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INFORMATION DISPLAY

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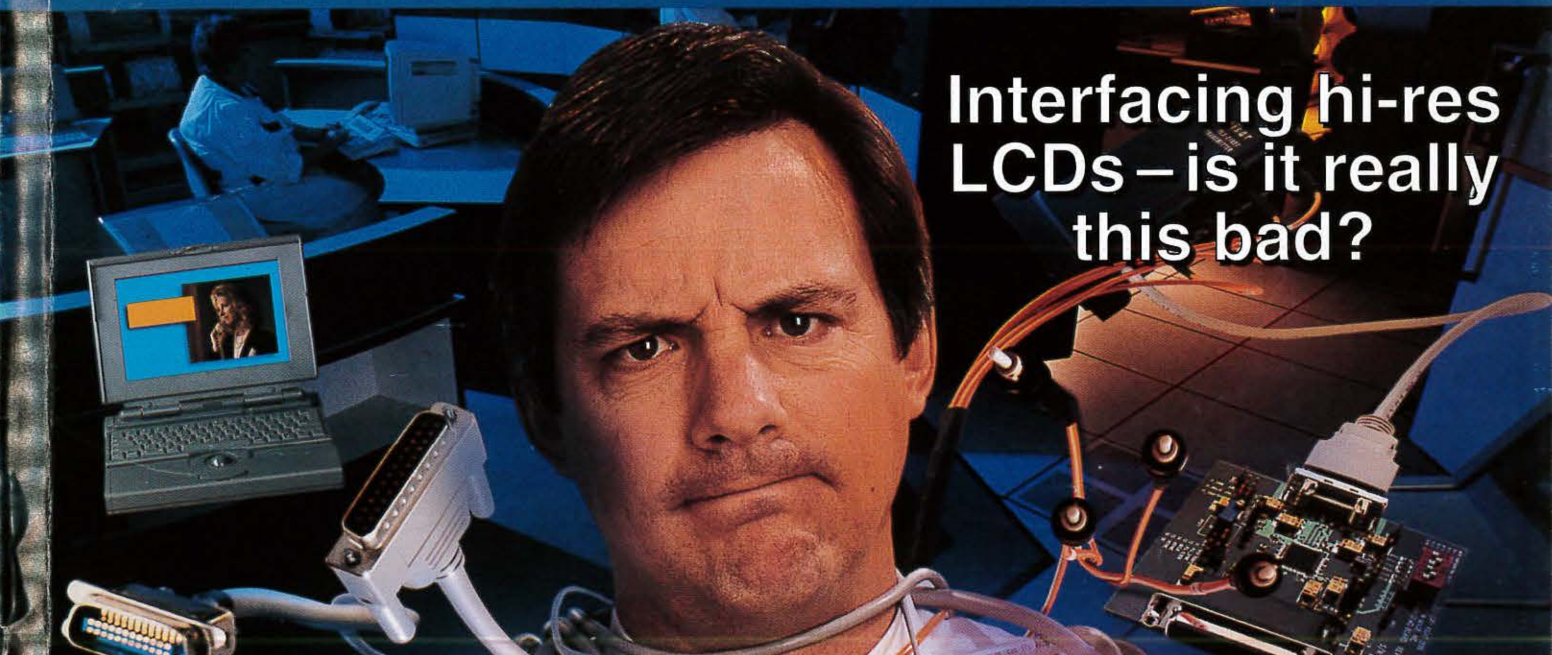
SID '97 SHOW ISSUE – PRODUCTS ON DISPLAY



Interfacing hi-res LCDs – is it really this bad?

Inside:

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COVER: The rapidly growing variety of display applications requires an increased number of display parameters, but an efficient interface standard demands a reduced set. While VESA committees work to provide a long-term answer, the poor integrator is caught in the middle. But there are solutions.

Credit: Sharp Electronics Corp. Art direction by Martin Rupert, Senior Art Director, Young & Rohr.

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

Next Month in
Information Display

CRT Centennial Issue
- Color CRT electron guns
- A new high-volume CRT
- The centennial of the CRT
- Neglected monitor service centers
- High-voltage CRT displays

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editorial

Radical Thoughts

Our now-prevalent view of the world as an "information society" constitutes a paradigm shift: our thinking has changed in a basic way. We now see the making of things (and the performing of services) as the tail, and the information about how to make those things, to whom we should market them, and to whom we should deliver them as the dog; whereas it used to be the other way around. We certainly view things differently, but are they *really* so different?

Certainly, the amount of information available to an engineer over his company's internal network, to a securities trader through a variety of networks feeding into his windowed display, or to a grade-school student through the family NetTV in the living room is staggering, as is the speed with which we can get it. But information - and its storage, retrieval, and delivery - has been valued throughout recorded history. (That's what made "recorded" history recorded.)

Some examples. Battles of the 18th and 19th centuries were generally set pieces, and battlefields were places where the commanders of both sides agreed to fight. Battlefield selection was important not only for the usual strategic and tactical reasons but also because generals had to have hills to stand on to observe the battle below. Brightly colored uniforms made great targets for opposing soldiers, but were essential if commanders were to identify their own and opposing forces. Swift mounted messengers carried orders from general officers on their hilltops to unit commanders below, and brought tactical information back.

Military leaders of the time knew as well as their modern counterparts do that information is at the heart of command and control, and new technology was harnessed to the task as soon as it was available. Indeed, if a hilltop were a valuable network node, wouldn't higher be even better? It certainly would.

In 1794, French army observers directed ground fire against Austrian forces from a balloon. From 1862 to 1863, during the American Civil War, the Army of the Potomac used balloons to observe Confederate troop movements.

A keen appreciation of the value of information was not limited to the military. In the late 18th century, Mayer Amschel Rothschild became a successful banker in Frankfurt am Main, but the House of Rothschild became a dominant financial power in Europe only when Rothschild sent four of his sons to open branches of the family bank in London, Paris, Vienna, and Naples. Among their keys to success: the rapid international communication of financial information.

As deputy postmaster general of the American colonies in the early 1750s, Benjamin Franklin won acclaim for establishing a post road between New York and Boston, which allowed for the rapid delivery of mail and government dispatches. The Boston Post Road - now also called U.S. Route 1 - is a few minutes' walk from where I sit now, and some of Franklin's road markers - large blocks of granite deeply incised with the initials BF - can still be found along the way. Only a few years after Franklin's achievement, the Royal Navy guaranteed the delivery of mail from London to Kingston, Jamaica, in under 30 days.

Samuel Morse knew it was a momentous event when he sent the first public intercity telegraph message, "What hath God wrought!" David Sarnoff knew he had a brilliant commercial model for broadcasting with the "radio music box."

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the display continuum

The End of an Era ...

by Aris Silzars

It's Sunday morning and I'm feeling great. The past week has been a busy one but I feel I was able to accomplish a few good things. Thus, my plan for this Sunday morning is to do nothing more strenuous than sit at the breakfast table, enjoy the view of the Issaquah Valley, and leaf through the typically fat Sunday paper. There's something very relaxing, almost meditative, about such an activity. So far, I've not been able to achieve a similar mind-state while staring at a computer screen.

This is also the one time that I am not bothered by the fact that most of what I see is advertising. Somehow, in this format, the ads are more informative and not nearly as obnoxious as those encountered on TV. Maybe it's because I can pick and choose what I peruse, and for how long, and through this process educate myself on what's new and where the best deals can most likely be found. Hmmm ... advertising as a way to *inform* the potential customer - maybe not such a bad concept after all.

Lately, I have been paying more attention to the ads for PCs. With all my other fun activities, I have let time and technology pass me by. My home-office machine is getting embarrassingly out of date. So, being a reasonably logical person, I've been thinking about what capabilities I would like my new machine to have. The list turns out to be quite manageable.

Obviously, I need word-processing capability. However, I don't do anything terribly fancy, such as merging documents or creating complex equations. I do like lots of interesting and convenient font choices though. Occasionally, I need to produce a spreadsheet. But here again, my needs are pretty modest. I need good e-mail capability and the ability to look in on the World Wide Web. I also need the ability to produce nice-looking overheads, and I would like to be able to create my own 35mm slides for presentations. The most challenging application I can think of is to be able to scan color slides, large-format negatives, and/or photos and then to try out various renditions before I select the ones I want to enlarge and print (with conventional chemicals) in my darkroom. I would also like to be able to do near-photographic-quality printing and occasionally scan in a document. I've never done much with playing computer games and don't intend to do so in the future, so that's a capability I can ignore. I also have zero interest, at least for now, in my computer playing music or making cute electronic sounds.

With this list of capabilities in mind, I started working my way through the Sunday ads to see which machine might best meet them. Of course, what I found were the typical specifications proclaiming Pentium speeds of up to 200 MHz with MMX technology, various multimedia options, 32 MB of EDO RAM, 16X CD-ROM drive, 3.8-Gbit hard-drive, 256-kB pipeline burst cache, 2-MB EDO video memory, and other capacities of various hugenesses, including modem speed specifications of 33.6/14.4, 16-bit stereo sound with BBE high-definition sound enhancement, S3 ViRGE 2-D and 3-D graphics, MPEG full-motion-video playback tuned for MMX technology, and preloaded Windows in a regular "95" flavor or in the super-duper "97" flavor. This gave me some rough idea of which merchant had the best sale going, but beyond that, I

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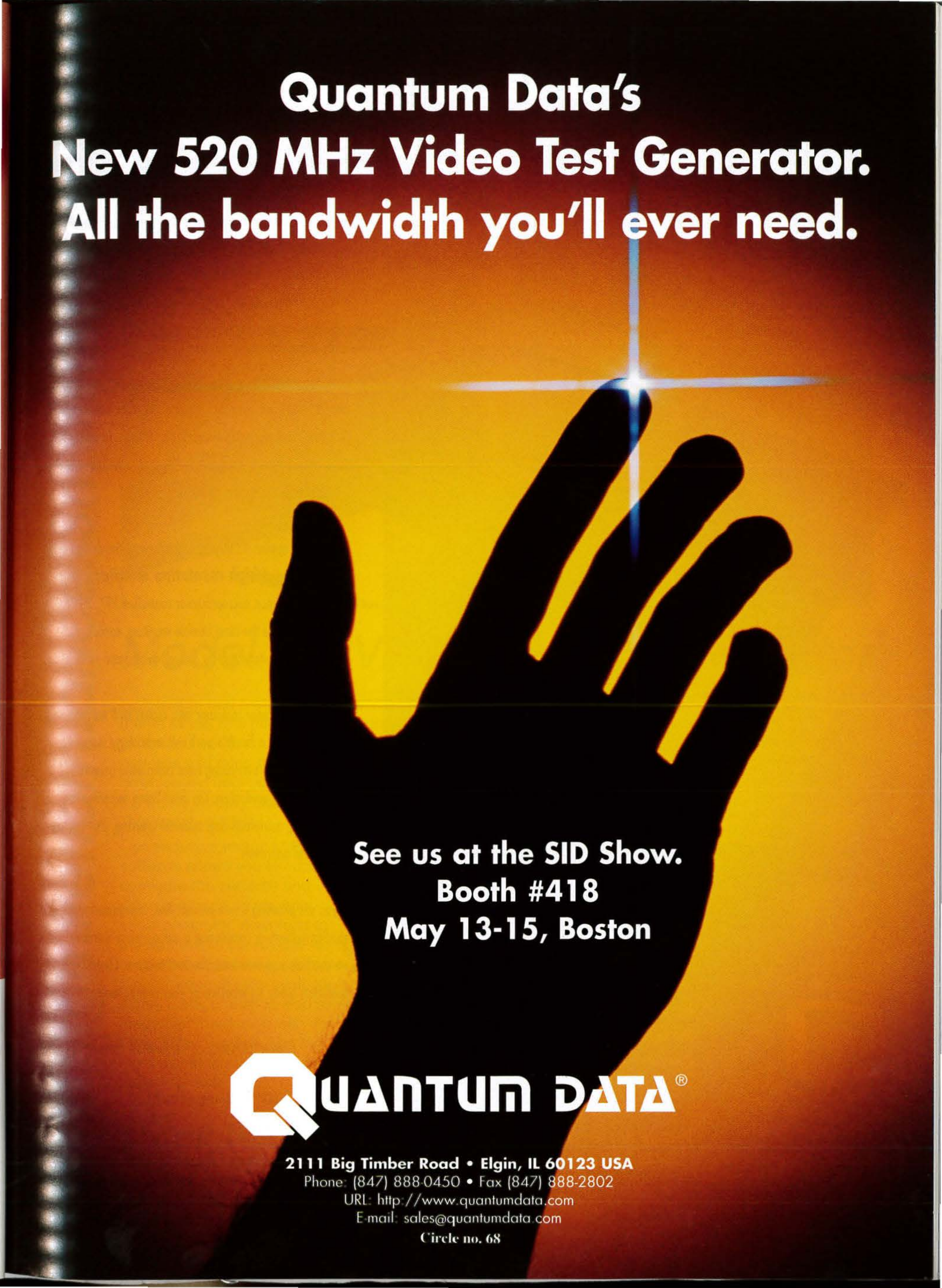
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Interfacing High-Resolution LCDs

The growing use of high-resolution LCDs is adding urgency to the search for better interfacing solutions and standards.

by Mark Waring

THIS IS AN EXCITING TIME. The flat-panel display is quickly evolving into a component that is showing up in an exploding number of applications and marketplaces.

How big is this growth? Stanford Resources predicted recently that the flat-panel-based desktop-monitor market alone will reach a worldwide annual volume of over 8 million units by the end of the year 2000.[1]

This potential can only be realized by showing more favorable tradeoffs between LCDs and their ubiquitous alternatives: displays based on the cathode-ray tube (CRT). From the interfacing standpoint, the CRT is a relatively simple and standardized animal - and a tough adversary for LCDs to compete against.

This article describes the current state of high-resolution LCD interfacing, and points out the directions that will, for the near future, determine what to expect for both design-level and end-user-level interfacing to most high-resolution LCDs.[2]

Current Interfacing Issues

The changing world of FPD applications brings with it a conflicting set of performance criteria. On the one hand is a field of display parameters that must expand to encompass the growing range of applications; on the other hand, these parameters must collapse to a limited set of standards that allow consistent and efficient application in various markets. The most far-reaching product-design consideration for these components is the electrical interface.

LCDs fall into two major technology families: active matrix (TFT) and passive matrix (STN). These families have very different characteristics in most respects, including their electrical-interface structures (Fig. 1). The TFT-panel input shown in Fig. 1 uses 18 pins to clock in one complete digitized color pixel per clock. The pixel typically consists of six bits each of red, green, and blue. (Six bits of R,G,B produces a 262,000-color capability and is the most common choice at present.) Gray scales are controlled simply by the control of these bits.

In addition to the subpixel inputs, digital pixel shift clock, row reset, and frame reset inputs are used to control timing. Many TFT panels also include a "display enable" (DISP or DispEnable) input, which synchronizes the start of each row data with the latching of this data onto the actual column drivers inside the LCD. (This allows the controller to have a

	TYP. TFT VGA PINOUT			TYPICAL PASSIVE VGA PINOUT
Vcc	Power (+5V or +3.3V) pin(s)		Vcc	Power (+5V or +3.3V)
RD0	red subpixel LSB		UD0	upper first subpixel
|			|	
RD5	red subpixel MSB		UD7	upper eighth subpixel
GD0	green subpixel LSB		LD0	lower first subpixel
|			|	
GD5	green subpixel MSB		LD7	lower eighth subpixel
BD0	blue subpixel LSB		LP	row driver reset pulse
|			XCK	pixel shift clock (approx. 9 MHz)
BD5	blue subpixel MSB		YD	Vert. frame reset pulse
XCLK	pixel shift clock (approx. 25 MHz)		Vee	Contrast adjust voltage (variable DC)
LP	horiz. line reset pulse		GND	ground pin(s)
FLM	vert. frame reset pulse			
DISP enable	display enable (start of row data flag)			
GND	ground pin(s)			
Total:	Approx. 31 Pins		Total:	Approx. 31 pins

Fig. 1: *Examples of current active-matrix (TFT) and passive-matrix (STN) LCD-interface methodologies are shown in VGA resolution.*

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flexible delay from the row-reset pulse to the start of actual row data.)

The passive color panel shown in Fig. 1 uses only three pins to input a complete color pixel, consisting of only 1 bit for each red, green, and blue subpixel. Gray scales must therefore be implemented by combinations of spatial dithering and interframe modulation (FRC) – complicated algorithms generated by the VGA controller to flicker individual pixels or blocks of pixels on and off rapidly to emulate a gray-scale effect.

One advantage of STN interfacing is a significantly lower clock frequency than a similar TFT panel, since the interface inputs multiple pixels per clock cycle. To further lower the frequency, these panels are electrically split into top and bottom halves. Each of these halves is written to simultaneously, reducing by a factor of 2 the input frequency required for any given refresh rate.

Inside the display, both types of LCDs utilize row and column shift-register digital drivers to apply voltages to transparent electrodes on the glass itself. (The TFT display also includes transistors formed at each subpixel location to hold charge at each subpixel electrode independently.) The driving of these row and column drivers, most often with the aid of an integrated input ASIC, is directly controlled by the input signals just described.

There are complications that stand in the way of standardizing the display interface. First, while the general rules just outlined are followed by all manufacturers, every panel may use different pinouts, connectors, and slightly different timing requirements that make customized input timing necessary. Second, for the TFT example shown, the input is a relatively high-frequency – over 25 MHz – highly parallel input-cable architecture. The resulting connector and cable designs are expensive, and it is difficult for a design to accommodate long cable lengths and pass stringent EMI emission requirements.

As resolutions increase to SVGA and XGA, these high-frequency effects get much worse. If the interface shown above were used for an XGA panel, the resulting pixel shift clock frequency jumps to around 50 MHz because of the greater number of pixels. This causes enormous problems for both the cable transmission and for the internal LCD drive circuitry.

To help address these problems, the common practice is to manufacture XGA panels with a double-pixel interface. In other words, the number of data-input pins is doubled to allow two full pixels to be sent to the panel each shift clock cycle. This reduces the frequency of digital data transmission by one-half, back to under 25 MHz. However, the wider cable also worsens the EMI picture, and complicates the cable and packaging design.

The Notebook Factor. As messy as the current interface picture is, for the most part it has been made to work. Since notebook computers are the major application of these displays, the evolution of LCD interfacing has been strongly coupled to the capabilities and limitations of PC-bus-based video (or "VGA") controllers used in notebooks. VGA-controller manufacturers have supported the notebook market by developing variations of their CRT output devices that also provide the required high-frequency digital output to drive LCDs. These controllers include programmable output pins that can change definition and timing via firmware BIOS changes, allowing a single controller to be "tweaked" or customized to match any given LCD display's timing requirements.[3]

The cabling requirements are also unique to each display, although this does not pose a significant problem in an integrated notebook design. Even so, the latest wave of XGA-resolution notebook designs are raising problems and forcing manufacturers to use new tricks to drive the panels. Among these tricks are differential driving, which is discussed in the following sections.

The Monitor Factor. A second factor driving today's LCD development is the ubiquity of the CRT as a primary computing display. Not only flat-panel manufacturers but many parties with a wide spectrum of backgrounds are currently developing LCDs into CRT-replacement products. These range from a plethora of niche, special-purpose, and dedicated market applications to the replacement of general-purpose PC desktop monitors.

While LCDs are digital by nature, the analog RGB-style CRT interface so dominates today's market that many product designers are pursuing the path of manufacturing analog/digital (A/D) interfaces that allow the LCD monitor to accept the same signals as a CRT. For the end user, the advantage is obvious: the flat panel can – at least in principle – be switched with a CRT in a plug-and-play manner. But from the performance and manufacturing-cost standpoint, this approach has some real problems. The A/D circuitry is not cheap, especially if it is made general-purpose to accept multisync – both multiple display resolution and multiple refresh rate – input, and maintaining image fidelity is difficult. Nevertheless, the market advantage of such an interface is so strong that many LCD-based monitors will probably use this solution, at least until the LCD digital interface is more mature and standardized.

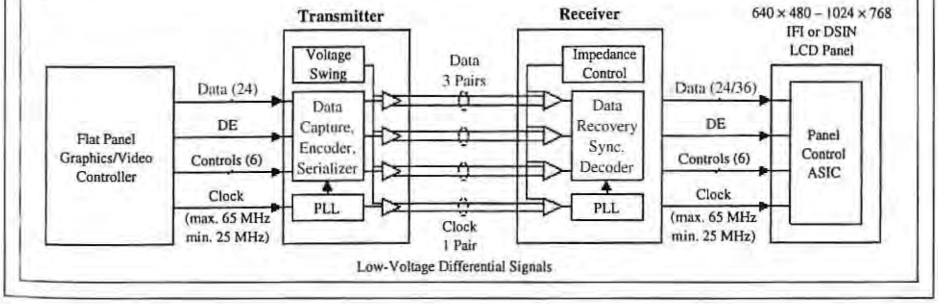


Fig. 2: Silicon Image's PanelLink™ is a differential driving solution for interfacing from a standard notebook VGA controller to a standard TFT- or STN-LCD high-resolution screen.

Standardization

So what is being done to turn the particular, unique, and difficult LCD interface into something that can address a CRT-type market: a market of thousands of different applications, all expecting an inexpensive, consistent, and interchangeable interface solution. Two major trends are under way:

- The use of differential driving, already being implemented as a matter of necessity.
- A more comprehensive attempt by the Video Electronics Standards Association (VESA) to standardize the LCD digital interface for future growth.

What's LVDS? Differential driving, also called low-voltage differential signaling (LVDS), has been introduced by chip manufacturers to allow cabling solutions that are less emissive - and therefore less prone to electrical crosstalk and EMI problems - and more robust when used for applications requiring long cable lengths, such as in monitors.

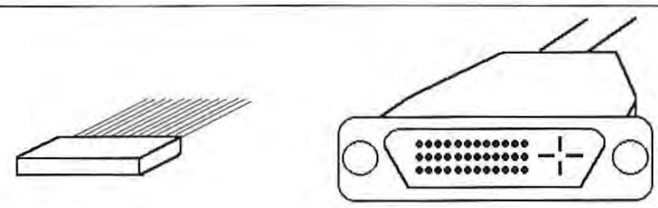
The idea behind differential driving is relatively simple, involving mating transmitter and receiver ICs. Take the normal digital outputs from an LCD digital PC controller, multiplex these outputs down to a smaller number of differential pairs, and transmit reduced-voltage-amplitude, high-frequency signals to the display end of the cable, where the receiver IC demultiplexes the differential signals back to parallel 3.3-V or TTL-level-logic signals.

Ideally, the solution is a "black box" that requires no design change to either the PC video controller or the LCD-panel input. One more advantage offered by this approach is the reduced number of lines in the cable itself, which saves space and even cost in some design situations.

The introduction of XGA TFT-LCD notebooks has sparked the immediate need for such a solution. National Semiconductor is the first company to successfully design their LVDS differential drivers into several manufacturers' XGA notebooks. Their chip sets - a transmitter and a receiver - multiplex seven input signals down to a single differential twisted-pair output. First production versions were rated at 40-MHz clock rates, requiring two chips operating in parallel for XGA signal transmission. More recently, 65-MHz versions have been introduced that are fast enough to route XGA-panel signals over a single chip.

Texas Instruments and Thine, a small Japanese manufacturer, are two other companies that are now supporting the same architecture with their own compatible ICs.

Silicon Image, Inc., a San Jose start-up, has introduced PanelLink™, its own version of a differential driving solution, and is aggressively staking a claim in the LCD-interface market (Fig. 2). Chips & Technologies, a manufacturing partner, will soon offer VGA controllers with the transmitter portion of PanelLink embedded in the controller silicon itself. Other controller manufacturers may follow suit.



(a) (b)

	Possible Component Level I/F Stdd.		Possible Monitor Level I/F Standard
#pins	Function	#pins	Function
1 or 2	Vcc (+5V or +3.3V)	1 or 2	+5Vdc
11	differential pairs for panel data/control	12	differential pairs for panel data/control
4	DDC (intelligent panel ID) pins	6	2 channels of high speed serial I/F
3	Gnds, shields	2	1 channel of alternate serial I/F
3	Misc. LCD control pins	3	DDC (intelligent panel ID) pins
		2	Charge power and return pins
		6	analog R,G,B support pins

Fig. 3: *VESA's still-to-be-finalized (a) component-level interface standard and (b) monitor-level interface standard are scheduled for completion in mid-1997.*

PanelLink distinguishes itself by a patented data-encoding scheme that uses a differential signaling layer but incorporates additional enhancements, such as dc-balancing, transition minimization, and multi-channel synchronization. This allows even better EMI reduction and higher speeds, and it can even be coupled to standard fiber-optic encoders and decoders.

Efforts to Standardize. VESA, based in San Jose, California, is investing significant effort to create high-resolution flat-panel interfacing standards. VESA has established two separate committees:

- Flat Panel Display Interface (FPDI), working on component-level LCD-interface timing, connector, and pinout standardization.
- Plug & Display (P&D), covering the same issues for finished monitor-styled flat-panel products.

Both committees are hoping to have their next published standards out by the middle of this year.

A component-level interface standard defining connector and pinout is being developed in the FPDI committee [Fig. 3(a)].[4] Differential driving is used as the standard signal-transmission scheme. Three differential pairs, plus a fourth pair carrying a reference clock, allow transmission of VGA, SVGA, or XGA timing. A pixel format up to 1600 × 1200 may be possible over the same standard architecture with the higher-speed versions of the differential drivers that have already been proposed.

A monitor-level interface standard is taking shape in VESA's P&D committee [Fig. 3(b)]. While sharing the same differential driving scheme as that used on the component level, the proposed monitor connector adds more functionality. In addition to differential driving, such a connector is likely to support one or more high-speed serial-transmission standards, while also maintaining pins specifically for CRT-compatible analog R,G,B transmission.

The committee is also paying attention to intelligent-monitor support - for routing keyboard input through the monitor and inputting compressed video-conferencing data, for example. Both standards are also likely to include pins for monitor ID so a system can recognize the type of monitor present and autoconfigure its output accordingly.

What's Next?

VESA's standardization attempts are in danger of falling behind the actual implementation of new high-resolution panels in both the notebook- and monitor-style marketplaces. Companies are making choices on their own for what makes sense to them and works best for their end customers. A variety of interface solutions are already available for designing both integrated displays and stand-alone monitors at up to XGA resolution, and VESA's non-binding standards will have to overcome resistance by many parties who already have invested in other paths. But there is no question that the present lack of any standardization of flat-panel interfacing is already an obstacle to reducing costs and increasing market acceptance.

Component-level LCD designs will likely proceed on their present course for some time, with VGA and SVGA screens still using the direct approach shown in Fig. 1. XGA (as well as any SXGA) screens will use some type of differential driving solution. For LCD-based monitors and monitor-like products, the only standard developing in the near term is the CRT analog-to-digital signal-conversion path, which makes the LCD monitor look just like a CRT to the system. However, if the projected growth in this market is actually to occur, standardized digital solutions will be necessary for further significant cost reductions and market acceptance.

Notes

[1]Stanford Resources, preliminary data, Nov. 19, 1996.

[2]In this article, we use "high resolution" to mean VGA (640 × 480) screen resolution and greater.

[3]The BIOS is actually an extended register table added to the standard VGA video BIOS used in all PCs. This table provides initialization data for matching the output timing to specific LCDs.

[4]Figures 3(a) and 3(b), and the preview of VESA's standards, were included with the generous agreement of the VESA committee chairs. ■

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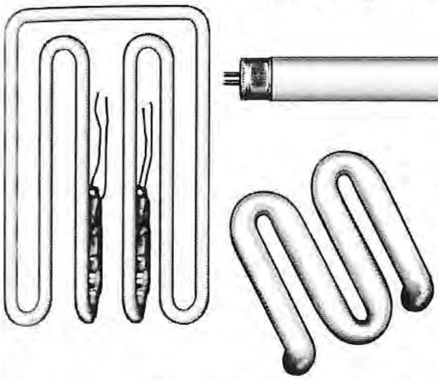

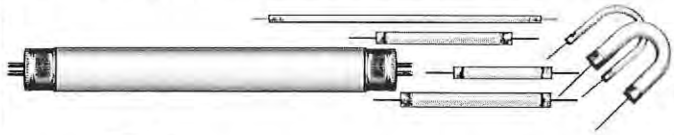

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Photolithography is often cited as the cause of high FED manufacturing costs, but "simpler" lithographic techniques require some genuine breakthroughs.

by Mark Lucas

FIELD-EMISSION DISPLAYS (FEDs) have gained a great deal of attention over the last several years as many international corporations - including PixTech, Raytheon, Micron Display Technology (MDT), FED Corp., Futaba, Motorola, and Candescent Technologies - have announced development programs. The FED is attractive because of its wide viewing angle, wide operating temperature range, and bright saturated colors obtained without power-hungry backlights.

From a manufacturing perspective, FEDs should have a lower cost of production because of the technology's increased tolerance to defects and because it has only a single critical lithographic layer. Achieving low-cost manufacturing is easier said than done, however, because the critical-layer patterns have demanding requirements that are challenging for traditional large-area patterning tools. This article discusses the essential lithographic requirements for FED manufacturing, and outlines an approach for dealing with these requirements that produces an attractive total low-cost-of-ownership lithography solution.

FED Technology Basics

FED R&D has splintered into three camps, each pursuing different routes for the fabrication of the field emitters. Everyone acknowledges that a low-cost production-worthy method for emitter fabrication is essential for long-term market success. The fundamental goal is the ability to construct emitters that combine high-electron-emission characteristics with a low turn-on voltage - and to do so reliably. High electron emission results in brighter displays, while lower turn-on voltage allows the use of low-cost driver ICs.

The Spindt cathode method - advocated by PixTech and its alliance members, Futaba, Motorola, and Raytheon - has benefited from the most R&D work. This method depends on lithographic formation of precise micrometer-sized holes in which conical emitters are formed through a special metal-deposition step.[1,2] PixTech and Futaba have both demonstrated prototypes of 5-in. displays fabricated on glass with traditional large-area lithographic approaches. MDT uses a different emitter-tip fabrication strategy. The structures themselves are functionally identical to the Spindt cathodes, but the method of formation is quite different. MDT's technique makes use of chemical-mechanical polishing (CMP) techniques to open up holes in a metal layer deposited over conical emitter structures formed during a previous etch-back process.[3] This method requires the lithographic formation of uniform micrometer-sized circular photoresist posts.

Other FED research efforts have focused on non-lithographic approaches to emitter fabrication. Amorphous-diamond thin films with high work function have been extensively investigated, but non-repeatable and slow manufacturing processes have inhibited their use.[4] Candescent has developed a proprietary technique for fabricating emitter tips that are on the order of 0.25 µm. If shown to be scalable to large areas, this approach could lead to a low-cost manufacturing solution requiring only coarse-resolution lithography. Equally important is that this approach permits the use of low-voltage drivers and high-voltage phos-

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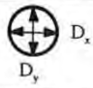
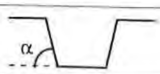
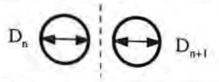
Table 1: Lithographic Requirements for Emitter-Tip Formation

Property	Specification	Illustration
Hole diameter D	1.0 µm ±7% (±70 nm)	
Hole circularity $C=D_x-D_y$	±5% (±50 nm)	
Side-wall angle α	≥80°	
Differential CD across stitched boundary $CD_s=D_n-D_{n+1}$	≤10% (≤100 nm)	

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phors, which together could provide the competitive advantage needed to be successful against AMLCDs.

Spindt Cathode Lithography Requirements

The cathode plate of a Spindt-based FED is a multilayer structure (Fig. 1). Fabrication starts with the deposition on glass of a low-resistivity base-metal layer, such as aluminum, followed by a current-limiting resistive layer, such as FeO_2 or doped amorphous silicon. These films are patterned to form the column electrodes – parallel lines that are nominally one tri-color-pixel wide (200–300 µm), separated by a 10–50-µm gap. The lines are terminated with fan-in patterns to permit connection to driver circuits. Two sequential etching processes define the electrodes, cutting first through the resistive layer and then the metal.

A relatively thick nitride insulating layer is deposited next, followed by a molybdenum metal film. The second patterning step at this stage is the most critical. On this level, the resist is exposed to form localized patches of hole arrays that must be registered to the column electrodes below to within 1 µm. The hole parameters must be precisely controlled (Table 1). CD variations (as defined in Table 1) and sidewall angle are the most critical. Typically, 1-µm-diameter holes are formed with sidewalls greater than 80°. Hole circularity must not vary by more than ±5%, and CDs must not vary more than ±7% across the exposure. When step-and-repeat stitching aligners are used, one must also provide tight control of CD variation across a stitching boundary. (A CD differential greater than 100 nm for a 1-µm hole is too large.)

After exposure of the holes, two etching steps are required: an RIE etch to open the hole to the underlying insulator, and then a chemical etch to cut back to the resistive layer and undercut the insulator. After this second etching step, the panel is placed in a deposition system where a sacrificial nickel film is deposited at a shallow angle as the substrate is rotated about its axis. Another deposition process – similar to the first except for a deposition angle that is normal to the surface – forms a conical niobium metal structure within the hole, along with a film on the top surface. Eventually, the hole is sealed and the process is terminated. Finally, the top metal

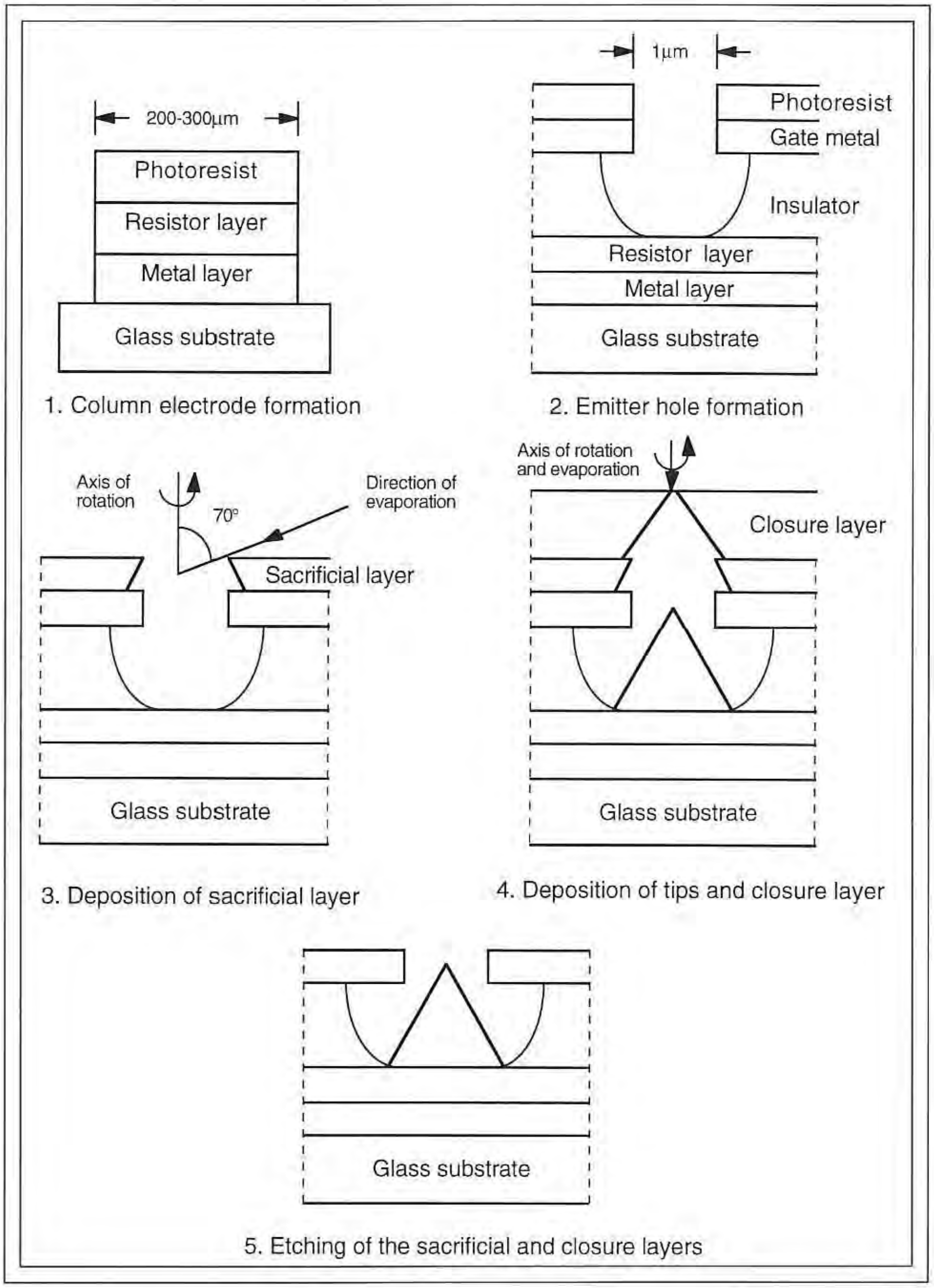

Fig. 1: *Fabricating Spindt tips – a key step in making FEDs – with step-and-repeat photolithography tools is now a well-developed process.*

film is removed in an etch and lift-off process leaving behind a fully formed emitter centered in each of the holes.

A third patterning step on the cathode plate defines the gate electrodes. These electrodes interconnect the hole arrays in an axis that is orthogonal to the column electrodes. In principle, these conductors are also the width of a tri-color pixel, just like the column electrodes. In practice, however, complex meshing patterns are used to minimize the cross-sectional area above the column electrodes in an attempt to reduce capacitance effects. This mesh geometry can also be used in the column electrodes and can push down into the 3-µm feature-size range.

Table 2: Overall FED Lithography Requirements

Cathode Plate Layer	Minimum Feature Size	Overlay Control
1. Column Electrodes	3-5 μm	N/A - first layer
2. Emitter Holes	1.0-1.5 μm	±1 μm (to layer 1)
3. Row Electrodes	3-5 μm	±1 μm (to layer 1 or 2)
Anode Plate Layer	**Minimum Feature Size**	**Overlay Control**
1. ITO Electrodes	10-15-μm line (exposed area) 50-100-μm space (unexposed area)	N/A - first layer (scaling may be desirable to match cathode plate)
2-4. Phosphors	25-90 μm (depending on monochrome or color)	±5 μm (to layer 1)

The overall lithography requirements for FEDs in terms of resolution and overlay are quite well defined (Table 2). The requirements break down into three categories based on resolution. The emitter tips present the most difficult challenge, and, to date, only step-and-repeat methods have proved successful as a fabrication technique.

Laser-interference lithography is a possible alternative for low-cost tip formation, but only research-lab results have been shown to date. This technique was originally developed at MIT, and has been developed more thoroughly through separate efforts at the MIT Lincoln Laboratory, Lawrence Livermore National Laboratory, and the University of New Mexico.

The method uses two or more coherent collimated laser beams illuminating a photosensitive material at an angle to form linear interference patterns on the surface of the resist (Fig. 2). The width and period of the patterns is controlled by the angle of the incident beams. Holes or posts are formed by rotating the plate 90° and re-exposing. This method can completely cover the plate with extremely uniform features in a relatively short period of time. A significant disadvantage, however, is that the method offers no control of the position of the patterns relative to the underlying column grid structure. Additional process steps are required to isolate groups of features into areas that correspond to pixel locations. This additional process complexity has hindered the development of this technique into a production-worthy methodology. FED Corp., however, has demonstrated working displays fabricated by this method.

Holographic Lithography

In the quest for a low-cost alternative to steppers, holographic lithography has often been identified as a leading candidate. Holtronics of Switzerland has developed a tool that can pattern an 8 × 10-in. area using holography to reproduce the fine FED structures. This technique requires the fabrication of a holographic mask from a traditional 1X chrome mask. The holographic image of the 1X mask is formed in a photosensitive polymer layer on a holographic transfer mask (Fig. 3). The transfer mask is then used in conjunction with a specially configured patterning tool in a similar arrangement to expose a flat-panel substrate.

To recreate the original hole pattern, a substrate takes the place of the original 1X mask and a reference beam illuminates the mask through the prism. A scanning laser tracks across the mask through the other face of the prism while the substrate is held in close proximity. The gap between the substrate and the mask is held constant by measuring the gap in real time and adjusting the space between the mask and substrate as the writing beam scans back and forth. Control of image placement on the substrate is done with traditional mask-alignment methods.

Samples made with this technique look promising. The patterns are uniform and placement accuracy is good. The larger issue that must be resolved if this technique is to become production-worthy is the development of a commercial supply of holographic masks. Currently, only Holtronics is capable of manufacturing these masks, although it is reported that several mask shops are prepared to take on this technology if the market demands it.

Mix and Match

It is clear from the wide range of patterning resolutions required for FED fabrication that a

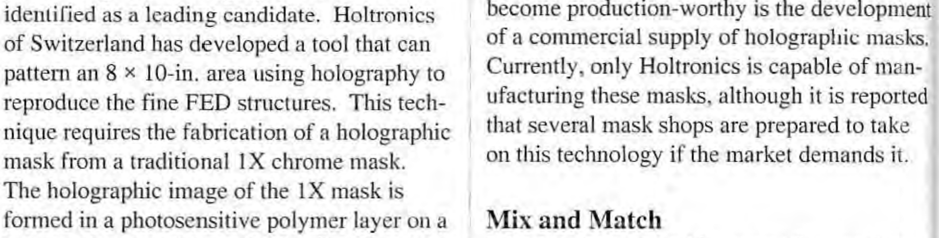

Fig. 2: Laser-interference lithography, currently a laboratory process, is a possible alternative for low-cost tip formation. The interference between two laser beams can completely cover the plate with extremely uniform features in a relatively short period of time, but there is no inherent control of pattern position relative to the underlying grid structure.

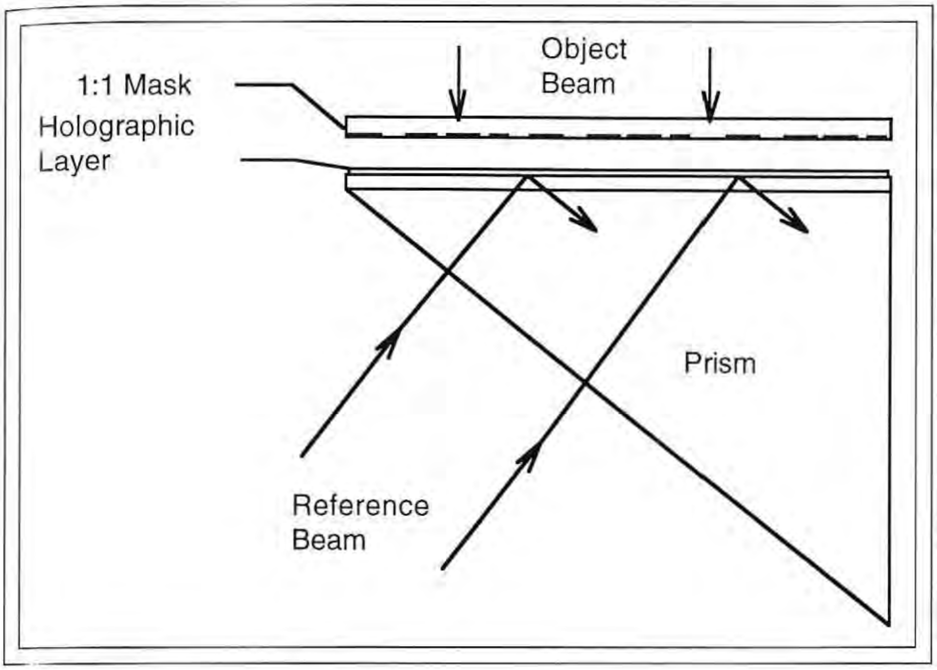

Fig. 3: Holographic lithography – a leading candidate as an alternative to steppers – requires the fabrication of a holographic mask from a traditional 1X chrome mask. The figure indicates how such a mask is formed.

mix-and-match strategy can be employed to minimize lithography equipment costs. The holy grail of display manufacturers is to move material at a 60-s total average cycle time (TACT). A 60-s TACT is a reasonable goal for the lower-resolution layers but is impossible for the emitter layer if steppers are used for patterning. The appeal of the other two high-resolution lithography techniques is the possibility of achieving the 60-s TACT on the emitter layer while avoiding stitching issues at the same time.

Laser power is the most significant impediment to achieving 60-s TACT for these tools. Commercially available UV lasers output 2-5 W maximum, but 25 W are required to expose 550 × 650-mm substrates in 60 s. Wide-field steppers similar to those used for AMLCD production would be suitable for the row and column layers of the cathode plate. The required resolution is beyond the reach of proximity tools, and the required overlay control is reliably achieved by these steppers. The anode-plate layers can be easily patterned with proximity tools as long as the substrate scale is not excessive.

If steppers are used for the emitter layer on second-generation substrates (370 × 470 mm), then a look at lithography cell load balancing reveals the curious fact that the coater/developer system is the lithography cell bottleneck, not the stepper. The reason is that a single coater/developer can be used to service both the high-resolution stepper and the lower-resolution tools. For monochrome displays, there are four low-resolution levels and only a single high-resolution level. Modeling the throughput of a pair of steppers - one a high-resolution unit with a smaller lens field and the other a low-resolution unit with a wide-field lens - reveals that they complement each other almost perfectly in terms of productivity, *i.e.,* the wide-field stepper is nearly four times as fast as the small-field stepper, and the two together consume 100% of the capacity of a coater/developer line while achieving an 85% utilization rate. No proximity tools are required at all! The wide-field stepper has capacity for all layers.

Extending this example to a color display, which adds three more layers, changes things somewhat. The first piece of equipment that must be added is a second coater/developer line. This provides additional capacity for the three new layers and allows a more realistic utilization level of both coater/developer lines - 60% rather than 100%. This change, however, raises the utilization expectation of the steppers from 85 to 95%. This is not perfect balance, but the same output volume can be maintained without adding lithography tools.

It might be reasonable to add a proximity tool at this stage to maintain better utilization levels, but it might be better to consider adding another wide-field stepper if overall factory volume is expected to increase over time.

Conclusion

The large-scale production of FEDs is now possible using processes and techniques developed for the AMLCD and wafer industries. Lithography tools specifically designed for FED emitter patterning are currently available from a number of vendors. The overall cost of lithography, however - especially for the emitter layer - must be brought down if FED production is to be cost-competitive.

The overall cost of lithography can be brought down if mix-and-match strategies are employed, but the "breakthrough" promised by the new holographic techniques is yet to be realized. These techniques have shown good results in lab situations, but it remains to be seen if they can be made production-worthy in time for FEDs to make a serious challenge to AMLCDs.

Notes

[1]Katherine Derbyshire, "Beyond AMLCDs: Field emission displays?" *Solid State Technology* (November 1994).
[2]Brian Dance, "Europe's FPD Development Offers a Chance to Compete," *Semiconductor International,* 229 (July 1995).
[3]David A. Cathey, "Field-Emission Displays," *Information Display,* 16 (October 1995).
[4]Jo Ann McDonald, "Diamonds are getting real in the USA," *III-Vs Review* **8**/5, 38. ■

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show report

Big Screens at Display Works 97

The show at Display Works was larger this year and leaned more toward manufacturing, but many of the displays that did appear on the floor were BIG.

by Alan Sobel

BIG, BRIGHT, COLOR DISPLAYS were standouts at the Display Works meeting and exhibition held in San Jose from January 27th to 30th. In addition to four big panels at Display FireWorks - the mini-exhibit of high-impact displays at the entrance to the exhibit hall - there were some spectacular displays on the show floor.

The first eye-catchers were three plasma panels. Fujitsu and NEC showed 42-in.-diagonal panels in 16 × 9 format with 852 × 480 pixels and vertical color stripes (Figs. 1 and 2). The published specifications for these two panels are very similar: 300 cd/m^2, about 3 in. thick, 8-bit color (a nominal 16,700,000 colors), and 18 kg (39.6 lb.). The two panels looked similar, but the NEC panel was clearly a prototype - there were a number of slight defects and probably lower luminance, although this was hard to tell - while the Fujitsu panel came off a production line and had very few defects. Plasmaco, owned by Matsushita since January 1996, also had a 42-in. panel, but this one is in 4 × 3 format with 640 × 480 pixels. Its luminance, thickness, color, and viewing-angle (160°) specifications are similar to those of its competitors' wide-format panels. All three panels were showing full-motion video, and to this viewer they all looked gorgeous.

The displays were in bright ambient light - NEC's was in a dark enclosure, but still exposed to bright light - and will clearly benefit from anti-reflection and contrast-enhancing coatings, which will, in turn, require higher luminance to be effective. But even without these coatings, the plasma displays still looked very good, either close up or from a distance. Striking fact: the panels are cool to the touch. Luminous efficacy has greatly improved over previous models.

All three of these panels, and a 33-in. NEC plasma panel on the show floor, showed a kind of "swimming" noise in large, non-moving areas seen close up. This is probably due to the way they all generate gray scale, by dividing each frame into eight sub-frames of different luminances. Because of the short persistence of plasma panels, this problem - as well as some motional artifacts - is more noticeable in large plasma panels than in large LCDs. Fixes will probably emerge in the near future.

The panels shown here were all ac plasma panels, which are currently favored over dc devices because of their higher efficiency,

Fujitsu

Fig. 1: Fujitsu showed the production version of its 42-in.-diagonal panel, which has a 16 × 9 format with 852 × 480 pixels and vertical color stripes.

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NEC

Fig. 2: NEC's new 42-in. plasma panel has specifications that are remarkably similar to Fujitsu's.

higher luminance, and longer life. NHK, the Japanese government broadcasting system, has sponsored development of dc plasma panels for over 20 years, showed a 40-in.-plus panel some years ago, and currently spearheads a 27-company consortium that is working on dc panels and talking about putting a 42-in. panel on the market by 1998. However, the fact that Matsushita - which has shown dc panels in the past - purchased Plasmaco is an indication that the ac-panel forces are moving ahead.

Large-Display Panel Discussion

In addition to showing its plasma display, Fujitsu sponsored a panel discussion on integrating large-area displays. Intelligence obtained during the discussion:

- Fujitsu and NEC are aiming at HDTV; Plasmaco will presumably move in the same direction.
- Prices are quoted at around $12,000 in single units now, but the manufacturers plan to reduce prices drastically over the next few years. They'll have to if they are going to move serious numbers of panels.
- David Mentley of Stanford Resources said that there is $4–8 billion committed to plasma production plants in the next 2–4 years - a huge number.

The conventional wisdom is that HDTV needs big pictures to be successful, and Japanese homes are too small to house projection TVs comfortably. This could provide the impetus for plasma's first market niche. However, the major world market for big TV pictures is the U.S., where space constraints are not as important as in Japan but price is a major consideration. To justify billions of dollars in plant investment, sales volume must be very large indeed.

Stewart Hough of Fujitsu said it will be 3–5 years before the price gets down to $3000. He stated that NEC will be at a lower price soon, implying that a price war in large panels is coming. (No NEC representative was available for comment.)

Fujitsu's program went from a 4 × 3 21-in. panel to the 16 × 9 42-in. panel on display at the show. The company did not build big 4 × 3 panels, as Plasmaco has done. Fujitsu anticipates having a 55-in. panel in production in 1998. The company predicts that the cost could be $100 per diagonal inch by 2001, and perhaps as low as $50/in. in 2005.

Major remaining technical problems are life - which should be more than 30,000 hours in TV service - and cost, including both the cost of the panel and the cost of the required high-voltage driver circuitry. Driver cost, now high for all plasma panels, must be reduced, and it should yield to higher volumes and ingenuity.

The New York Stock Exchange installed a number of Fujitsu color panels in 1994. The $8500-per-panel cost, while acceptable to the well-heeled Big Board, has been an obstacle for other exchanges. Much earlier, the NYSE installed some 1000 NEC monochrome plasma panels.

LCDs Are Getting Big, Too

The other large-screen contenders at this meeting were LCDs. Sharp showed their spectacular 40-in. SVGA (800 × 600 pixels) AMLCD at the Display FireWorks exhibit. It is made by joining two 29-in. panels with a seam which is very hard to detect. The viewing angle is not as good as the plasma panels', nor is the luminance as high, but power consumption is lower. Sharp is using an improved addressing system on their 21.4-in. XGA STN-LCD, which may be as much as 30% less expensive than an active-matrix panel of the same size.

For this observer, however, the LCD standout was NEC's 20.1-in. 1280 × 1024-pixel AMLCD (Fig. 3). Its viewing angle is ±80° in both the horizontal and vertical directions, there is no contrast reversal at extreme angles, and the panel looked very good indeed. This is a real workstation-capable device, but at $8500 it won't find too many users. The price will inevitably come down in time. This big panel dwarfed the excellent 14.1-in. display next to it. Although the new unit is not yet quite fast enough for full-motion video, that, too, will come.

While HDTV appears to be the main driving force behind big plasma panels, many large LCDs are aiming at desktop applications. Large high-resolution CRTs require a lot of desktop space, and their depth can be a

NEC

Fig. 3: The LCD standout was NEC's 20.1-in. 1280 × 1024-pixel AMLCD with exceptionally wide viewing angles. But this workstation-capable device won't find too many users at $8500.

significant problem. Furthermore, while a 21-in. LCD truly provides 21 in. of viewable display, a "21-in." CRT will have only about 19 in. of viewable display, surrounded by several inches of bezel. There are enough potential advantages to the LCD that its higher price may not always knock it out of the running.

As usual, the display industry provides a fascinating spectator sport, as well as excitement for the participants. ■

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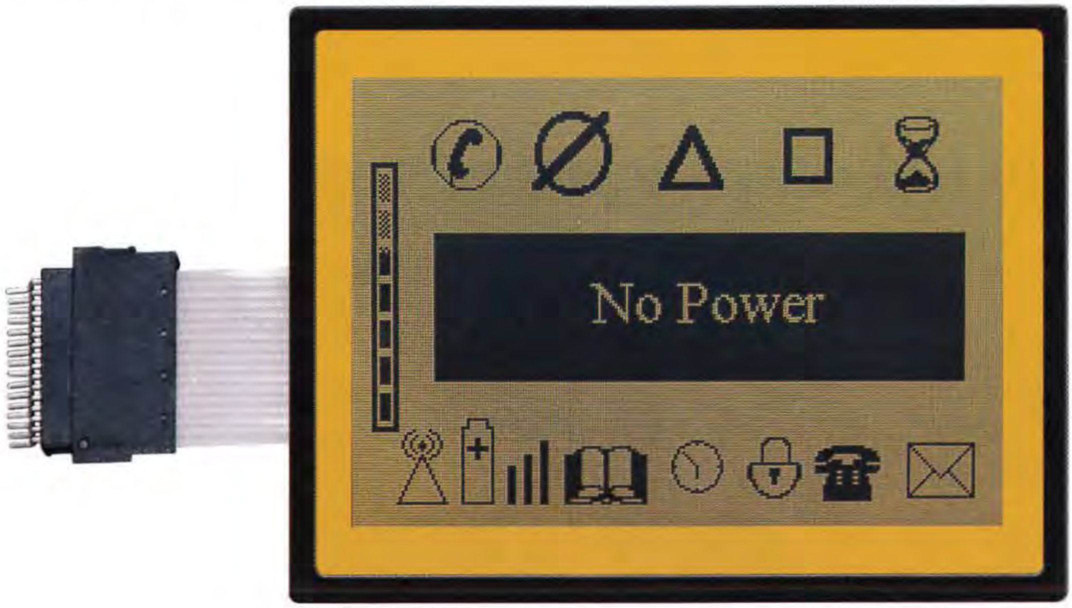

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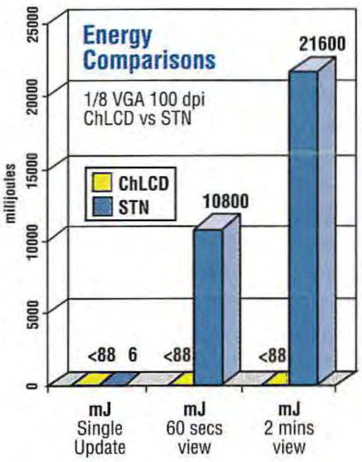

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conference/show report

Dramatic Industry Growth Predicted at Display Works 97

Houses were sliding down northern California's muddy hills as a 6-year drought ended with a vengeance, but in the San Jose Convention Center all predicted movements were up.

by Ken Werner

WHEN Way Tu, President of Lam Research, said at the Display Works 97 Investor's Conference on Wednesday, January 29th, that the flat-panel-display (FPD) market could grow to as much as $200 billion by the year 2014, the audience of investors and analysts appeared interested. Interested, respectful, perhaps excited - but certainly not incredulous.

The projection, made in Tu's keynote address, "A View of FPDs in the 21st Century," depended upon drawing certain parallels between the growth of FPD sales and the growth of semiconductor sales at a similar stage in that industry's growth. Tu also cited "a stream of paradigm shifts," including:

- Computer revenues surpassed those from TV in 1995.
- Cellular phone lines will soon exceed traditional lines in California and other selected areas.
- FPD sales will surpass CRT sales early in the 21st century.

FPDs are moving into every facet of daily life, said Tu, a point that was expanded upon by Aris Silzars of the Display Continuum, an organization that advises clients on display selection, application, integration, and market-development issues. Silzars, speaking at the Display Works Press Luncheon, noted that the history of the FPD's proliferation has not been one of replacing the CRT but of finding new applications for which it is uniquely suited. Despite the fact that FPDs are now beginning to move onto the CRT's traditional turf, Silzars predicted that it will be a wide range of new products and new applications that will fuel further, vibrant FPD growth. Among these will be many new information and communications appliances that, unlike personal

Quadritton Flatscreen Technologies

***Fig. 1:** At the Large Display Integrators Forum, Quadritton announced the imminent introduction of its FlatScreen™ television receivers with Fujitsu plasma panels at New York's upscale Hammacher Schlemmer department store. A 21-in. model (shown) and a 42-in. model are available in the special-for-Hammacher-Schlemmer stainless-steel-encased Signature Series. The QFTV plasma TV set is the first to be available through retail channels.*

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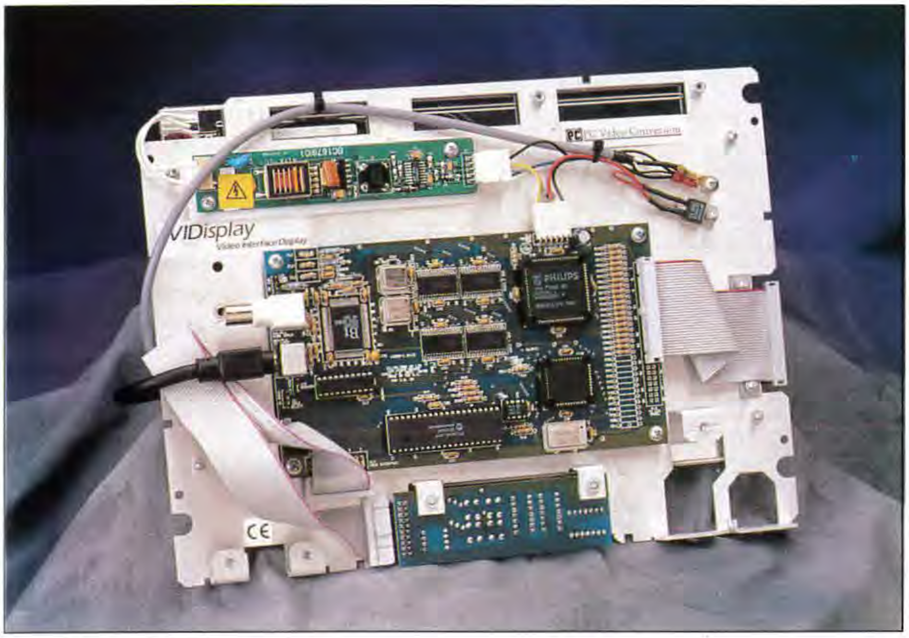


PC Video Conversion

Fig. 2: PC Video Conversion introduced its VIDisplay 640 interface that accepts composite (NTSC, PAL, and SECAM) and Y/C (S-VHS) inputs and shows them as high-quality video on LCD panels.

computers, will be single-purpose, easy-to-use devices. One result of this trend will be a proliferation of FPDs at many levels of sophistication and complexity. This segmentation, said Silzars, will create opportunities.

Silzars' dynamic makes Tu's exponential curve seem credible. In a subsequent conversation, David Mentley of Stanford Resources expressed the opinion that Tu's projection seemed overly enthusiastic and noted that a 15% annual growth is at the high end of what he would expect. Starting with $31 billion of projected flat-panel sales in 2003 (the last year for which Stanford Resources has made detailed projections) and figuring 15% annual growth for 10 years provides a sales estimate of $125 billion in 2013. A more conservative 10% annual growth rate gives a projection of $67 billion in 2013, said Mentley. Interestingly, the enthusiastic Mr. Tu and the methodical Mr. Mentley are separated by only a factor of 3. Even the lowest of their projections should be enough to gladden the hearts of people who make displays or the equipment to produce them.

In an industry forecast that followed Tu's keynote address at the Investor's Conference, Hideki Wakabayashi, Senior Analyst at the Nomura Research Institute, commented that the LCD market bottomed out in July 1996 and has since rebounded strongly. The rebound was tied to accelerating sales of laptop PCs, which resulted from several factors:

- Laptop PCs reached the critical price of $2000.
- Batteries and LCDs got better.
- Hard-drive capacity and CD-ROM integration caught up with the requirements of Windows 95.
- The price gap between a laptop and a desktop computer narrowed from about $1000 to about $500.

Wakabayashi predicted that one-third of the LCD market will be in monitors by 2005, and that the price of a 21-in. LCD monitor will equal that of an equivalent CRT monitor in 1999. This last prediction raised some eyebrows, but it is consistent with predictions made by the Philips CRT group at Euro-Display last October.

The new fabs coming on line in late 1998 and in 1999 would convert the current undersupply of 12.1-in. AMLCDs to an oversupply by the year 2000 in the absence of an LCD-monitor market, but Wakabayashi believes there *will* be a monitor market and that the undersupply of 12.1-in. AMLCDs will therefore continue. Nonetheless, says Wakabayashi, the AMLCD business has an inherent 2-year cycle as panel sizes and fab generations succeed each other with necessarily awkward interactions.

At the Display Works Business Conference, sponsored by USDC on Tuesday, January 28th, Hidehiko Katoh, General Manager of NEC Corporation's Electronic Development Division, discussed "NEC's Flat Panel Display Development Strategy." In 1977, NEC proposed its "C&C" concept, which was that the merging of computers and communications would drive electronic and display development. The concept pointed the way to what is now known as the multimedia society, and has been an invaluable strategic tool. NEC projects that the size of the electronic-display market will continue to grow along with the development of multimedia.

In LCDs, NEC will focus on TFT types covering the notebook, monitor, and automation/consumer markets. The focus of future product development will be the "Super-Fine TFT," NEC's name for its very-wide-angle AMLCD technology. The company currently makes 10.4-in. VGA, 14.1-in. XGA, and 20.1-in. SXGA "Super-Fine" models, and is planning a large-screen UXGA version for the future. Notebook-PC displays include 11.3-, 12.1-, and 13.3-in. models.

In PDPs, NEC has been operating a 2000-unit-a-month prototype line at its Tamagawa plant since June 1996, and started construction on a larger-volume facility in Kagoshima in October. Production in Kagoshima is slated to begin at 10,000 40-in. units per month in April 1998 and increase to 30,000 a month. NEC was expecting to ship a 42-in. TV display in February 1997.

In a conversation following the presentation, Sham Rayan, Senior Engineer for consumer systems engineering at AST Computer, observed that 65% of the cost of a CRT monitor is in the CRT and 35% is in the electronics and plastic. But in an LCD monitor, 95% of the value is in the panel. Therefore, there is no place for a monitor maker to add value, and it will get worse as more and more electronics is integrated onto the display substrate. Katoh agreed.

In a late-morning panel discussion, Ross Young, President of DisplaySearch, noted that 24 new LCD fab lines are scheduled to be built over the next 3 years. That makes a

Luxell

Fig. 3: Luxell was showing its sunlight-readable monochrome TFEL displays, which feature a proprietary internal "black layer" internal interference structure for suppressing reflections without external filters.

panel surplus all but inevitable once these lines are producing with reasonable yield – unless a substantial LCD-monitor market develops. How quickly that market is likely to develop remains unclear. Sales forecasts for 1998 range from 200,000 to 2 million, said Young. Well, what's an order of magnitude among friends?

Chuck McLaughlin, President of the McLaughlin Consulting Group, cited a study he had done showing that CIOs responsible for the purchase of a thousand or more monitors would pay a premium for AMLCD monitors having image quality equal to that of CRT monitors. However, the perception of most of these CIOs is that AMLCD monitors are *inferior* to CRT monitors in virtually all parameters. Perception is trailing the reality, said McLaughlin, and some good public relations is required. McLaughlin went on to say that miniature displays have very interesting potential in the U.S. and Asia and that rear-projection monitors using miniature displays should appear next year.

A lively question period followed the panelists' presentations. One questioner asked why manufacturers can't agree on third- and fourth-generation substrate sizes. Answer: because everybody is looking for a competitive advantage by optimizing substrate size for their favored panel dimensions. And a comment from the floor: There is a fundamental mismatch between the typical laptop-model life cycle (about 3 months) and the typical AMLCD development time (about 2.5 years).

Economist Bill Finan of Technecon Analytic Research, Inc., one of the panelists, noted that standardization may benefit makers of manufacturing equipment and laptop computers, but LCD manufacturers do not yet see standardization as being in their best interests. From the floor, Samsung's Tom Striegler commented that because each substrate size has a "sweet spot" for one or more panel sizes, standards for substrate size are *not* necessary.

The conversation wandered to the questions of why high-volume AMLCD manufacturing is almost exclusively an Asian business and why third-generation lines are seemingly being implemented slowly. Byron Walker: "U.S. capital is known to be impatient." Ross Young: "The first third-generation players in Japan will make a lot of money."

After lunch, Tei Iki, Senior Vice President, Display Systems, Sony Electronics (San Diego) delivered an entertaining and information-rich talk, "The Coming Battle of CRTs vs. FPDs." "The display business," he said, "is a service industry that delivers information to the user. The user therefore pays for the value of the service rather than the cost of the components that go into the display."

In 1996, said Iki, the number of Sony monitors sold exceeded the number of CPUs sold by 300,000. The difference was primarily due to people buying CRT monitors to go with laptop computers. (As a result, Sony sold more monitors than they had projected.) What the world wants, said Iki, "is a flat display that performs like a CRT for a CRT price."

In 1996, 220 million CRTs were sold worldwide for $20 billion, and the revenue from computer monitors exceeded the revenue from TV receivers for the first time. The well-developed infrastructure, said Iki, "makes it possible to compete in this crazy business." How crazy? The typical monitor has 1200 electronic parts, 90% of them made on the Pacific Rim. And a finished monitor or TV receiver costs about twice as much as the CRT that's in it.

"I think you have to make things to innovate," said Iki. "Materials cost is the key." "I don't think FPD makers want to compete with CRTs: Why would anybody in their right mind want to get into this kind of business?" Iki concluded by saying we should be putting priority on integrating CRT and FPD technologies, not talking about battles between FPDs and CRTs.

In "The Changing Needs of the Military Customer," Robert Michaels, Section Head of the Advanced Displays Group at Honeywell, noted that the U.S. Department of Defense estimates it will buy 60,000 FPDs over the next 5 years for cockpit displays. In regard to helmet-mounted displays (HMDs), Michaels said that the U.S. is a bit behind some European countries in implementing these displays in weapons systems.

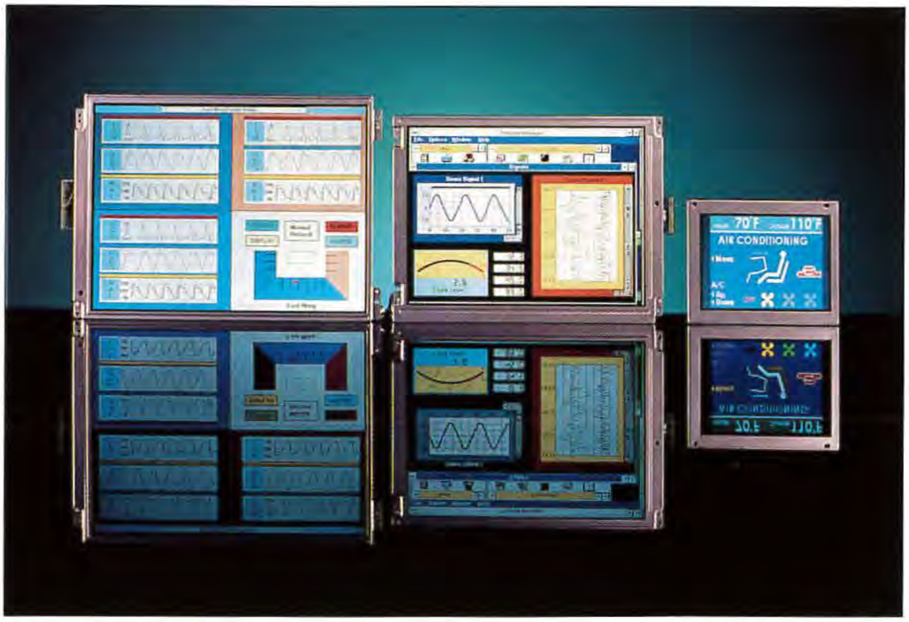
CRTs are currently the most common display in avionics HMDs, but it is hard to maintain brightness when converting from stroke to raster. This probably makes AMLCD the display technology of choice. The military needs 3000–5000 fL minimum with high resolution and wide field of view (FOV), and pilots don't want to trade resolution for color. Field-sequential color is a possible avenue, but response time and image break-up are concerns. Subtractive color may be the solution.

Although AMLCDs look good for HMDs for the near term, they will be resolution-limited by FOV. The ultimate solution may be an emissive HMD or even a retinal-scan display. Laser-threat weapons – weapons designed to blind the pilot – may require a completely closed cockpit and a 360° projector.

AWACS planes currently use a 19-in. CRT monitor that has been a disaster. The mean time between failures (MTBF) is 300 hours, and the non-U.S. vendor is withdrawing from the business, said Michaels. The DoD would like to replace this monitor with a multi-use device being called the Common Large Area Display (CLAD), and AWACS requirements alone amount to over 500 displays this year. Target specifications are 21-in. diagonal, 1280 × 1024 pixels, 24-bit color, and 200-W power consumption for the Air Force version (125 W for the Navy version). An FPD is preferred, but a projection display would be considered. One limitation is that the Air Force would like the CLAD to survive decompression at 40,000 ft.

The Navy would like its own FPDs. PDPs of 21 and 30 in. are currently being tested on submarines, and the Navy would like displays larger than 30 in. There is a 60*g* shock requirement for these displays so that they can survive torpedo attacks. The NSSN new attack submarine is to incorporate 75 displays of various types.

The DoD estimates it will need about 14,000 command-and-control displays. In general, the military wants to leverage commercial products, said Michaels, but managing the commercial off-the-shelf (COTS) *vs.* custom decision requires careful thought. "How," for example, "do you support long-term military programs with rapid-turnover commercial products?"



Planar

Fig. 4: Planar introduced its new ColorBrite™ AMLCD family. Left to right: 12.2-in. SVGA, 10.4-in. VGA, and 5.5-in. quarter-VGA.

The Technology Program

The Manufacturing Technology Conference at Display Works, sponsored by the Society for Information Display, kicked off with three closely coupled keynote addresses. All three speakers discussed the lessons learned from starting a display company. James McGroddy of IBM discussed the creation of DTI – the highly successful IBM-Toshiba joint display-manufacturing venture – and he discussed it in surprising detail. A significant contribution to DTI's success was the care taken in dealing with cultural differences.

Charlie Hoke discussed the development of a free-standing display company, and drew an analogy between the human body and his LCD company, Standish Industries. Finance is the heart, said Hoke, without which nothing else can survive.

Malcolm Thompson, President and CEO of dpiX, discussed the lessons learned from spinning off his company from Xerox. The Xerox new-venture model gives employees an equity stake in the new company, and also provides the option of reabsorbing the company as a Xerox operating unit if that makes sense in the future. If the company is reabsorbed, the employee-stakeholders continue to receive equity-based compensation, much as if the company had stayed independent.

The Rugged Display Roundtable, new this year, provided the organizers with a substantial surprise, said Roger Ellis of FED Corp., the Conference Chair. "We expected 20 people on Tuesday evening," said Ellis, "and we got over 200. It was a very lively, interactive session, and after the scheduled 2 hours people broke up into smaller groups and talked for an hour more!"

At the roundtable were DoD representatives, integrators such as SAIC and Kaiser, and suppliers such as dpiX and OIS. One of the most lively topics of conversation related to just how far COTS can be pushed, and when it is necessary to design a custom part.

Next year, the organizers will build on the roundtable's success and expand it into a full-fledged technical session under the chairmanship of Ellis and Rex Tapp of OIS.

An associated event on Thursday morning was the Large Display Integrators Forum sponsored by Fujitsu Microelectronics, which drew 58 people. Panelists Burt Hashizume of Pixel Vision, Stewart Hough of Fujitsu, Chuck Branch of SAIC, Peter Marcus of Quadritton Flatscreen Technologies, and Tim Shea of Pixelink discussed target markets, product features, power consumption, packaging, performance, lifetime, pricing, customer acceptance, and distribution. Marcus announced the imminent introduction of Quadritton FlatScreen™ Television (QFTV) with a Fujitsu plasma panel at New York's upscale Hammacher Schlemmer department store. Quadritton's limited Signature Series, which is exclusive to Hammacher Schlemmer, includes tuner, speakers, and special stainless-steel case. The 21-in. model (Fig. 1) will retail for $15,000, the 42-in. model for $25,000. A 42-in. model for more general distribution will carry an MSRP of $16,000-plus, depending on options and features. Quadritton's plasma television set is the first to be available through retail channels.

Onto the Show Floor

There were 152 exhibitors occupying 197 booths (up from 192 in 1996). The show had more exhibitors overall but fewer display manufacturers, so the character was more that of a manufacturing show than a vertical one. There were 1840 attendees, but after Tuesday morning traffic often looked light. Nonetheless, most exhibitors reported being at least reasonably content with the number of high-quality contacts.

Many of the display makers who exhibited at the "Display Fireworks" exhibit in the lobby or on the main exhibit floor were showing large displays. (See the accompanying article, "Big Screens at Display Works 97," by Alan Sobel.)

On the relatively small display front, ***NEC*** introduced a 10.4-in. 262,000-color 180-nit VGA display using the Super Fine Technology™ (SFT) used in its 20.1-in. display with very wide viewing angle. The unit is intended for industrial control, instrumentation, and medical applications. Said NEC's Omid Milani: "NEC is reinforcing its commitment to the 10.4-in. market by introducing the latest technology in that size."

NEC will have its third-generation fab installed in July, and expects to have its fourth-generation fab operating about 2 years after that. The probable fourth-generation size is 900 × 950 mm, which will permit four-up fabrication of 20.1-in. displays, said Milani.

PC Video Conversion introduced its VIDisplay 640 interface that accepts composite (NTSC, PAL, and SECAM) and Y/C (S-VHS) inputs and shows them as high-quality video on LCD panels (Fig. 2). Interface boards are currently available for FPD Corp., Toshiba, Sharp, and Goldstar VGA panels; $995 each, $600 each in lots of 1000. A complete development kit, including an AMLCD, is available for $2995.

MRS Technology was happily announcing the sale of a 5200HR PanelPrinter to a non-display customer, SciTex Digital Printing, which will use it to make the print-head orifices for its commercial-quality ink-jet printers. Now that the DARPA contract funding development of the new-technology Model 7000 PanelPrinter has expired, MRS has reduced the pace of 7000 development and is applying the fruits of 7000 R&D to the current line. The benefits will include increased throughput and the accommodation of larger substrates, said Mark Lucas, VP of product marketing. Lucas feels MRS will now be able to pick up the sales they need in the U.S., and expects to benefit from Taiwanese and Korean ramp-ups.

Photon Dynamics is happy with the sales of its in-line panel inspection and repair equipment, mostly to Asia. Eighty percent of last year's sales were to Korea and Japan; it will be 90% this year. "The aggressive Korean expansion will continue," said VP Alan Nolet. "The key to continued success in the Asian market is to provide stellar support in an acceptable cultural fashion: Give it to them in *their* culture; don't force them to negotiate yours." Nolet was excited about Photon's new blended laser beam that permits, for example, one-step repair of an integrated stack.

Nolet wondered aloud why, "in the face of a shortage of supply [of AMLCDs], prices are going down," and buttonholed Rick Knox, Compaq's manager of portable technology, for an analysis. Said Knox: "All manufacturers forward-priced in anticipation of yield improvements, etc., that didn't quite materialize. Prices will now firm up."

New exhibitor ***Luxell*** of Mississauga, Ontario, Canada, was showing its good-looking new sunlight-readable military/industrial/aerospace monochrome TFEL displays, which feature a proprietary internal "black layer" internal interference structure for suppressing reflections without external filters (Fig. 3). The structure was developed in collaboration with the National Research Council of Canada (NRC). The company has received a development contract from Lockheed Martin for an avionics data-entry panel using the display, and expects to win a $3 million (Canadian) initial production contract when development is complete, said CEO Brian Kennedy. The company will be working with the NRC on developing color organic EL displays.

Westaim of Fort Saskatchewan in Alberta, Canada, was showing the good-looking thick-dielectric EL (TDEL) alphanumeric modules first shown at EID/EuroDisplay last fall. It is tempting to think of Canada as becoming "EL North," even though Fort Saskatchewan and Mississauga are separated by 1500 miles and cultures that are as different as Denver's and Boston's. Still …

Sharp was showing their 40-in. tiled SVGA AMLCD described by Alan Sobel, but senior applications engineer David Blass also wanted to talk about 15-, 17.7-, and XGA 21-in. passive displays. The 15- and 17.7-in. displays are "being positioned as low-cost monitor solutions," and have faster response than previous STN displays. Currently, there is a choice of 100-ms response with a 35:1 contrast ratio (CR) or a 300-ms response with a 50:1 (CR). By fall, there will a 150-ms unit with 45:1 CR, and wide-angle viewing will be available in Q4. Sharp, said Blass, feels that a large segment of the monitor market needs low price more than it needs the best possible performance.

TMA was showing Liquid 1.2, its soup-to-nuts LCD-simulation software and revealing its plans to introduce version 1.3 by March. Autronic-Melchers showed its new DIMOS LCD Workbench and Toolset for LCD simulation and optimization under Windows 95 or NT. The package now includes a pretilt-angle evaluation system.

Progressive System Technologies (PST) was showing its "PST generation 2 cassette designed to USDC specifications." The cassette reduces the sag of third-generation (650 × 550 mm) plates from as much as 11 mm to about 1 mm by supporting the plates closer to their centers, and USDC regards it as a significant advance in substrate handling. Andrew Bushong, a PST marketing and sales executive, said there is substantial interest in the new cassettes from a variety of sources, including Korea. PST's sales more than doubled from 1995 to 1996, with sales split about 50-50 between the U.S. and Asia. PST's sales are also split between the semiconductor and FPD industries, which provides increased stability, Bushong says.

SI Diamond's original 1994 plans to make laptop FEDs using emitting films of diamond-like carbon (DLC) within 3 years has proved overly ambitious. The company has regrouped under new management and demonstrated DLC FED lamps for outdoor displays at Display Works. The flat lamps were mounted at the tops of vacuum tubes, with the entire assembly looking remarkably like the old "magic eye" tuning indicators of the 1930s. These tubes were used because they are standard packages, said SI Diamond representatives, and will be replaced with flatter vacuum packages as product development proceeds. The lamps operate at 10 kV, with the green lamps producing 11,000 fL at 28 lm/W, red producing 2000 fL, and blue producing 5000 fL. Standard TV phosphors are used.

OIS was showing its 5 × 5-in. and 6¼ × 6¼-in. aerospace AMLCD modules with 64 gray levels. The 6¼-in. module has been designed into the Apache helicopter.

Quantum Data has introduced a 150-MHz video generator on a PC plug-in card for $1995. For more information, try www.quantumdata.com. ***TEAM Systems*** showed its new ASTRO VG-823 analog signal generator, "which offers a pixel frequency of 250 MHz that is compatible with tomorrow's 1600 × 1280 monitors," said TEAM's George Stoeppel. TEAM, too, has a PC-based video generator and a Website. Theirs is at www.team-systems.com.

MDC Vacuum Corp. was showing its impressive selection of vacuum products, fittings, and widgets for the semiconductor and UHV industries.

Virtual i-O's ***Virtual i-glasses*** was demonstrating its low-cost 3-D HMDs in the Display Fireworks show in the Convention Center lobby. This is the product that won Information Display's 1997 Display Product of the Year Award Honorable Mention. Lots of interest - and surprise at how good 180,000 pixels can look.

At the booth of the FPD repair firm ***Man & Machine***, Bruce Davis said the steadily increasing interest in AMLCD repair now seems to be extending to "the military/rugged-display side."

Planar Systems introduced its new family of ColorBrite™ AMLCDs for medical, industrial, and transportation applications (Fig. 4). The company will back the displays - which range from 5.5 in. ¼-VGA to 12.1 in. XGA - with a secure and reliable source of supply, customization services, and attentive customer support, said Curt Stevens, GM of Planar's Display Components Group.

Lam Research happily announced $10 million worth of new orders from Motorola and other companies for its Continuum™ plasma etch system. They had recently sold a system to FED developer Candescent. Lam's market is primarily in the U.S. now, but Lam President Way Tu expects that the company's market will soon be dominated by Asian companies. Tu expects to sell between 6 and 10 units in 1997 and between 18 and 30 units in 1998. Tu feels the scalability of Lam's technology - which permits convenient expansion to 600 × 720-mm substrates - is a big advantage.

dpiX introduced its Eagle-5 5 × 5-in. avionics display, which incorporates the quad-green subpixel pattern that produces sharper monochrome FLIR imagery. Also on display were the impressive 7-Mpixel 282-dpi 13.5-in. gray-scale monochrome display and its 1536 × 1120-pixel 4096-color cousin.

Wrap-up

Display Works 97 was a very rich - sometimes confusingly rich - event, consisting of contributions from its three sponsoring organizations: the Society for Information Display (SID), SEMI, and the United States Display Consortium (USDC). But the event's richness and special character depend on these three sources, according to technology conference chair Roger Ellis: "Display manufacturing is, after all, the bringing together of business and technology." SID provides the manufacturing-technology content and know-how about running a high-quality technical conference. SEMI contributes its infrastructure and close relationship with the semiconductor manufacturing-equipment community. And USDC contributes its special relationship with the display-manufacturing business and investment communities.

These interwoven threads are apparent to the organizers, said Ellis, but need to be made more obvious to attendees. As a result, the business and technology conferences, as well as the exhibits, will be more tightly focused on the "technology of display manufacturing," and "our view of manufacturing will broaden to include the manufacture of modules and display subsystems as well as panels," said Ellis. ■

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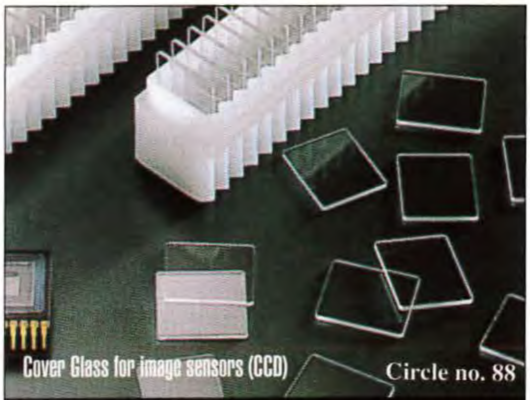

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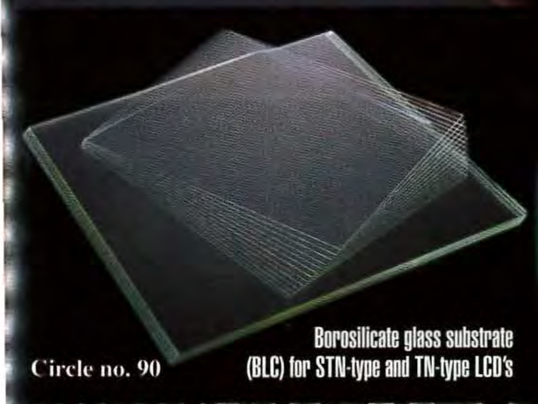

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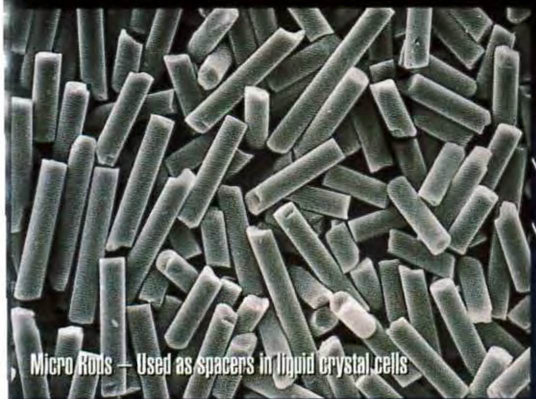

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conference report

Phosphors for Next-Generation Displays

FEDs, PDPs, CRTs, and EL all depend on phosphors – and the ones we have now are often not good enough.

by William K. Bohannon

THE SECOND ANNUAL International Conference on the Science and Technology of Display Phosphors was held at the Hyatt Islandia Hotel, San Diego, California, November 18–20, 1996 – unfortunately, the same week as the Las Vegas COMDEX, where the latest display devices using phosphors are shown.

The three-day phosphor conference was sponsored by the Phosphor Technology Center of Excellence (PTCOE), the Defense Advanced Research Projects Agency (DARPA), and the Society for Information Display (SID). This unique academic gathering was organized to discuss recent activities and future prospects for the phosphors used in electroluminescent (EL) displays, field-emission displays (FEDs), CRTs, and plasma displays, as well as in other devices, such as photoluminescent devices and EL devices for printer applications.

Almost 250 people – about one-half of them from outside the U.S. – attended the conference. In addition to listening to some very interesting tutorial and research papers, the attendees found time to explore some of the many tourist activities, such as a San Diego harbor dinner cruise – the conference's special event.

Wine and cheese was served as an inducement to linger over technical conversations at the poster session, so this event also combined business and pleasure.

Papers were presented that covered new phosphors; aspects of phosphor growth and synthesis; the characterization of phosphor structural, electrical, photoconductive, and optical properties; and process and surface-mechanical issues. In addition, papers covering the mechanisms of saturation, relaxation, and degradation were presented, along with papers covering material modeling and device parameters.

The conference was organized in a single track, with each session devoted to a particular topic or technology area. The morning of the first day featured a plenary session that presented a broad view of the field. The afternoon consisted of a "New Phosphor Developments" session and a Late-News Paper session, followed by the harbor dinner cruise.

The second day offered sessions devoted to EL phosphor mechanisms, devices, and materials. A poster session that was held in the evening was organized into four groups: plasma, organic EL materials, EL materials and devices, and FED phosphors.

The last day consisted of sessions devoted to FED phosphors: low-voltage properties,

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The Second Annual International Conference on the Science and Technology of Display Phosphors was held at the Hyatt Islandia Hotel on San Diego's Mission Bay.

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thin films, phosphor synthesis, and phosphor surfaces and coatings.

The First Day

The conference was opened by the Conference Chair, Christopher J. Summers, of the PTCOE and the Georgia Institute of Technology. Summers was followed by Bruce Gnade, the new program manager for High Definition Display System Engineering at DARPA, who gave an overview of PTCOE, its funding, and its activities. Gnade described how each year PTCOE has funded – with DARPA funds – 30–40 programs, professors, and studies directed towards phosphor research connected with industry needs.

The connection between PTCOE and these studies became clear during the conference as many of the presenters gave credit and recognition to PTCOE for support and assistance. Gnade also described the PTCOE-compiled database of FED phosphors and their characteristics. However, this database is only available to the institutional and associate members of PTCOE, who pay fees of $10,000 and $5000, respectively.

In the plenary session, William W. Beers of GE Lighting gave an overview presentation entitled "Fundamentals of Luminescence and New Plasma Phosphors." Dr. Beers described some of the results his team has achieved in its "arduous" effort to discover more-efficient materials. Next, Richard Tuenge of Planar Systems presented "Active-Matrix Electroluminescence and Color EL Displays." According to Tuenge, Planar has produced exciting miniature EL displays with 1000-lpi resolution that are suitable for head-mounted applications. But the development of full-color EL displays has been hindered by the lack of a blue phosphor with sufficient brightness and luminous efficiency.

At earlier conferences, Planar had shown a full-color EL display made with a filtered "white" phosphor. Tuenge described how pure blue emission without filtering has been demonstrated for cerium-activated thiogallate phosphors – but without the luminous efficiency required for commercial applications. AMEL devices need still higher blue-phosphor efficiencies and/or improved blue emission in the broadband phosphors used for the color-filter approach.

In "Organic Electroluminescent Materials and Devices," C. W. Tang of the Eastman Kodak Co. reported on some very exciting results for full-color thin-film organic EL materials that are "quite respectable" for display applications. Tang described a blue EL phosphor that has 2-lm/W optical efficiency and a long lifetime when made with an evaporated multi-layer structure.

A high-efficiency red-orange phosphor was also discussed by Tang, as were materials that produce other colors. One of the key items he described was the "tunable" nature of thin-film organic EL materials, where slight changes in the dopant-host combination can produce a wide range of visible colors.

Homer Autoniadis from Hewlett-Packard Laboratories gave a paper entitled "Inorganic versus Organic LED Displays." Organic LEDs (OLEDs) have great promise in allowing the creation of large, flexible, high-information-content (HIC) displays. One of the barriers that must be overcome, however, is the issue of drive electronics and their voltage-current requirements *vs.* OLED pixel density. Autoniadis discussed the goal of reducing the drive-voltage requirement to a level compatible with low-cost CMOS circuits.

Robert Meyer from CEA-LETI presented "Recent Advances in FEDs." Although FEDs have been the hope for the next "great" flat-panel-display technology, there are many difficulties to overcome before any real advances in the technology can be achieved. Meyer described the LETI-PixTech display work and stated that, given some recent improvements in FED performance levels, FEDs are now suitable for many small-size display applications. However, this commentator finds it hard to see a commercially viable niche given the vast quantity of cheap LCD-based displays that are available today – a hurdle also faced by other display technologies that would like a piece of the flat-panel pie.

The plenary session illustrated both the technical excellence the many distinguished speakers brought to the conference and their research perspective. Even though the conference and the PTCOE were established to promote phosphor research connected with the industry, only a few device or display manufacturers were in attendance. Perhaps the manufacturers' representatives had schedule conflicts, particularly with COMDEX. But some speakers complained privately that the phosphor materials they developed and spoke about had been tested by display manufacturers – but that these test results had not been shared or disclosed. The presenters were therefore in the position of announcing the results of their process and materials research and hoping that display manufacturers would hear and use the results, but whether or not they were listening is another question.

In this commentator's opinion, the continuing success of the phosphor conference depends upon the acceptance of the phosphor research community into the mainstream of the display development and manufacturing industry. The necessary acceptance by the display industry needs to be nurtured by the conference's organization committee in the same fashion that the conference committees for the big SID International Symposium have nurtured researcher-industry interaction and acceptance of the research side by other segments of the display community.

The sessions devoted to new phosphor developments and late news contained some interesting papers, such as "New Concepts for VUV Phosphors with High Quantum Efficiency," given by H. Donker and his colleagues, which described increased quantum efficiency in plasma-display phosphors through quantum cutting. Another paper, presented by Vaddi Butchi Reddy from Osram, showed the advantage of using layered phosphor structures called intercalation compounds.

A paper presented by T. Hisamune from Kasei Optronix showed that the utilization of $Ba_{0.6}Al_2O_3$:Mn can give plasma displays a much better green color without sacrificing brightness. In "A New Material for Thin-Film Low-Voltage Blue Phosphors," a group from Rochester, New York, described thin films of $Ta_2Zn_3O_8$ made by incorporating Ta (or other metal ions) in ZnO films. This material showed a good low-voltage cathodoluminescence response peaking at 400 nm. The authors feel that these materials will offer tremendous potential for low-voltage FED applications.

Mark Phillips from Sandia National Laboratories reported on his team's method of creating good low-voltage phosphors by using quantum-confined semiconductor intercalates. These quantum-confined structures are clusters of 5–8 atoms arranged in extended networks within host oxide lattices. These extremely small structures exhibit luminescence characteristics that differ markedly from the bulk material. According to the Sandia team, one of the most remarkable results is that both the CL and PL excitation of $Sr_4S(AlO_2)_6$ yielded deep-blue emission.

The Second Day

The fact that more than 26 papers were given on EL phosphors and devices is a clear indication of the continuing popularity of EL displays among the scientific community. Perhaps this is also an indication of how interesting EL phosphor work can be, rather than how rewarding or commercially successful EL displays are today. But given the recent advances in EL materials, particularly the organic versions, commercial success may be near. There is not enough space to give every EL paper a substantial review, but here are a few.

"Electroluminescent Edge-Emitter Technologies," a very interesting invited paper given by Gerd O. Mueller of Hewlett-Packard, described the construction of an EL edge emitter using principles usually reserved for laser diodes, work that has applications to high-speed high-resolution printers.

According to another interesting paper, "Time-Resolved Electro-Optical Characterization of ZnS:Mn in the AC Thick-Dielectric EL Device," presented by P. Bailey from the Westaim Corp. in Fort Saskatchewan, Canada, glass-substrate TFEL devices experience problems during high-temperature fabrication and also have the potential for catastrophic breakdown of the thin-film insulators. Westaim researchers have solved these problems by using ceramic substrates along with a special composite thick-film dielectric layer.

In "Microcavity Effects in Thin-Film Electroluminescence," Regina Mueller-Mach reported on work done by her team at Hewlett-Packard Laboratories. This paper, like the one presented by Gerd O. Mueller, appeared to combine EL phenomena with laser-diode construction, but instead of using an edge-emitter technique Mueller-Mach's team used a vertical-cavity construction. Just like vertical-cavity lasers, the EL device's emission beam profile was narrowed in the micro-cavity EL devices (MiCELs). The narrow beam allows for more-efficient optical coupling with printers or other optical systems.

"Ga-Rich CaGaS:Ce as a New Blue Electroluminescent Phosphor," by A. Kato and his associates from the Denso Corporation's Research Laboratories in Aichi, Japan, reported on efforts to advance full-color EL-display technology. The Denso team's goal was to develop a bright blue EL phosphor. Ga-rich CaGaS:Ce thin films, where the Ga/Ca ratio was between 2.5 and 4, were grown by MOCVD. The new film emitted a deeper blue than ordinary films, with a luminance of 2 cd/m^2 at 40 V.

Among the other good EL papers were "Local Ce Environments and Their Effects on Optical Properties of SrS and $SrGa_2S_4$ Phosphors," by W. L. Warren and his colleagues at Sandia National Laboratories, and "Growth Kinetics and Characterization of $SrGa_2S_4$ Films Prepared by Deposition from Binary Vapors," by a team from Tottori University in Japan.

The Third Day

There were fewer papers presented on FED phosphors than on EL phosphors - and less than the number given last year. But there were still many interesting FED developments reported.

Aron Vecht's invited paper "New Low-Voltage Phosphors" summarized the specific FED phosphor requirements pertaining to the three main voltage regimes: 0–300, 300–3000, and over 3000 V. Then he further divided the phosphors for both powdered and thin-film FED devices into two categories: oxides and sulfides. In the oxide group, Vecht and his associates have studied the yttrium-oxide/niobium-oxide system using bismuth dopants to create a blue FED phosphor with an efficiency greater than 0.5 lm/W. In the sulfide group, Vecht's team has investigated europium-activated strontium gallium sulfide for a high-efficiency green and a barium zinc sulfide phosphor doped with manganese for red. In conversation, Vecht stated that if even a fraction of the money spent on producing LCDs could be directed towards FED phosphor research, then the FED could become a commercially viable display. Without that kind of commitment, Vecht said, it might take so long to develop FEDs that they will not be able to overcome the market momentum of other display technologies.

In "Low-Voltage Properties of Y_2O_3:Eu FED Phosphors," a team from PTCOE studied the red europium-doped phosphor under a range of europium concentrations to identify the factors affecting luminous efficiency, saturation, and other characteristics.

Additional interesting papers were:

- "The Efficiency of Green Cathodoluminescence in ZnO at Low Electron Energies" by a team from Sandia National Laboratories and the University of Greenwich
- "New Phosphors in the $SrS-Sc_2S_3$ System Doped by Europium" by a team from the National Academy of Science of Ukraine and the University of Florida
- "Synthesis of CRT/FED Phosphors" by a team composed of people from Toshiba and the Neutren Company in Japan.

The Third Annual International Conference on the Science and Technology of Display Phosphors will be held November 3-5, 1997, in Huntington Beach, California. That conference is likely to be as large and as lively as this one, but I hope we see more application papers from device manufacturers. This would demonstrate that researchers and industry people are working together to create the next generation of displays. More important, it would bring us that new generation of displays more quickly. ■

3 97

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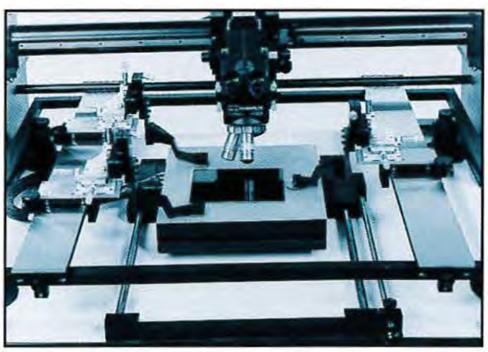

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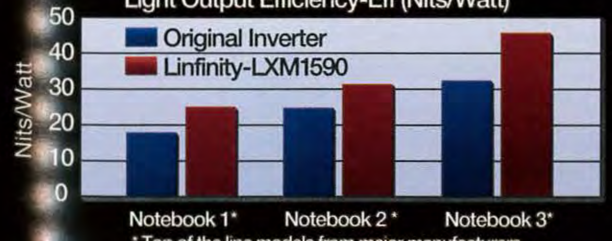

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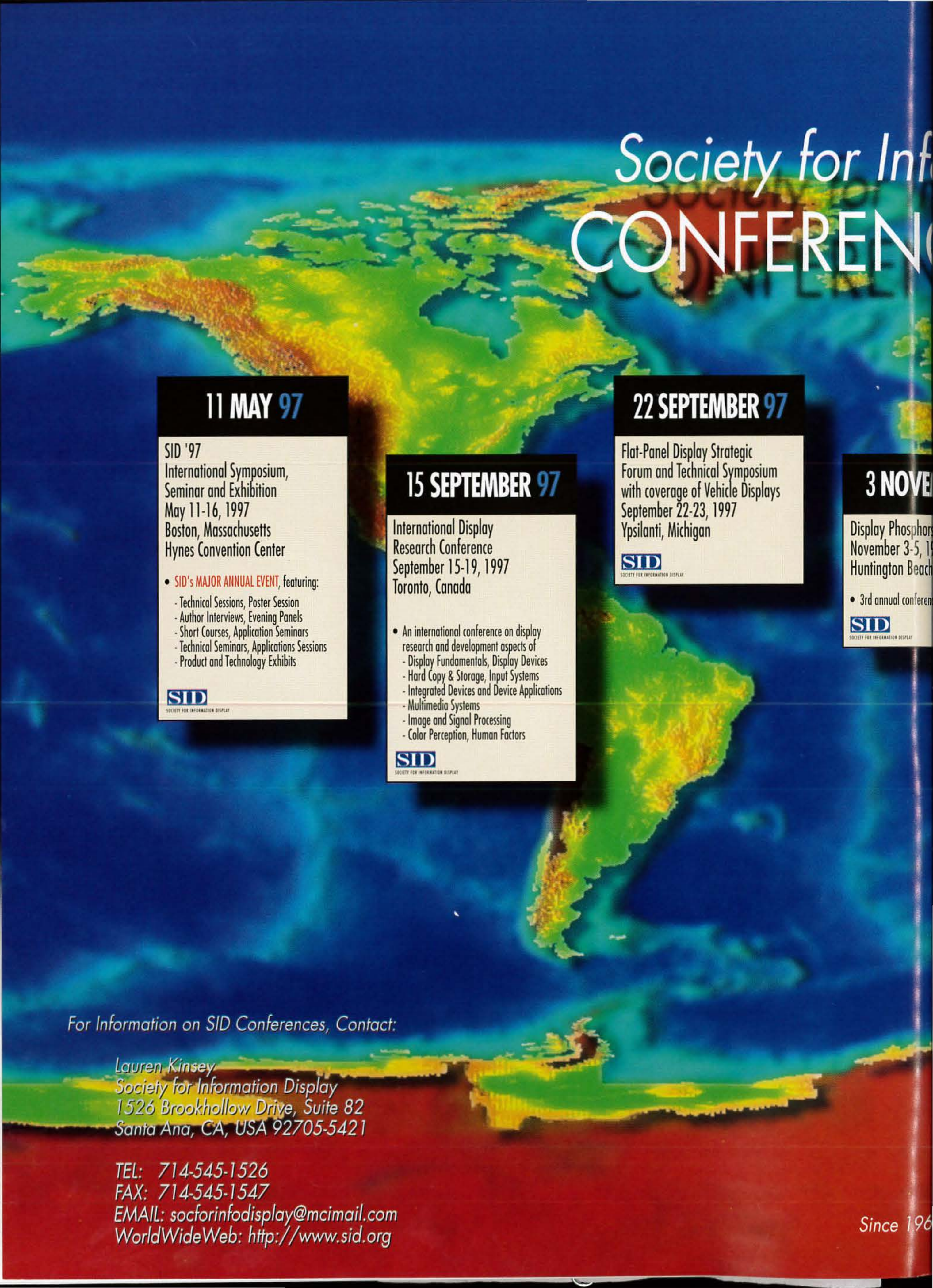
See Us at SID '97 Booth 819/821

Circle no. 98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Thurs.: 9:00 am - 2:00 pm
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Products on Display at SID '97

Some of the products on display at SID's largest exhibition ever are previewed.

by THE EDITORIAL STAFF

THE SID '97 International Symposium, Seminar & Exhibition will be held at the Hynes Convention Center in Boston, Massachusetts, the week of May 11. For 3 days, May 13-15, leading manufacturers will present the latest displays, display components, and display systems. To give you a preview of the show, we invited the exhibitors to highlight their offerings. The following is based on their responses.

APPLIED FILMS CORPORATION
Boulder, CO 303/581-5444
Booth 1110

Sputtering equipment/thin-film coatings

Applied Films will offer a complete line of in-line sputtering equipment and thin-film coatings, including SiO_2 and ITO-coated glass substrates, for the flat-panel-display industry. Their conductive coatings and sputtering systems are presently used for plasma, electroluminescent, field-emission, organic LED, and electrochromic displays, as well as in other markets.

Circle no. 1

AST PRODUCTS
Billerica, MA 508/663-7652
Booth 1113

FPD surface-analysis system

AST Products will display the VCA-4000™, an FPD surface-analysis system providing quantitative assessment of surface properties by measuring the tangent angle created at the interface of a liquid and a solid. The system was designed for analyzing the surface of a flat panel during various stages in the processing cycle, such as cleaning, coating-process assessment of HMDS priming, and quality-control checks. The imaging software displays the droplet and automatically calculates the contact angle and droplet properties, which can be analyzed, stored, and printed.

Circle no. 2

ASTRA PRODUCTS
Baldwin, NY 516/223-7500
Booths 100/101

Edge-lighting panels

Astra Products will display Clarex® HSOT panels for edge-lighting applications. Highly scattered optical-transmission (HSOT) panels convert the incident beam to very homogenous illumination, yielding a 50% increase in luminance while eliminating the need for conventional diffuser film or printed dots. HSOT samples for other applications will also be on display.

Circle no. 3

AVED DISPLAY TECHNOLOGIES
Tustin, CA 714/573-5035
Booth 709

Multiple-frequency analog controllers

AVED Display Technologies will introduce the AV-ANLG-MS family of multiple-frequency analog controllers that take in analog RGB from any graphics card, workstation, or embedded controller and drive AMLCD panels. The controllers support 3.3-V CMOS, 5.0-V CMOS, 36-bit CMOS, and LVDS panel interfaces, and 640 × 480, 800 × 600, and 1024 × 768 panel resolutions with 16 million colors. Spatial-temporal modulation provides extended gray shades on 18-bit panels. Other features include multiple-frequency operation, plug-and-play compatibility, advanced sync detection, remote video gain control and contrast adjustments, and monitor bypass output.

Circle no. 4

BALZERS THIN FILMS
Golden, CO 303/273-9700
Booths 430/432

Cube for projection displays

Balzers Thin Films introduces the new ColorCube™ for color separation/recombination in projection displays. A newly developed high-volume manufacturing process, including Balzers' patented proprietary sputtering deposition, results in highly reliable cubes with excellent angle accuracy and minimal centerline induced effects. Flexibility in product configuration is also now possible with Balzers' unique production process. The new ColorCube™ is just part of the total light-management solution for projection displays which includes dichroic color-separation filters, hot and cold mirrors, broadband polarizing beamsplitters, and cold light mirror reflectors.

Circle no. 5

BREAULT RESEARCH ORGANIZATION
Tucson, AZ 520/721-0500
Booth 105

Illumination software

Breault Research Organization will feature ASAP, an advanced systems-analysis program offering comprehensive source-modeling capability that provides everything from serpentine fluorescents to LEDs to polychromatic volumetric emission from arc lamps. The illumination software handles micro-optics for backlit displays, complex dichroics for projectors, as well as polarization and scattering effects. ASAP's non-sequential ray-trace algorithm is one of the fastest on the market. Photometric performance can be evaluated anywhere in end-to-end models. ASAP possesses a bi-directional CAD translator and IGES export utility.
Circle no. 6

BRITEVIEW TECHNOLOGIES
Holland, OH 419/868-7290
Booth 213

Flat collimated backlighting systems

BriteView Technologies will exhibit flat collimate-based backlighting systems, including a highly collimated extremely high-brightness backlighting system that uses a stacked light-pipe (use up to eight CCFLs) technology and a dual-mode (day/night vision) backlighting system. A transparent front-lighting system is also made for reflective-type displays. A highly efficient and very uniform backlighting system using LEDs and miniature incandescent lamps will also be exhibited.

Circle no. 7

CFM TECHNOLOGIES
West Chester, PA 610/696-8300
Booths 1009/1011

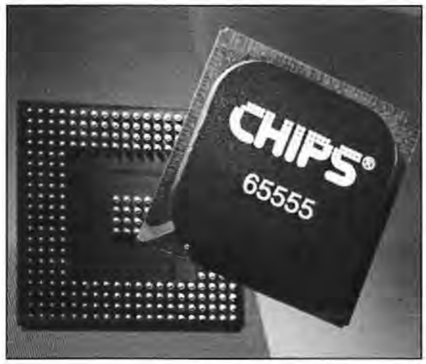
Wet-processing system

CFM Technologies will feature the FPD Full-Flow™ system, a wet-processing system that performs cleaning, etching, stripping, and drying of various sized flat-panel displays in one integrated, fully automated system. The equipment is easily adaptable to next-generation panel sizes with a typical throughput of 100 plates/hour. The single-chamber design eliminates plate movement during processing, minimizing handling concerns. The system uses a totally enclosed processing vessel for high performance and produces plates without watermarks or other drying defects.
Circle no. 8

CHIPS AND TECHNOLOGIES
San Jose, CA 408/434-0600
Booths 1005/1007

Flat-panel graphics controllers

Chips and Technologies will feature the HiQVision™ (68554) and HiQVPro™ (65555) mobile/desktop graphics accelerators used as the first flat-panel graphics controllers designed for both desktop and notebook computers. With advanced multimedia capabilities, the HiQVPro™ accelerator also drives images and text on TV sets with reduced flicker.



Circle no. 9

CLINTON ELECTRONICS CORP.
Loves Park, IL 815/633-1444
Booths 600/601

Medical-imaging CRTs

Clinton Electronics will feature their expanded line of medical-imaging CRTs, including a new high-performance 20V (21 in. on the diagonal) CRT for radiology read stations, a 17-in. 90° CRT targeted at referral and primary care for smaller form factors, and a custom 7-in. precision optic CRT for photo imaging or specialized displays. The microprocessor-based Digital Series monitors now includes the new High Brite Medical DS2000HB, rated at 65 fL nominal with a peak luminance of 100 fL. The DS2000HB retains the full multi-frequency of the DS series for system compatibility with industry-standard video cards.

Circle no. 10

DISPLAY LABORATORIES
Boulder, CO 303/938-9099
Booths 1000/1001

CRT-monitor controller

Display Laboratories will demonstrate SoftOSD™, a convergence and geometry control program that once loaded onto a PC can be executed at any time. Using the DDC2B+ specification protocol over a video cable, adjustments to geometry and convergence of a CRT can be done in real time. In its initial release, several popular makes of monitors will be supported. SoftOSD eliminates the need for expensive OSD chips and can be used on any supported monitor.
Circle no. 11

DOLCH COMPUTER SYSTEMS
Fremont, CA 510/661-2220
Booth 429

Rugged flat-panel systems

Dolch Computer Systems will feature rugged NEMA-4/12 environmentally protected flat-panel monitors and network-ready workstations. These all-metal systems are based on active-matrix TFT FPD technology combined with Dolch's proprietary AutoSync™ analog video adapters. Bright and crisp 10.4–16.1-in.-diagonal displays are offered in resolutions from VGA to SXGA, and all are available with touch screens. Dolch monitors are designed to work with conventional analog video cards without special interfacing. Workstations are equipped with Pentium processors to 200 MHz, including on-board Ethernet and PC/104 expansion in addition to the normal serial and parallel ports. All systems offer panel, pedestal, and OEM mounting configurations.

Circle no. 12

SID '98
Anaheim, California
Anaheim Convention Center
May 17–22, 1998

EATON CORP.
Danvers, MA 508/524-9350
Booth 231

Flat-panel ion implanter

Eaton Corp. will feature the ORion NV6072, an ion-implantation system that addresses the challenges of low-temperature TFT manufacturing. The NV6072 combines ion-implantation technology derived from the semiconductor industry with a new patented ion source and state-of-the-art panel handling and cooling to provide flat-panel manufacturers with expanded process capability, enhanced process control, and low cost of equipment ownership.

Circle no. 13

ELDIM
Caen, France +33-2-31-94-76-00
Booth 217

Automated LCD-measurement system

ELDIM will feature the EZContrast AX 160D, a fully automated LCD-measurement system designed for instant testing of any LCD panel up to 22 in. on the diagonal. The system measures luminance, contrast, and color coordinates as a function of viewing direction. It can analyze gray-level inversion, evaluate color shift, measure flicker and response time, and perform uniformity testing – all from any viewing direction. The AX 160D includes the latest EZMotion XYZ tables, sample illumination system, and automation and analysis software. Performance levels include a ±80° incident-angle range, a 0–360° azimuth-angle range, a measurement step down to 0.2°, and a measurement time of 3–4 s for full luminance measurement at an accuracy better than 3%. The full nine-point measurement speed is less than 3.5 min.
Circle no. 14

ENDICOTT RESEARCH GROUP
Endicott, NY 607/754-9187
Booth 319

Inverters for dual-CCFT LCDs

Endicott Research Group will feature their K Series of low-cost compact dc-to-ac inverters that power backlit LCDs having two CCFTs. The inverters' dual-output connectors permit a single K Series inverter to power two separate CCFT tubes in synchronization, eliminating the need to use separate inverters to light each tube. Multiple dimming options are available. The low-profile K series are less than 8 mm in height and are priced at less than $8.00 each in OEM quantities.

Circle no. 15

FAS TECHNOLOGIES
Dallas, TX 214/553-9991
Booths 1129/1131

Coat and bake system

FAS Technologies and Tokyo Ohka Kogyo Co., Ltd., will introduce the Extrude & Spin (E&S) Coat and Bake System, which combines extrusion coating with conventional spin coating. Moving over a large-area substrate, such as a third-generation display glass, an extrusion head applies thin-film coatings of color filters, photoresists, polyimides, and other polymers onto the entire substrate surface; a brief spin cycle then provides final uniformity. Proven feasible for phosphors, E&S should interest both FED and PDP manufacturers. Unlike conventional spin coaters that produce 95% material waste, E&S decreases material consumption by 75%; furthermore, required spin time decreases to provide higher throughput.
Circle no. 16

GERBER SYSTEMS CORP.
South Windsor, CT 860/648-8024
Booth 944

Direct-write laser systems

Gerber Systems will feature the MaskWrite 800 and 1550 large-area high-resolution direct-write imaging systems, utilizing raster technology to image on film, glass, and other photosensitive-type plates. Both imagers are used for producing lead frames, flat-panel displays, shadow masks, as well as for any other application requiring high-precision high-resolution images. The MaskWrite offers an interchangeable write head with a selection of four lenses. Each lens offers a different resolution and feature size to meet the needs of the application. The MaskWrite 800 imager supports a maximum 800 × 610-mm glass plate, while the MaskWrite 1550 supports up to 1550 × 1100-mm glass plates.

Circle no. 17

GRASEBY OPTRONICS
Orlando, FL 407/282-1408
Booth 528

Tri-stimulus colorimeter

Graseby Optronics will feature the SLS 9400, a tri-stimulus colorimeter designed to provide lab-grade accuracy and precision at an affordable price. Its unique proprietary sensor design closely mirrors the CIE tri-stimulus curves, resulting in highly accurate color measurements that are independent of the phosphor type under test. Ergonomically designed to rest comfortably in one hand, the SLS 9400 operates from simple menu-driven commands. Measurements can be displayed in either RGB bargraph mode, CIE chromaticity graph mode, or CIE numerical mode on the large backlit graphics display. Remote operation is possible via an RS-232 port and Graseby's software, which is available as an accessory.

Circle no. 18

Please send new product releases or news items to Joan Gorman, Departments Editor, Information Display, c/o Palisades Institute for Research Services, Inc., 201 Varick Street, New York, NY 10014.

HOFFMAN ENGINEERING
Stamford, CT 203/425-8900
Booth 136

Virtual instrument interface

Hoffman Engineering will demonstrate the PCO-2000, a computer data acquisition system replacement for the original electronics console provided with the 1980A photometer. Utilizing a customer-supplied computer and the 1980A photometer head, the PCO-2000 provides a virtual instrument interface. The system software stores all correction factors, calibration defaults, and test configurations. Because it is PC-controlled, all calculations for color temperature, color coordinates, tri-stimulus values, and contrast are automatically performed. Data is stored in a Microsoft® Access database format to allow data manipulation and report generation.

Circle no. 19

HOLOGRAPHIC LITHOGRAPHY SYSTEMS
Bedford, MA 617/276-4060
Booth 1116

Maskless lithography process

Holographic Lithography Systems will feature the HLS System 1000, a manufacturing tool and process that effectively utilizes holographic, or interferometric, lithography capable of producing sub-half-micron structures. Features such as lines, holes, tips, cones, vias, mesas, grids, and microlenses can be generated. The HLS System 1000 incorporates holographic lithography in a maskless, high-throughput production environment process featuring large field size, high-resolution patterning. It also generates surface relief, or moth-eye, structures for certain visible and IR applications with precise requirements for light reflectance and transmittance.

Circle no. 20

HOLTRONIC TECHNOLOGIES SA
Marin, Switzerland +41-327-536-800
Booth 229

Large-substrate mask aligner

Holtronic Technologies will be exhibiting the HMA400, a large-substrate high-resolution mask aligner that can print patterns of 0.5-μm resolution with a field size of 10 × 12 in. (250 × 300 mm^2) onto substrates of up to 370 × 470 mm^2. The system can be adapted to even the most demanding needs of FPD lithography, such as FEDs, poly-Si TFTs, and projection displays. Due to its unique capacity for high-resolution large-area printing, complete displays can be printed without the need for stepping.

Circle no. 21

HORNELL ENGINEERING
Twinsburg, OH 216/405-1418
Booth 1039

Combined rubbing/dry-cleaning module

Hornell Engineering has announced an innovation in LCD manufacturing. By integrating two processes, the combined rubbing/dry-cleaning module reduces substrate handling, increases LCD throughput, and reduces equipment costs and cleanroom space while improving overall efficiency. The non-contact dry-cleaning process eliminates 95% of particles greater than 1 μm. High-frequency pressure waves from an ultrasonic head cause particles to vibrate, which are then removed by an exhaust airflow. The rubbing process features rotation of both the table *and* rubbing roller to achieve highly uniform rubbing action, which prolongs the life of the rub fabric and is excellent for high-volume production.

Circle no. 22

ILC TECHNOLOGY
Sunnyvale, CA 408/745-7900
Booth 1019

Xenon arc lamps

ILC Technology will feature CERMAX® xenon arc lamps with integral reflectors, arc gaps of less than 1 mm and up to 2 mm, focal speeds from f/1.0 to f/2.0, and lifetimes up to 5000 hours. These lamps are ideal light sources for video-projector designs that incorporate poly-Si panels or very small reflective devices. ILC also designs and manufactures small and efficient lamp power supplies for incorporation into video-projector designs.

Circle no. 23

INCLINE
Newbury Park, CA 805/376-3300
Booth 238

LCD universal test system

Incline will introduce a universal test solution for flat panels. The test system facilitates comprehensive testing of the individual LCD assembly as well as the final whole screen assembly and electronics. Test functionality includes immediate boot-up, quick connect and disconnect, a menu-driven software interface, and a unique modular interface connector system that facilitates current and future interface technologies. The small footprint incorporates built-in illumination, a single-board computer, power adapter, and a backlight inverter. The system will support network connection, data collection, and full I/O connectivity.

Circle no. 24

INSTRUMENT SYSTEMS
Ottawa, Ontario, Canada 613/729-0614
Booth 436

Compact array spectrometer

Instrument Systems will demonstrate the CAS 140B, a portable, robust, CCD-based compact array spectrometer that features a 1024 × 128 (binning mode) CCD detector. For display testing, this system typically offers speed and sensitivity improvements of tenfold over diode array systems. The CAS 140B incorporates new Windows™-based software that supports full multi-tasking data acquisition and analysis.

Circle no. 25

INTERFACE PRODUCTS
Oceanside, CA 619/945-0230
Booth 335

Control display unit

Interface Products will feature a control display unit with embedded PC capabilities that provides a cost-effective commercial off-the-shelf solution to data display and entry. A color AMLCD controlled by an embedded PC-compatible CPU PCB allows 10 lines of 20 0.2-in. characters to be displayed in multiple colors. The display is capable of graphic representation with user-defined programming. Up to 32 switch positions can be selected by the user, and response codes can be defined. Two card slots are available.

Circle no. 26

INTERNATIONAL POLARIZER
Marlborough, MA 508/481-4943
Booth 1123

LCD sheet polarizers

International Polarizer has announced the first in a planned family of sheet polarizers for use in LCD fabrication. These neutral-gray LCD polarizers exhibit 40% transmittance and 99.5% polarization efficiency, and are an integral part of LCDs, FPDs, scoreboard matrices, and read-outs for automotive applications. Accessory layers such as adhesives and reflectors are frequently required by the industry to facilitate the manufacture of LCDs. Configurations include: transmissive mode, adhesive applied to one side; reflective mode, adhesive applied to one side and a reflector applied to the other; uncoated mode, without coatings. Standard sizes are 17 × 39⅜ × 0.005 (or 0.010) in. thickness exclusive of coatings.

Circle no. 27

ITO AMERICA CORP.
Boca Raton, FL 561/392-2555
Booth 208

Heat-seal connectors

Ito America will feature FlexEC etched copper heat-seal connectors used to connect FPDs to their driver circuitry. These copper connectors are particularly good for high-voltage applications in plasma and EL displays. Information will also be available for display-assembly equipment for TAB mounting/bonding, ACF attach, heat-seal connector bonding, polarizer or other film lamination, TAB forming, TAB-to-board ACF or solder attach, post-bond interconnect test, and associated support materials and devices.

Circle no. 28

KLEIN INSTRUMENTS CORP.
Portland, OR 503/245-1012
Booth 608

Video pattern generator

Klein Instruments will introduce the Klein VPG250, a stand-alone and/or PC-programmable video pattern generator that features storage for 32 patterns, a timing grouping feature, a four-line LCD, and a PC interface. The fully remote-controllable VPG250 can perform 100 standard timings and over 500 programmable timings.

Circle no. 29

KOPIN CORPORATION
Taunton, MA 508/824-6696
Booth 829

Small, very-high-resolution AMLCDs

Kopin Corp. will present the CyberDisplays™ line of monochrome and full-color small-format very-high-resolution AMLCDs, including a 0.25-in.-diameter 320 × 240 display that requires less than 30 mW to operate. Because of their low cost and high information content, CyberDisplays are the first AMLCDs that can be effectively used in personal information devices, such as cellular phones, pagers, PDAs, smart cards, optical processors, toys/games, and other consumer products.

Circle no. 30

KORRY ELECTRONICS CO.
Seattle, WA 206/281-1331
Booth 731

AMLCD backlights

Korry Electronics has developed a unique technology using light-management optics to provide an efficient, cost-effective solution to AMLCD backlighting. Custom military and commercial backlights using Korry's proprietary Nightshield® filters are available in 6 × 8, 6 × 6, 5 × 5, and 4 × 4-in. sizes.

Circle no. 31

KYOCERA INDUSTRIAL CERAMICS CORP.
Vancouver, WA 360/750-6124
Booths 611/613

Bright SVGA STN-LCD

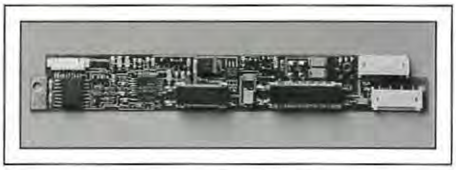
Kyocera will demonstrate the KCT10276BSTT, a 15-in. color dual-scan LCD that features a dot resolution of 1024 × 768, field-replaceable CFL backlight tubes, a response time of 200 msec, a contrast ratio of 25:1, a color saturation of over 60%, and a wide viewing angle of 40°. It also features Kyocera's advanced STN driving-method IC for clear, crisp text and graphics. The KCT10276BSTT is designed for industrial-control and monitor applications, and is priced at $2000 in sample quantities.

Circle no. 32

LINFINITY MICROELECTRONICS, INC.
Garden Grove, CA 714/898-8121
Booths 819/821

Quad-lamp backlight inverter

Linfinity Microelectronics will feature the LXM1640, a backlight inverter capable of supporting four cold-cathode fluorescent lamps (CCFLs) suitable for use with desktop LCD monitors and large LCD panels, including panels ranging in size from 15 to 20 in. and beyond. The single-stage LXM1640 converts a 12-V unregulated dc voltage to a high-voltage high-frequency sine wave needed to ignite and operate a CCFL. The inverter regulates the line voltage and lamp current, permitting lamp dimming by using a single synchronous power stage built from a pair of complementary low-loss MOSFETs.



Circle no. 33

MECC
Des Plains, IL 847/827-4874
Booths 1117/1119

Universal CRT and yoke drivers

MECC will introduce the YAM-20 Series, universal CRT and deflection-yoke drivers that can meet a variety of applications from development to production, and corresponding to a wide range of deflection frequencies and inductances without replacing any boards. The system satisfies all of the requirements regarding CRTs or yokes of larger size, higher resolution, wider deflection angle, and flatter face. The YAM-20 operates at 30–88 kHz, while the YAM-21 operates at 30–120 kHz. The YAM-22 will operate at 15–65 kHz, and will be especially designed for multimedia use.

Circle no. 34

THE MICROMANIPULATOR CO.
Carson City, NV 702/882-2400
Booth 1033

Probe station

The Micromanipulator Co. will feature the Model 2250 probe station, a large-area, flat-panel-type tester for diagnostic probing on substrates or board-mounted delidded packaged devices. The system features two independent X-motion track-driven platens, allowing for greater speed of the probing application due to the extra axis of control. Individual probes, microwave probes, or probe cards are also supported. The massive microscope mount and boom assembly provide maximum stability as well as a vibration-isolation air table which is the standard platform for the system. Sealed bearings, debris trays, and covers are supplied to meet most cleanroom applications. A full line of accessories are available.

Circle no. 35

MITSUBISHI ELECTRONICS AMERICA
Sunnyvale, CA 408/774-3192
Booth 113

Large TFT-LCDs

Mitsubishi Electronics America will preview two new TFT-LCDs, incuding the second generation of the 14.2-in. display that is the industry's largest for notebook PCs. In the ANGLEVIEW™ series of LCDs will be the 15.1-in SXGA and XGA desktop TFT-LCDs, the 13.1-in. EWS-class of TFT-LCDs, and two low-power lightweight 12.1-in. TFT-LCDs in SVGA and XGA versions. All TFT-LCDs feature 18-bit color, state-of-the-art 4.3-μm cell gap, and low-reflectivity black-matrix technology. The 15-in. XGA TFT-LCD is designed to replace the CRT in desktop PC monitors. The 14.2-in. TFT-LCDs are targeted at high-end "Mega-Note" and multimedia notebook PCs as well as "all-in-one" desktop PCs.

Circle no. 36

MRS TECHNOLOGY
Chelmsford, MA 508/250-0450
Booth 330

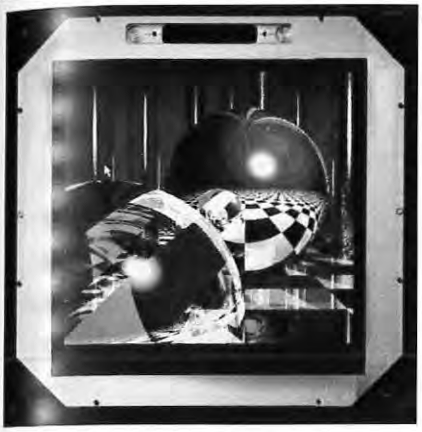
Large-area lithography solutions

MRS Technology will introduce the Model 6000 PanelPrinter™, a large-area lithography system offering state-of-the-art high-speed stage motions and providing advanced wide-area photolithography for Gen 3 and Gen 3.5 flat-panel production of AMLCDs, FEDs, color filters, and other products utilizing high-resolution large-area microlithography. The PanelPrinters can be equipped with wide-field I-line lenses for exposing pigment-dispersed color-filter materials and other DUV-sensitive materials, and feature an automatic edge-exposure system, an advanced graphical job-setup interface, and state-of-the-art factory automation interfaces. **Circle no. 37**

OIS OPTICAL IMAGING SYSTEMS
Northville, MI 313/207-1213
Booths 424/426

Rugged AMLCDs

OIS Optical Imaging Systems will introduce the CQ6363, an AMLCD designed for use in demanding environments, especially avionics and tactical military applications. The CQ6363, a design improvement on the F-22 and F-18 multifunction display, is currently being delivered to AlliedSignal for the AH-64 Longbow Apache upgrade. Features include an active area of 6.25 × 6.25 in., a resolution of 512 × 512, 64 gray shades, NVIS compatibility, and a contrast ratio of 80:1 at optimum viewing angle. Diffuse and specular reflectivity are less than 0.09 and 0.75%, respectively.



Circle no. 38

PHOTO RESEARCH
Chatsworth, CA 818/341-5151
Booths 505/509

Portable spectraradiometer

Photo Research will introduce the PR-705 SpectraScan® System, a new state-of-the-art spectraradiometer that features compact portability, increased flexibility, and improved sensitivity. The PR-705 includes Pritchard® optics for alignment accuracy, a multiple-aperture wheel for flexibility, on-board 3½-in. floppy drive for data storage, and Windows software for easy data analysis. Unsurpassed accuracy and repeatability for characterizing display color and luminance have never been made simpler.

PHOTO RESEARCH, INC.

Circle no. 39

PIXTECH
Santa Clara, CA 408/986-8868
Booth 928

FED evaluation kits

PixTech will feature field-emission displays (FEDs) characterized by extremely wide viewing angles (160° horizontally and vertically), low power consumption (1 W at 70 fL), high brightness (70–150 fL), full video speed (1-ms response), and instant-on at any temperature from –40°C to +85°C. FED evaluation kits, currently being delivered to qualified display integrators and OEMs, contain two 5-in. monochromatic (green) fully packaged FED panels along with a controller circuit card. The panels produce 70 fL of image brightness at all viewing angles.

Circle no. 40

PLANAR SYSTEMS
Beaverton, OR 503/690-6987
Booths 305/307

Field-sequential-color AMEL display

Planar Systems will demonstrate a 0.7-in.-diagonal color VGA active-matrix electroluminescent (AMEL) display that uses an LC color shutter to provide field-sequential filtering of broadband EL phosphor emission. The temporal color approach produces full color on every pixel, reducing the number of active-matrix pixels to one-fourth that required for the patterned spatial approach. A digital gray-scale addressing scheme produces 256 colors. The display is expected to provide a low-cost solution for a compact high-resolution miniature color display suitable for a variety of military and commercial head-mounted and personal-viewing applications.

Circle no. 41

PLASMACO, INC.
Highland, NY 914/883-6800
Booth 513/515

Large-area ac plasma displays

Plasmaco will display their line of large-area ac plasma displays that provide 16.7 million colors with a bright high-contrast image and a 160° viewing angle, the widest of any existing flat-panel technology. Plasmaco 42-in.-diagonal displays with both 4:3 and 16:9 aspect ratios will be exhibited.

Circle no. 42

PROGRESSIVE SYSTEM TECHNOLOGIES
Austin, TX 512/342-2000
Booths 118/120/122

Next-generation pod

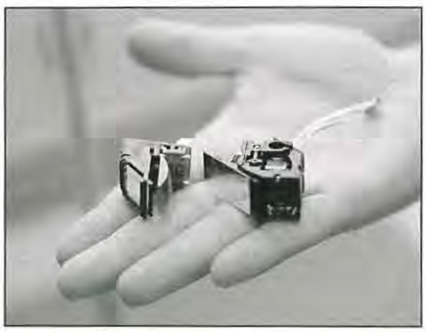
Progressive System Technologies will have on display KPOD™, the next-generation ultra-clean lightweight transport carrier for 650 × 550-mm substrates. The pod achieves better than a Class 1 environment around the substrates. Utilizing a side-door design (removed by a standard mechanical interface at each process tool) the KPOD simplifies robotic handling with an integral substrate aligner locating the substrate to ±0.50 mm and a support structure reducing substrate deflections to less than 1.0 mm. The product is available in an open-type version that can be upgraded in the field to a KPOD.

Circle no. 43

REFLECTION TECHNOLOGY
Waltham, MA 617/890-5905
Booth 844

Full-color VGA virtual display

Reflection Technology will feature the P7 color virtual display which utilizes scanned-linear-array (SLA) technology to create up to full VGA resolution and 4096 simultaneous colors. The inherent low cost, high performance, low power consumption (0.25 W or less), and high contrast ratio (5000:1) make SLA displays ideal for portable communications products, digital cameras, and personal interactive entertainment products. These displays have proven high-volume manufacturability for the cost-sensitive consumer marketplace and are presently used in Reflection's FaxView™ personal fax reader and Nintendo's Virtual Boy™ game system.

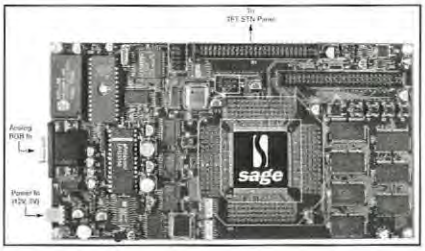


Circle no. 44

SAGE
Santa Clara, CA 408/748-0500
Booth 1133

LCD monitor board

Sage will feature Cheetah, an LCD monitor board that accepts standard analog RGB and SYNC (CRT-like) signals from any XGA/SVGA board and generates all the necessary control signals and panel data to drive both TFT and CSTN panels. The board supports XGA and lower resolutions at vertical refresh rates from 60 to 85 Hz and true colors using 8-bit A/D converters and proprietary FRC and dithering logic. The LCD-monitor ASIC implements all the necessary logic to drive CSTN and TFT panels. The user interface includes phase, brightness, contrast, and horizontal and vertical position adjustment via on-screen programming. The Sage Cheetah is plug and play for all LCD-monitor applications.



Circle no. 45

SI DIAMOND TECHNOLOGY
Austin, TX 512/331-6200
Booth 444

Large-area high-brightness light source

SI Diamond Technology will demonstrate FEPix™, a large-area high-brightness light source that uses diamond thin-film field-emission cathodes. Sealed units with both diode and triode device structure demonstrate a brightness as high as 10,000 fL. FEPix's advantages include very high power efficiency, low heat generation, all colors, thin profile, large area, low weight, operation over a wide temperature range, and fabrication of multiple light sources in one glass envelope. FEPix light sources are useful in electronic billboards, indoor and outdoor signs, LCD backlights, large-area high-brightness lamps, and other specialty lighting applications.

Circle no. 46

SOLOMON TECHNOLOGY CORP.
Walnut, CA 909/468-3733
Booth 618

Graphics display

Solomon Technology will feature the LM6430FBF, a quarter-VGA (320 × 240 dot resolution) graphics display with overall dimensions of 174 × 112 × 14 mm. The display features a viewing area of 122 × 92 mm, a dot size of 0.33 × 0.33 mm, and a duty cycle of 1/240. The backlight is provided by a cold-cathode fluorescent lamp.

Circle no. 47

STANFORD RESOURCES
San Jose, CA 408/448-4440
Booth 530

Electronic-display reports

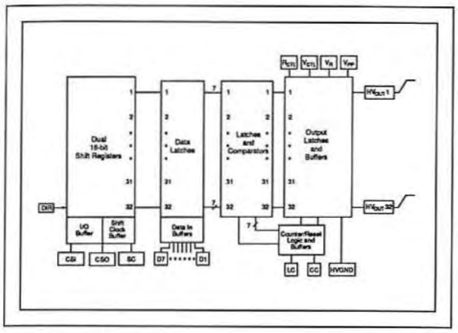
Stanford Resources will have available the *Electronic Display World®* newsletter and the quarterly *Monitrak®, Workstation Monitrak®, Display Price Trends®,* and *Comtrak®* reports. Multi-client reports will include *Liquid Crystal Displays; Flat Information Displays; Cathode Ray Tubes; Large Screen Information Displays; Flat Panel Display Manufacturing Costs; LCD Manufacturing, Materials, and Equipment; Monitor Market Trends; LCD Monitors;* and *Projection Displays.*
Circle no. 48

SUPERTEX
Sunnyvale, CA 408/744-0100
Booth 508

Amplitude-modulated driver IC

Supertex will feature the industry's first amplitude-modulated high-voltage 128-gray-shade display driver IC suitable for various display technologies.

Packaged in a 64-lead plastic surface-mount QFP, this IC has 32 output channels rated at a maximum of 80 V. Its high-voltage-output source/sink current capability is 5 mA/1.7 mA typical. The 5-V logic supply voltage allows a data throughput rate of 20 MHz. The IC can be cascaded when multiple devices are required to drive a large number of lines on display panels. Its direction function allows the data to be clocked in clockwise or counterclockwise.



Circle no. 49

TDK CORPORATION OF AMERICA
Indianapolis, IN 317/876-2685
Booths 924/926

Power supply for metal-halide lamps

TDK Corporation of America will feature the PKP-K250A, a power supply operating from an input of 190–390 Vdc while delivering a regulated constant power of 250 W to short-arc dc metal-halide lamps. The PKP-K250A provides 58 V at 4.3 A with a 3% ripple and an 87% conversion efficiency. It has the ability to hot-restrike lamps with its built-in high-voltage ignitor. The power supply features a power density of 9.5 W/in.^{3} in a low-profile package, weighs less than 350 g, and operates in a temperature range of 0–60°C. Other features include microprocessor control for adaptation to new lamps, LampLit, and output-enable signals.

Circle no. 50

trade show preview

TEAM SYSTEMS
Santa Clara, CA 408/720-8877
Booths 525/527

Video generators for flat-panel devices

TEAM Systems will feature two video generators. The ASTRO VG-840 is an analog and jitter video generator that allows the engineers who design, evaluate, and test flat-panel devices to introduce synchronized or non-synchronized jitter into the analog RGB signal to judge the noise tolerance of these devices. It offers fully programmable pixel frequencies up to 150 MHz. The synchronized jitter for HS and VS and the non-synchronized jitter can be programmed from 50 Hz to 100 kHz. The hybrid ASTRO VG-827 analog/digital video generator offers 8 bits/pixel/color in its digital outputs and standard RGB signals in its analog BNC outputs. The dot clock is up to 150 MHz analog and 75 MHz digital in the 1/1 clock mode.

Circle no. 51

TEKRA ATG
Evanston, IL 847/475-4500
Booths 1132/1134

Hardcoated films

Tekra Advanced Technologies Group will demonstrate its Terrapin™ line of hardcoated films designed for the computer-display market. Terrapin hardcoated polyester films were specifically developed to meet the demands of the advanced display marketplace. Design applications include touch screens, flat-panel displays, and vacuum-deposition coatings. Terrapin films exhibit excellent clarity, superior adhesion, chemical and scratch resistance, exceptional light transmission, and pass the critical 3H pencil hardness test.
Circle no. 52

TELETRAC
Santa Barbara, CA 805/968-4333
Booth 344

Electrical probers

TELETRAC has announced the LA-8 and LA-9 electrical probers for the flat-panel industry. The LA-8 moves panels up to 1 × 1 m in size under a stationary probe head. Its companion, the LA-9, employs four independently programmable probe heads to allow access to any area on panels up to 1 × 1 m. Special versions of the probers are expected to incorporate shorts-detection technology and pulsed lasers for excess chrome removal.

Circle no. 53

THOMAS ELECTRONICS
Wayne, NJ 201/696-5200
Booths 908/910

Miniature monitors

Thomas Electronics will feature two high-resolution high-brightness miniature monitors. The 1-in. monitor provides 800 TV lines at a brightness of 1000 cd/m^2, and the 1.5-in. monitor provides 1000 TV lines at a brightness of 130 fL. Both monitors operate at 12 V with a power consumption of less than 3 W. The units weigh 4.00 and 5.20 oz., respectively. The typical input signal is 1.0-V peak-to-peak NTSC, with PAL available at no additional charge. These monitors are designed for miniature viewfinders and portable-display applications.

Circle no. 54

THREE-FIVE SYSTEMS
Tempe, AZ 602/389-8741
Booths 921/923

Dot-matrix LCD

Three-Five Systems will feature the liquid-crystal intense display (LCiD), a dot-matrix LCD incorporating a proprietary approach that results in a display with cost and design advantages not available in traditional LED or LCD technologies. The LCiD offers the reduced power requirements and cost efficiencies of an LCD, but provides the quality and intensity of a typical LED display. The LCiD can be read in direct sunlight, providing a significant advantage over LEDs; it also provides a higher information content than a typical LED at a lower cost, and allows displays to be produced in virtually any color.

Circle no. 55

UNIAX CORP.
Santa Barbara, CA 805/562-9293
Booth 1044

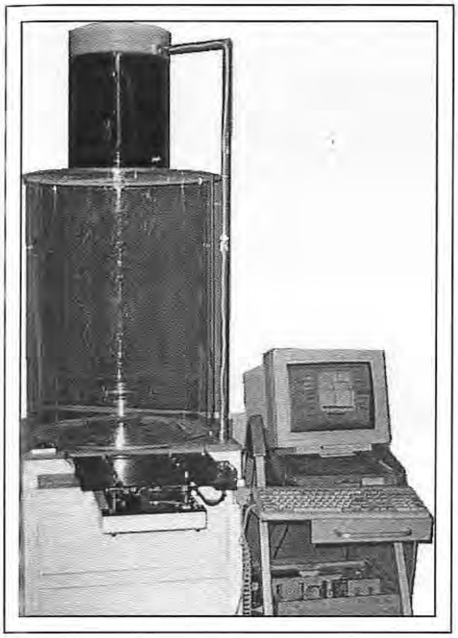
Low-power polymer ELs

UNIAX is developing low-power polymer EL displays for use in hand-held electronic applications. Commercial prototypes will be ready for evaluation by OEMs late this year. These small display panels can be configured to display one or more rows of alphanumeric characters in a dot-matrix format on pitches of up to 42 dpi. The emission color of existing monochrome displays is orange (peak wavelength ≈ 610 nm), with alternative color sources still in development. The displays operate at under 10 Vdc and require less than 1 mA/pixel, producing a daylight-readable intensity of as much as 200 cd/m^2.
Circle no. 56

WANDE, INC.
Dallas, TX 972/701-8886
Booths 200/201

Spacer-application machine

Wande will feature a new-generation spacer-application machine with a revolutionary spacer-delivery unit that prevents spacer caking during storage. The system can deliver a uniform application of fine particles to the surface of substrates. The spacer uniformity and repeatability and clusters meet the requirements of FPD manufacturing. The machine can be operated either automatically in-line or through a robotic substrate system manually. The machine has a computer control to set the processing parameters and operate the processing sequences automatically.

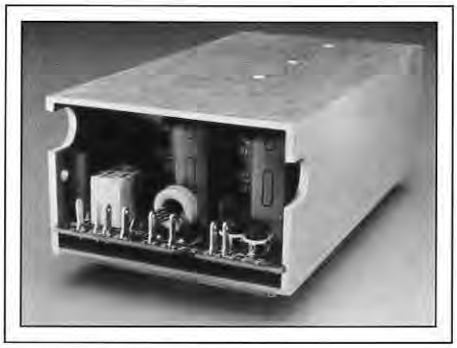


Circle no. 57

WPI ELECTRONICS
Warner, NH 603/456-3111
Booth 642

Electronic ballast module

WPI Electronics will introduce FLEXARC™, an electronic ballast platform for metal halide lamps used in DLP, LCD, and overhead projection displays. Consisting of separate ballast, ignitor, and readily available input filter modules, the FLEXARC lets the designer mix and match the exact operational features needed for a specific market anywhere in the world. The selectable ballast module output allows one ballast to operate a variety of lamps.



Circle no. 59

WYLE ELECTRONICS
Irvine, CA 714/788-3720
Booth 517

FPD Controller

Wyle Electronics will feature a new flat-panel-display controller which enables a VGA or SVGA TFT display to accept NTSC/PAL video signals. A Sharp 10.4-in. TFT display running NTSC video will be demonstrated. The display is integrated into an industrial enclosure and can be customized to specific customer applications. Wyle is an industrial distributor of Sharp FPDs, controllers, and integrated solutions for customer-specific applications.

Circle no. 60 ■

WINTRON, INC.
Bellefonte, PA 814/355-1521
Booth 602

Neck-down clamshell yokes

WinTron has developed a clamshell yoke kit to aid customers as they move to neck-down CRT tubes, optimizing power and compactness. The industry gains the benefit of closer magnetics while retaining the larger gun structure. WinTron's specialized vacuum impregnation technique produces a set of snap-together parts so easily adjusted and bonded that they can be readily assembled by any customer.

Circle no. 58

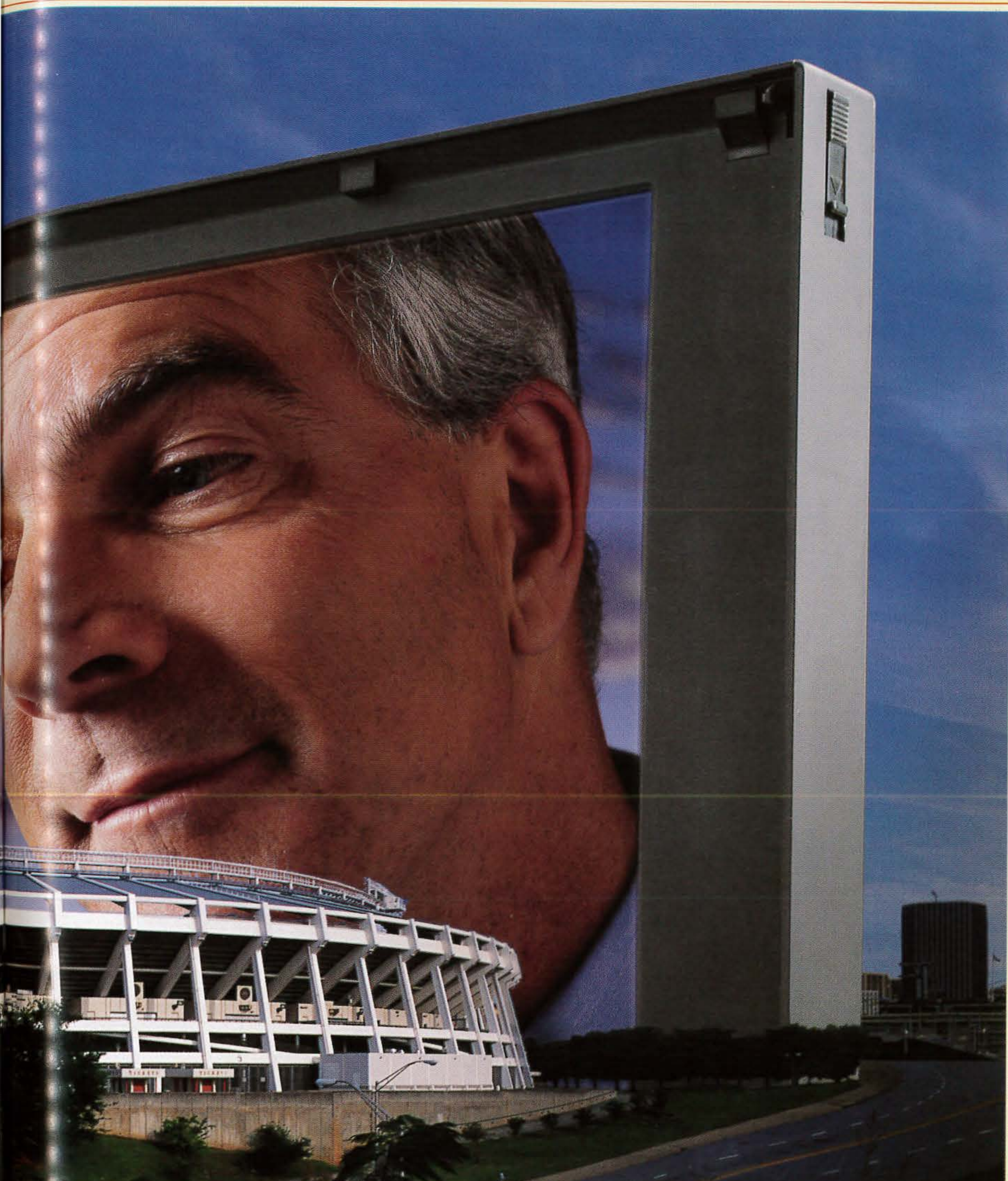
Our LCD's *have grown.*

In the two short years since we entered the market, Samsung has become one of the world's leading TFT LCD manufacturers.

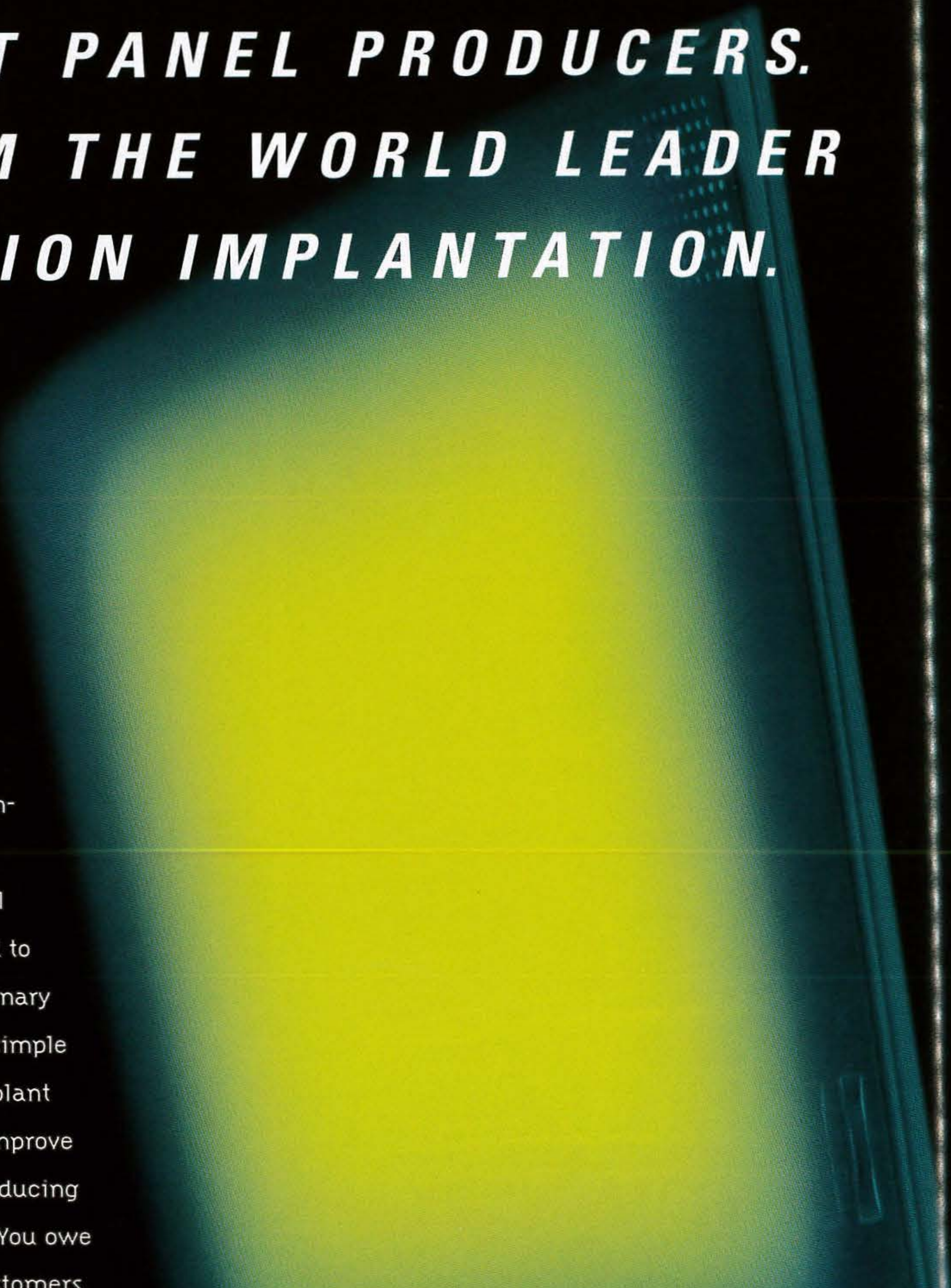
As you may know, we already offer a line of TFTs 20% brighter

See Us at SID '97 Booth 437

Circle no. 101



IMPORTANT NEWS FOR FLAT PANEL PRODUCERS. FROM THE WORLD LEADER IN ION IMPLANTATION.



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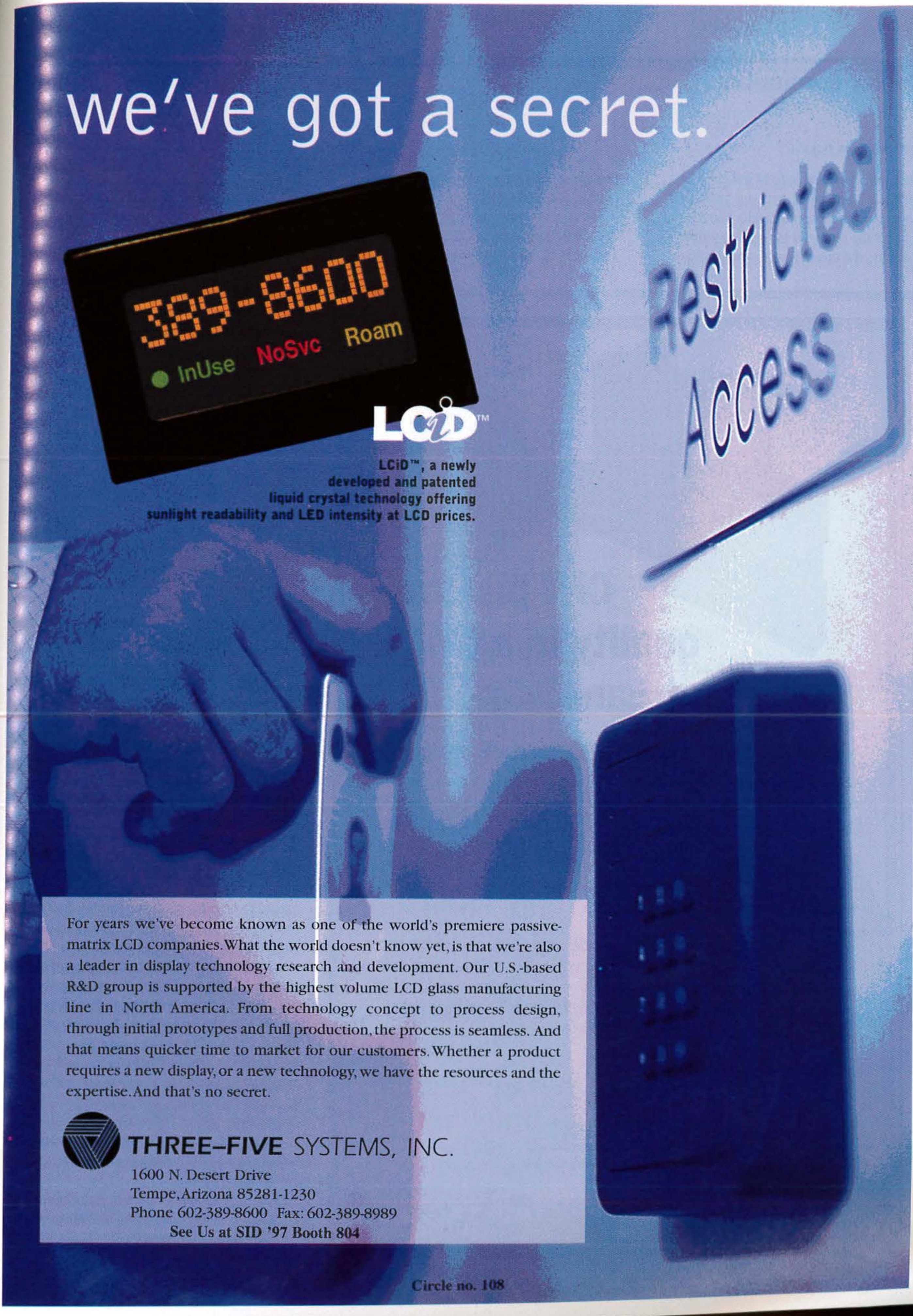
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continued from page 4

didn't gain even one byte of insight into which machine would meet my needs. Of course, the ads were practically shouting at me to get the one with the most multimedia capability, the most storage, and the fastest processor. Bigger and faster is apparently better! But to do what?

By now you may be thinking, "OK, Aris, don't belabor the point. You know that the answer is in the software you select." Yes, I do know that. But how do I put all this together? The typical store clerk is not terribly knowledgeable. And configuring a computer with all of these choices is becoming an ever more daunting task. It wasn't so bad a few years ago – even with DOS – because the choices were limited. Now, we have stores full of software and shelves full of manuals. And every year the previous year's stuff becomes obsolete. I have so many other interesting things to occupy my time that I don't want to devote much of it to these wonderful software-related learning opportunities.

I have asked some of you how you do it. For many, your company takes care of your software, network implementation, and update needs. A few of you simply love this stuff and spend every spare minute keeping up to date. And you have even suggested (with great enthusiasm) that you will hold my hand and help me put everything together. For this show of support, I am truly grateful. However, many of you are like me, wishing that it wouldn't require so much effort and study to do what we want to do with our computers, and also to be able to make upgrades more easily.

However, it may be that the rapid increase in complexity is beginning to overwhelm even all you dedicated computer nerds. Lately, I seem to be hearing more and more stories of unexpected and seemingly unexplainable computer-system malfunctions. The same problem that has plagued software writers since punch-card days is now catching up with the PC as software and operating-system complexity increases. Simply stated, ***no matter how innocent a change one makes, it's bound to affect something else in some other remote part of the operating system that couldn't possibly have been affected.*** It's the Murphy's Law software corollary applied to each and every computer. As complexity grows, so do these problems and so does the task of chasing them down. I first experienced this law back in the early 70s writing Fortran programs. Unfortunately, such universal and basic laws never change and never go away.

As an example of what I am suggesting, consider this excerpted text from a computer users' column in the *Seattle Times* – a typical *family* newspaper.

"I recently added 16 megabytes of RAM to my Pentium 60. The original 8 megabytes of RAM was 70 nanoseconds and the new

RAM is 60 nanoseconds. I was told this would be OK. The computer has recognized and is using the new RAM except that the system seems to lock up more often and a couple of times I was even dumped out of a program to a DOS prompt."

The answer for this problem included the following:

"... you have to consider whether your original RAM is parity-checking RAM or not. (A 72-pin SIMM with parity checking devotes 32 of its 36 bits to data and the other 4 bits to checking on the integrity of the SIMM itself.) Fact is, many, if not most, of the PCs sold today have the less expensive non-parity checking RAM..."

Good Grief! I can't even find this level of technical complexity in *EE Times*. Isn't this the stuff by which computer systems engineers earn their keep? Do Bill Gates and Andy Grove expect all of us to know this? Do *they* keep up to date on parity checking RAMs? And this is just one randomly selected tidbyte of information. To know the detail of every component and every system interface specification, and to keep up with all these as new hardware and software products are introduced, is I'm quite sure *not* what the information society was supposed to be about.

While pondering all this, I had a thought! What if we had to buy kitchen appliances the way we buy computers? Let's say we want to buy an appliance in which to store our food and keep it from spoiling for as long as possible. In such a pretend world - that learned all it knows from PC ads - we would most likely find descriptions of food-storage units that told us they had a 200-millihorsepower compressor (clearly better than the 130-millihorsepower version), that various control units were available but that the best ones had the highest-speed and highest-resolution thermocouples, that the box was made of insulating material that had an R-150 rating (of course, better than one with only an R-145 rating), that the unit had the latest 16X high-speed humidity control, and that ice was produced with a full-motion full-duplex 8-bit controlled crusher. The interior of such a cooling unit would be configured by going to a different set of merchants who specialized in such interior configurations. Arriving at one of these stores, one would need to specify to which standard the cooling unit was designed so that the correct interconnectors could be selected. Then such features as slide-out shelves, food crispers, door bins, and spill-proof compartments, among others, would be purchased. Installation would be done at home and require extensive study of a 200-page manual. Why? Because incorrect placement, incorrect sequencing, or the slightest misalignment of even one shelf-bracket would immediately cause everything to fall out onto the floor and require one to start over from the beginning. "But I just want to keep my food cold enough so that it doesn't spoil," you might protest in frustration. Yes, and I just want to write my column and send an occasional e-mail. So, why can't I get a reasonably priced and simple-to-use product that does just that? Why do I have to go through innumerable steps to try to install an e-mail program that eventually leads me to a dead-end error message that says it can't find a carrier when I know it's plugged into a working and dedicated phone line? Why do I find out after a dozen tries that the reason my Windows changes didn't take effect was because I didn't exit in exactly the right sequence? Even the help menu just said "exit" – it didn't say it had to be through a special and apparently unique sequence.

And that is why I think the current era of PC growth is coming to an end. Now, don't get me wrong. I am not suggesting that the PC will disappear. Not at all. But, on the other hand, it's not going to continue to proliferate at the growth-rate of the past few years to become the ubiquitous information center in homes and businesses, the way some folks expected. When something becomes too difficult and time-consuming for even technically educated people to use, what are the chances that the average non-technical person can learn to enjoy the experience?

Out of helpless desperation, many of today's families have learned to rely on their teen-age kids to keep their home computers running. As teen-agers, we human beings seem to have an incredible capacity for absorbing trivia. Not only that, we have lots of free time and we are exceedingly curious. The computer becomes a challenge – a puzzle that demands to be solved. And, in any case, staring at the glowing screen is ever so much more fun than mandatory home-work duty.

However, by the time we reach adulthood most of us lose these talents and become "average persons." As "average persons" we lose our inquisitiveness and don't even particularly like the personal computer. In a recent *Business Week* survey of inventions that average Americans said they couldn't live without, the automobile was first at 63%, followed by the light bulb at 54%, the telephone at 42%, and television at 22%. The personal computer came in at 7.6% just behind the blow-dryer at 7.8%. The microwave oven was perceived as almost twice as important at 13%.

Consider this, how many hours are you willing to spend learning how to operate the next blow-dryer you buy? Whatever your answer is, that's how much time I would *like* to spend learning how to use a new word-processor or a new e-mail device.

Often, I think we technologists take ourselves a bit too seriously. We proclaim how the Internet is going to change civilization and how the information society will convert the world from "atoms to bits." It's kind of fun to put it all in perspective. We're changing civilization all right – just not quite as much as the blow-dryer. If that doesn't put a smile on your face, you are in need of an immediate and lengthy sabbatical!

The problems and challenges of today become the opportunities of tomorrow. ***I believe the complexities we have created with the PC will lead to the dawning of The Era of the Information Appliance.***

The PC will certainly continue to improve and grow, but at a much slower rate. The exciting new growth will be in compact e-mail devices that sit by – or become part of – our telephones, TV-set-top boxes that allow us to "surf" the Internet as easily as we surf today's content-free cable channels. We will do it with minimal need to think and interact because that's all we're capable of at day's end, sprawled on our couches. We will have truly lightweight laptops on which to do the simple word-processing, business-card storage, e-mail, and telephone/fax dialing that meets the needs of most of us – and the batteries won't go dead after two or three hours. Many of these machines will be further specialized based on our particular occupations, such as the ones already being used by rental car agencies and by FEDEX and UPS drivers. And there will be plenty of specialized game machines with a variety of displays, including head-mounted ones. We will specialize just as we have in every other technology area in the history of mankind.

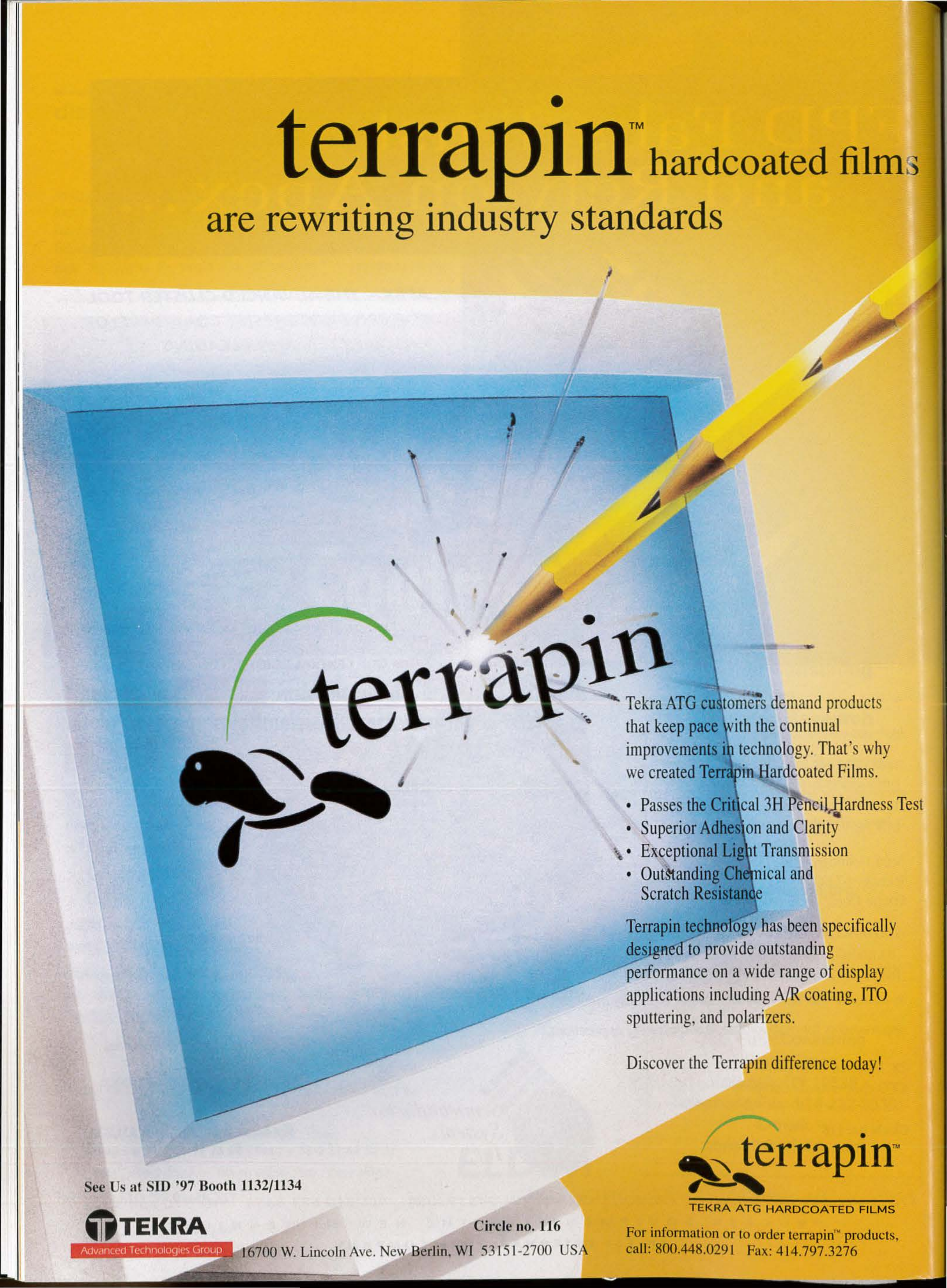
And I can hardly wait. I want to *enjoy* all of these things. I get no pleasure from reading 2-in.-thick manuals for every function I want to perform. I get no pleasure in knowing that the information I learn today will be obsolete next year, and I will have to re-learn it all in a different format. I get no pleasure in having to call help lines that tell me (after multiple menu choices) that "All our customer-service representatives are busy. Good-bye."

The opportunities for us in the display business will be about as boundless as boundless can get. Each of these information appliances will need its own customized and specialized display. A great variety of shapes, sizes, and technologies will be needed. Specialization demands optimization. Just as liquid crystals allowed the digital-watch business to succeed and later created the laptop-computer business, other display technologies will facilitate products that have yet to be conceived. ***Historically, in the display business new technologies have not done nearly as much to displace existing products as they have to create new markets and new opportunities.***

Such opportunities exist today in better ways to inform us while we are mobile, stimulate us at sports and other events, compete for our attention in retail environments, and educate us as we participate in various indoor and outdoor activities. We will need large displays, bright displays, non-video displays, wrap-around displays, and displays that "go bump in the night." It's going to be a lot of fun for all of us. Perhaps, the Society for Information Display should adopt as its slogan, "lighting up the world with information."

Yet another piece of good news is that all this variety may provide new and interesting opportunities to develop display technologies without the massive investments required for anyone to attempt to compete in the well-entrenched LCD business. The concept of competing against core LCD products with new "leapfrog" display technologies may turn out to be not much more than wishful thinking, whereas developing a new display technology for a specialized and modest-size market will, I believe, be a more manageable undertaking. But even here, success will come only to those who develop *both* an interesting technology and a carefully considered and sensitive understanding of the products needed to serve the customers within each newly developing market.

I look forward to seeing many of you at this year's SID Symposium in Boston. I always enjoy sharing ideas with you, but it's especially great in person. However, just in case that doesn't work out, you can still contact me by phone at 206/557-8850, by fax at 206/557-8983, by e-mail at silzars@ibm.net, or send me a paper missile at 22513 S.E. 47th Place, Issaquah, WA 98029. ■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To the Editor:

The publication "Reflective Cholesteric Liquid-Crystal Displays" by J. William Doane and Michael E. Stefanov, published in *Information Display,* Vol. 12, No. 12, p. 18, Dec. 1996, disregards relevant prior work, thus giving readers a false perspective.

That cholesteric liquid-crystal films can exhibit two stable states: a) planar (Grandjean or disturbed), which depending on the helical pitch can exhibit reflection colors, and b) focal-conic (undisturbed), which is light scattering, has been known at least since 1969, see for ex. "Optical Properties of Certain Cholesteric Liquid-Crystal Films," J. E. Adams *et al., J. Chem. Phys.,* Vol. 50, No. 6, p. 2458 (1969) or "Electric-Field-Induced Color Changes and Pitch Dilation in Cholesteric Liquid Crystals," F. J. Kahn, *Phys. Rev. Lett.,* Vol. 24(5), p. 209 (1970), or many other subsequent publications.

Already in 1972, Dir *et al.,* in perhaps the most comprehensive paper on the subject, "Cholesteric Liquid Crystal Texture Change Displays," *Proc. SID,* Vol. 13/2, p. 105 (1972), described the same elements of reflective cholesteric texture change displays as presented today: two stable states, a color reflecting planar state and a scattering focal-conic state (memory) electrical switching between the two states; a transient planar texture; gray scale; low power consumption and dark background. Liquid crystals with polymers only became known in 1985 and therefore were not used in this work.

Since these papers, and others, precede the use of polymers in liquid crystals by 13–16 years, it is incomprehensible that the authors of "Reflective Cholesteric Liquid-Crystal Displays" were surprised by the fact that "polymers were not needed at all to create the display features"!

Study of the use of cholesterics in displays [was] not "stopped abruptly around 1970". See for ex. *SID Intl. Symp. Digest Tech. Papers* 1971 p. 132; 1973 p. 44; 1977 p. 95; 1979 p. 114; 1985 p. 135; *Molecular Crystals and Liquid Crystals,* Vol. 25, p. 19 (1974); *J. SID* 11, 14 (1974) and others.

– Werner E. Haas
Fellow, SID
Webster, N. Y.

Dr. Doane responds:

The invited article, "Reflective Cholesteric Liquid-Crystal Displays," is a brief overview of the display technology under development at Kent Displays, Inc. and Kent State University. The article was not intended as a review of the various cholesteric display technologies or the vast literature on cholesteric materials. The authors regret their one short paragraph and two references on past work have been interpreted as not giving justice to the pioneers in the field.

In the late 1960's and early 1970's, there was a burst of activity on cholesteric displays. Following that activity, coming largely from Xerox, literature on cholesteric display technology became meager compared to other liquid-crystal technologies such as TN, STN, AMLCD, FLC, and ECB based on nematic and smectic phases. Lasting for more than a decade up until almost 1990, display activity involving cholesteric materials lay comparatively dormant. Revival of interest came in later years. The work on Ch-LCDs at Kent State University was first published in 1991. A review of all that past work at Xerox, Westinghouse, RCA, and in Europe would indeed make for fascinating reading.

Finally, we note for the record that Mr. Haas has been retained as a paid expert witness against Kent State University in litigation concerning a patent on cholesteric liquid-crystal technology, which is the subject of our article.

– J. William Doane
Vice President
Research & Development
and Chief Science Officer
Kent Displays, Inc.

To the Editor:

FED Patents

In his informative article "Asian Flat-Panel Industry Surveyed in Oregon Workshop," [*ID* Nov. 1996 - Ed.] Ted Lucas mentions that "... the basic FED patent is held by Jean P. Biberian" of France. Mr. Lucas also noted that Asian companies hold "a total of 37 issued patents on FED technology."

In a recent judgment by a Paris (France) court, a ruling was handed down that while the Biberian patent was not infringed by the glass portion of PixTech's FED design, the means for holding unaddressed columns at a fixed (*e.g.,* zero) voltage was an infringement. Since this patent was also filed in Germany, it is likely that the German courts will rule likewise.

PixTech has exclusive rights to the LETI patents, which were the object of this lawsuit. In order to provide an unencumbered use of the LETI patent portfolio for PixTech, CEA (The French Atomic Energy Commission, of which LETI is a research laboratory) has recently purchased all rights to the Biberian patents, and included them in the patents to which PixTech has exclusive access, and which it sub-licenses to its alliance partners Motorola, Raytheon and Futaba.

A second, unrelated objection had been voiced from time to time concerning the fundamental PixTech "resistive layer" patent, a seemingly essential element of any microtip or Spindt-tip FED emitter. A Dr. Lee is said to have worked on a resistive-layer concept prior to the LETI application. This patent was resubmitted to the U.S. Patent Office and re-examined in light of Dr. Lee's work. In a recent ruling, the LETI resistive-layer patent was upheld by the U.S. Patent Office.

Further, you will be pleased to learn, the PixTech Alliance portfolio now contains over 122 issued patents in addition to 168 patent applications.

– Tom Holzel
V.P., Marketing & Sales
PixTech, Inc. ■

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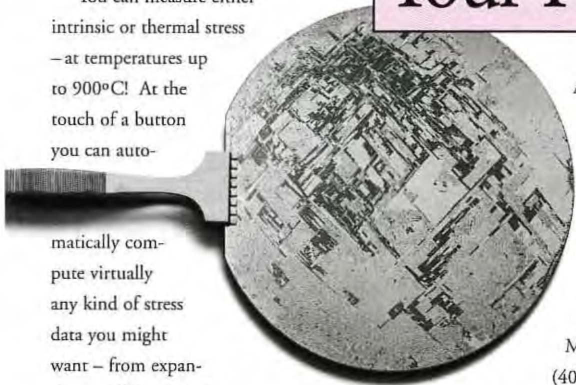

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Sept. 15-19, 1997 Toronto, Canada

1997 Flat-Panel Display Strategic Forum and Technical Symposium. Co-sponsored by the University of Michigan, Center for Display Technology and Manufacturing. Contact: R. Donofrio, Display Device Consultants, 6170 Plymouth Rd., Ann Arbor, MI 48105; 313/665-4266, fax -4211.
Sept. 22-23, 1997 Ypsilanti, MI

The Third International Conference on the Science and Technology of Display Phosphors. Co-sponsored by the Phosphor Technology Center of Excellence, Defense Research Projects Agency, and Society for Information Display. Contact: Bill Klein, Palisades Institute for Research Services, Inc., 201 Varick Street, Suite 1006, New York, NY 10014; 212/620-3377, fax -3379, e-mail: bklein@newyork.palisades.org.
Nov. 3-5, 1997 Huntington Beach, CA

Fifth Color Imaging Conference: Color Science, Systems & Applications. Co-sponsored by IS&T and SID. Contact: IS&T, 7003 Kilworth Lane, Springfield, VA 22151; 703/642-9090, fax -9094.
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Electronic Information Displays (EID '97). In association with the Society for Information Display. Contact: Association Exhibitors; +44-1822-614671, fax -614818.
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The Fourth International Displays Workshop (IDW '97). Co-sponsored by the Institute of Television Engineers of Japan and the Japan Chapter of SID. Contact: IDW '97 Secretariat, c/o The Convention; +81-3-3423-4180, fax +81-3-3423-4108.
Nov. 19-21, 1997 Nagoya, Japan ■

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.
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- 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. Professional 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 - to the Honors and Awards Chairman, Dr. John A. van Raalte, Thomson Tubes and Displays, Av. du General De Gaulle, Genlis, France 21110 by **October 1, 1997.**

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editorial

continued from page 2

The world knew Marconi and Braun had done something exceptional when they were awarded the Nobel Prize for the development of practical wireless telegraphy. That is the same Braun who, 100 years ago, invented what we now recognize as the first modern cathode-ray tube.

The celebration of the Braun tube's centennial will be a major theme when the international display community congregates in Boston in a few days for SID '97. We will do so in the city where Paul Revere had lanterns raised in the steeple of Old North Church to warn that British soldiers were on the march to seize a large cache of arms that radically minded colonists had hidden away. Revere's successful use of optical communications helped establish a nation – and change the way people all over the world would think about government.

We have understood the value of information for a very long time, it seems. We move much more information now, much faster, but we think about it much less. Much of it seems to signify very little compared to a few words such as these:

We hold these Truths to be self-evident, that all Men are created equal, that they are endowed by their Creator with certain unalienable Rights, that among these are Life, Liberty, and the Pursuit of Happiness – That to secure these Rights, Governments are instituted among Men, deriving their just Powers from the Consent of the Governed...

Those words are more than information. They embody an ennobling vision of human life and society. The information we move and display can help us win battles, make mergers, and sell goods. But our high-resolution monitors will mean much more to us if we remember to use them also to display the words and images that convey the human enterprise at its best – and have the courage to be changed by what is displayed.

– Ken Werner

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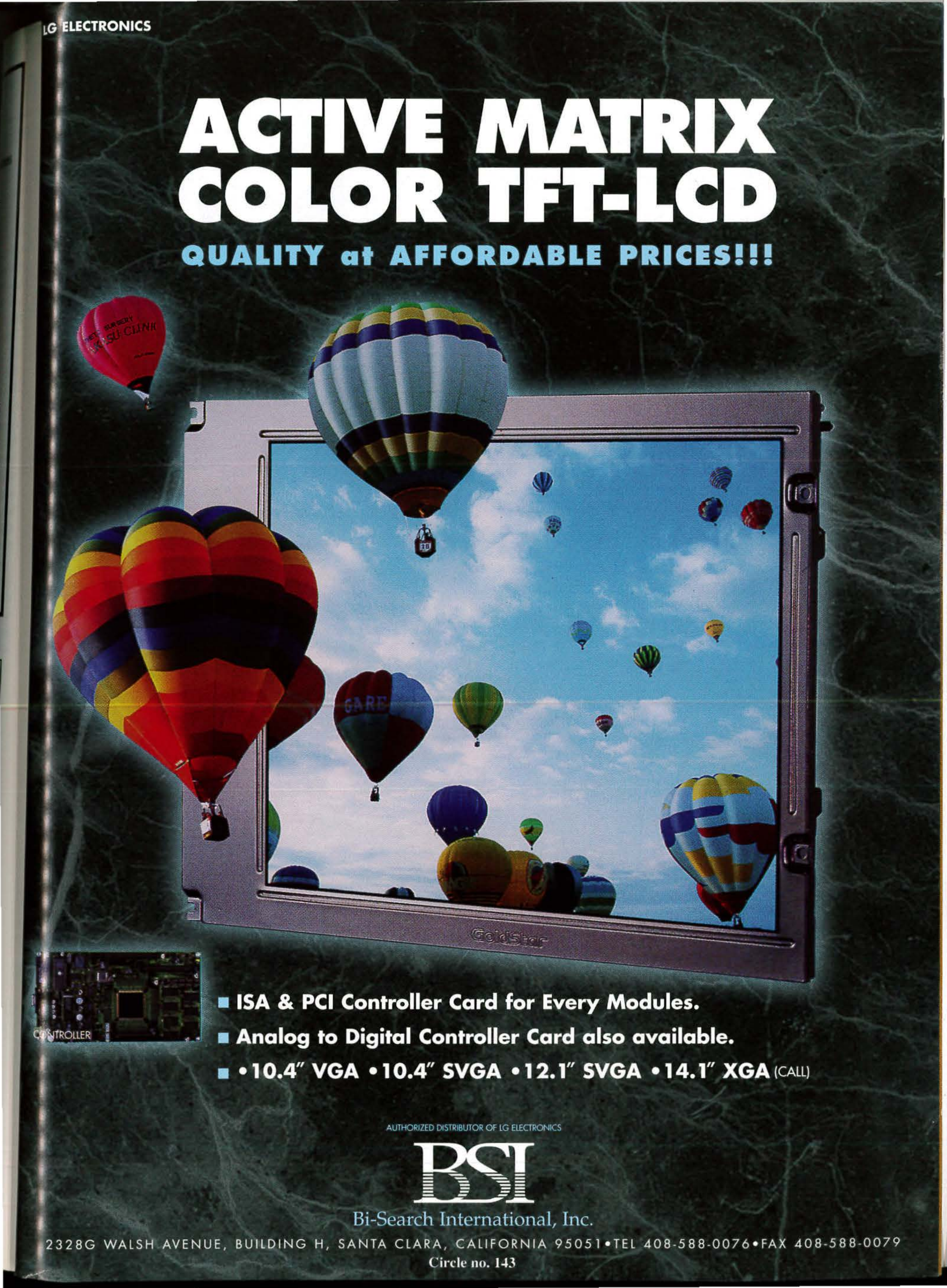
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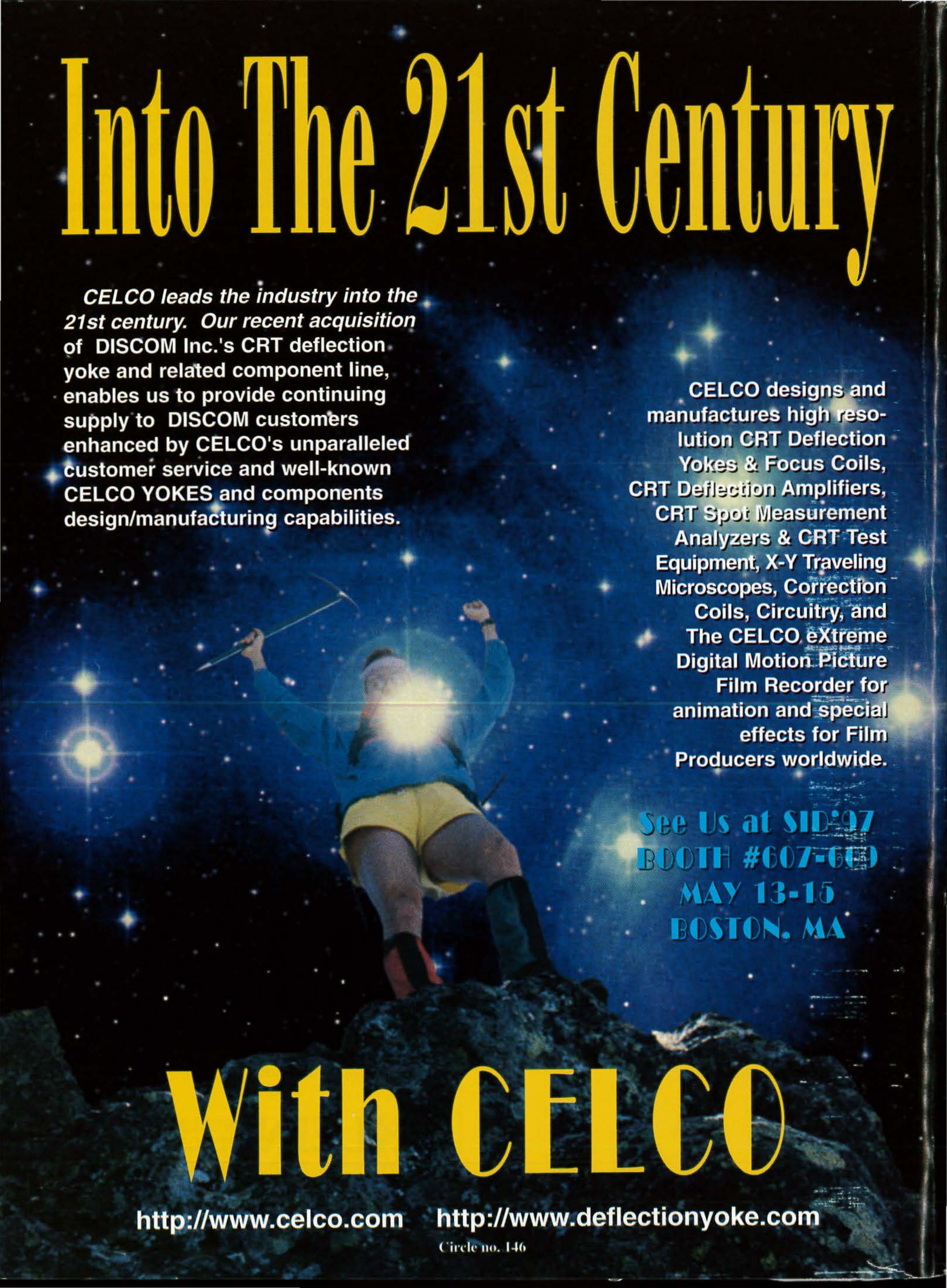
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