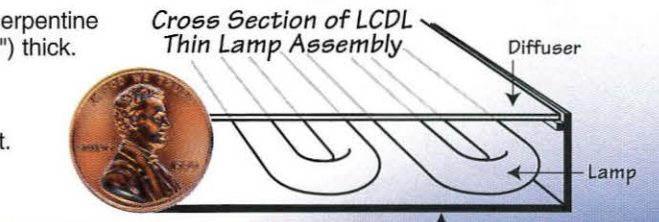

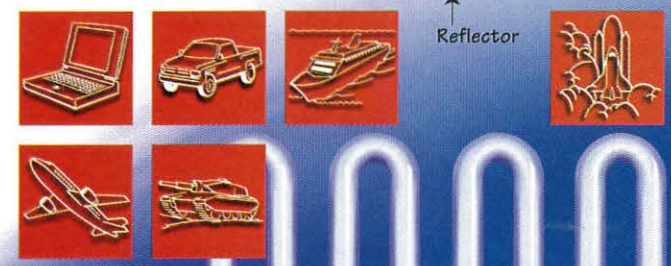

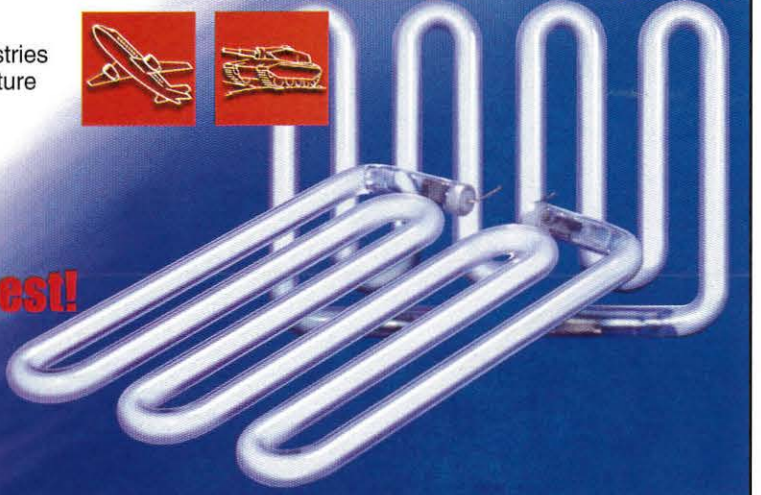

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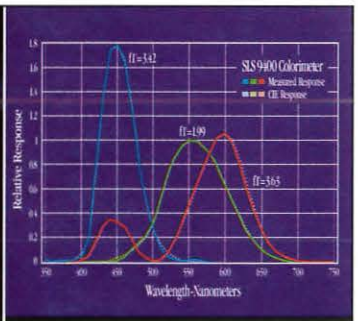

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Circle No. 3

The Year of the Rabbit

This is The Year of the Rabbit in the Chinese calendar – a congenial time in which money can be made. But the largest SID Symposium ever held seemed more notable for its energetic diversity than for marking a year of anything in particular.

by Ken Werner

THE SOCIETY FOR INFORMATION DISPLAY'S 1999 International Symposium, Seminar & Exhibition (SID '99) was a great success, but it punctuated a year of contradictions. Overall attendance was up to approximately 6600 from last year's 6200; 255 exhibitors rented 402 booths compared to 235 exhibitors and 380 booths in 1998; and registrations to the technical symposium were up to 1710 from 1660. (Only registrations for the Monday and Friday seminars were down, which left the SID 2000 Executive Committee considering whether some fine tuning was in order.)

The growth occurred despite continuing bearishness (in the sense of a "bear market" – there is no "Year of the Bear" in the Chinese calendar) among many Asian display manufacturers and substantial continuing losses at some of the major Asian electronics conglomerates. For the first time, one major Japanese display supplier did not participate, while other Asian companies cut back on their original booth reservations.

But these cutbacks were more than made up for by new exhibitors that included components, materials, and applications-oriented companies. Among these were ***Dai Nippon Printing*** with its Display-of-the-Year-Award-winning Ultra Contrast Screen, single-board-computer maker ***Applied Data Systems,*** micro-prism-backlight producer ***Lumitex,*** and new EL vendor and OLED developer ***Lite Array.***

Ken Werner

The early morning sunshine illuminates San Jose's McEnery Convention Center (with the red slashes of tile work over the entrance) during SID '99.

Similarly, the increase in overall attendance occurred despite the likelihood that employees of at least some Asian companies were finding it harder to obtain travel expenses. This left members of the SID Executive Committee, the SID 2000 organizing committee, and Show Management very optimistic about continuing growth next year in Long Beach. Substantial growth is anticipated on top of the growth experienced this year. The Asian display industry is expected to continue to recover from last year's LCD glut and the effects of the "Asian flu" and grow more bullish. The Symposium plans to extend this year's successful initiation of the Display Electronics and Display Applications tracks,

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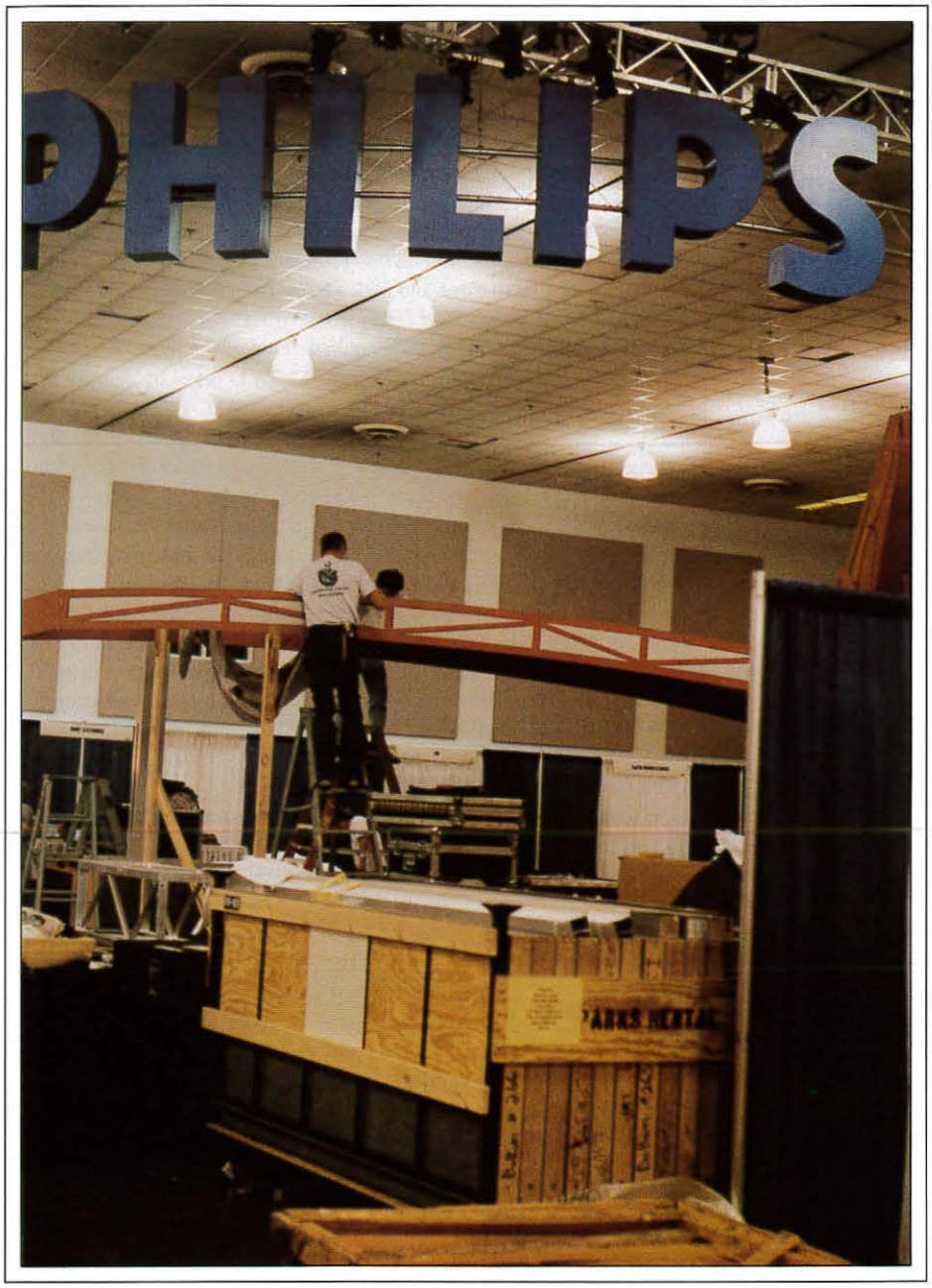


Ken Werner

During show set-up, workmen erect the Golden Gate Bridge reproduction that spanned the Philips Flat Display Systems booth during the show.

and to undertake a serious expansion of its Display Manufacturing track.

Although this was not a year in which any one item dominated the entire conference and show, a remarkable number of activities, trends, demonstrations, and new products were significant. Some were exciting, and one could reshape the entire flat-panel industry – if it lives up to its promise (more on this later).

The flashiest story at SID was the very well attended Keynote Session, which presented the rationale for digital cinema and included exciting large-screen demonstrations of the two leading digital projection technologies: Hughes-JVC's ILA® and Texas Instruments' DLP™. The session was kicked off by Hollywood veteran Curt Behlmer (Studio Systems, Inc.), who traced the visual, acoustic, and venue development of cinema from the beginning (Edison and the Lumiere brothers) to the present (cup holders on theater seats and digital sound), and outlined the compelling technical and financial case for electronic projection. He concluded that "digital cinema is inevitable," but among the implementation issues to be resolved are technical standards, the choice of an end-to-end or component system, and the way of allocating costs and benefits. (Without adjustments, distributors will reap the biggest financial benefits and exhibitors will incur the largest expenses.)

After Behlmer's introduction, Bill Bleha of Hughes-JVC described his company's ILA® technology. The theatrical version of the EC 12 projector produces 12,000 lm, a sequential contrast ratio (CR) of 1500:1, and 2000 × 1080 pixels – the same number that film projectors produce in theaters. The new D-ILA technology, which won this year's SID/*Information Display* Display Product of the Year Award, will be used for cinema in the future.

Then Larry Hornbeck discussed the Texas Instruments cinema projector based on the company's DLP system, which incorporates Digital Micromirror Devices (DMDs). The three-chip third-generation projector was producing 10,000 lm and had a 42-bit color depth, a sequential CR of 800:1, and 1280 × 1024 pixels stretched to wide-screen proportions by an anamorphic lens. Hornbeck made much of the fact that DLP is a completely digital system.

Both projectors were demonstrated with telecine conversions from feature-film stock onto D5 digital video tape, with images shown on a 50-ft. screen. From a viewing position close to the screen, the greater pixel count of the Hughes-JVC projector made a marked difference, but as one moved far enough back so that the difference in pixel count was no longer visible, the high contrast and color depth of the TI projector was extremely impressive. (For more details, see Chuck McLaughlin's microdisplay article elsewhere in this issue.)

Wait Until Next Year

It's a little too soon for this to be the "Year of the Microdisplay," but the consensus among microdisplay developers is that next year will be big time.

The Display Technology Showcase

In the San Jose Convention Center's cavernous Exhibit Hall 1 was a large white tent bearing an invitation to step into the Display Technology Showcase (DTS). As one entered, the dim lights and hushed voices of observers gave the impression that one had stumbled into an art museum by mistake. But instead of paintings by the masters, the room was filled with products crafted by the masters of display technology.

For the second year in a row, the SID Symposium included space for the DTS, where participants could view the latest designs side by side with their peers. These ranged from technology demonstrations and prototypes to commercially available products.

To level the playing field, all devices received the same images at appropriate resolutions. ***ALTINEX*** (Brea, California; www.altinex.com) provided the technical expertise to design, construct, and monitor the signal distribution and conversion so that each device was assured a clean source for the image data. The most challenging infrastructural requirement was providing simultaneous analog and digital versions of the same images, said ALTINEX President Jack Gershfeld. (An employee of one of ALTINEX's competitors was overheard to say that doing this was "impossible.")

The test patterns were designed and provided by ***Sonera Technologies*** (Rumson, New Jersey; www.displaymate.com), publisher of the DisplayMate program. Motion-video source material came from Universal Studios Home Video and Sony Entertainment. (A CD-ROM containing the still images - test patterns, 24-bit photos, and 24-bit scans of fine art - used during DTS is available for $100 plus shipping and handling; contact Nutmeg Consultants at 203/853-7069, fax 203/855-9769.)

The displays were divided into four categories: Microdisplays, Desktop Displays, Larger Video Graphics (direct-view and projection), and HD Video Displays. The two entries in the Microdisplay category were from ***Colorado Microdisplay*** and ***MicroDisplay Corp.,*** using viewfinder-style mountings.

Five of the desktop displays demonstrated scaling engines from ***Arithmos*** and ***Genesis Microchip,*** while three more focused on controller circuitry from ***Sage*** and ***Silicon Image. Data Modul, Emco Electronics,*** and ***Mitsubishi*** exhibited AMLCD panels ranging in size from 8.4 to 15.1 in. on the diagonal. One of the most striking products in this group was the 18.1-in. AMLCD panel by ***Planar Advance*** designed to be readable in direct sunlight. Rated at 800 cd/m^2, it was dramatically brighter than most other panels. Also high in brightness (rated at 1700 cd/m^2) was the Emco panel designed for sunlight viewing, particularly in ATM applications).

The Larger Video Graphics group of displays were dominated by 42-in. panels and were noticeably brighter and had more contrast than in the past. ***IEE, NEC,*** and ***Plasmaco*** provided plasma-display panels (PDPs). ***Electrohome*** showed a high-brightness data projector using three TI DLP chips to create the image. ***Genesis Microchip*** demonstrated a scaling engine used in a ***Lightware*** Scout projector that weighs under 6 lbs. ***Raytheon*** showed an intriguing rear-projection desktop monitor that is commercially available; the 32-in. display had SXGA (1280 × 1024) resolution using TI DLP technology in a ruggedized housing.

The two entries in the HD Video Displays group were Sony's completely flat 34-in. FD HDTV TV set with a direct-view CRT and 16:9 aspect ratio, and a prototype of Plasmaco's 60-in.-diagonal PDP. (The DTS booklet provided specifications for the 50-in. Plasmaco PDP, but the company finished three 60-in. models in time for the show. One of them was at DTS, one was on the show floor, and one was kept in a hotel room as a spare.) This 16:9-format display provided an impressive image compared with the smaller designs around it.

In contrast to all the other PDPs, which are intended for HDTV or as multimedia monitors, Fujitsu's 25-in. SXGA PDP monitor with 0.39-mm pixel pitch is intended as an engineering-workstation display.

The purpose of the DTS is to help people understand the inherent strengths of the various display technologies, and to help system houses and product designers make optimal matches between display technologies and applications. Therefore, there are no winners and no losers at DTS. Both last year and this year, the comparisons were informative and entertaining, and produced a couple of interesting surprises.

- Alfred Poor

Ken Werner

The opening "Indian head" slide appeared simultaneously on close to 30 displays around the Display Technology Showcase tent. It was the first in a sequence of still images and video designed to help attendees assess the characteristics of widely differing display technologies and products.

SID Honors Leaders in the Display Industry

The honorees at the 1999 Society for Information Display (SID) Honors and Awards Banquet again represented an elite group of key contributors to the display industry. Andy Lakatos (Xerox Corp.), Chair of the Honors and Awards Committee, opened the ceremonies by recognizing all the award winners for their "hard work, innovations, and entrepreneurial spirit." As SID President Tony Lowe noted in his written comments in the awards program, each year through the Honors and Awards program, the Society recognizes "not only the highest achievements from basic research to entrepreneurial success, but also outstanding service to the Society and the display industry in general." This year's honorees clearly embody this goal.

The **Karl Ferdinand Braun Prize** was awarded this year to ***Larry J. Hornbeck,*** a TI Fellow in Digital Imaging at Texas Instruments. The Braun Prize is awarded for outstanding technical achievement in, or contribution to, display technology. Dr. Hornbeck received his award for the invention and development of the Digital Micromirror Device (DMD™) projector.

As he explained in his acceptance remarks, Dr. Hornbeck's first work on analog light-modulator technology resulted in the original Deformable Mirror Device, a plastic membrane over a silicon transistor array. The technology was intended for optical signal processing, but executives at TI immediately started to encourage him to make a display out of it. In 1984, he designed an improved version that was intended as a substitute for the light bar on Xerographic printers. The first digital version was developed in 1988 and was used successfully in a Xerographic airline-ticket printer application.

Further encouraged by managers who wanted to make a display device out of his printer imager, Dr. Hornbeck completed the first prototype of a projection system based on a DMD in 1992. Since then, he has further refined this remarkable device with "hidden hinge" technology and dramatically greater resolutions. A true measure of his success was stunningly illustrated at the opening session of the SID Symposium with a demonstration of a full-size commercially viable movie-theater projection system using three DMDs. As DMD projectors begin to appear in a variety of business markets, the full reach of the DMD development is yet to be fully explored. However, it is one of the more unique and creative contributions seen in the display industry. This year's Braun prize also included a $2000 stipend courtesy of Thomson Consumer Electronics.

The **Johann Gutenberg Prize** is awarded each year for outstanding achievement in, or contribution to, printer technology. This year's winner, ***Dan Hays,*** was recognized for decades of scientific discovery and innovation in the electrophotographic process that enabled outstanding copy quality in three generations of copier and printer products. Dr. Hays, who is currently a Research Fellow at Xerox Corporation, guided the audience through the revolutionary history of electrophotography and how Xerox Corporation actually came about.

Among Dr. Hays's accomplishments are his many inventions in the area of toners and transfer systems, without which we literally would not have today's ubiquitous photocopying technology. This year's award carried with it a $2000 stipend from the Xerox Foundation.

This year's winner of the **Lewis and Beatrice Winner Award** for exceptional and sustained service to the Society was ***Philip M. Heyman.*** His services to both SID and the display community are numerous, including major innovations in the manufacturability of CRTs and research into ferroelectric TFTs, lasers, and photochromic materials. Dr. Heyman has served in a variety of posts on Symposium committees, was a major architect of the current business plan for *Information Display Magazine,* and is currently Chair of the Conventions Committee. A member of SID since 1975, he commented in his acceptance remarks about how far the Society has grown from its roots as a U.S.-based organization to a truly international society with conferences, meetings, and interests in almost every part of the world. Because he knew Lewis Winner, Dr. Heyman said, he was particularly honored to receive this award, and was especially pleased to see that we still honor Lewis Winner's standards of quality today.

Also honored were six winners of the 1999 Special Recognition Awards:

- ***John C. C. Fan*** for the development and commercialization of single-crystal wafer-based TFT-LCD technologies. Dr. Fan is the Chairman, CEO, and President of Kopin Corporation.
- ***Yasuyuki Gotoh*** for the development of a new class of fluorinated liquid-crystal compounds suitable for TFT-LCDs. Dr. Gotoh is a technical manager in the Liquid Crystal Production Unit of Chisso Corporation.
- ***Kenji Okamoto*** for the development of novel and innovative multi-domain vertical-alignment processes for fast, large-screen LCD applications. Dr. Okamoto is a Deputy Director in the LCD Development Department of Fujitsu Limited.
- ***Kouji Suzuki*** for the development of novel large-area TFT-LCD array structures and drive systems. Mr. Suzuki is a Chief Research Scientist at Toshiba Corporation.
- ***Yasumasa Takeuchi*** for the development of low-temperature alignment materials for TFT-LCD applications. Mr. Takeuchi is a Member of the Technical Staff of the Opto-Electronic Materials Business of Bridgestone Tire Company, Ltd.
- ***Malcolm Thompson*** for entrepreneurship and leadership in the display industry, in particular in high-resolution display and sensor products. Dr. Thompson was, until recently, President and CEO of dpiX Corp. Ironically, he announced the sale of dpiX to a group of companies during his acceptance remarks. He is now President and CEO of Novalux and is also the Chairman of the Board of the United States Display Consortium (USDC).

Four distinguished researchers were named Fellows of the SID.

- ***Makoto Maeda*** (Sony Corp.) for his contributions to the performance of the Trinitron as well as monochrome flat CRTs.
- ***Shoichi Matsumoto*** (Asahi Glass Co., Ltd.) for his contributions to the research and development of both passive and active LCDs, and for his leadership in the LCD community.
- ***Terry J. Scheffer*** (In Focus Systems) for his invention of several seminal display technologies, including STN and active-addressed™ LCDs.
- ***Tsutae Shinoda*** (Fujitsu Laboratories) for the development and commercialization of color display technologies.

– Stephen J. Atwood

Convergence and Effervescence Fuel Success of Evening Panels

Tuesday-evening panel discussions are a tradition at SID, but success depends on a mixture of topic, moderator, audience, and enthusiasm that is not entirely predictable. The chemistry ignited beautifully at "Computer Television Convergence: The Start of a New Paradigm?," and those in attendance may have been surprised on two counts. First, panel members largely concurred on the major issues. Even more striking is the fact that their view of "convergence" is a bit different from the widely held vision.

Panel moderator Nikhil Balram of Faroudja Laboratories started the discussion by presenting a list of trends in the broader marketplace. Analog entertainment is giving way to digital – as demonstrated by audio-CD replacement of vinyl records – and low-cost increased-capacity storage media makes this shift more cost-effective. The lower-cost/increased-performance trend also applies to other components, including CPUs and multimedia accelerators, leading to the point where it is now possible to obtain "free" PCs. High-bandwidth connections – ISDN, xDSL, and cable – make more data readily available, and families have started to network multiple devices in their homes. Digital displays and game consoles place impressive amounts of computing power and resolution within easy reach of many users. And as the Internet delivers entertainment and two-way interaction as part of its content stream, the lines between communications, entertainment, and productivity applications become increasingly blurred.

This opening set the stage for a lively discussion among the panel participants: Eric Haseltine of Walt Disney Imagineering, Robert Logan of Thomson Consumer Electronics, Dave Marsh of Microsoft, Charles McLaughlin of McLaughlin Consulting Group, Sai Naimpally of Panasonic AVC American Laboratories, and Trey Smith of Compaq Computer.

The panelists generally agreed that there would not be one single "converged" device in the home, and that the single "killer app" remains elusive. Marsh asserted that what the market wants most is simply "a better TV." Naimpally pointed out that the functions of the device will be shaped by where it will be used – living room, kitchen, or bedroom – and by the users' buying habits, which are influenced by familiarity with the technology, price, and perceived value. Haseltine observed that there "never has been a new medium that obsoleted those that preceded it." (True for AM radio surviving the advent of FM and for broadcast TV after cable and satellite became available. But vinyl records didn't survive the audio CD except as a low-volume curiosity, so they're the exception to Haseltine's Rule.)

Marsh presented an interesting way to analyze technological convergence in the home which separates functions into different components. The "receiver" acts as the conduit for information, and can be connected to cable, telephone, or other sources. One or more receivers then communicate with the "intelligence" component, using a high-speed digital connection such as FireWire, USB, or PCI bus. The intelligence device can then be connected to one or more "glass" components – the displays – which can be sized and formatted as appropriate for different locations and applications. The glass components could use either analog RGB connections or digital connections such as DVI.

Smith made the point that televisions are already too difficult to operate, and adding more content sources will only increase the need to streamline the user interface, which will take lots of development and processing power. Logan stressed that a better interactive programming guide, which makes it easier to choose content, would be an important step. Both Smith and Marsh agreed that consumers are ready for the hardware to start making choices for them, to automatically pick only those items that might be of interest based on past choices. This is a feature that is already appearing in some video caching devices.

Haseltine pointed out that a critical factor in this automated selection process is "who owns the customer?" There may be enormous economic advantages to owning the first image that comes up on the user's display, as is the case with "portals" on the World Wide Web today.

The panelists also tackled the format question. Most agreed that television will go to the 16:9 format, although McLaughlin observed that making this change is likely to wreak havoc on production yields for LCD panels, at least in the short term. He also predicted that wide-

format monitors for desktop computing will be an important development over the next few years, although other panelists felt that this will only happen if the extra pixels can be delivered for little or no additional cost.

In response to a question from the audience concerning the possible impact of this new technology on a more global level, Haseltine reported that there are interesting cases where there was no prior technology in place. In parts of Africa, for example, the first telephone systems are cellular. In China, many families can only afford one device, so they buy a personal computer. Then, they get a TV tuner card for it and use it to watch broadcast television.

Another audience member observed that group viewing seems to inhibit content "surfing," whether it's changing channels or accessing the Web. Haseltine responded that the interactive component can be effective if designed properly, but that interactive activity generally does lead to fragmentation, with each family member watching his or her own TV. One possible solution would be to have a large screen for group viewing, with each viewer having a separate handset with integral display for controlling individual surfing content.

So where can we expect to go from here? Smith observed that we are now in a situation where we expect too much in the short term, but underestimate the long-term changes. Among the important trends the panelists expect to emerge in the next few years are improved programming guides, video caching and time-shifting devices, and storage built into TV sets for guide data and other content. And if the past is prologue to the future, watch for applications in the workplace to migrate to the home, bringing new digital technology and devices along with them.

The second panel session, "Reflective Displays for Portable Devices," treated a narrower topic, but an important one for the display industry and makers of portable systems, which are believed to be one of the big growth opportunities for flat-panel displays over the next few years. When moderator Bill Doane of Kent Displays introduced his interestingly varied panel of experts – Robert Akins of Motorola, Edward F. Kelley of the National Institute of Standards and Technology (NIST), Takashi Orimoto of Casio Computer, and Tatsuo Uchida of Tohoku University – one person was missing. Daniel Munyan of Everybook had run into airline flight difficulties, but arrived during the introductory remarks.

This panel discussion was more notable for interesting sound bites than for surprising revelations or philosophical positions. Uchida commented that LCDs lost their early advantage of high brightness when manufacturers moved from monochrome to color. But once color was established, attempts were again made to remove or improve the backlight. Guest-host technology achieves brightness by removing the polarizers, but it has poor contrast.

In LCDs, continued Uchida, a rough back surface diffuses incident light, with some light being internally reflected off the front surface back into the display, and with reflectance depending strongly on viewing direction. The display doesn't look like paper at all; however, at Tohoku University they have designed surfaces that multiply the luminance by a factor of 7 by using parabolic figures with different periods. They have built units that have indoor reflective performance similar to that of standard backlit units in notebook PCs. Outdoors, the standard units wash out completely, while these new reflective units are easily visible, said Uchida.

Akins pithily informed the audience why the display industry is excited about the mobile market: From $160 million in 1998, it is projected to grow to $330 million by 2005.

Munyan, victorious in his battle with the airlines, said that Everybook will be prototyping cholesteric displays from Kent Displays this summer for a 2-lb. e-book. It's the only current technology that will give them both the light weight and the low power consumption they need, he said. In answer to a question from the floor, Munyan said a display needs to be 300 dpi – or an effective 300 dpi with the help of Cleartype or other technology – for people to react to the display as they would to a printed book.

Recent experience we've had with IBM's 200-dpi color "Roentgen" AMLCD and other high-resolution displays supports that assertion.

– Alfred Poor and Ken Werner

Haviland Wright (CEO, Displaytech): "The big news is a high-volume product for the Christmas [1999] market. The manufacturing will be done by Miyota - the leading maker of mini-CRTs for camcorder viewfinders - and Displaytech, with manufacturing rolling out in July."

Mark Willner (CEO, Colorado Microdisplay): "I agree that this is the year we'll be selling product. We expect to do well this year and much better next year, with most of our sales in near-eye applications."

Referring to David Mentley's introduction at the Microdisplay Roundtable press event, Philip Alveida (MicroDisplay Corp.) pointed out that "David's presentation makes it sound like we're selling futures, and that's no longer true. We'll be shipping in volume this year, and that means a distribution and sales support infrastructure. Next year at this Roundtable we'll be comparing how many we've sold instead of talking about how many we hope to sell."

Glen Kephart (Kopin): "We're adding another shift for production."

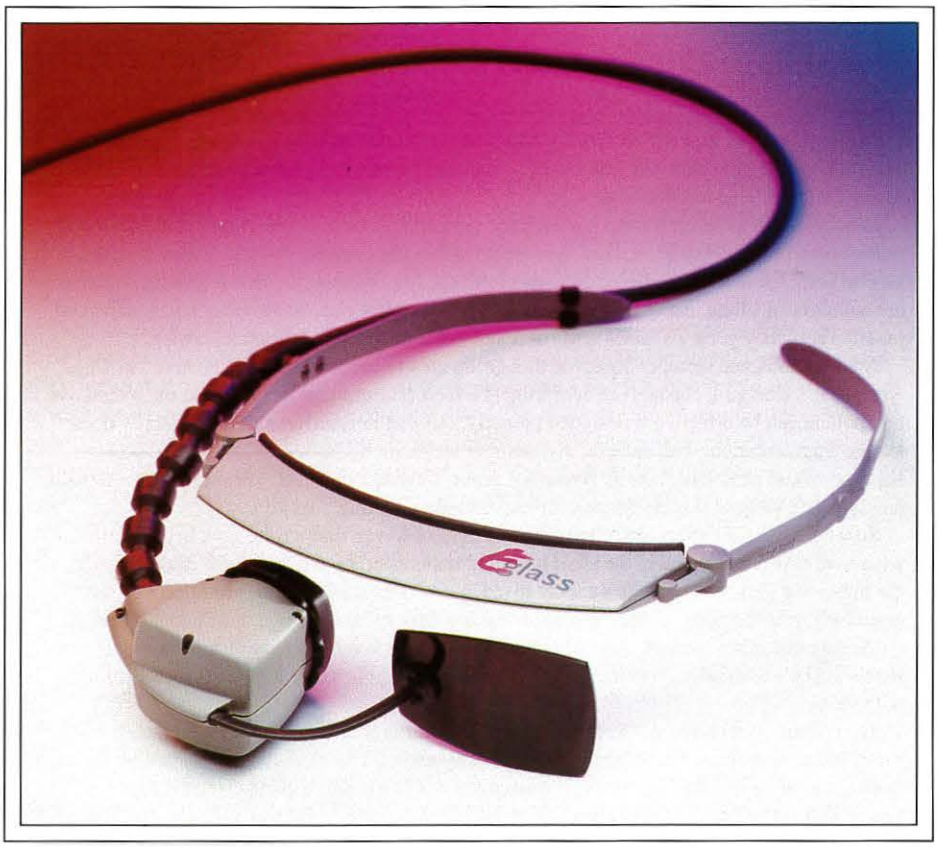
And what are the applications that will drive the microdisplay explosion, according to participants in the Microdisplay Roundtable? Kephart: Camcorders and digital cameras this year. Alan Marty (Hewlett Packard, representing the HP-Displaytech partnership): "Gaming and entertainment in 2000." Kephart: "Cellular phones won't come in until 2001 or 2002 in volume because of the lack of a high-bandwidth wireless infrastructure." Willner: "We see lots of headsets this year."

In the projection portion of the Roundtable, Alfred Poor asked, "When will we see rear-projection products?" Haviland Wright said, "At Samsung's 30th birthday party in Korea, we will see a 43-in. rear-projection HDTV set." Tom Chubb (Three Five Systems): "A 24-in. RP monitor for about $1000 should be seen at COMDEX." Wright: "Definitely under $1000 for the 24-in., but not until 2000." Dick Flasck (consultant to Digital Reflection, Inc.): "Mid-2000 at about $1500."

Nuggets

In a show as large, rich, and - yes - intimidating as SID has become, what stood out? Here are some personal picks:

Plasmaco's 60-in. 720p plasma-display panel, with record-breaking size and a handsome image, was shown both on the show floor and at the Display Technology Showcase (DTS).



Virtual Vision

FED Corp. subsidiary Virtual Vision (Santa Clara, California) showed this strikingly designed eGlass™ head-mounted monitor, which incorporates a Colorado Microdisplay SVGA full-color display. Will Virtual Vision headsets ever incorporate an FED Corp. OLED display? Now that FED Corp. is concentrating on OLEDs, how much longer can it retain the name "FED Corp."?

Candescent's FED panel is long overdue, but the company now has a panel that looks like a product. Before it really is one, though, Candescent must complete its manufacturing facility and show it can produce a reliable, consistent, long-lived product in volume - a challenge that has (temporarily, at least) derailed Motorola's Flat Panel Division, which delayed its planned FED-manufacturing rollout and cancelled its SID exhibition plans.

Seiko Instruments' iChip, which puts the TCP/IP stack into a small IC instead of into software, is setting the stage for a cheap smart display module that can communicate directly with the Internet or an intranet. Picture a vending machine that tells its manager when it needs to be filled up with more Mountain Dew.

Sony's stunning ultra-high-resolution CRT prototype, with 0.126-mm pitch at screen center and 0.161 mm at the sides, marks another step forward for CRT technology. And Sony's 34-in. perfectly flat, 16:9 1080i HDTV set - shown both in Sony's booth and the DTS - may have been producing the best-looking video at the show outside of the digital cinema demonstration. The only thing wrong with this delightful product is its $9000 price tag.

Colorado Microdisplay has carefully made microdisplay technology easy for system makers to integrate by developing a three-chip chip set (the display, display interface ASIC, and illumination controller). As announced at SID, the chips are in ball-grid-array (BGA) packages, which makes it easy to use the technology in a typical electronic-manufacturing environment.

Genesis, Arithmos, and ***Pixelworks*** have developed scaling engines that are rapidly overcoming the "native resolution problem" in flat-panel displays (FPDs). Particularly

impressive was Genesis's soon-to-be-shipped video de-interlacing and scaling engine that showed excellent video on a 15-in. LCD shown at the Display Technology Showcase.

And Then There's Alien Technology

Early in this article I mentioned an exciting technology that could – if it lived it up to its promise – reshape the flat-panel industry. ***Alien Technology*** (Hayward, California) was playing it cool, making its pitch one-on-one in a suite at the Hyatt Sainte Clair to invited journalists and analysts. But the pitch itself was exciting.

Alien, formerly Beckmen Displays, is developing a new potentially much cheaper way of making LCD drivers, single-crystal switching transistors for active-matrix displays, and other bits of display-related circuitry.

The idea of using single-crystal-silicon replacements for TFTs and polysilicon on-board drivers is not new. ***Kopin*** uses an extremely clever proprietary process that fabricates the transistors on a thin layer of silicon that is transferred to the LCD backplate, and all silicon-backplane microdisplays are aiming at the same target, even if their approach is very different from Kopin's.

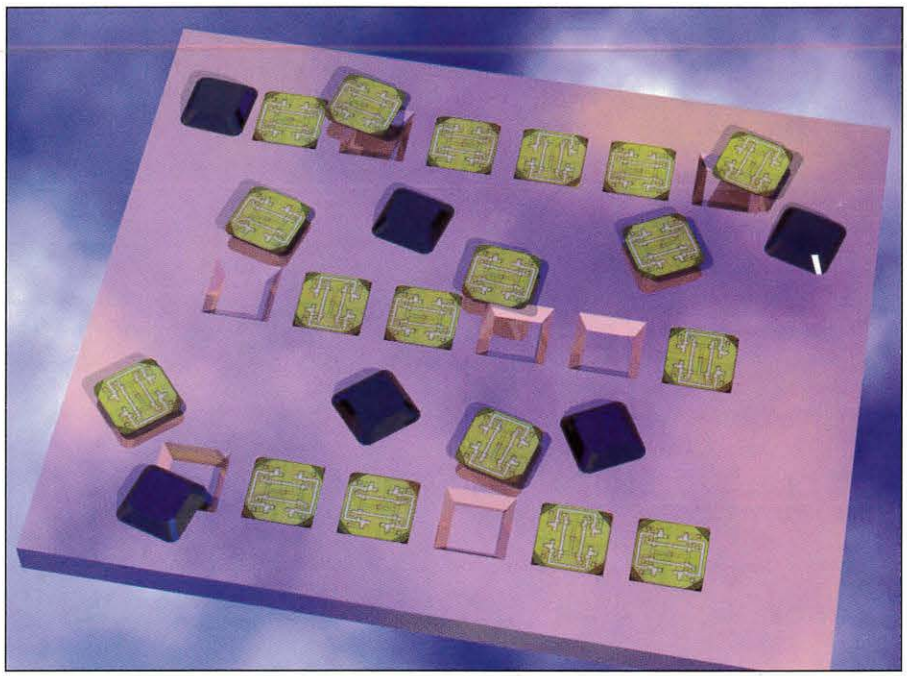
But Alien's approach is unique: fluidic self-assembly (FSA). The drivers, clusters of transistor pixel switches, or whatever, are fabricated in a standard CMOS process and then etched out of the mother wafer, becoming little NanoBlocks™ that have distinctive shapes related to their function. An assortment of NanoBlocks are suspended in a fluid and washed over the display backplane, which contains indentations that match the shapes of the various blocks. If it is done right (selecting the proper fluid viscosity and flow rate), the correct NanoBlocks fall into the matching holes quite rapidly with 100% fill rate. Once the blocks have fallen into the indentations, connections are made. At this point, one has made a large-area AMLCD, for instance, without large-area silicon processing and without doing any high-temperature processing on the LCD plate. That makes the approach well suited to polymer substrates.

Jeff Jacobsen, president and CEO, said, "One-line pager modules sell for 90 cents. The cost is in the flip-chip IC and interconnects. We can do it for 20 cents by using distributed intelligence instead of one chip with high-density interconnects." Jacobsen continued, "Everybody is looking for a place to hide where the Japanese or Koreans can't find them. I don't want to hide. Alien is going after major display markets. The people still making pager displays need a dollar's worth of silicon. Wait till they see us do it for 20 cents."

Alien is planning to produce 2 million displays per month starting in 2000, and although the initial displays will be small, Alien plans to build bigger ones 2–3 years out. They are already working with an overseas partner on a 14-in. display with NanoBlock drivers, said Jacobsen.

Does Alien need money? Not at the moment. "I went out to raise $6 million," said Jacobsen. "I'm oversubscribed." There's talented support, too. Nobel Prize winner Arno Penzias is a technical advisor.

Alien's technology could remake a good portion of the FPD industry – if the company lives up to its promise in volume manufacturing. Let's see if that 2 million small displays per month actually materializes in 2000 with the kind of cost savings Jacobsen predicts. Any significant delay or shortfall would be a danger sign and should provoke hard questions from the press and Alien's investors. But if Alien makes its projections, the display-industry roller coaster could be launched on an even more exciting ride.



Alien Technology

Alien Technology proposes to put active-matrix switches and drive circuitry for displays on NanoBlocks™ that have been etched out of silicon wafers, "wash" the blocks into matching cavities on a display backplane using fluidic self-assembly (FSA), and use the technique to enable low-cost processing of rigid displays and roll-to-roll processing of flexible polymer-substrate displays.

Reviewing SID '99

This issue of *Information Display* is devoted to reviewing SID '99. In the articles that follow, six knowledgeable journalists and analysts will discuss the state of the art in LCDs, emissive displays, microdisplays, CRTs, manufacturing equipment and materials, and related matters as seen through the lens of SID '99. All of them will add insights and information to the quick overview presented in this article, and they may even disagree with some of the points made here.

So be it. The Year of the Rabbit is a congenial time in which negotiation is valued and differences of opinion are tolerated. ■

The Beat Goes On

As the tempo accelerates, microdisplay developers are exhilarated by the dance – but at least one has become a wallflower.

by Charles W. McLaughlin

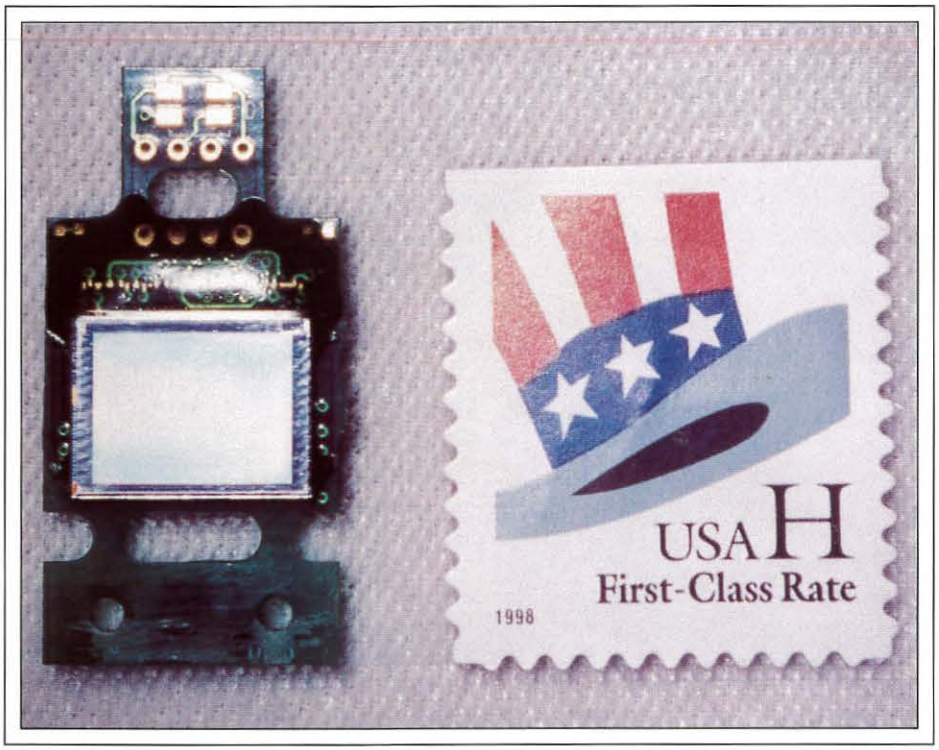
THE MICRODISPLAY beat goes on, and it's becoming more obvious that the developers of microdisplays, personal displays, and projection imagers are increasingly dancing to different drums. The major players are clearly working to position themselves in different market segments, and most remain bullish that the growth of the projection market will be sustained and that 1999 will see the introduction of several high-volume consumer products with embedded microdisplays.

The SID '99 International Symposium showcased a variety of microdisplay-based products. The kick-off keynote address featured demonstrations of electronic cinema, with additional symposium sessions on consumer HDTV, microdisplays, and projection systems. Once again the annual Microdisplay Roundtable press conference was a lively event, and throughout the exhibit hall, one was never far from a booth where microdisplays were featured.

Electronic Cinema and Projection

The electronic-cinema session was a really big show. One of the major sections of the convention center was configured as a movie auditorium with a 50-ft.-wide screen and a booming THX™ sound system. It was certainly an effective wake-up call. After an excellent market overview by Curt Belmer of ***Studio Systems, Inc.*** (Studio City, California), both ***Hughes-JVC*** (Carlsbad, California) and ***Texas Instruments*** (Plano, Texas) demonstrated their latest projectors targeted at electronic cinema. In addition, later in the symposium, ***Silicon Light Machines*** (Sunnyvale, California) presented a paper describing further progress with their laser-scanning linear microelectromechanical-systems (MEMS) array.

The performance of both of the showcased systems was impressive, and the consensus of



The MicroDisplay Corp.

It really is possible to get an SVGA LCOS display onto a 0.5-in.-diagonal chip, as demonstrated by this MicroDisplay MD800G6 "MicroMonitor."

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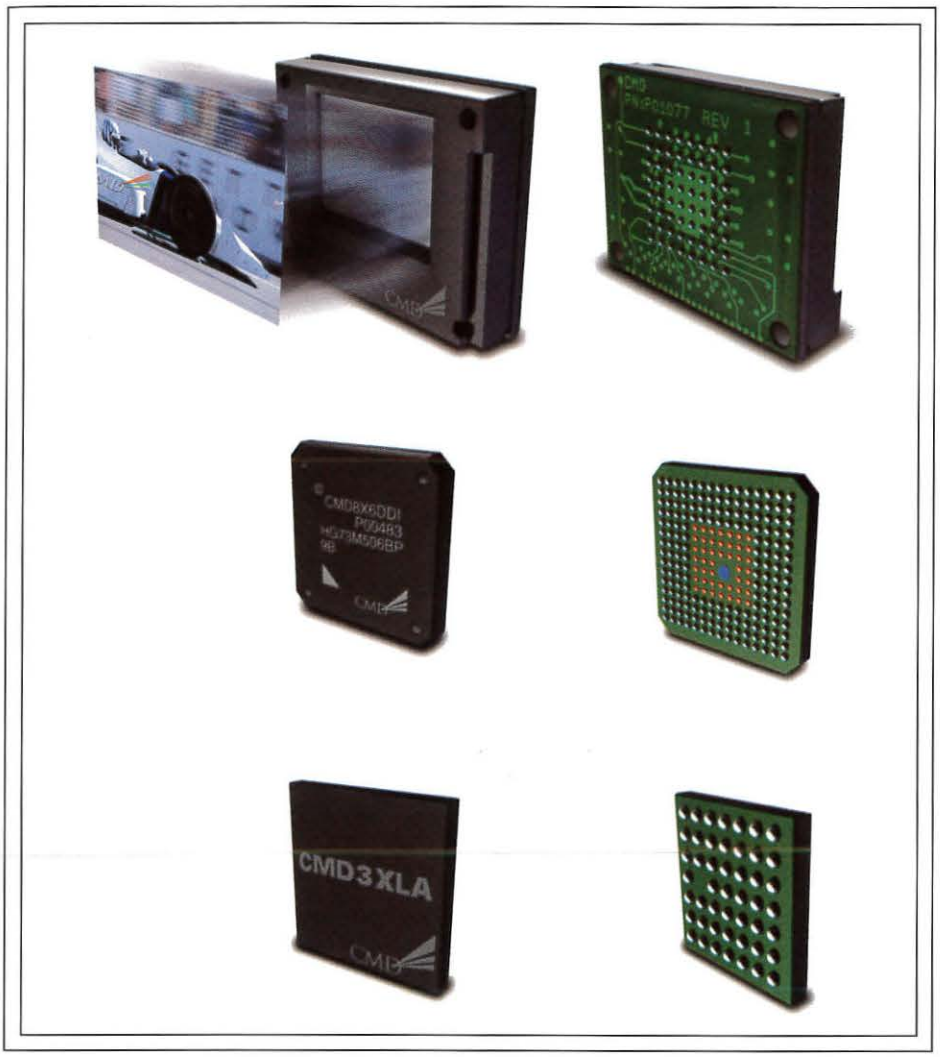

Colorado Microdisplay

With the announcement of a complete ball-grid-array chipset, Colorado Microdisplay is making it easier for customers to integrate its display. The three-chip set consists of an SVGA microdisplay chip, an interface ASIC, and a small interface chip for lighting.

most observers was that the projectors are ready for show time. ***Hughes-JVC*** demonstrated their ILA-12K model that uses three of their electron-beam-addressed reflective LCD imagers and a 7000-W xenon lamp to project more than 10,000 lm at true high definition – greater than 1080 lines.

The ***TI*** unit takes the unique design approach of mounting to an existing film-projector xenon lamp housing, and uses a three-chip DMD™ design to project more than 5000 lm. (In his presentation, TI's Larry Hornbeck claimed 10,000 lm.) The 720-line HDTV format is utilized. While several purists judged the Hughes-JVC image sharper and brighter, even the most discerning felt that the TI projector was ready for the local 20-plex.

The technology is here to fully convert the movie production and distribution process from film to electronics, but there are at least two major stumbling blocks: a business model that works for everyone and concerns of piracy. At issue is how do the theater operators get back their investment in the projection equipment?

Moving from the promise of a new market to the reality of the existing presentations and television markets, there were a variety of papers and exhibits that point to continued growth and progress in these markets. The TI DLP™ system continues to be successful in both the ultraportable and large-venue segments, but continuous improvements in performance and price are required to keep pace.

S-Vision (Santa Clara, California, at the time of the SID show, but now relocated to San Jose) attracted a lot of attention at the show with their demonstration of a rear-projection (RP) monitor. And the company presented several papers describing their liquid-crystal-on-silicon (LCOS) devices. Unfortunately, things were looking bleak for the company by the end of the week as prospects for continued funding dimmed. ***National Semiconductor Company*** (Santa Clara, California), another developer of projection-imaging LCOS microdisplays, was not at the SID show, and rumors abound that the company's program will be restructured.

On the brighter side, ***Displaytech*** (Longmont, Colorado), has clearly thrown its hat into the projection ring, joining ***Three Five Systems, Varitronix, IBM,*** and ***JVC,*** all of whom have SXGA LCOS devices. A single-chip HDTV display was demonstrated off the floor, and Displaytech president Haviland Wright reported that the company's partner, Samsung, would demonstrate an HDTV receiver later this year. There are now about 10 front-projector models on the market that use three-chip SXGA LCOS imaging. With more than 1000 lm of output and pricing in excess of $15,000, these products are positioned for boardroom applications.

Personal Displays and Headsets

Microdisplay developers remain bullish that we will see consumer products with embedded microdisplays by year's end. This year the ***Displaytech/Hewlett-Packard*** partnership joined ***Kopin Corp.*** (Taunton, Massachusetts) in predicting the appearance of consumer products by Christmas. Both companies are offering small, inexpensive QVGA microdisplays for digital-camera and camcorder viewfinder applications. Kopin predicts success with monochrome viewfinders, while the Displaytech/H-P partnership confidently looks to digital cameras. The companies forecasted success at both the low-priced high-volume end of the market in toy-like cameras and the high-performance end of the market. It should be noted that both of these developers have worked hard to implement camera-friendly interfaces, with Displaytech and H-P working in tandem, and Kopin working with ***Fuji Camera*** and others.

Inviso, Inc.

Inviso, formerly Siliscape, is targeting a variety of cellular-phone and other applications with its impressive Optiscape II imaging module. This is an Inviso personal viewer demonstrator.

Colorado Microdisplay (Boulder, Colorado) is targeting more upscale applications, and announced availability of a complete chipset that provides interfaces for both computer and entertainment-system compatibility. Peripheral headsets and viewers for computers, DVDs, and information products are targeted. The three-chip set consists of an SVGA full-color video-rate microdisplay chip, an interface ASIC, and a small interface chip for lighting. CMD president Mark Willner emphasized, "It is important to offer integrators a complete solution, and the availability of the chipset will accelerate market acceptance." As usual, though, Willner did not elect to reveal large-volume integrators, but he did predict product roll-outs by year's end and volume production of "near-eye" systems next year.

An old player with a new name, ***Inviso, Inc.*** (Sunnyvale, California), formerly ***Siliscape,*** remains focused on the use of microdisplays in wireless data applications. ***Three Five Systems,*** a major shareholder, is leading the charge into the cellular-phone market for embedded displays, while Inviso itself is now developing its own palmtop wireless information appliance.

At the heart of these efforts is the new Optiscape II imaging module that delivers the outstanding SVGA optics of its predecessor, with two major upgrades: 3-bit-per-color gray scale and an integrated interface that keeps total power consumption well under 100 mW. Such performance makes the Inviso module the benchmark for embedded wireless applications. The industry panelists at the Microdisplay Roundtable press conference remain bullish on wireless data-appliance applications, but the consensus is that production is still 2 years off.

Another developer, ***MicroDisplay Corp.*** (San Pablo, California), was also on the floor promoting a wide range of available microdisplay configurations from QVGA to XGA. The company continues to integrate interface functionality into their microdisplay backplane, as well as evolve interface ASICs. The company reports working with several partners who will be going into production next year.

In addition to the prototype headsets shown by microdisplay developers, three headset makers were also exhibiting. ***Virtual Vision*** (a subsidiary of ***FED Corp.***) demonstrated a range of designs including a lightweight monocular display with an SVGA CMD imager. ***MicroOptical Corp.*** (Westwood, Massachusetts) was showing two different design approaches for integrating their monocular display with eyeglasses. A QVGA ***Kopin*** microdisplay was being used as the image source. ■

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Circle no. 13

Flat and Formidable

In the display world, it is still true that only LCDs combine the critical mass of sales volume with the critical mass of exciting technology required to dominate both the market and the imagination.

by Ken Werner

LIQUID-CRYSTAL-DISPLAY (LCD) technology is exciting. And LCDs generate a lot of revenue – $10.5 billion in 1999 according to Nikkei Microdevices.[1] What continues to fuel the excitement today are both new technologies, such as Fujitsu's vertically aligned multi-domain AMLCD that won the SID/*Information Display* Silver Display of the Year Award, and new market opportunities.

Fujitsu's technology was aimed at the burgeoning, if still small, market for desktop monitors based on LCDs. These liquid-crystal monitors (LCMs) – dangled before a salivating LCD industry as its salvation from the devil of a one-application market (notebook computers) – have been slow to take off in volume terms, partly because a rebounding industry has been able to raise prices, and many LCMs are price-sensitive products. But nobody doubts that the volume is coming. PC Expo, held in New York just a month after SID '99 closed, contained an impressive array of LCMs from the likes of Compaq, ViewSonic, LG, and Eizo, including 18-in. models in the $3400–4000 range.

But there has also been excitement on other fronts, and this was evident at SID '99. The electronics world is experiencing a boom in portable electronics – particularly, at the moment, cellular phones, PDAs, and palmtop computers. This has created an expanding market for low- and medium-information-content LCDs from companies such as Optrex, Solomon, and EDT.

But we are now at the beginning of a powerful movement to combine portable devices with high-bandwidth wireless data communications. The Palm VII organizer, although it has very limited communications capabilities, has stimulated a lot of excitement. Perhaps

Toshiba America Electronic Components

Toshiba has been pushing the envelope for low-temperature polysilicon (LTPS) direct-view displays. This good-looking 4-in. VGA LTPS LCD has 202 pixels/in.

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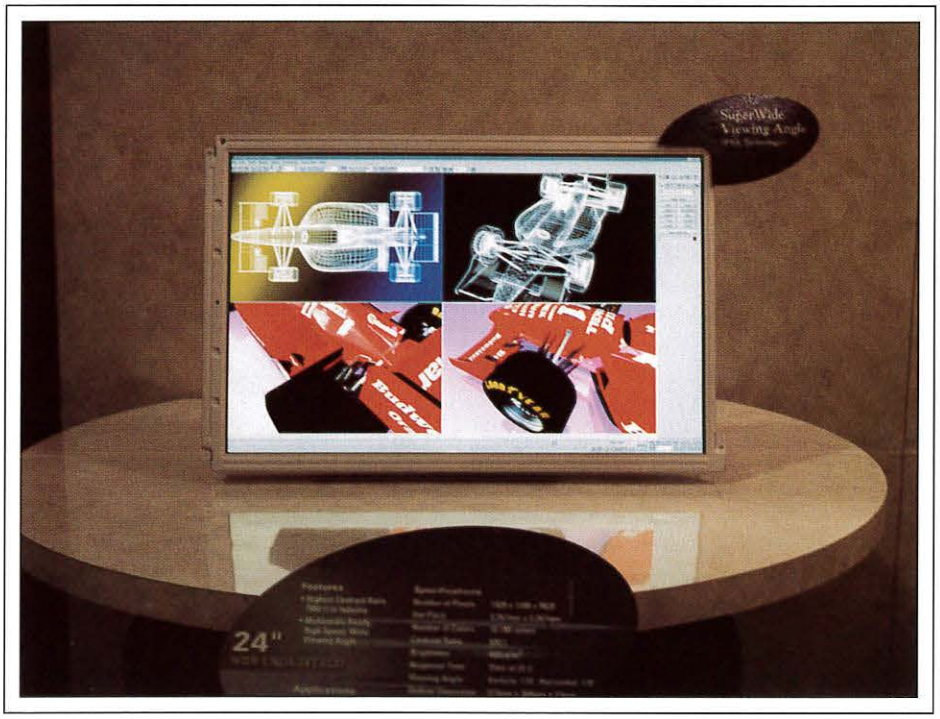


Ken Werner

Samsung's unannounced 24-in. HDTV TFT-LCD with 1920 × 1200 pixels and 170° viewing angle was an impressive surprise. Samples should be available in Q4 '99 or Q1 '00.

more indicative of things to come are the growing number of cellular digital packet data (CDPD) modems and integrated devices, which connect wirelessly at 19.2 kb/s. Even at this leisurely speed, it is practical to download Web pages that require rather capable displays for effective viewing. Microdisplay makers are excited by this prospect, but an alternative approach is to use direct-view displays optimized for such applications. It is this potentially lush market that is motivating Sharp and others to develop reflective color displays with relatively high pixel densities, and to work on lighter, thinner, more rugged displays based on polymer, instead of glass, substrates. And there are a variety of other applications, big and small, that are attracting one or another of the LCD manufacturers. And each niche creates its own opportunities – real or imagined – for backlight and component makers.

Let's see how some of these trends presented themselves at SID '99, with the understanding that the size of the SID show makes any such survey selective.

Mitsubishi mounted a large exhibit beneath the display division's signature ultralight aircraft. Product manager Dale Maunu was emphasizing the company's AngleView™ high-brightness industrial units. Among them was a 12.1-in. SVGA unit with 300 cd/m^2, a 10.4-in. VGA unit with 400 cd/m^2, and an 8.4-in. VGA unit with 300 cd/m^2; all with 262,000 colors, CMOS/TTL digital interfaces, and 150*g* shock/1*g* vibration tolerance. Mitsubishi knows that medical, instrumentation, and other non-PC markets require distributor support, and they have established alliances with All American, Arrow Electronics, and Bell Microproducts, as well as with Sequel for service support. Mitsubishi hasn't abandoned the PC market. A nice 15-in. model with 200 cd/m^2 was showing good video, and a 17.3-in. wide-SXGA unit with 235 cd/m^2 was being shown in a Silicon Graphics monitor.

Toshiba has aggressively been developing low-temperature polysilicon (LTPS) technology, and has made large LTPS LCDs more quickly than many people thought possible. Steve Vrablik, Business Development Director for Toshiba America Electronic Components (TAEC's), was pushing LTPS as being nothing less than a paradigm shift in the way LCDs are made and enable enhanced capabilities in the products that use them.

Toshiba's Fukaya Works in Saitama Prefecture is the site of the company's LTPS LCD-production facility. Construction began in the first half of 1998, and the start of production was announced at SID. By Q4 '99, capability will be 100,000 pieces per month (on a 10.4-in. basis), said Vrablik. In the booth was a good-looking 4.0-in. VGA LTPS LCD. With 202 ppi, this display may now be leading the direct-view pixel-density sweepstakes, with a transmittance of 5.2%. Also on display were 10.4-in.-diagonal XGA 200 cd/m^2 and 8.4-in.-diagonal SVGA 130 cd/m^2 LTPS LCDs. Although Toshiba has shown reflective LTPS prototypes in the past, current production is devoted to backlit versions.

Toshiba also had bright amorphous-silicon (a-Si) thin-film transistor (TFT) displays of 5.8 and 7.0 in. on the diagonal with an aspect ratio of 16:9 and a luminance of 350 cd/m^2 for automotive and entertainment applications. The 7-in. has 480 × 234 stripes and the 5.8-in. has 400 × 234 stripes; both accept NTSC composite and analog RGB signals.

It's a measure of the competitiveness of the LCD business that established Japanese manufacturers are pursuing specialized markets. On a smaller scale, specialized markets are what has kept the few remaining North American FPD makers going – in some cases very successfully.

Planar Systems is one of those successes, in part because it has "evolved from an electroluminescent (EL) display company to a multitechnology company serving specialized markets," said Chris King (Group V.P., Planar Components Group). On the EL side, Tom Kingsley, marketing V.P., was happy about the incorporation of a Planar design into Mack Trucks driver-information systems. Many Planar products, regardless of technology, are ruggedized against shake and shock, and tolerate a wide operating-temperature range.

The company was showing new color products, which now include industrial-grade NEC displays in addition to Planar-made devices. Among the new products were high-brightness AMLCDs with a luminance of 1000 cd/m2 in 6.5-, 10.4-, and 12.1-in. sizes. The 10.4- and 12.1-in. have a 50:1 contrast ratio (CR) at 3000-lux ambient illumination – typical for a bright sunlit room or a medical operating theater.

During SID '99 a consortium of companies including Planar signed a previously

announced agreement with Xerox Corp. to acquire 80% of dpiX. The buyers are dpiX's primary customers: Trixell (a joint venture of Philips Medical Systems, Siemens Medical Engineering, and Thomson-CSF), Planar Systems, and Varian Medical Systems. Trixell is the majority owner.

dpiX therefore remains the only North American maker of high-resolution liquid-crystal panels for the defense and aerospace markets (which are integrated into military displays by Planar). But many people in the U.S. defense community are losing their aversion to Asian glass. Recent history clearly indicates that Japan is a more reliable supplier of defense/aerospace glass than, let us say, Michigan. And the confidence level goes up when that Asian glass is integrated by an experienced U.S. defense contractor.

Two of those contractors have now decided to sell their displays on the open market. ***Rockwell Collins*** (Cedar Rapids, Iowa) has extensive experience in developing displays for internal use, "but the phone started ringing off the hook with the demise of OIS," said Steven Mosnik. Rockwell uses glass from Sharp, with whom the company has a 30-year relationship, and is now selling ruggedized 3ATI and 5ATI modules as commercial products.

Gary Frederick, manager of strategic business development, said he is talking with "lots" of avionics people at the component level, and is also looking for non-avionic applications such as off-road and construction vehicles. Rockwell was showing 7.25-in. square and ARINC D (8 × 8-in. box) modules. The displays were bright but exhibited very little glare. (The ARINC D, which is not yet for sale, will be used in the new Boeing 767-400, to be certified in 2000.

Eaton Navy Controls Division (Danbury, Connecticut) has seen the same light as Rockwell, and it is offering ruggedized AMLCDs, plasma, and EL displays. The division was showing a rack-mounted 20.1-in. AMLCD incorporating ruggedized NEC glass. Also available are modules based on Sharp 18.1-in. glass and DTI 16.1-in. glass, said Robert Stetson. (DTI is still shipping 16.1-in. panels but will discontinue them when their 18.1-in. panels start shipping. Eaton's modules will accommodate the 18.1-in. as a replacement.)

NEC was showing a range of AMLCDs from 6.4-in. VGA to 20.1- in. SXGA, including 15.4- and 18.1-in. models. The 18.1-in. features full-color SXGA, 200 cd/m^2, a viewing angle of ±80°, and includes an interface board. Target applications are financial, industrial, medical monitors, and kiosks, said senior marketing manager Omid Milani. He said NEC has customers that want an SXGA AMLCD but feel that 18 in. is too large for their application. So NEC has created a new 15.4-in. display in SXGA rather than the XGA display that is more common for this size. "We'll see how it flies," said Milani.

Solomon Technology (USA) Corp.

A new addition to Solomon Technology's broad range of small LCD modules was this quarter-VGA module with white-LED backlighting.

The star of ***Samsung***'s booth was a spectacular but unannounced 24-in. HDTV TFT-LCD with 1920 × 1200 pixels and 170° vertical alignment (both vertically and horizontally, said the accompanying news release). Only still images were being used for the demonstration, but they looked impressive. Sampling is expected in Q4 '99 or Q1 '00. The handsome 30-in. UXGA AMLCD – the large AMLCD made on a single sheet of glass – seemed to be the same one shown at Asia Display and Display Works, and it's still a prototype and still most definitely not for sale, said sales and marketing director Carl Steudle. Still, there were persistent rumors that a military contractor had offered $30,000 for the prototype – and had been turned down.

Only in Samsung's booth would 17-, 18-, and 20.1-in. AMLCDs look small. The 17-in. SXGA SyncMaster 700 was advertised as having a "superwide" vertical alignment – and it did – and a nice matte screen. The 20.1-in. is clearly aimed at NEC's ground-breaking 20.1-in., and very competitive prices are being quoted. A 15.0-in. "SXGA" AMLCD actually had 1400 × 1050 color pixels, a 200:1 CR (minimum), 150 cd/m^2, and a 40-ms response time at 25°C.

Samsung is also on the reflective-color warpath. A 5.8-in. display had 400 × 234 pixels (16:9 aspect ratio), 30% reflectance, 30-ms response, and 0.15-W power consumption.

Sarnoff Corp. was showing its self-scanned a-Si display (SASID), which is an a-Si TFT-LCD with integrated drivers also made of a-Si. SASID promises all the advantages of integrated drivers with the added benefits of 30% lower manufacturing costs than conventional AMLCDs and the ability to make displays on standard AMLCD production lines without new equipment or facilities, said Roger Stewart, head of solid-state displays at Sarnoff. (Stewart has since left Sarnoff for Alien Technologies.)

The big news at the ***Philips Flat Display Systems (FDS)*** booth under an attention-get-

ting replica of the Golden Gate Bridge was that Philips and LG Electronics had just signed a letter of intent under which Philips will acquire 50% of LG LCD, the largest AMLCD manufacturer in the world. Philips is investing about $1.6 billion.

The focus of Philips' LCD exhibits was an "office of the future": a futuristic desk with (among other things) an 18-in. SXGA FPM, an 8.4-in. reflective monitor, a fingerprint sensor, and, of course, a Philips Nino palmtop computer. FDS CEO Matthew Medeiros said, "We're entering an image-centric age in which displays - or human interface surfaces, as we like to call them - become critical to simple, everyday functions such as talking on the telephone or cooking a meal."

Sony had some marvelous CRT products to look at and the born-again FEDs of partner Candescent, but the Sony/Sharp/Philips plasma-addressed liquid-crystal (PALC) display was not in evidence. Indeed, the only LCD in the booth was Sony's three-panel 50-in. rear-projection TV, which is compact and produces a very nice image.

ROLIC Technologies Ltd. (RTL) (Basel, Switzerland) is a joint venture of ROLIC Ltd. and BTG, "a worldwide leader in the management and commercialization of Intellectual Property Rights." RTL wasn't selling displays at its booth; its mission is to commercialize the LCD technology developed by Martin Schadt and his team at ROLIC Ltd. ROLIC has a portfolio of 800 patents and patent applications, and RTL's goal is nothing less than to become "the leading independent supplier of innovative electro-optical materials and device technology." Among the technologies covered by the portfolio are linearly polarized-light multi-domain alignment, linearly photopolymerizable polymers, deformed-helix ferroelectric LCDs, and compact cholesteric color filters and polarizers for projection displays. (*ID* will look at some of these technologies in more detail as part of our coverage of EuroDisplay '99.)

IEE

IEE's ShopVue™ POS pole displays have dual inputs so that transaction information can be displayed when input is being received from an electronic cash register. Advertising can be displayed at other times.

A Conversation with Joel Pollack

If any single company dominates the notebook market, it's ***Sharp***, but V.P. Joel Pollack was more interested in talking about reflective displays. And Sharp's booth contained some nice reflective displays from the company's HR series, including an impressive 8.4-in. TFT VGA unit. Also shown was an interesting 2-in. display on a polymer substrate. In a philosophical mood, Pollack said, "The ideal display is a piece of paper. In a good-enough reflective display, nobody would complain about brightness. Reflectives are now (finally) good enough to support color. The Game Boy color display [made by Sharp] is very successful."

Although some standard-sized reflective displays were being shown in the booth, most of the business is custom, said Pollack. Variations are available with front light and touch panels. Sharp was also showing a transflective color STN. "The contrast isn't as good as a TFT's but it's getting much better," said Pollack. "The reflector is built into the display, just as it is in the HR TFT." "[Reflectives are an] important direction for Sharp and the industry as a whole."

Plastic substrates are another avenue that Sharp is pursuing. Early efforts had price premiums that were more than the industry could tolerate. Now, Sharp has gone back and used a different substrate that is thinner and meets the same environmental specifications as glass, said Pollack. Five products are about to be manufactured in Japan at an affordable price. Companies will come out with glass and plastic displays that look alike, and the market will be able to choose. Plastic substrates could enable thinner cellular phones, but customers need to have the opportunity to become familiar with the plastic devices and learn to trust them.

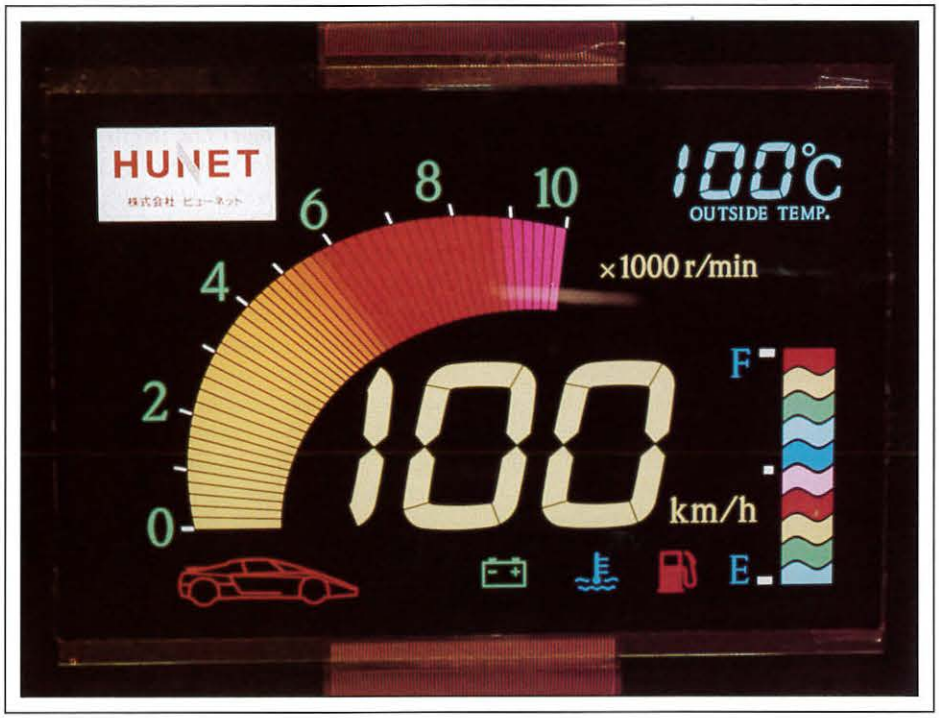
On the large end of the LCD spectrum, Sharp has developed an 18.1-in. SXGA with both wide vertical alignment and fast response, said Pollack. It will be available in Q4 '99, and will be followed by a 20-in. version. Sharp is committed to digital interfaces for FPD monitors (FPMs). "The next-generation Genesis and PanelLink chips are very

good. The largest manufacturers of these monitors will determine the actual standard." Pollack thinks the supply situation for LCDs should remain tight into the third quarter of 2000. "And some people say longer," he said.

Sharp anticipated the growth in non-PC display products, and is now seeing the take-off of automotive displays in North America. The first application will be a 6.4-in. display for rear-seat entertainment, followed by 3.8-in., 5.8-in., and other sizes for automotive PCs incorporating navigation and information functions. Pollack thinks this has potential for big growth.

Pollack is pleased with Sharp's color multi-bit addressing (MBA) display, an STN display with 100:1 CR and 150-ms response that is less costly than other multi-line-addressing (MLA) approaches, he said. There has been some rebound for STN displays in the notebook market, the cause of the TFT shortage.

Although Sharp has dabbled in microdisplays, "it is not a thrust for us." Sharp's approach for projection is in its continuous-grain-silicon (CGS) TFTs, perhaps going to high-resolution with 3-in. imagers. Initially, Sharp will produce the entire projection engine, and TV receivers will be available through the Shoigi division. Corporate executives have committed Sharp to getting rid of CRTs in television. In addition to projection, Sharp is exploring large direct-view LCDs, Pollack said.



Hunet

Hunet showed bright field-sequential-color (FSC) TN-LCD modules, which are now available. Also for sale was a 12.1-in. three-color backlight and controller to turn a monochrome LCD into an FSC unit.

Small LCDs

Optrex was showing its dizzying variety of standard and custom LCDs, ranging from small alphanumeric and graphic modules to high-resolution monochrome and color technologies, including multi-line addressing. White-LED backlights for small modules are *de rigueur* this year, and Optrex has them. The company now has full design and manufacturing facilities in North America and Europe, as well as Asia.

Seiko Instruments introduced its G4 Vitrium chip-on-glass (COG) display. The 1/4-VGA display is the big brother of the 1/8-VGA G8 introduced last year. The COG units are admirably light and thin (at 2.2 mm without backlight and 4 mm with backlight) compared to the chip-on-board (COB) displays they replace. The G4 has a CR of 8:1 and luminance of 14–16 fL. It's available in portrait or landscape versions, and a plug-and-play kit is available for evaluation. Early customers are using the G4 for point-of-sale (POS) terminals, GPS applications, and bar-code readers. The current display is monochrome, but two-color and full-color are part of the product plans, said product marketing manager Mike McLachlan.

If COG doesn't make a display that's thin enough, Seiko has something else in the works: chip-on-flex (COF), in which the driver chips are bonded not to the display glass but to the flex connector. Seiko patented this technology in Japan and planned to initiate limited production during the summer. When Seiko rolls out its iChip (see manufacturing article elsewhere in this issue), it will be in a COF package.

The LCD department of ***Hunet*** (Tokyo) is now selling bright color TN-LCD modules based on the field-sequential color (FSC) technology developed over the last several years by Bright Labs. Because there is no color filter to absorb light, FSC displays can have five times the luminance of traditional color LCDs based on color-matrix filters with the same power consumption, or they can consume one-fifth the power at the same luminance, said Masaya Okita. The demonstration units indeed displayed bright, pure, saturated colors. Also for sale at a SID special price of $4800 was a 12.1-in. three-color backlight and controller that turns a monochrome LCD into an FSC unit. The driving technology that allows an AMLCD with 50-ms response time to show clean video when driven in FSC mode requiring (at least) a 17-ms response time is part of Hunet/Bright Labs' closely held intellectual property (IP). LCD color break-up is not a problem because it can be "tuned out." How? Okita just smiled, but then said, "Data transfer is changed a little."

Data Modul was showing a wide range of industrial alphanumeric and graphic LCD modules and displays, and LCD monitors up to 20 in. with NEC glass. There was also a 42-in. plasma-display-panel (PDP) monitor based on Fujitsu glass with built-in speakers and with all of the components placed inside the monitor.

IEE is NEC's value-added reseller for PDPs. (The company ruggedizes the displays, supplies the video card, and provides a cus-

Seiko Instruments

At SID '99, Seiko Instruments introduced the Vitrium™ G4, the quarter-VGA version of the extremely light and thin eighth-VGA chip-on-glass (COG) Vitrium™ G8 introduced last year.

tomized housing.) Although a variety of nice IEE 42-in. PDPs were scattered around the show floor, the company's major business has been LCDs packaged for special applications. IEE's new ShopVue POS pole displays can take two inputs, one from the POS terminal (that's electronic cash register to most of us) and one from a program source. When a transaction is being tallied, it is shown on the pole display. When there's no input from the register, advertising or public-information material is shown. The pole displays come in 5.5-in. active-matrix or 7.75-in. passive-matrix flavors, both in color. IEE is currently negotiating with Coca-Cola to implement an arrangement in which pole displays will carry Coke advertising exclusively at Hershey Park points of sale, said regional sales manager Rod Bone.

Among the broad line of modules from ***Solomon LCM Division*** was a "paper-white" 1/4-VGA module available with white-LED backlighting or as a reflective display. A cellular-phone module had very even lighting by way of a white LED and a special diffuser. The company is building a new 6000-m^2 factory in Kaohsiung, Taiwan. The in-house technology is backlighting, COB, COF, TAB, COG, and TAB-on-board. Marketing director Judith Lovgret said the capacity is 1.5 million modules a month. Backlights are now as thin as 2 mm, and modules now run on 2.4 V to match current microprocessor voltage requirements.

Emerging Display Technologies (EDT), a Taiwan-based maker of LCD modules, was exhibiting at SID for the first time. The company is "about the same size as Solomon," said marketing manager Deanna Lofquist. New products include a 20 × 2 module with a white-LED backlight and 320 × 200 graphic FSTN display with CCFL backlighting.

Crystaloid (Hudson, Ohio) is another U.S. LCD maker that has been doing very nicely, thank you, by supplying niche markets. The company's niche is custom-designed TN and STN displays for industrial, military, and avionics applications. Crystaloid announced that it now had COG capabilities and was offering it initially in two standard products: a 2 × 16 positive-mode STN and a 3 × 12 positive/green-mode STN. Both are 2.7 mm thick. Pricing starts at $12.00 in quantities of 100.

Advanced Display Systems (ADS) (Amarillo, Texas) and ***Kent Displays*** (Kent, Ohio) talk to each other mainly through their attorneys these days, but we can mention them in the same paragraph. Both companies have developed low-power reflective cholesteric LCDs. (It's who developed what that's one of the bones of contention between them.) Kent has products now, and is actively pitching to the POS, signage, and portable-products markets. ADS reported reduced drive voltage and showed video-rate, reflective-color, and public-information prototypes. Strategic planning director Ken Richardson says ADS will have products out this year.

Backlights and Inverters

Although the likes of Sharp, Samsung, and Philips are working hard on reflective LCDs, the backlight companies keep rolling along. Indeed, the urge to make reflective displays despite an awareness of their remaining limitations leads some manufacturers to compromise by designing *transflective* displays, which provide another niche for the backlighters. Backlight makers are driven by several factors: sunlight readability for displays, such as those made by ***Emco*** (ATM monitors – Emco makes its own backlights), ***Planar/dpiX***, and ***Rockwell Collins*** (avionics displays); low power consumption (for PDAs and cellular phones); and some of each in varying combinations for notebook PCs and desktop monitors. Being very thin and very lightweight is highly desirable for portable applications, low-temperature operation is necessary for automotive applications, and being lower in cost than your competitors is a good idea in general.

Landmark Technologies (San Jose, California) specializes in backlights for sunlight readability. Sizes now include a 20.1-in. model that can give NEC's 20.1-in. IPS AMLCD a luminance of 650 cd/m^2, said accounts manager Annabelle Lee.

Linfinity Microelectronics (Garden Grove, California) held the first public demonstration of its new dual-mode power-inverter technology for operating CCFLs at severe temperatures. The LXM1614 module accelerates heat and light output of CCFLs with a controlled power boost, and then shifts into a digital-dimming duty-cycle mode with a dimming ratio of up to 500:1.

"We're at the start of a significant ramp-up in LCD applications," said sales and marketing V.P. Roger Holliday. "Between navigation systems, automotive PCs, and desktop displays, you're looking at a market potential in the 10-million-unit range by the year

2003." Some new self-heating lamps can be operated effectively with the new module from -40 to +85°C, said Holliday. Pricing is $19.98 in quantities of a thousand.

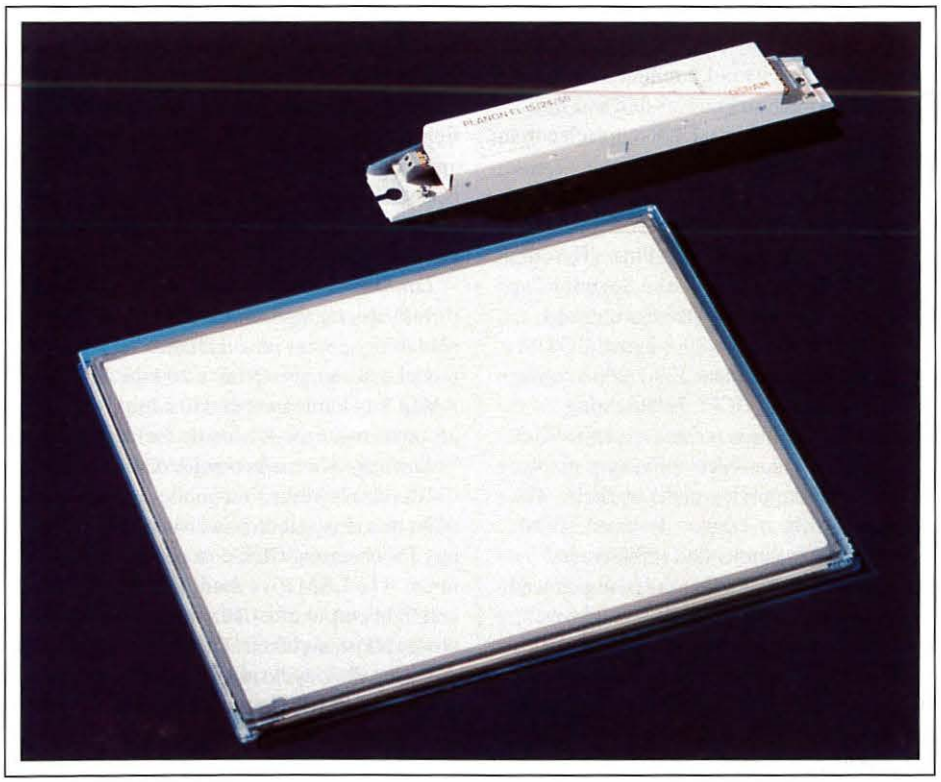
Lumitex (Strongsville, Ohio) was showing its efficient, thin microlens backlights for small modules, as well as its older woven-fiber lights for medical and other high-brightness applications. Seiko Instruments is a happy customer for the microlens backlights. Sales director Brad Lizotte said white LEDs are hot. He was delighted with the large number of serious contacts he made at the show, even delaying his return to scenic Ohio for follow-on conversations. Lizotte said there are plans afoot to make the microprism backlights in larger sizes.

Astra Products (Baldwin, New York) makes a thin backlight with a wedge-shaped polymethyl methacrylate (PMMA) light pipe containing several inorganic particulates to scatter the light. The company's Clarex high-scattering optical-transmission (HSOT) light-pipe material received its public introduction at SID, but has already been applied in a Casio hand-held LCD TV set.

In addition to a remarkably extensive line of phosphors for everything from FEDs to CCFTs, ***OSRAM Sylvania*** (Danvers, Massachusetts) was showing its Planon™ flat backlight for LCMs. Looking like a white tile, the lamp – made by OSRAM GmbH in Germany – produces a luminance of 5000–7000 cd/m^2 at a luminous efficiency of 8.5 cd/W, increasing to 10 cd/W by the beginning of next year. The lamp has a Lambertian distribution and uses xenon for a mercury-free light source, which is temperature-independent and has a lifetime of 100,000 hours. The lamp is intended for desktop monitors, television, multimedia, and industrial applications. Standard sizes are 5, 18, and 20 in. on the diagonal. Prices are 2–3 times that of an edge-lit system, but the goal is for mass production to bring prices down to a 30–50% premium, said Diane Seymour.

Endicott Research Group (ERG) (Endicott, New York) introduced its K series of inverters for dual-CCFT low-cost 8-mm-high backlights and its R series for powering up to 10 CCFTs with up to 30 W. The fully encapsulated R series is an enhancement of ERG's MT series, which it replaces. Also new is the MC Platform, an open-frame module that consists of the innards of the R series but can supply up to 40 W of output power, said regional sales manager Bryon Cole.

The press folder said www.xentek.com on the front, but the message inside was that ***Xentek Power Systems*** was in the process of merging with parent company ***Taiyo Yuden*** (San Marcos, California) and would take on the Taiyo Yuden moniker. There was a new addition to Taiyo's family of backlight inverters, said sales and marketing V.P. Eddie Yanagida. The SIPF-200 is designed as an industrial-grade single-tube CCFT inverter. It accepts dc input voltages from 8.5 to 20 V and has a 4-W output. The price is $16 each in OEM quantities.



OSRAM Sylvania

OSRAM Sylvania introduced its Planon™ flat backlight for LCD monitors. The lamp produces a luminance of 5000–7000 cd/m^2 at a luminous efficiency of 8.5 cd/W, is mercury-free, and has a lifetime of 100,000 hours.

Notes

[1]Nikkei Microdevices, *Flat Panel Display 1999 Yearbook*, p. 15 (Nikkei Business Publications, 1999). Translated and published in English by InterLingua, Redondo Beach, California. ■

Emissives Sizzle and Fizzle

No single emissive display technology is a universal solution, but a wide variety of technologies are available, are being worked on, and are being sold.

by Alan Sobel

PLASMA DISPLAYS are getting bigger and brighter. In addition to some dazzling demonstrations on the SID '99 show floor, there were many research papers presented at the Symposium. Research contributions from Korean organizations are increasing, although there were no plasma-display panels (PDPs) from Korea on the show floor.

All of the PDP manufacturers have effectively solved the problems of motional artifacts, which was a serious issue a few years ago. Now, one has to strain to see anything of the sort. One problem – common to most displays that use pulse-width modulation for gray scale – is scintillation or "swimming" that is noticeable and moderately annoying in large areas, especially in single colors. But from the usual viewing distance, this is not a real problem.

Plasmaco had two 3-week-old 60-in. 16:9 high-definition displays, one in the Display Technology Showcase (DTS) and one on the show floor. They are aimed at HDTV, featuring a 16:9 aspect ratio, 1366 × 768-pixel resolution, 450 cd/m^2 of luminance, and a claimed intrinsic contrast ratio (no ambient light) of 500:1. They looked very good indeed, as did Plasmaco's smaller panels.

At the DTS, there was a 34-in. ***Sony*** CRT next to Plasmaco's big panel. Size does make a difference, of course, but even a plasma aficionado like myself must admit that the CRT's blacks are blacker, the whites are whiter, and the overall picture punch is punchier. If I had to choose between them it would be a difficult choice.

PDPs were also being displayed by ***Fujitsu***, ***Philips*** (allied with ***Pioneer*** – Philips does the electronics and Pioneer provides the glass), and ***NEC*** (alone and also in an arrangement with ***IEE***). While most of the panels were 42 in. on the diagonal, Fujitsu had a 25-in. 4:3 unit displaying video games, which looked excellent.

Fujitsu described a new addressing technique for PDPs – Alternate Lighting of Sur-

Plasmaco

Plasmaco had two very-good-looking 3-week-old 60-in. 16:9 high-definition plasma displays – the largest color PDPs ever shown – aimed at HDTV and featuring 1366 × 768 pixels, a luminance of 450 cd/m^2, and a claimed dark-room contrast ratio of 500:1.

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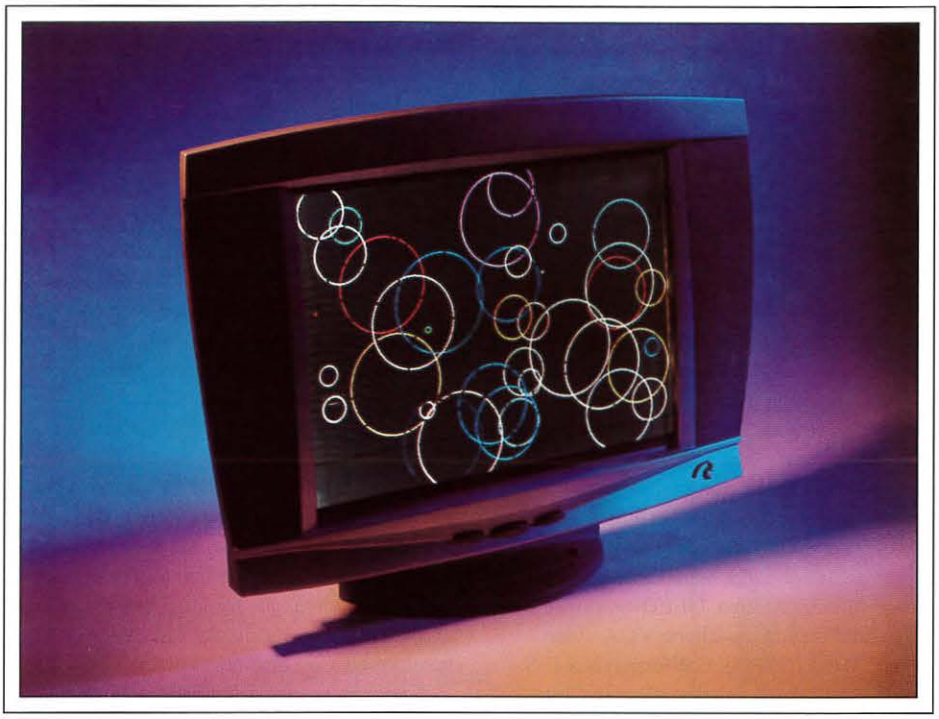

Westaim ADT

Westaim showed a 17-in. prototype of its thick-film electroluminescent display, which the company plans to develop as a lower-cost competitor to plasma for large-screen flat television.

faces (AliS) – which dramatically reduces the number of row drivers at the "expense" of requiring an interlaced display. The company's 42-in. 16:9 panel has a claimed 400-cd/m^2 luminance and 852 × 480-pixel resolution. For computer monitors, interlaced scanning can cause annoying flickering of text; this was not apparent in the pictorial images on the Fujitsu panel.

Booth attendants said this panel, to be in limited production later this year, would cost about $6000 as a component. ***Fujitsu*** and ***Hitachi*** have announced an alliance, evidently aimed at reducing the substantial risks involved in setting up volume production of displays. The consensus is that the cost of HDTV sets must drop to about $2000 to become mass-market items, thus putting pressure on plasma manufacturers to meet this goal.

A major obstacle is the cost of the drive electronics. Efforts directed at lowering the cost by using innovative circuit techniques and changing the panel design to reduce the required voltages, among other schemes, are under way. Papers in Sessions 14 and 21 described some of these approaches.

Surprisingly, there was no plasma-addressed liquid-crystal (PALC) display on the show floor. The PALC approach has been demonstrating continuous improvement over the last several years. Invented at ***Tektronix,*** it is now being pursued by an alliance made up of ***Philips, Sharp,*** and ***Sony.*** The alliance cancelled its plans to exhibit their newest version so close to show time that the display was still listed as a participant in the DTS Guide.

FEDs Fizzling?

After all the hype and hope of a few years ago, visible progress on this technology has slowed abruptly. Big problems include the use of spacers. With atmospheric pressure of one ton per square foot, the only sensible way to build lightweight FEDs is to place spacers inside the panel. Making these invisible and avoiding the problems of electric-field distortion and spacer charging are among the truly major problems facing this technology. Another is lifetime. There is a much larger ratio of surface to volume in FEDs than in CRTs, and there is no satisfactory place to put getters. Thus, the desorption of gas from the panel surfaces is a continuing threat, as is the outgassing of the phosphors themselves, which is a problem that is considerably worse in color than in monochrome displays.

PixTech was on the show floor showing small FEDs, including a few color models. The company's 15-in. unit, which is clearly a laboratory model, demonstrates that making FEDs of this size can be done, but with major problems involving the concealment of the spacers.

Futaba showed a 7-in. 16:9 color panel. ***Candescent Technologies*** displayed several 5.3-in. panels (evidently these are what their pilot line is producing) that looked quite good, but the company has apparently slowed down while taking another long hard look at some of the technical problems that must be solved. ***Motorola*** was not even present on the show floor, after its showy debut last year.

Where will this technology go? The early boasts of challenging LCDs for notebook displays have faded as LCDs get better-looking, less expensive, and more efficient. There are some niche markets, such as seatback displays for passenger airplanes, but this is not big enough to sustain the industry. Could FEDs challenge thin-film electroluminescent (TFEL) displays in medical and instrumentation applications? Perhaps. Currently, it appears that the few players are rethinking the situation. Both PixTech and Candescent have declined orders for 500,000 units; production capabilities are not that advanced – not yet.

OLEDs: The New Kids on the Block

There is a great deal of interest in organic light-emitting diodes (OLEDs). Indeed, ***Pioneer*** (Japan) received the SID/*Information Display* Display of the Year Award for the first commercial OLED, used in some of their auto radios. The promise is good color gamut, good efficiency, low cost, and even the possibility of flexible displays. These could lead to very interesting products, from large roll-up displays to pocketable portable devices.

OLEDs use semiconducting polymers in various combinations to emit light at low applied voltage. In principal, they are inexpensive to build – the semiconductor is put down by spin-coating, screen printing, or ink-jet printing. Even if a TFT matrix is needed, the solid polymers could be less expensive to handle than liquid crystals, and there is the possibility of organic TFTs, even on flexible substrates.

There wasn't much on the show floor. ***Philips*** showed a few small polymer LEDs (PLEDs) – Philips' preferred terminology – which looked good. ***Cambridge Display Technology (CDT),*** associated with Cambridge University in England, has many patents, lots of ideas, and a trunkful of alliances with major companies as suppliers, researchers, and eventually display manufacturers. The principal alliance is ***Aventis Research and Technologies.*** One of the co-operators is ***Sarnoff Corp.,*** which has done in-depth studies of problems and applications. CDT has some excellent people working on this, but by no means has a monopoly on talent.

FED Corp. showed a small white OLED demo off the show floor, featuring white, 2.5 lm/W at 50 cd/m^2, and 5 cd^2/area said FED's Webster Howard. The company has several major OLED research achievements to its credit: full-color video, OLED-on-polysilicon video, and OLED-on-silicon VGA video.

Lite Array (Novato, California) is a U.S. company with a production plant in China, and it is using Chinese university research groups to provide R&D. The company is working on both organic and inorganic electroluminescent (EL) displays, and it showed OLED prototypes from several Chinese universities. Monochrome inorganic EL displays are now available at half the price of those made by the U.S. and Japanese competition, said Technology and Sales V.P. Paul Beatty.

OLED technology is moving at an accelerating pace, with more organizations getting into the field and substantial progress being reported. At the IDRC in Toronto in 1997, there were concerns that TV-like luminance would result in melted displays, but that concern is a thing of the past. It is possible that OLEDs will overtake FEDs as the major new-technology challenger to LCDs, with the advantage of much easier scale-up to large sizes than FEDs – but it will take a few years for this horse to even approach the finish line.

Electroluminescence has been a high-cost niche technology, providing limited color gamut, excellent viewing angle, and ruggedness, in products limited to about 12 in. on the diagonal. Color has been slow in coming.

A relatively new EL product area has been microdisplays fabricated on silicon dice to include drive circuitry and reduce the number of external connections. There have been only two major suppliers – ***Planar*** in the U.S. and ***Sharp*** in Japan – but two Canadian companies, ***Luxell*** and ***Westaim Advanced Display Technologies (ADT),*** have emerged. Westaim ADT calls their product a "Solid-State Display." It uses a thick phosphor on a ceramic substrate rather than the expensive thin-film phosphors of the company's rivals. Westaim showed 5- and 7-in. 1/4-VGA color displays, which looked good, and a 17-in. device which was clearly a lab model but shows promise. Westaim claims that its thick-film material will be much less expensive than the TFEL of their rivals and will be more capable of large sizes. With ample capital behind it, the company bears watching.

Very Large Displays

Last year there were large LED displays for outdoor applications. They were not in evidence at this year's show, but they are very much in evidence on the Las Vegas strip, which is a showplace for large bright displays of all sorts. Interior displays at casinos and hotel lobbies are also noteworthy.

A new entry was described by ***SI Diamond Technology.*** They are talking about 2 × 4-ft. modules using a hot-cathode FED – details were scanty – to make up billboards of 20 × 60 ft. or more. The market niche is outdoor advertising visible in direct sunlight, with contents changeable rapidly and remotely. The product launch is scheduled for later this year in Austin, Texas.

Summary

A wide variety of emissive technologies are either available, are being worked on, or are being sold. No one of these technologies is appropriate for every application. None is as universal as the CRT, but each has advantages: plasma for large sizes, EL for ruggedness, and FEDs and potentially OLEDs for niche applications. As has been the case for years, the display market is in flux. ■

Manufacturing Materials, Equipment, and Components

The SID exhibition contains a sizeable show within a show devoted to display-manufacturing materials, components, and equipment.

by Alfred Poor

THE "EXHIBITION" PORTION of the SID International Symposium, Seminar, and Exhibition has grown to a substantial size. More than 240 exhibitors were on hand this year – a 15% increase from last year – and many filled multiple booths with elaborate exhibits.

No longer can one just plan on "cruising the floor" during the breaks between paper presentations, or covering the exhibits by skipping one or two sessions. If one were to spend just 2 minutes with each exhibitor, it would still take a full 8-hour day to get to them all.

The exhibits that garner the lion's share of the attention are certainly those with displays, featuring the bright colors and moving images that make new technologies stand out. But there are many other interesting and exciting stories concerning the remaining majority of exhibits, the ones that offer the films, coatings, chips, test equipment, and manufacturing machinery that make it possible to create the attention-grabbing displays.

There aren't enough pages in *Information Display* to tell all the stories that need to be told about this year's show, but here are some representative highlights.

Production Equipment

As the demand for larger displays grows, manufacturers must handle larger and larger

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Techni-Met, Inc.

Techni-Met, Inc. (Windsor, Connecticut) does thin-film depositions on flexible substrates such as polyimide and woven fabrics. The company was exhibiting its line of ITO-coated films, and happily announced its strategic supplier alliance with Gould's Electronic Materials Division.

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TRICOR Systems

TRICOR Systems (Elgin, Illinois) displayed its Model 820 video photometer, which comes with software that allows the user to outline up to 254 regions of interest with a mouse. The photometer can then analyze each region independently.

substrates. This is especially the case for the large plasma-display panels. A number of manufacturers of thin-film coating machinery have developed systems capable of handling substrates up to 1200 × 1600 mm. That's roughly 4 × 5 ft. – about the same surface area as a typical door! ***Balzers Process Systems (BPS)*** has a New Aristo 1600 model that can process 1600 × 1600-mm substrates.

Responding to the growing interest in polysilicon AMLCDs, ***Intevac***'s Rapid Thermal Processing (RTP) Systems are capable of processing substrates at a rate as fast as 60 per hour. The company's transient heating process reportedly results in reduced leakage and increased electron mobility compared with typical furnace designs.

Organic light-emitting diodes (OLEDs) are also a hot topic these days, and ***ULVAC Technologies*** is ready to help. The company has already designed, built, and delivered automated pilot production systems that can produce OLED displays.

Ion Systems has added to its range of ionizing products that help reduce damage from electrostatic discharge and contamination while also decreasing the chances of microprocessor lock-up. Some settings require less stringent contamination control. The company's new Gas Jet AeroBar sheathes the emitter points with a low flow of air – clean dry air (CDA) or nitrogen gas – that inhibits particles from accumulating on the emitters, so the emitters don't need to be cleaned as frequently.

Shibaura Mechatronics (Shibatec) creates etch-processing tools for flat-panel displays (FPDs), and their new UHC series of machines uses a two-tier design that delivers the same capacity as prior models but with a significantly smaller footprint.

PTG was demonstrating its laser-scribing equipment that uses "zero-width cutting technology." The laser system is capable of cutting 400–600 mm/sec in substrates from 50 μm to 5 mm thick. (PTG is making it a yearly ritual to sue Accudyne for patent infringement during or just after the SID show, and this year threw in a suit against USDC for good measure.) Accudyne president Jim Lawson calls these suits "the action of a desperate company that cannot compete against a superior technology and a more highly engineered tool."

Laser glass cutting is not yet the norm, and Richard Seery of ***Villa Precision*** – which separates glass in the tried-and-true scribe-and-break way – was a happy man. "The show is good," he said. "When people are spending like this on capital equipment, you know things are going up."

Lasers are also making their mark in the photolithography side of display production. ***Micronic Laser Systems*** offers the LRS 1700, designed to write masks up to 1100 × 1700 mm, with a climate-controlled chamber and semi-automatic mask loading. ***Holtronic Technologies Ltd.*** also uses lasers to create photomasks, but instead of a simple raster-scan process, the company uses holographic imaging to create a detailed pattern. The company's HMA 400 machine automatically loads substrates up to 370 × 470 mm.

Test and Repair Equipment

As panel sizes and resolutions increase, the chances and costs of defects are greater than ever. Faster and more accurate ways to identify flaws – and, if possible, to correct them – can have a significant impact on a manufacturer's finances.

Nikon's L-MAC700 combines both macroscopic and microscopic inspection in a single unit that features a smaller footprint than previous products, and the integrated macro- and micro-inspection speeds processing.

Dark Field Technologies (recently moved from the building it shared with LED displaymaker Trans-Lux in Norwalk, Connecticut, to a light-industry-in-the-woods concentration in Shelton, Connecticut) has new laser-based scanning systems that can detect defects in substrates or coatings. One model is capable of in-line processing at up to 10 m/min.

ELDIM makes automated test equipment for LCD panels, measuring a range of features including luminance, contrast, and color under varying conditions such as viewing angle, temperature, and ambient lighting. The CCD-based equipment uses 16-bit samples, which provides an extensive dynamic range for measurements, and it uses conoscopic optics so that all angles are captured at once. (Moving a photosensor around on an arm to measure angles is, fortunately, a thing of the past – at least for those with adequate equipment budgets.) ELDIM announced it was taking its approach into the microdisplay realm with the

Extron Electronics

Extron Electronics showed its recently introduced "universal" CVC 200 Video Converter that converts 720p and 1080i HDTV and SMPTE 240 to RGBS or RGBHV. It also converts Betacam, SMPTE component video, W-VHS, and DVD component video to RGBS or RGBHV.

EZLite Micro. The device analyzes a microdisplay system and its polarizing beam splitter over an angular range of ±30° with a working distance of 40 mm. "This is the only solution for this type of measurement," said ELDIM's Jean-Noel Curt.

Photon Dynamics is not content to just inspect and test FPDs; it also makes equipment designed to repair some types of defects. Such repairs can increase overall yields and recoup costs that might otherwise be lost to flawed units. The ILW-410 Array Repair Station can import test and inspection defect maps, and then use lasers to cut and weld to repair the panel.

TEAM Systems offers the new UNIGRAF VTG-1108 test generator for flat panels. This ISA board is designed to work with any flat-panel technology, and supports a range of timings and resolutions.

Not all test equipment is for flat panels; the CRT market is still alive and well. ***IPS Automation*** has a new ADI 9200 ITC which is a fully automated ITC alignment system. It connects the CRT to the test system and adjusts convergence, purity, and other parameters, aligning up to 120 ITC/hour. ***Minolta*** has introduced the new IA-1000 CRT image analyzer, which also provides high-speed inspection for convergence and geometry.

Sencore showed two new display analyzers. The CM2250 combines a signal generator with a sensor to test convergence, color, focus, and resolution. The handheld CP290 provides portable color analysis.

Materials

Dozens of exhibitors offered the raw materials that can be transformed into high-resolution displays. Glass substrates could be found in a wide range of specifications at SID '99, along with all manner of sputtering targets for coating processes.

Films appear to be garnering a lot of interest among manufacturers for a variety of applications. According to some industry observers, rear-projection televisions and computer monitors may be poised for rapid growth in the marketplace, and films for rear-projection screens could be in high demand. ***Dai Nippon Printing*** specializes in this area. (Its Ultra Contrast Screen won this year's SID/*Information Display* Display Material or Component of the Year Award.) ***Polaroid*** announced a new film for rear-projection use, with 99% polarizing efficiency, that comes sandwiched between two layers of anti-reflective (AR) glass.

3M was present with a number of new film products, including one designed to improve the brightness of reflective displays, such as those used in PDAs and cellular phones. According to the company, the new film can double the effective brightness of such devices without decreasing viewing angle.

Some unusual films were on display as well. At the ***DuPont*** exhibit, ***Zebra Imaging*** demonstrated its reflective holographic system. The process takes digital image data and converts it to a holographic image with full color and a wide viewing angle. The hologram can be as large as 2 ft. square, but these can then be tiled to create an image of unlimited size, such as a billboard. ***Physical Optics Corporation*** showed their holographic diffuser products, including high-gain rear- and front-projection screens.

Sheldahl has a full line of film products, and made a point of highlighting their roll-to-roll laser inspection system that can check the in-line resistance and transmission attributes of their products.

Among the filters and diffusers on display, ***Astra Products*** had new high-scatter panels for improved display brightness. The product lines from ***Balzers Thin Films*** and ***OCLI*** include color-wheel components to support the growing application of field-sequential color in new display technologies. It's ironic that color-wheel technology, which was considered passé in the early 1950s, once again has things spinning its way. When it comes to color wheels, it seems that what goes around keeps going around again.

ColorLink demonstrated the new ColorSwitch product that takes a different tack for field-sequential illumination. This electronically switchable color filter can produce additive or subtractive primary RGB outputs (as well as white and black), with analog control for up to 16 million colors. The device is capable of up to 360-Hz operation with no mechanical moving parts, which eliminates the noise and vibration that can occur with color wheels.

CLCEO demonstrated another novel materials application, using cholesteric liquid crystals for a variety of uses ranging from color filters to windows that can be electronically switched from clear to opaque for privacy. And the company has even used the material to create iridescent paints for a variety of products, including Mercedes-Benz automobiles.

A large number of companies were on hand to offer their services in applying thin-film coatings to a variety of products. ***Thin Film Devices*** has developed a black-chrome coating process that provides 94% light absorbance. ***Viratec*** recently completed a $15 million expansion program, adding the Infin-

ity V vertical anti-reflection coater with a production capacity of 20 million ft.^{2}/year. The company also has created a new lightweight coated glass faceplate for AMLCD screens that protects the panel against dents and scratches while enhancing brightness and reducing glare.

Getting film layers to stay where one wants them can pose challenges, especially in the attempt to combine them with other layers. ***Adhesives Research*** specializes in pressure-sensitive adhesives, and the new ARclear product line is optically clear and designed for use in FPD manufacturing.

Elo TouchSystems specializes in touch-screen technology, and offers IntelliTouch surface-acoustic-wave and AccuTouch five-wire designs. The new iTouch touch-on tube-surface product puts the IntelliTouch system right onto the screen of Apple Computer's iMac displays to create a user-friendly touch-screen interface.

Electronics

As direct-address displays take on increasing importance in the marketplace, the logic devices required to process analog or digital signals of different resolutions and timings become significant partners in this success. ***Arithmos, SAGE, Pixelworks,*** and ***Genesis Microchip*** were all on hand with their latest products, offering improved scaling technology and high levels of integration that help reduce development time and production costs for FPD designers.

Genesis Microchip also was demonstrating their new gmWarp24 image-processing chip. Like a silicon version of Kai's PowerTools, this programmable device can deform an image with sophisticated warping and scaling abilities. One of the most interesting potential applications for this chip is in low-cost projection systems. The chip could be used to compensate for defects in the optics of a display, creating a corrected image with perfect geometry.

Another new chip was to be found at an improbable location: a display manufacturer's booth. ***Seiko Instruments*** was highlighting their new chip-on-glass displays, but also exhibited their new iChip. This remarkable device incorporates TCP/IP support, including a network stack, plus e-mail, Web browser, and peripheral interface support, on a single chip – without the need for separate software. The result is that manufacturers can build Web-enabled devices that don't have to boot up and have significantly reduced power consumption and component counts.

Molex

Molex introduced its MicroCross connectors designed to support the DDWG's newly adopted Digital Video Interface (DVI) standard. Molex is clearly not ignoring the virtual certainty that there are going to be a lot of DVI monitors and controller cards coming.

Silicon Image also presented new products based on the widely adopted PanelLink™ digital interface for monitors that is now available from a number of sources. Silicon Image is creating chips that put the digital interface, all-digital image processing, and a "display adaption layer" all on a single device, making desktop monitors easier to design at lower cost.

Among the companies with complete electronics products, ***Appian Technology*** was on hand with their multi-port graphics adapters, which make it possible to connect more than one monitor to a single system while using only a single expansion slot. The company's HydraVision software for Windows makes it easy to manage multiple displays, and can even run them at different resolutions if desired.

Applied Data Systems demonstrated their single-board computers intended for embedded applications ranging from crop-seeding systems to interactive displays in golf carts. And ***Extron Electronics*** demonstrated their latest products in an extensive line of signal adapters, line doublers, and switching devices.

Even something as simple as cables and connectors made news at the exhibits. ***Molex*** presented their MicroCross I/O connectors designed to support the newly adopted Digital Video Interface (DVI). This standard calls for a number of different configurations that still maintain compatibility, and Molex now offers a full range of cables, adapters, and receptacles.

Without doubt, this high-speed sprint through the hundreds of exhibits is sure to overlook important new items that would be of special interest to certain *Information Display* readers. The only way to make sure one doesn't miss out on the newest items is to start making plans for next year. When coming to Long Beach next May for SID 2000, make sure to leave plenty of time to give the exhibits the attention they require – and deserve. And, if recent history is a guide, one can expect that the exhibits will be even more numerous and informative than this year's. ■

The Old Dog – Some New Tricks

CRTs are a very mature, very effective technology, so we expect no more than evolutionary progress – but there were innovations to be seen at SID '99.

by Joe Hallett

ONCE AGAIN, the annual SID International Symposium was not to be the occasion to lament the departure of the cathode-ray tube (CRT). In fact, in what has become an annual ritual, market projections continued to push out the magic moment when the CRT begins its serious decline. According to Dave Mentley of Stanford Resources, we can expect to see component dollar expenditures for CRTs fall below that of flat-panel displays (FPDs) sometime around 2002 or 2003. Although that means FPDs have a higher growth rate, the CRT business is still expanding. And parity occurs at an annual expenditure for components of around $20 billion worldwide. That's not too shabby for a declining market share! As a result, CRT manufacturers at the SID show could afford to be optimistic about the future of their mature technology.

It's been said that it takes a village to raise a child, and it certainly takes an extended infrastructure to build, test, and apply a CRT. Most of the necessary elements were represented among the exhibitors at this year's SID show. Glass bulbs and faceplates from ***Schott Corp.*** and ***Techneglas;*** internal parts and materials by ***OSRAM-Sylvania, Superior MicroPowders,*** and ***Viratec Thin Films;*** special test and assembly equipment by ***Chroma Ate, LMT, MECC, Minolta, Quantum Data,*** and ***Sencore Electronics;*** magnetic deflection yokes by ***CELCO, Syntronic Instruments,*** and ***WinTron Technologies;*** magnetic shields by ***Ad-Vance Magnetics, Amuneal Manufacturing Corp.,*** and ***Gerome Manufacturing;*** special power supplies by ***American High Voltage, Eldec Corp., Emco High Voltage Corp.,*** and ***TDK Corporation of America;*** deflection amplifiers by ***Citronix;*** photomasks and plotting equipment by ***Micronic Laser Systems AB*** and ***Advance Reproductions Corp.;*** and CRT applications and monitors by ***Kristel Corp., Sarnoff Corp., SGB Enterprises,*** and ***Sony Electronics.*** Of course, CRT makers were represented as well:

Sony

Sony is aggressively extending the application of CRTs with completely flat screens. This 21-in. flat monitor with a 0.22-mm grille pitch was shown at SID, along with flat-screen HDTV and NTSC television receivers.

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Brimar, Imaging & Sensing Technology Corp., Lexel Imaging Systems, Teltron Technologies, Thomas Electronics, and ***Thomson Components & Tubes Corp.***

Each year there have been some changes in CRT industry infrastructure, or a significant missing person or company at the SID show. This time it was ***Clinton Electronics*** - still a major force in the business - which decided to spend its trade-show dollars elsewhere. But yoke-maker ***WinTron Technologies*** - one of last year's missing exhibitors - was back this year.

Optimism for the future of projection displays was obvious at the technical symposium. Sessions on new light sources and imaging devices drew overflow audiences that spilled into the halls. "The CRT still is a very significant part of our business," said ***Electrohome***'s Terry Schmidt. "It is very good for entertainment displays and simulators that require edge-blending for multiple screens, fast phosphors for 3-D display, and warped displays for domed screens."

Sony's large exhibit emphasized a "flat is beautiful" theme, with impressive new widescreen digital TV sets, monitors, and projectors. A developmental CRT, using an extremely fine mask pitch, was shown by Sony. The mask technology - described in a conference technical paper by ***Dai Nippon Printing*** of Japan - has been tested down to a 0.065-mm pitch, a significant reduction over 0.25-mm designs currently used.

There continue to be significant pockets of CRT activity. ***CELCO***'s John Constantine said, "There aren't many new military CRT programs, but there's good activity in the training and flight-simulation areas." Andrew Fay of ***Thomson Components & Tubes*** said, "We're comfortable with market niches where the CRT is hard to beat. Projection is still an exciting opportunity for us."

"We still see a long life for the CRT," said James Kyle of ***Techneglas,*** a major supplier of glass bulbs. "Today's customers are looking for superior quality. We are providing bulbs to makers of projection CRTs - it's a growing market."

Suprasad Baidyaroy, president of CRT-supplier ***Princeton Display Technologies***, was found working the floor as an attendee. "Volume is going down, especially in military and industrial applications," he said, "but I see sustaining work where platforms are already developed and need to be maintained. However, new programs are in question."

One of the show highlights - keynote talks and demonstrations of digital electronic cinema - gave some CRT folks a reason to smile, especially the CRTs that help the ***Hughes-JVC*** light-valve projector achieve its remarkable image quality. The Hughes-JVC electronic cinema projector uses CRTs made by longtime CRT maker ***Lexel Imaging Systems*** - which was once a part of Hughes. "People have stopped at our booth, looking to see if they can do new things with CRTs," said Lexel's George Petro. "It's been a good show."

Some firms are looking for ways to diversify, using their expertise from years of CRT activity to gain entry into new businesses. ***Gerome Manufacturing Co.*** is leveraging metal-fabrication capabilities to uses other than magnetic shields. "Our CRT shield business is now mostly test and measurement," said Gerome's Dave Ryner.

"We are rebounding from last year's absence," said ***WinTron***'s Bill Holt. "We're focusing on yokes, flybacks, and power supplies. We are seeing activity, but it's slower than in past years, and there are not really any new applications, just some new customers in preexisting fields. We're hopeful for business in new medical imaging and display equipment. And we're looking at other opportunities in electronic assembly."

"It's been a good show," said a spokesman for ***OSRAM-Sylvania.*** "The CRT is still a very dynamic business for us. Probably 20-40% of all CRTs use our materials and parts."

From ***Honeywell***'s John O'Donnell came a quotable comment that may have summed it up best: "CRTs are still pulling the plow." ■

SID honors and awards nominations

As chairman of the SID Honors and Awards Committee, I am appealing for your active participation in the nomination of deserving individuals for the various SID honors and awards. These awards include the prestigious major professional prizes (the Karl Ferdinand Braun prize, the Johann Gutenberg prize, and the Jan Rajchman prize), the major society prize (the Lewis & Beatrice Winner award), the SID Fellow awards, and the SID Special Recognition awards. The selection and nomination process is relatively simple, but requires that you and perhaps some of your colleagues devote some time in the preparation of the supporting material that the Honors and Awards Committee needs in order to evaluate each nomination for its merit.

Nominations can now be entered through the Internet simply by logging in at www.sid.org. At the SID Web site, in the SID Information Center box, click on ***Awards***. This action opens the Honors and Awards section of the SID site. Then click on the ***Nomination Form*** found on the middle of the page, *i.e.*, the display screen, to open the Nomination Form. The "How to Use This Form" box at the beginning of the Nomination Form very simply explains how you can use this electronic form to nominate someone for any of the prizes or awards. The SID Honors and Awards Committee encourages the use of this electronic version. Volunteer labor is used to process all the nominations. Electronic filing saves a lot of administrative work, and helps with reducing the workload on our volunteers. But we will still accept hardcopy nominations. The associated text box appearing in this column contains a complete description of each of the prizes and awards, along with a detailed description of the information that is asked for in support of each nomination. ***Please note that there is one significant change in the nomination process for the Fellow Awards. With each Fellow Award nomination, five written endorsements by five SID members will be required. These brief endorsements – a minimum of 2–3 sentences to a maximum of one-half page in length – must state why, in the opinion of the endorser of the nominee, deserves to receive the Fellow Award. Identical endorsements by two or more endorsers will be automatically rejected (no form letters please). Please send these***

SID honors and awards nominations

Nominations are now being solicited from SID members for candidates who qualify for SID Honors and Awards.

- FELLOW. Conferred annually upon a SID member of outstanding qualifications and experience as a scientist or engineer in the field of information display, and who has made a widely recognized and significant contribution to the advancement of the display field.
- JAN RAJCHMAN PRIZE. Awarded for an outstanding *scientific* or *technical* achievement in, or contribution to, research on flat-panel displays.
- KARL FERDINAND BRAUN PRIZE. Awarded for an outstanding *technical* achievement in, or contribution to, display technology.
- JOHANN GUTENBERG PRIZE. Awarded for an outstanding *technical* achievement in, or contribution to, printer technology.
- LEWIS & BEATRICE WINNER AWARD. Awarded to a SID member for exceptional and sustained service to SID.
- SPECIAL RECOGNITION AWARDS. Granted to members of the technical, scientific, and business community (not necessarily SID members) for distinguished and valued contributions to the information-display field. These awards may be made for contributions in one or more of the following categories: (a) outstanding technical accomplishments; (b) outstanding contributions to the literature; (c) outstanding service to the Society; and (d) outstanding entrepreneurial accomplishments.

Nominations for SID Honors and Awards must include the following information, preferably in the order given below.

1. Name, Present Occupation, Business and Home Address, Phone and Fax Numbers, and SID Grade (Member or Fellow) of Nominee.

2. Award being recommended:
   Fellow*
   Jan Rajchman Prize
   Karl Ferdinand Braun Prize
   Johann Gutenberg Prize
   Beatrice Winner Award
   Special Recognition Award

*Fellow nominations must be supported and signed by at least five SID members.

3. Proposed Citation. This should not exceed 30 words.

4. Name, Address, Telephone Number, and SID Membership Grade of Nominator.

5. Education and Professional History of Candidate. Include college and/or university degrees, positions and responsibilities of each professional employment.

6. Profcssional Awards and Other Professional Society Affiliations and Grades of Membership.

7. Specific statement by the nominator concerning the most significant achievement or achievements or outstanding technical leadership which qualifies the candidate for the award. This is the most important consideration for the awards committee, and it should be specific (citing references when necessary) and concise.

8. Supportive material. Cite evidence of technical achievements and creativity, such as patents and publications, or other evidence of success and peer recognition. Cite material that specifically supports the citation and statement in (7) above. (Note: the nominee may be asked by the nominator to supply information for his candidacy where this may be useful to establish or complete the list of qualifications).

9. References. Fellow nominations must be supported by the references indicated in (2) above. Supportive letters of reference will strengthen the nominations for any award.

Send the complete nomination – including all the above material by **October 15, 1999** – to the Honors and Awards Chairman, Dr. Andras I. Lakatos, Joseph C. Wilson Center for Research and Technology, Xerox Corp., 800 Phillips Rd., M/S 0105-73C, Webster, NY 14580; 716/422-1617; fax -7716; e-mail: Alakatos@wb.xerox.com.

endorsements to me either in hardcopy or by e-mail (preferred). The Honors and Awards section of the SID Web site contains all this information along with the names of all previous award winners.

Last year the Honors and Awards Committee received a good selection of nominees for the Fellow and Special Recognition Awards, but there were very few nominees for most of the major awards. I am especially appealing to you and urge you to nominate worthy candidates for all the major prizes as well as candidates for the Fellow and Special Recognition awards.

As I wrote last year: "In our professional lives, there are few greater rewards than recognition by our peers. For an individual in the field of displays, an award or prize from SID, that represents her or his peers worldwide, is a most significant happy and satisfying experience. In addition, the overall reputation of the society depends on the individuals who are in its 'Hall of Fame'.

When you nominate someone for an award or prize, you are bringing happiness to the individual and his or her family and friends, and you are also benefiting the society as a whole."

Thank you for your nominations in advance.

– Andras I. Lakatos, Chairman
Honors and Awards Committee

Please send new product releases or news items to Information Display, c/o Palisades Institute for Research Services, Inc., 411 Lafayette Street, 2nd Floor, New York, NY 10003.

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Among the vendors I talked to, ***Sceptre*** was the price leader at $2299 for an 18-in. LCD monitor, but the unit was back-ordered. A representative said the glass was Japanese, and that the response time was 20 ms on, 30 ms off.

Sony was not the first company to produce CRT monitors with completely flat screens, but it is now the company pushing the technology forward most aggressively. The first of Sony's "FD" monitors were expensive 21- and 19-in. units intended for graphic artists, magazine-layout people, and the like. The performance was uncompromising – and the prices intimidating.

At PC Expo, Sony introduced a less expensive G range of FD monitors with 21-, 19-, and 17-in. diagonals. The 21-in. CPD-G500, for example, has a 0.24-mm grille pitch and will sell for an estimated $1199.99, compared to the 0.22-mm grille pitch and $1899.99 MSRP for the flagship GDM-F500. The 17-in. CPD-G200 has a 0.24–0.25-mm variable grille pitch and will come with a $499.99 estimated selling price. The G-series monitors have screen resolutions ranging from 1600 × 1200 at 75-Hz refresh for the G200 to 2048 × 1536 for the G500, and only the most discerning eye is likely to be aware of the performance difference between the G- and F-series. These are fine-looking monitors.

Sony was also showing its WVGA 42-in. plasma-display panel (PDP), which could be seen all over the hall as a presentation device in other booths. Sony has been selling the panel for about a year, said Visual Communications Business Manager Lloyd Klarke. When asked, Klarke said the glass in the PDP was Japanese, but declined to reveal the maker. Plasma-addressed liquid-crystal (PALC) displays, he said, are not yet commercial products.

Eizo was also showing a fully flat 17-in. CRT monitor. The tension-mask unit is good for 1280 × 1024 at 76 Hz or 1024 × 768 at 101 Hz, at a price of about $579. The company also had a 42-in. PDP that looked like it had a lot more luminance than its claimed 120 cd/m^2. ***Mitsubishi*** was showing "Natural Flat" CRT monitors using Diamondtron™ NF CRTs (and Sony-licensed technology). The 17-in. is new, and will go for an estimated street price of $449. ***iiyama*** had 17-, 19-, and 22-in. "TrueFlat" CRT monitors using Diamondtron tubes. The 22-in. VisionMaster Pro 510 has an aperture-grille pitch of 0.25 mm, and a maximum screen resolution of 2048 × 1536 at 80 Hz, for an ESP of $1229 (the 19-in. is $699; the 17-in. is $469).

Sony

Sony's completely flat-screen CRT monitor for the masses – the 17-in. CPD-G200 – was introduced at the PC Expo.

Toshiba was focusing mainly on its projector line, but also introduced 41-in. SVGA videowall cubes based on TI's DLP™ technology, and announced the company's first PDP, a 42-in. WVGA display with an intrinsic contrast ratio of 550:1. The unit accepts 1080i HDTV signals.

Princeton Graphic Systems introduced the model AF3.0HD, "the world's first 30-in. all-format high-definition display for HDTV, NTSC, and XGA." S-video and component video are processed with a built-in line doubler; the aspect ratio is 16:9 and the MSRP is $4100.

The major makers of digital cameras were out in force; most of the cameras had a 1.8- or 2.0-in. LCD on their backs. The only camera-related display innovation I saw was the SunCatcher™ on Agfa's 1.9-Mpixel ePhoto® CL50. The SunCatcher is a little door over the LCD that flips up to reveal a lens whose length is about the same as the width of the display. The lens is intended to capture sunlight and directs it behind the LCD, acting as a solar backlight.

Bausch & Lomb introduced its PC Magni-Viewer, a 6 × 8-in. magnifier with mounting hardware that sits between the front of the PC monitor and the user's eyes, but considerably closer to the eyes. The magnifier makes the images on the screen look larger and, perhaps more importantly, makes the image appear to be 33–60 in. away from the user's eyes. This reduces the need for near focusing and, B&L claims, reduces eyestrain.

Not Displays

Well, I couldn't ignore the non-display exhibits completely. First of all, there was iMac-inspired translucent colored plastic everywhere, some of it in an iMac near-looka-

like that corrects two of the iMac's deficiencies: omitting a floppy drive and running the Mac OS. This Windows monoputer comes in "five brilliant gemstone colors" and is made by Future Power (Santa Clara, California), a joint venture backed by Daewoo Telecom.

I was impressed by cellular digital packet data (CDPD) PCMCIA-card wireless modems. Slide one of these into the PC card slot on the portable computing device of your choice, and you have wireless access to the Internet at (currently) 19.2 kb/s. Several carriers - including AT&T, Bell Atlantic, and GTE - provide CDPD services, with Internet access running in the range of $40–59 per month. Where use is not unlimited, payment is by the kilobyte, not by the minute, so one can still be connected all the time.

Novatel Wireless seems to be pushing the price-conscious end of the CDPD wireless-modem business - "price-conscious" being an attractive term for those of us on an editorial budget. The company's new "Merlin" is a Type-2 PC card that works with Windows CE and Windows 95 and higher, and will sell for $279 when it becomes available in August, said marketing and media relations manager Mona Thomas. The same performance can be had in the Minstrel 3, a cradle that wraps around a Palm III or IIIX. Since the price is $369, one can get more functionality than can be had from a Palm VII at less cost.

Minstrel versions are coming for the Cassio E-15 and Palm V, high-speed modems are in the works for late this year, and modems with smaller form factors - such as Qualcomm's Flash - are being developed.

3Com® had a large area with tiny booths for its software and service providers. One of these was ***Etak***, which is "known for the best digital maps," said marketing V.P. Craig Lynar. Now the company is expanding by supplying applications and information services to sit on top of those maps. One of those services is real-time traffic information. For the Palm VII, the information is delivered as pure text to describe incidents along a route previously defined by the user. If the user departs from such a route, regional information that has not been customized can be obtained.

Starting in 2001, Etak sees substantial automotive applications, and not just for simple navigation systems. Full automotive information systems would include active traffic information, e-mail, and other features, along intelligent systems. (The system knows where you are, knows things about you and your vehicle, and has access to a database; so, it can suggest directions to a gas station when the fuel level is low. Or, knowing that you like Italian food for lunch on Tuesdays, it can suggest nearby Italian restaurants at lunchtime - whether in New York or Dubuque.

Now that I think of it, these "non-display" items all have display aspects to them. And many things do - or will. We are embarking upon an even more exciting era of display applications than we have yet seen. All we have to do is keep up with it - or, better yet, lead it.

- KIW

We welcome your comments and suggestions. You can reach me by e-mail at kwerner@sid.org, 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).

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16 MAY 99

SID '99
International Symposium, Seminar and Exhibition
May 16-21, 1999
San Jose, California
San Jose Convention Center

- SID's MAJOR ANNUAL EVENT, featuring:
  - Technical Sessions, Poster Session
  - Author Interviews, Evening Panels
  - Short Courses, Application Seminars
  - Technical Seminars, Application Sessions
  - Product and Technology Exhibits
  - Display Technology Showcase

SID

6 SEPTEMBER 99

Euro Display
September 6-9, 1999
Berlin, Germany

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

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8 NOVEMBER 99

Display Phosphors Conference
November 8-10, 1999
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- 5th annual international conference on display phosphors

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16 NOVEMBER 99

EID '99
NOVEMBER 16-18, 1999
Esher, Surrey, UK

- EID is a single-track technical conference and exhibition featuring UK and European display products.

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16 NOVEMBER 99

Color Imaging Conference
November 16-19, 1999
Scottsdale, Arizona

- An international multi-disciplinary forum for dialogue on:
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  - Color image reproduction and interchange
  - Color image display
- Co-sponsored with IS&T

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1 DECEMBER 99

IDW '99
December 1-3, 1999
Sendai, Japan

- Information Display Workshops
- Invited experts will present talks at workshops on:
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  - Non-Emissive Displays
  - Plasma and EL Displays
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SID
SOCIETY FOR INFORMATION DISPLAY

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"find a need and meet it" is more applicable than ever because of the explosive growth in the variety of display applications.

Therefore, if we can capture the *essence* of the Internet, we should be able to predict what will happen in the future, what the impact will be, and what this will mean to us in the display community. With this perspective, are you ready to do a little playful puzzle solving? Here is your assignment. Take a small sheet of paper and, in as few words as possible, write down what *unique* function you think the Internet (or, if you prefer, the World Wide Web) performs. Next, again in as few words as possible, write down what unique functions are provided by each of the following: the post office, telephone, radio, movies, television, fax, and the PC. After all, all these technologies co-exist and have become an integral part of our lives. Why is that?

Are you finding this easy or challenging? I found it quite challenging. Here are my answers for the technologies mentioned. (I will leave it to you to match them with the corresponding technology.)

- Instant access to remote programmed audio information and entertainment.
- Instant, bi-directional, site-to-site transmission of text and printed images, mostly in monochrome.
- Remote, instant, location-to-location voice and data communications.
- Site-to-site movement of written and printed communications, and the movement of some material goods.
- Instant access to remote programmed visual and audio information and entertainment.
- Remote, repeatable, pre-selected visual and audio information and entertainment.
- Computing power, data storage, and data communications for each individual and location.

Do we agree? Quite well? Not at all? As always, I would enjoy hearing your thoughts. If you would like to help me refine these definitions, as well as the one that follows for the Internet, please send me your ideas using any of the information-transmission media listed at the end of this column.

As we can see, each of the technologies listed can be described in a way that makes it uniquely different from the others. Therefore, if the Internet is so darn important, we should be able to give it a description that endows it with its own unique capabilities. Here is my try at it.

I believe that ***the Internet fundamentally provides a near-instant and worldwide "search and acquire" capability.*** What we search for may be information or a product. And what we acquire as a result of our searching may also be information or a material item. In very simple language, the Internet is an ***instant and giant worldwide swap meet for information and goods.***

Given this, is it any wonder that so many business types have jumped into the fray?

The Internet is a new channel for commerce. It's as important as creating new shipping channels were in the days of Christopher Columbus. It's as important as railroads were in the second half of the 19th century. And it's as important as electronic communications and computers have been in the last five decades of this century.

On the other hand, there are many functions and activities that the Internet will *not* replace. All the technologies listed above will continue to exist: the telephone, radio, television, movies, fax machines, and PCs – as well as newspapers, books, and magazines. The Internet is an added capability, not a replacement of what we have today. Most stores will not go out of business. And the ones that do will fail because of lousy customer service (while conveniently laying the blame on competition from Web-based businesses). Newspapers will continue to exist. Bookstores will continue to be filled with best sellers and rows upon rows of computer self-help books. Mail-order houses will stay in business and simply add the Web as a convenient alternative to the printed catalog. But catalogs will continue to be sent and printed advertising will be just as prevalent ten years from now as it is today. However, every merchant will need to add a Web site as a parallel information channel. Would you like to guess who is eventually going to be paying for all this extra convenience?

The Internet will not grow into some kind of giant super-intelligent artificial brain with all the remote computers being interconnected in neuron-like fashion. In fact, it will take many years for us just to be able to expect reasonably reliable information-retrieval and mail-order services over the Internet. The problems we are having today with various viruses, computer hackers, and the basic fragility of software will get worse before they get better.

We are currently in a transitional period during which the Internet has been changing from mostly a scientific data-communications tool to now predominantly a tool of commerce. As a scientific and data-communications tool, it was managed and used by knowledgeable people who had mostly good intentions. High average integrity levels and a low greed coefficient made for a generally friendly and supportive environment. But now there are fortunes to be made and market shares to be won. So much for good intentions and a supportive environment! What happened in the past with the railroad barons, and with the developers of the telegraph, telephone, television, and film industries will now happen with the Internet. Money and greed really do cause problems, don't they?

The good news is that eventually this will all pass. We adults are a little slow at this, but consider a group of children anywhere in the world. Put a group of kids together and

within minutes they have figured out how to "play fair." But since adults are sometimes a little more "sophisticated" in their ways, I predict that it will take us the entire first decade of the next century to figure out how to do this with the Internet. And furthermore, I will make the easy prediction that Microsoft *will not* lead the way. The other kids will have to show them how it should be done. Sometimes the "rich kids" are the last to pick up on such obvious concepts as "playing fair."

In the meantime, we display engineers will be blessed with many new opportunities. As a medium of commerce, the Internet will demand displays that provide instant and sometimes location-independent access. That means displays of every size and shape, including ones that can be portable and wearable. Information-transmission bandwidth will grow faster than computing power in the first decade of the next century, which will allow for the transmission of more images and more-complex data. This high information complexity will require correspondingly higher-quality displays, especially for portable use.

In many ways, we can look at the Internet as the modern version of a gold rush. And as with the gold rushes of old, while only a few miners made it rich, most of the provisioners did exceedingly well. We in the display business are like the provisioners. While the miners seek their riches, we will create successes that are, perhaps not as spectacular, but will have more lasting value, both from a technology and from a business standpoint. The time is right. The opportunities abound.

Should you wish to add your thoughts, to suggest alternative scenarios, or to challenge my expectations regarding the Internet, you may reach me by any of the following communications media: e-mail at silzars@ibm.net, fax at 425/557-8983, telephone at 425/557-8850, or the post office at 22513 S.E. 47th Place, Issaquah, WA 98029. ■

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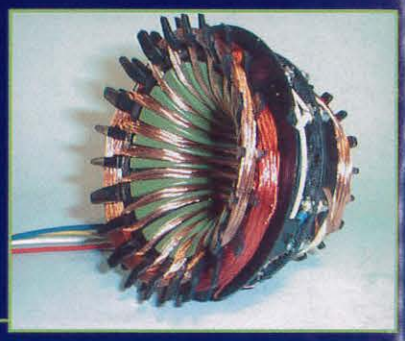

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As CELCO celebrates their 49th year providing state-of-the-art components for CRT displays, we wish to thank not only our longtime friends, but also the new pioneers in the CRT imaging industry.

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CELCO's *newest generation* of high resolution yokes is the result of challenges to meet the needs of high performance in specialized medical imaging displays.

CELCO, a Charter Member of the ever-growing Society for Information Display, annually exhibits their newest products for the CRT display industry at SID.

CELCO founder and CEO, John M. Constantine, Sr., is a SID Fellow honored by the Society "for his widely recognized and significant contribution to the advancement of the display field."

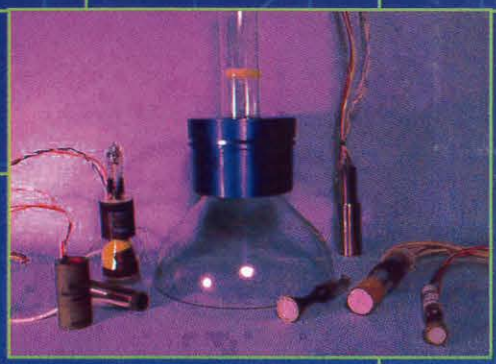
CELCO Yoke for Naval Shipboard Display

Left: Commerical Head-Up Display Yoke

Top: Flight Mgt. Display Yoke

Bottom: F-18 Map Display Yoke

CELCO HMA400 Deflection Yokes for Helmet-Mounted, Miniature and Virtual Reality Displays



CELCO

Contact CELCO Yoke Design Engineers with your exact display requirements.

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