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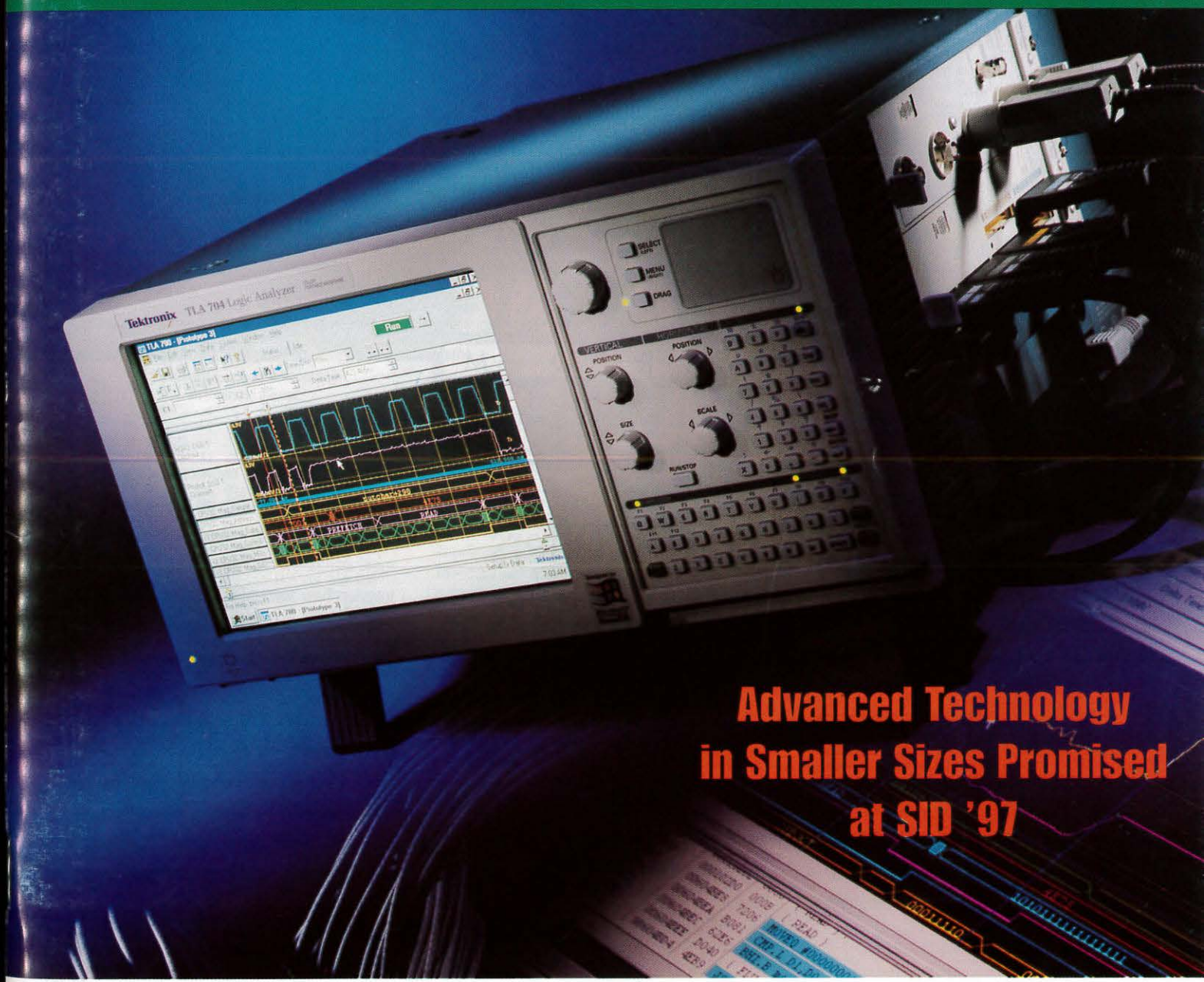
INFORMATION DISPLAY

SID

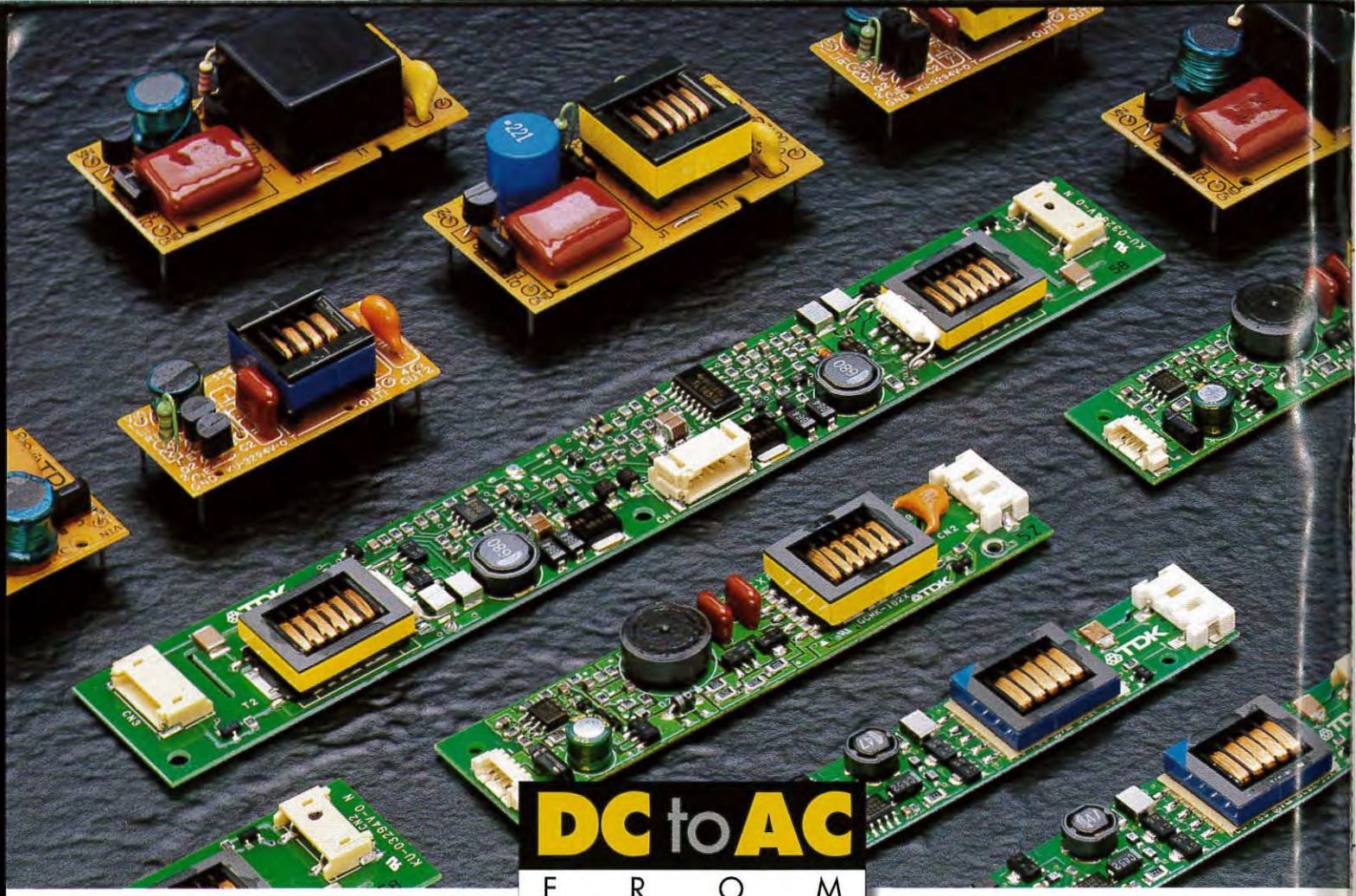
September 1997 – Vol. 13, No. 9

SPECIAL SID '97 REVIEW ISSUE



Advanced Technology in Smaller Sizes Promised at SID '97

SID '97 Review:
- Highlights
- CRTs/FEDs
- Emissives
- Flat Panels
- Manufacturing



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Circle no. 12

Official Monthly Publication of the Society for Information Display

INFORMATION DISPLAY

SEPTEMBER 1997
VOL. 13, NO. 9

COVER: At SID '97, major FPD suppliers promised a long-term commitment to provide advanced technology in smaller sizes for instrumentation, industrial control, and factory-automation applications. In its booth, NEC showed Tektronix's TLA 704 Logic Analyzer, which uses NEC's wide-viewing-angle 10.4-in. VGA AMLCD. The design win had been announced a month before the show.

Credit: Tektronix

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

Next Month in *Information Display*

Flat-Panel Issue

- Birth of the active matrix
- New VESA interface standards
- PDPs come of age
- Scan-conversion techniques
- Computex Taipei '97

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The Third of July

I am writing this on the third of July. In the United States, this is the day before the day we celebrate as the anniversary of our Declaration of Independence from foreign power. I write in the library of a 113-year-old hotel on the coast of Maine, a part of the United States where they take their July Fourth traditions seriously, and I am looking forward to tomorrow's fireworks, band concert on the town green, and (this being Maine) seafood served on the town athletic field by the Rotary Club.

There had been wars for independence and autonomy before, of course, but the one that created the United States had revolutionary philosophical underpinnings: this was to be a nation that welcomed people with differing origins and beliefs. To societies that value their homogeneity, this idea may still seem strange. Even to those of us who see the ideal as noble, it is clear that its implementation has often been seriously flawed or grossly inadequate. Yet, the United States is a wildly diverse and hugely productive society, even if its citizens are sometimes fractious and have a tendency to retreat into tribal enclaves.

Those of us who design, make, market, integrate, invest in, or comment upon displays have become so used to the accurate and agreeable phrase "the international display community" that it rolls smoothly off the tongue - and smoothly off my keyboard-tapping fingers. But just within the United States, the display community comprises a world of varying cultural origins, a variety that enriches our community and vastly benefits U.S. display companies and the U.S.-based marketing and manufacturing divisions of Asian and European companies.

Before, during, and after the recent SID International Symposium in Boston, I spoke in person and on the telephone with literally hundreds of people from the display community. Among those working in the U.S., I could identify names with many national and cultural origins: Anglo-Saxon, Italian, Irish, Scottish, German, Lithuanian, Russian, Indian, Pakistani, Japanese, Korean, Chinese, Finnish (I think), Russian, French, and Spanish/Hispanic. (There are others I could not identify, and there are surely many people whose complex family histories lie concealed behind the European names that are so common in the United States.)

An example. In the Summer issue of the company publication put out by Technology Modeling Associates (which produces Liquid, the LCD design and simulation software exhibited at SID '97), a short article welcomes four new TMA staff members:

- An internal consulting engineer with an MSEE from Louisiana Tech whose previous job was in New Delhi.
- A materials scientist with a Ph.D. from UC Santa Barbara and an M.Sc. from the Moscow Institute of Physics and Technology.
- A former head of the process and device simulation group at National Semiconductor who has a Ph.D. from Gauhati University in India.
- A computer scientist with an M.S. from Iowa State and a B.S. in Physics from Wuhan University in China.

TMA is clearly happy to have been able to hire these new staff members.

I am thinking of this not only because I am in Maine on the third of July but because there are members of the U.S. Congress who would severely limit the

continued on page 49

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the display continuum

Bump... Oh, Excuse Me. Thump... Whoops. Crash!...

by Aris Silzars

The sounds you have just heard are those of the Information Society in full operation just a few years from now. They are the sounds of errant information packets colliding with stationary objects, moving objects, and with each other.

"But how can this be?" you may be thinking. "Information has no mass and doesn't collide with objects, stationary or otherwise."

Well, I'm glad you asked - because that is exactly the topic of this month's column. I'm about to tell you that not only does information have velocity and acceleration, as was explained in the January 1993 "Display Continuum," but that it also acquires mass by inextricably bonding itself to various groupings of atoms.

This month's column is going to be incredibly significant because, for the first time ever, you will be able to learn about the Unified Theory of the Information Age. This will clearly supersede the old classical Negropontian theory of the Information Age, which tried to describe what was happening by asserting that the world was changing over from working with atoms to working with bits. This hypothesis was OK, for a first try, but did not explain how we display engineers and others like us, who mostly work with atoms, would continue to function in this bit-dominated world. It also didn't explain how all this information would move around and interface with other information repositories or with us atom-needy human beings.

All these thoughts are going through my head as I do my morning run up and down the hills of the Issaquah plateau. It's a cool, cloudy morning typical of the Seattle area. By now, I have learned to always bring a hat with me in case a raindrop or two lets loose from the fluffy clouds above. Once I am well into my run, I don't mind a bit of wetness. It's quite invigorating - really. As I run and watch the various four-wheel-drive vehicles - cars have almost become extinct here - heading off for work with their single occupants, I can't help but notice how the Information Age has already changed our society. Within a few hundred meters of home, most occupants already have their cell-phones to their ears and are busily communicating as they drive. This is 7:30 in the morning! With whom are they communicating? And from what I can see, it's a gender-neutral activity: everyone is doing it. I have learned to watch the traffic and to cross streets with ever more caution. These folks don't have the time or the attention to watch out for semisoft moving objects like me.

Last Sunday evening, I stopped by my favorite Barnes and Noble bookstore. As I was enjoying my browsing revery, I was jarred by the person next to me suddenly speaking at full voice. I looked around for someone who might be the recipient of this loud message. However, this person seemed to be talking right into the bookshelf. Most of us regular folks aren't known for doing that. Then I realized ... he was making a call on his cell-phone! In a bookstore? On a Sunday evening? My angry glare didn't seem to dissuade him one bit. I'm not so sure that I like this part of the Information Society. When I first got my car phone in the mid-eighties, it was great fun. Few others had them and I could

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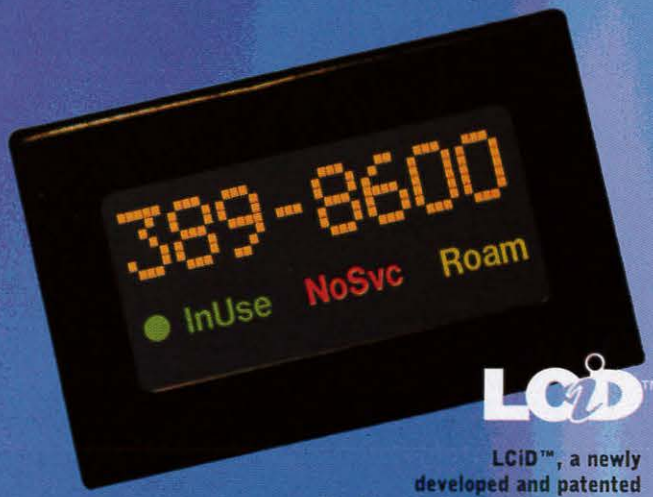

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Circle no. 14

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Circle no. 16

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Brightness (typical)	200 nit
Power Consumption	30W
Multiscan	Yes
PC/Mac Compatible	Yes
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Circle no. 18

SID '97: Exciting Circus in a Big Tent

Through the lens of SID '97, the shape of the display world was changing once again – and "this kind of growth supports diversity."

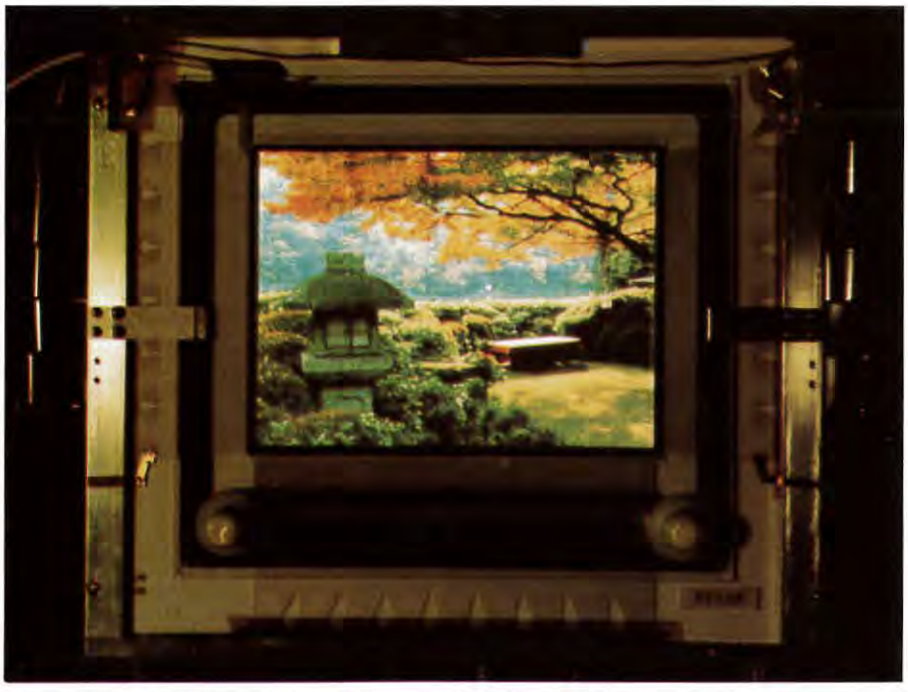
by Ken Werner

FULL ORDER BOOKS of the major Asian suppliers and the appearance of diverse new display applications created an enthusiastic atmosphere at the Society for Information Display's 28th annual International Symposium, Seminar & Exhibition, held in Boston, Massachusetts, May 11-16, 1997. The growth of conventional applications and the creation of new ones created a widespread impression that the display industry was becoming a big tent capable of sheltering many technologies, a tent under which many kinds of display businesses can prosper.

There was therefore little of the traditional North American handwringing over why it's so easy to get a billion dollars worth of financing for a theme park and so hard to get that amount for an LCD fab. Rather, there was excitement from all geographical areas about the other opportunities for designing, making, integrating, modifying, applying, and repairing displays of all sorts – and the diversity was technological as well as commercial. The sheer variety of new technologies and new technological twists presented in the technical sessions and shown on the exhibit floor were proof of this pluralism and optimism.

Among these were a reflective display based on interference-generated color that avoids the losses of color filters and polarizers (***Iridigm Display Corp.***), a color EL display that uses a blue phosphor and organic fluorescent color-changing media (CCM) to change the blue to red or green where appropriate (***Idemitsu***), a commercial display that finally integrates LEDs in the way ICs integrate transistors (***Motorola***), the generally impressive developments in microdisplays for portable electronics (***Displaytech, Planar, Reflection Technology, Kopin, Motorola***), and ***Philips***' convincing set of papers describing a 1-cm-thick cathode-ray-tube panel (CRP).

Canon Research Center described a technique for making its surface-conduction elec-



Canon Research Center

Fig. 1: *Canon impressed observers by showing a 10.4-in. version of its surface-electron-emission-cathode display (SED) at the author interviews.*

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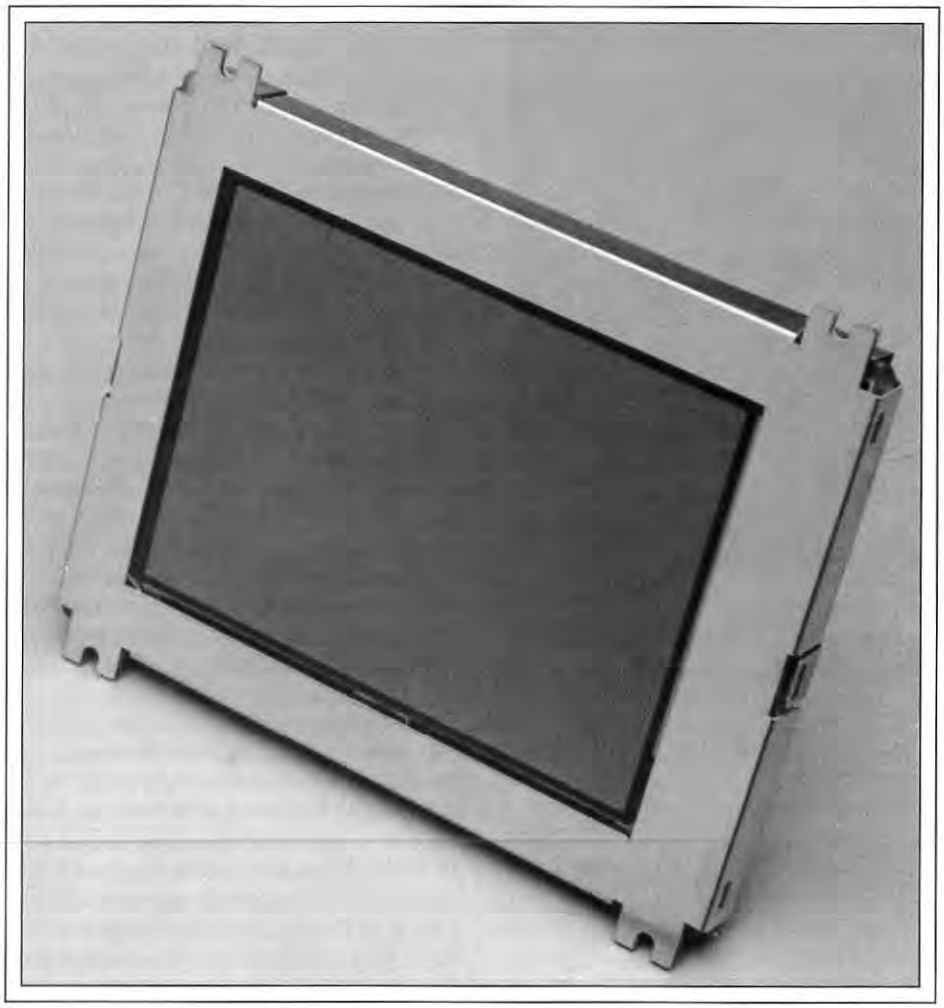

Motorola Flat Panel Division

Fig. 2: *Motorola showed its 5.1-in. FED prototype in a hotel suite, promising engineering samples in the second half of the year and a significant presence on the show floor at SID '98.*

tron-emitter (SCE) cathodes with an economical ink-jet printing process, and showed an impressive 10.4-in. example of the SCE display (SED) at the author interviews (Fig. 1). "SEDs could replace traditional FEDs and maybe even PDPs," said one experienced display hand. "At least they could if the technology weren't being developed by Canon. Canon is the Xerox PARC of Japan."

Motorola showed its 5.1-in. FED prototypes in an off-site hotel suite (Fig. 2), but its new 275,000-ft.^{2} manufacturing facility in Tempe, Arizona, and its promise of engineering samples in the second half of this year added a substantial head of steam to the FED locomotive.

Plasma display panels with 40- and 42-in. diagonals seemed to be everywhere, and substantial numbers of controller and interface vendors finally seem to have discovered the SID show.

And to add a little icing to the cake, the tradition of not building high-volume FPD fabs in North America showed some signs of cracking. We already have ***Three-Five Systems***' successful high-volume plant and ***Motorola***'s new FED plant, both in Tempe, Arizona, and ***Sharp***'s assembly operation in Camas, Washington. As if to accentuate the point, Bob Pinnell said at the USDC press conference on Wednesday, "There is no longer any reason to question the ability to build a complete fab in the U.S. based on U.S.-made manufacturing equipment and materials." And, if you choose, it now seems you can build a fab in the U.S. without using U.S. equipment. ***Wande*** is building an STN-LCD plant in Dallas, Texas, to process up to half a million 350 × 350-mm substrates per year. The factory and cleanrooms are completed, and equipment was being installed while the SID show was in progress. Wande intends to do contract production and some standard products.

In addition, the representatives of ***Meissner & Wurst*** of Stuttgart, Germany, were overwhelmed with the interest in their turn-key fabs.

New activity is certainly not limited to North America and, on a vastly larger scale, to Japan. ***Mitsubishi*** and ***Chunghwa Picture Tubes (CPT)*** have a technical alliance, according to Dale Maunu of Mitsubishi. CPT will replicate Mitsubishi's generation 2½ facility in Taiwan. Mitsubishi is supplying factory and LCD design and set-up information in return for a portion of the factory's output. And ***Samsung***'s Tom Striegler proudly discussed the construction of the company's new "third line," which could catapult the company from the No. 3 maker of LCDs (by volume) to No. 2.

Biggest East Coast SID

By some measures, this was the biggest SID event yet. Overall attendance was 5600, compared with 5500 last year in San Diego, according to Symposium Coordinator Mark Goldfarb. There were 240 exhibitors hawking their wares from 347 booths, compared with 223 exhibitors and 330 booths in San Diego.

The increasing interest in using displays was indicated by the higher registration for the applications seminars: 535 compared with 320 last year. The only indicators that were down were registration for the technical symposium (1660 *vs.* 1715 last year) and the Monday and Friday seminars (775 *vs.* 830). Even if only the least favorable indicators are considered, SID '97 is still the largest SID Symposium ever held on the East Coast.

Investor's Forum

A new event held in conjunction with SID was Monday's Flat Panel Display Investor's Forum, sponsored by Josephthal, Lyon & Ross and coordinated by Elliott Schlam. The strategy was to open a channel between display companies seeking capital and the investment community (Fig. 3).

The message was upbeat. SID President Web Howard opened the proceedings by say-

QFTV

Fig. 3: *QFTV, the company that established its place in the annals of display history last February with the first commercially available plasma TV receiver, displayed its set at the FPD Investor's Forum at SID '97.*

ing, "Growth in computers virtually demands growth in displays to help people cope with the ever-increasing amounts of information directed at them." Paul Fitzgerald, President of Josephthal, Lyon & Ross followed with, "We believe the flat-panel industry is on the verge of exploding, but we've had a hard time convincing investors of that. This forum is a way of helping that change. There is a lot of competition for investor dollars, but we believe this is an industry where that money belongs."

That Fitzgerald had only taken the first few steps in his journey of a thousand miles was underscored when only half of the brokers and analysts who had registered to attend actually showed up. "We have further work to do," said consultant Schlam, "in order to heighten the investment community's awareness of the merits of the flat-panel industry and to increase their interest in attending the second Flat Panel Investor's Forum, planned for next year. Josephthal is committed to this for the long haul. The company presentations were universally regarded as being useful and of high quality. We have the product, and now we have to find a way of communicating that to the audience of brokers and investors."

Larry Weber of ***Plasmaco*** gave the keynote address, saying, "If someone says they have a wonderful new display technology, be *very* suspicious, especially if they can't show you a working model."

Elliott Schlam followed with an analysis of the display industry. "We feel the $20 billion display market will be an $80 billion market before the next decade is over." The U.S. will emerge as an important player in that market, said Schlam, because (1) there will be a dramatic growth in demand, (2) new display technologies will develop, and (3) greater U.S. participation is expected.

"I believe," said Schlam, "we're entering a second wave of the FPD industry, in which notebook PCs will become only one component of the FPD market instead of most of it." As two examples of the buoyant outlook for displays, Schlam noted that 100-million PC telephones were projected by the end of the decade and that most of the 240-million TV sets in the U.S. would be replaced by digital sets over the next 10 years.

Dean Clubb, Executive VP at *Texas Instruments*, was at the Forum to talk about TI's Digital Light Processing™ (DLP) technology and business, following a year of dramatic restructuring during which the future of the display activity sometimes seemed in doubt. In a one-on-one interview, Clubb told *ID*, "TI is committed to DLP. We've been restructuring over the last year, but the bottom line is that we want to focus on technologies in which we have a particular advantage and can make money. DLP is that." Clubb said that SVGA and XGA products were coming, as was an under-1-lb. 1-chip projector.

The speaker at the Investor's Forum Luncheon was the always quotable Nicholas Negroponte, Director of MIT's Media Lab. Negroponte said that direction of computer development "is a conspiracy between Andy Grove and Bill Gates" to hold the price of a computer at $1500. Andy makes a faster processor, Bill uses more of it ... There is an extraordinary obesity in systems software and everything else that drives displays.

On whether the ideal display format will ultimately prove to be landscape (for watching *The Lost World* and calculating spreadsheets) or portrait (for editing a full page of text or reading an x-ray), Negroponte said, "The ideal aspect ratio is probably square." That is, when the display becomes big enough and has enough pixels, it won't be necessary to choose either portrait or landscape.

Opening Sessions

SID opened with the traditional business meeting, which was followed by a new Formal Opening Session. Joseph Donovan, from the State of Massachusetts, welcomed the attendees to Massachusetts and outlined the state's benefits for technology companies. Then Kent Hughes, Associate Deputy Secretary, Office of Global Competitiveness, U.S. Department of Commerce, said that technology and the entire innovation chain are central to the Clinton Administration's long-term growth strategy, including an economic climate that facilitates rapid commercialization.

Earlier, at a breakfast for members of the press, Hughes commented that the political pressures that had been on the National Institute of Science and Technology (part of the Department of Commerce) and on the Department of Commerce itself 18 months ago had now eased. The Department has successfully made the case to Congress of its usefulness to the country and now enjoyed, said Hughes, substantial Congressional support.

During the subsequent keynote addresses, Peter Keller of Tektronix reviewed the history of the CRT, celebrating its 100th anniversary this year, and Peter Brody discussed the fabrication of the first active-matrix LCD, enjoying its 25th anniversary. Shinji Morozumi of Hosiden discussed the rise of AMLCDs in Japan.

The Wednesday Luncheon

Five hundred and sixty people gathered in the Sheraton Boston's Grand Ballroom to witness the distribution of various awards and listen to a provocative luncheon speaker. SID President Web Howard of FED Corp. opened the proceedings by saying, "This kind of growth supports diversity."

When the Second Annual SID/*Information Display* Display of the Year Awards - which had been previously announced in the December issue of *Information Display Magazine* and in other publications - were presented, many members of the audience were surprised to learn that Virtual i-O, winner of the Honorable Mention for Display Product of the Year Award, had gone out of business just 2 weeks earlier.

In previously prepared written comments, Display of the Year Award Committee Founding Chair Shunsuke Kobayashi said, "We give these awards for technical excellence, not for a company's business acumen." (At a meeting of the Display of the Year Awards Committee held that evening, Professor Kobayashi stepped down as chair after 2 years' service to be replaced by Jean-Noel Perbet of Sextant Avionique.)

The luncheon speaker, Dr. Robert H. Webb of the Schepens Eye Research Institute in Boston, took as his topic "The Image Stops Here: A View of the Final Projection Screen." Webb and his colleagues commercialized a research instrument called the scanning ophthalmoscope 10 years ago, and this device can be used as a scanning retinal display. Webb's group is currently looking at issues such as spot size and scan rate to understand both how the eye processes signals that excite only a small area of the retina and how one might optimize such a display. All the needed elements of a smart, retina-scanning display are here today, but not all together and not all fast enough. "In 10 years," said Webb, "we should be able to make a little retina-scanning display that can hang on your eyeglasses."

CRT Centennial Exhibition

As part of its celebration of the 100th anniversary of the CRT, SID sponsored a special historical exhibition entitled "From the Braun Tube to the Information Age, 1897-1997: The 100th Anniversary of the CRT." For the 3 days of the exhibit - which was organized by Nutmeg Consultants, curated by Pete Keller, and managed by Dian Mecca - a steady stream of people circulated through a quiet area just outside the main exhibit hall to view nearly 50 significant artifacts of display history. Included were a 1910 reproduction of Braun's original 1897 indicator tube, a 1921 Western Electric 224A (the first commercial CRT in the U.S.), a 1932 General Radio cathode-ray oscillograph (the first commercial oscilloscope in the U.S.), a 5FP7 World War II CRT used in radar PPI indicators for Boeing B-17 bombers, a 1954 RCA 15GP22 (the first commercial shadow-mask color CRT), and a CBS color-wheel TV receiver. But the star of the show was an operating 1954 RCA CT100 TV receiver, the first commercial color receiver based on a shadow-mask tube. (See the text box, The Beginning of Color, which accompanies Joe Hallett's CRT article in this issue.)

Touring the Circus

In 1992, the last time SID was in Boston, ***Sharp*** proudly introduced an 8.4-in. VGA AMLCD that displayed 512 colors, consumed 6 W to produce a luminance of 65 cd/m^2, and cost $1800. In the display world, 5 years is a very long time. It was still possible in 1992 for one person to do a reasonable job of covering at least the exhibition portion of the big SID event, which was not so big then.

This year it took four of us, and I would like to thank Joe Hallett, Chuck McLaughlin, and Ross Young for their knowledgeable, insightful, and professional contributions. But it's really many more than four because each of us used scores of sources and advisors. Those who are quoted in the articles receive due credit, but there are many people who provided insightful comments, indicated a presentation of particular significance, or simply pointed us toward something entertaining, and these contributions may not be acknowledged in the normal course of writing an article.

On my own behalf, I would like to give particular thanks this year to Aris Silzars, Ed Stupp, Heiju Uchiike, Larry Weber, Alfred Poor, Alan Mosley, Ernst Lueder, Youichi Funaki, and Terutoshi Sato - and probably many others.

Now, let's turn the page and take a more detailed look at the circus.■

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CRTs, FEDs, and the Pieces Thereof

On the 100th anniversary of the CRT, medical monitors push the CRT envelope while Philips flattens it and Motorola prepares to burst out of the FED closet.

by Joe Hallett

As SID '97 celebrated the CRT's 100th birthday with a commemorative exhibition, many attendees could relish their knowledge that the venerable technology's major growth in instrumentation, radar, and television applications took place during their lifetime. Although the CRT marketplace may be maturing, it is far from the end of its life, despite significant growth in alternatives such as solid-state and flat-panel display (FPD) components. CRTs still offer versatility and high performance to many demanding display applications.

In an invited paper at the SID meeting, Dr. Joseph Castellano – president of the market research firm ***Stanford Resources*** – predicted that the CRT market would continue to grow, remaining as the largest single electronic-display segment for at least five more years, and probably for the first two decades of the 21st century. Anyone for the 125th anniversary celebration?

The CRT industry is not static, but there are signs of change among suppliers of traditional CRTs and CRT-related components such as power supplies and deflection yokes. ***Celco*** announced the completion of its takeover of ***Discom***'s deflection-yoke and related-components business. ***Thomson Tubes Electroniques*** announced a 1280 × 1024-pixel plasma display panel with an analog-type interface that makes it interchangeable with a CRT.

Longtime SID exhibitor ***MultiComp,*** a supplier of custom CRT components and power supplies, has ceased to exist. ***Brimar Ltd.,*** the

Clinton Electronics

Fig. 1: *Clinton's new 20-in. flat-profile monitor for radiology stations was showing medical imagery at SID '97.*

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Philips Research Laboratories

Fig. 2: *Philips' cathode-ray-tube panel (CRP) was described in a series of papers, and a 17-in.-diagonal prototype was shown. The image is CRT-like, and the panel thickness is about 1 cm for any screen diagonal. Electron transport is through insulating structures that provide the panel with a support structure that does not compromise image quality.*

U.K.-based supplier of high-performance CRTs, announced a management buyout that will complete its disassociation from the Rank organization. And the industry lost a senior statesman, ***Syntronic Instruments*** founder Henry Marcy, who died earlier this year.

Diversification is also an option for suppliers of CRT-related products, a notion that was quickly reinforced on the show floor by seeing adjacent exhibitors ***Thomas Electronics*** (CRTs and flat-panel backlights) and ***Syntronic Instruments*** (yokes and loudspeakers).

While cost reduction has driven many of these changes, there can be no doubt that changing market requirements have also played a big role. For example, putting the World Wide Web on TV raises some new issues. According to a representative from one big CRT maker that wasn't exhibiting, screen burning is a concern when images are stationary, and corner focus can be a problem, especially at the normally high light-output levels of conventional TV.

Large CRT-based gray-scale monitors continue to grow in importance for viewing medical x-ray images. This growth is also seen by yoke suppliers. "There is growth in the radiology market," said ***Syntronic Instruments*** president Gardner Marcy. And Celco, manufacturer of yokes and deflection amplifiers, agrees. "We see big growth in the medical area, thanks in part to acquisition of ***Discom***'s business," said ***Celco*** VP John Constantine, Jr.

As noted last year, increasing acceptance of electronic displays in medical-imaging applications is causing pressure to reduce costs, since an installation may require relatively large quantities of such monitors.

These monitors typically display 2k × 2.5k pixels, with 8 or 10 bits of gray levels, depending on the controller that is used. There is some controversy over the necessary bit depth for medical applications. Price is important but performance still prevails. Improvements are ongoing: a 7-million-pixel system is coming for mammography, said ***Orwin Associates*** marketing director Ben Iannotta.

Clinton Electronics is finding increasing activity in monitors for the medical market, too, and is working to reduce costs. According to Ken Compton, Clinton's general manager for monitors, "The medical market is our hot area. Our customers are feeling some cost pressures, and we have been able to provide monitors that help them to achieve lower overall costs." As an example, Clinton showed a 21-in. 1280 × 1024-pixel monitor with a P45-phosphor screen that is being built for Siemens, and a 20-in. monitor with P104 phosphor (Fig. 1). According to Compton, "both monitors are derived from our standard products, with microprocessor control." Clinton also showed 17- and 21-in. high-brightness monochrome CRTs with bipotential focus in colored glass. "We are moving toward high-performance displays," said Compton.

Orwin Associates is an OEM supplier of gray-scale monitors for medical PACS (Picture Archiving and Communications Systems) and for scientific and government image-analysis systems. ***Orwin*** monitors were shown at the SID exhibition by ***Hughes*** – a recently approved CRT source – to demonstrate its tube and by ***Techneglas,*** which was showing the monitor with the original ***Thomas*** CRT (which uses a Techneglas bulb).

"Our business has tripled over 3 years for image-analysis (intelligence and earth-resource applications)," said Iannotta. "The move to digitized and filmless medical imaging has been under way for 10–12 years. Now it's happening. Good new young guys – doctors that grew up with computers – say, 'How can you do without it?' Boston is a center of this activity – a hot spot." Iannotta concluded by saying, "I invited people from the medical community to come to this SID show – and they came!"

Hitachi showed a new 19-in. color-monitor CRT that is optimized for desktop-computer applications. The tube has a dot screen, with mask pitch at 0.22 mm horizontal and 0.26 mm vertical. The gun uses elliptical, multi-step apertures and multiple dynamic focus to control spot shape. A prototype 27-in. tube was also shown. It had a 0.58-mm/0.66-mm mask and was displaying the SVGA (800 × 600) format.

According to a spokesman for ***Hughes,*** "More than 50% of our business is now non-military." While making tubes for helmet displays and for medical monitors such as ***Orwin***'s, ***Hughes*** also makes the special CRTs used in a high-end light-valve projector by ***Hughes-JVC.***

WinTron showed a prototype synchronous power supply for high-scan-rate applications – now at 130 kHz and aiming for 200 kHz by year's end – and a "snap-and-wrap" version of their wraparound yoke for low-power small-screen CRT applications. "Necking down the area where deflection takes place increases sensitivity," said WinTron's engineering

The Beginning of Color

The television picture tube has come a long way in the 100 years since Carl Ferdinand Braun invented the cathode-ray tube (CRT) in 1897. A 1910 reproduction of Braun's indicator tube was featured at the special CRT Centennial Exhibition at SID '97 entitled "From the Braun Tube to the Information Age." Many individuals and companies made improvements to Braun's original design, and a generous sampling of those improvements could be seen at the exhibition. But it wasn't until 1954 that RCA succeeded in producing the first color CRT suitable for the then-new American NTSC color-television standards.

That tube, the 15GP22, was on display in Boston, and it was the key element in the first color television set mass-produced for consumers, the RCA CT100. The 15GP22 was developed and manufactured at RCA's facility in Lancaster, Pennsylvania. Today, that location serves as the R&D site for the North American Tube Division of Thomson Consumer Electronics, maker of the RCA, GE, and ProScan brands.

The 15GP22 was a direct-view CRT with a glass envelope. It had a flat face with rounded sides and could display both black-and-white and color images measuring 11½ × 8⅝ in. The tube contained three separate electrostatic guns spaced at 120° in a triangular, or "Delta," configuration and a flat shadow mask. Although the 15GP22 incorporated many important technological breakthroughs, the shadow mask was the most critical and it remains the key common element in all color CRTs mass-produced today for either television or computer use.

Today's big-screen color CRTs have a basic similarity to the 15GP22, but there are also substantial differences in the components and processes used for their fabrication. Instead of silkscreening red, blue, and green phosphors onto a flat glass plate – as was done in 1954 – current practice deposits the phosphors directly on the inside surface of the panel.

Thomson Consumer Electronics

The RCA CT100, made in 1954, was RCA's first commercial color television set and the first commercial set to use a shadow-mask picture tube. This particular set appeared at the CRT Centennial Exhibition at SID '97 in Boston, and was photographed shortly after being returned to Thomson's facilities.

Today's tubes use in-line electron guns manufactured as an integrated unit for closer beam spacing and smaller tube-neck size, which result in reduced manufacturing and operating costs. Modern tubes also use self-converging yokes that can be adjusted entirely at the tube factory instead of during TV final assembly. The previous Delta technology required complex manual adjustments during TV final assembly to converge the three beams.

The smaller-neck in-line technology reduces deflection power substantially, and also makes 110° deflection possible. As a result, today's 36-in. tubes are actually shorter than their ancestors of 1954, while providing sharper images and nearly seven times the viewing area.

That said, the CT100 displayed in Boston ran reliably for the three days of the Centennial Exhibition and drew a steady stream of viewers. Some said it never looked better, driven as it was by a video signal from a new DVD player. (Thomson engineer Frank Koch had the foresight to bring a DVD player with 300-Ω output and some twin-lead to satisfy the CT100's appetites. Many DVD models have only coax and RCA plug outputs.) The CT100 played next to a new 36-in. ProScan PS36190. (The two sets are compared in the accompanying table.) The newer set displayed much richer reds, a result of extensive research into more-efficient red phosphors than were available in 1954.

– Mark E. Corbin
Thomson Consumer Electronics

43 Years of Color Television: A 1954 RCA 15-in. CT100 Compared with the 1997 ProScan 36-in. PS36190

1954	Year	1997
CT-100	Receiver model	PS36190
CTC2	Chassis	CTC-189
$1000	Receiver cost	$2200
16.2	Anode voltage @I_b limit (kV)	31.5
15	Maximum beam power (W)	70
15GP22	Tube type	A90AFF15X11
45°	Deflection angle	111°
664	Tube length (mm)	550
50.8	Neck diameter (mm)	32.5
Delta	Gun arrangement	In-line
Electrostatic	Convergence method	Magnetic self-converging
571	Screen area (cm^2)	3903
Metal-backed (aluminized) tricolor phosphor dot 195,000 triangular groups	Screen type	Aluminized matrix screen Vertical line array, 0.9-mm trio spacing
Silkscreening on a flat filterglass plate	Screening process	Slurry
Flat tension mask	Mask type	Invar super arch mask

Note. These two receivers share a lineage, which can be seen in the common chassis numbering system that has extended over 43 years. CTC stands for color television chassis.

director Norman Lewis. "We found a unique way to encapsulate four half shells (comprising a saddle-saddle deflection yoke) so that they can be easily put back together ... This allows the CRT and yoke to be integrated by the CRT manufacturer. We have a couple of CRT manufacturers that are already making the tubes."

Among the OEM monitor suppliers exhibiting in Boston were ***Z-Axis*** and ***Teltron Technologies. Advanced Video Technologies*** showed a rack-mountable 20-in. Trinitron-based monitor for industrial/military applications.

Other monitor technologies are also moving ahead. ***Display Laboratories*** showed a custom integrated circuit that performs what they call "dynamic digital convergence" of CRT monitors and projectors. This chip, used in conjunction with the company's automatic alignment system, will provide manufacturers with tools to automate dynamic convergence. Samples should be available now, with production in Q4. And waiting in the wings are improving flat-panel technologies, such as the ***dpiX*** 13.5-in. 3072 × 2240-pixel 4-bit grayscale AMLCD panel, which is already being promoted as a display for image analysis.

Flat CRTs and FEDs

In a series of invited papers, ***Philips Research Laboratories*** described an experimental 17-in.-diagonal thin CRT with a 16:9 aspect ratio (Fig. 2). Insiders said the new CRT was every bit as good as it looked in the photographs and is manufacturable in volume.

Field-emission displays (FEDs) are being called thin CRTs by some people, so they are included here. In some ways this year's SID exhibition was like previous years, as far as FEDs were concerned, in that the better-known players continued to play hide-and-seek with the rest of the world, and lesser-known players continued to hide in the shadows. But there were some noteworthy moves.

PixTech announced that it had started shipping 5-in. green-screen quarter-VGA devices for a medical-equipment application. Their booth also showed progress in color devices, demonstrating on demand a 10-in. VGA unit promised for late this year. There were also some realistic-looking applications of green-screen devices to replace AMLCDs - which just replaced CRTs, didn't they? - in video test equipment.

Futaba joined the ranks of the visible players by exhibiting 5-in. quarter-VGA green-screen devices. ***Candescent Technologies*** was a notable no-show among the previously visible, but it made news by announcing a joint venture with ***Schott Glass*** for development of special glass for thin CRTs. ***Raytheon*** exhibited its very bright FED intended for government and military markets, while ***Motorola*** - and possibly others - showed their FEDs in the shadows of hotel suites. But ***Motorola*** promises to go public soon, and intends to have the world's first operating high-volume FED production facility. Engineering samples should be available before the end of the year, and Barry Moehring, manager of marketing and communications for Motorola's Flat Panel Display Division in Tempe, Arizona, promises ***Motorola*** will have a substantial presence at SID '98 in Anaheim.

In his notes describing the CRT Centennial Exhibition, Peter Keller pointed out that "the shadow-mask color picture tube marked the last major milestone in CRT development. Since then, the name of the game has been refinement." That's nearly 50 years of incremental improvements. (See text box, The Beginning of Color).

Tube rebuilder ***Video Display Corp.*** might agree. It proudly proclaimed to the SID press corps, "Recycling of CRTs is a big business," providing replacements for obsolete tube types and helping to keep a lot of mature equipment on the air. ■

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Circle no. 20

Liquid-Crystal Displays

There were so many LCD varieties at SID '97 that it's hard to view them all as part of a single technology.

by Ken Werner

At SID '96 in San Diego, ***NEC***'s 20.1-in. SXGA wide-viewing-angle (WVA) AMLCD was so startling that show attendees literally stopped in their tracks as they turned into the aisle and saw the display. This year, ***NEC*** topped itself with a UXGA (1600 × 1200) 20.3-in. prototype, while ***Samsung*** was also showing a 20-in. UXGA AMLCD. ***Sharp*** exhibited a 20-in. STN-LCD and showed its tiled 40-in. AMLCD during the author interviews. Fifteen-inch CRT-killer AMLCDs were everywhere, as were 13-in. displays for "mega-notebooks."

LCDs were smaller as well as larger – as small as ¼ in. on the diagonal in the case of ***Kopin***'s quarter-VGA (QVGA) microdisplay. Reflective and bistable displays using a variety of technologies were being shown, and polysilicon displays are getting larger (see Chuck McLaughlin's accompanying article on miniature displays).

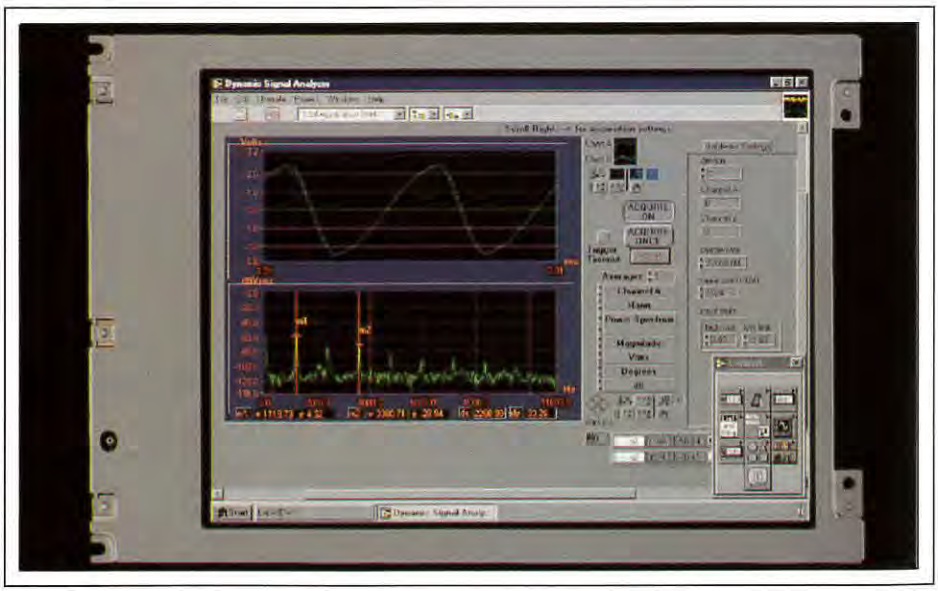
Part of the excitement at SID '97 stemmed from the conviction that we were witnessing the beginning of a sea change in the LCD business, in which many other applications would join laptop computers as major markets for LCDs – along with other flat-panel displays (FPDs).

LCDs

In years past, we would examine each LCD carefully for splotches, blotches, ghosting, uneven backlighting, poor color, and impossibly narrow viewing angles. It is now hard to find a bad-looking LCD from an established manufacturer using a mainstream design.

Mitsubishi showed its new 15.1-in. SXGA AngleView AMLCD with a WVA of about 120° (H). The display shows 260,000 colors, produces a luminance of about 200 nits with a power consumption of 18 W, and uses optical-compensation-film technology combined with Mitsubishi's thinner-than-usual LC layer. There is an optional integrated inverter for the two hot-cathode fluorescent lamps (HCFLs) that edgelight the display from top and bottom. An XGA version also produces 200 nits. A new 8.4-in. VGA WVA display looked bright and exhibited high subjective contrast (Fig. 1). Mitsubishi representatives took pains to point out that the company was providing its latest WVA technology in smaller sizes to support the industrial-control and factory-automation markets.

Sequel (Santa Clara, California) is providing in-warranty and out-of-warranty service for Mitsubishi in the U.S. and worldwide. Repair is a big issue, said a Mitsubishi staffer. Other vendors have to ship their displays back to Japan for repair, so Mitsubishi is looking for a competitive advantage in the U.S. by having Sequel do it here. Mitsubishi supports



Mitsubishi

Fig. 1: *Mitsubishi's bright new 8.4-in. VGA display has a wide viewing angle for the industrial-control and factory-automation markets.*

Ken Werner *is Editor of* Information Display Magazine; *telephone 203/853-7069; fax 203/855-9769; e-mail: kwerner@netaxis.com.*

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What the Abbreviations Mean

VA:	Viewing angle - VA (H) is viewing angle, horizontal; VA (V) is viewing angle, vertical
WVA:	Wide viewing angle
CCFT:	Cold-cathode fluorescent tube
HCFL:	Hot-cathode fluorescent lamp
CR:	Contrast ratio
cd/m^2:	Candela per meter square, the unit of luminance; also called a *nit*
LC:	Liquid crystal; refers to the gel inside the display
LCD:	Liquid-crystal display
AMLCD:	Active-matrix liquid-crystal display
STN-LCD:	Supertwisted-nematic liquid-crystal display
FPD:	Flat-panel display
VGA:	In FPDs, usually shorthand for "VGA-compatible pixel format," or 640 × 480 pixels
SVGA:	SVGA-compatible pixel format, or 800 × 600 pixels
XGA:	XGA-compatible pixel format, or 1024 × 768 pixels
SXGA:	1280 × 1024 pixels
UXGA:	1600 × 1200 pixels
LVDS:	Low-voltage differential signaling; a de facto semi-standard for digital interfacing of an FPD that permits the panel to be positioned up to 25 ft. from the host system
TFT:	Thin-film transistor

Sequel with parts and advance knowledge of new models and operation.

NEC showed its beautiful 20.3-in. UXGA AMLCD prototype with full-color analog interface, 0.26-mm pixel pitch, and luminance of 200 cd/m^2. This is a technology demonstration, said NEC's David Schultz and Alison Niday, but engineering samples of the 20.1-in. WVA SXGA module were scheduled for June or July availability at a price of $8500, and mass production was scheduled for September. The production pricing target was $6500, but could go lower for a mass-consumer application.

A new 14.1-in. XGA panel is on the same sampling and production schedule as the 20.1 in., with engineering samples at $2500. There was also a 15-in. XGA technology demo. Both of these displays use NEC's SFT ultra-wide VA system, which is a variant of in-plane switching.

NEC believes the 15-in. LCD monitor is the sweet spot for both manufacturing and marketing. They can be manufactured 4-up on a third-generation (550 × 650-mm) line, which will also do 19-in. panels 2-up and 20.1-in. panels 1-up.

NEC sees 13.3 in. as being the hot size for premium notebook computers. There are lots of 6-up 12.1 in. displays in the industry, and there is talk of a 14.1 in. for luggables. NEC's 13.3-in. XGA module has a digital RGB interface and LVDS, and will sell for $1100 in small quantities, said Schultz. For large quantities delivered in Taiwan, the price is $925/1000, and an SVGA version costs $680/720.

A nice 10.4-in. VGA TFT unit is intended for factory automation, instrumentation, business machines (copiers), and point-of-sale (POS) applications. The unit has a digital interface, 6-bit color, and 180 cd/m^2. Sounding the same theme as Mitsubishi, with its 8.4 in., Schultz said NEC will stay in the 10.4-in. market over the long term to serve these industrial market segments. NEC was showing the 10.4 in. in a Tektronix TLA 704 Logic Analyzer, a design win that was announced about a month before the show (Fig. 2).

Samsung's Tom Striegler said Samsung is building its third line, and is the first company to announce a line that will operate in mid-1998 with 600 × 720-mm mother glass. These dimensions make for economical production of 13.3-in. displays 6-up and 17.1-in. displays 4-up on 0.7-mm glass. The line is being built in Chonan, Korea, 50 miles south of Seoul, at a cost of $900 million. Samsung, now the No. 3 maker of portable computer displays by volume, has set a goal of becoming No. 2 in 1998, said Striegler. In an aside, Striegler mentioned that Samsung now owns 100% of AST computer.

Samsung had just decided to convert its 21.3-in. UXGA TFT-LCD prototype into a product. Samples will be offered to strategic

Tektronix

Fig. 2: *NEC showed its wide-angle 10.4-in. VGA AMLCD in a Tektronix Logic Analyzer.*

Sharp

Fig. 3: *Sharp's new LM12S02 multi-line-addressed 12.1-in. STN-LCD module offers 150-ms response time, 40:1 CR, and 260,000 colors – without TFTs.*

customers in Q3, and production will begin in the middle of next year. The handsome prototype was on display, along with 13.3-in. XGA, 14.0-in. XGA, 15.0-in. XGA, and 15.1-in. SXGA displays.

Sharp, the perennial LCD leader, packed a large number of significant displays into its modest booth. Sharp seems to have a philosophy of using straightforward technology to deliver displays to its customers. Said Sharp's Joel Pollack: "In-plane switching cuts response time in half and requires much more power – and it's not yet on the market. A combination of compensation film, metallurgy, and LC parameter changes do the job now." Sharp calls this design approach, used to obtain WVA, in combination with its high-aperture-ratio technology, "Super V." It produces lovely results in Sharp's 20.1-in. 300-nit SVGA AMLCD, which will be a product in '98.

Sharp's LQ12S41 is a 12.1-in. SVGA module made with the Super V process. The backlight delivers a conservative 30,000 hours.

The transition from 12.1-in. notebook displays is going much faster than anticipated, said Pollack. At Sharp, too, 13.3 in. is the size for meganotes. A nice XGA unit with 300:1 CR, 70 nits, and very narrow surround was on display – and is receiving a big push in production now.

A 13.8-in. AMLCD for industrial and desktop applications used Super V technology. The aperture ratio is an impressive 85%, the CR is 300:1, and the module uses an analog PC interface. Sharp has expressed a clear preference for digital interfaces in the past, but, says Pollack, "Analog and digital interfaces are both needed to go to market."

A 15-in. color TFT Super V module was shown next to a 17-in. CRT. This 200-nit 300:1-CR display looked very good on static imagery, and is available now. A substantial goal for Sharp is to capture 5% of the CRT-monitor market by the end of '98, said Pollack.

Doing this requires a 2× price point – a price for the LCD module that allows the monitor to carry a price no more than twice that of an equivalent CRT monitor. That can be accomplished with color STN modules, most of which will be 15 in., but with some 13.8, 17.7, and 21.4 in. A 15-in. 200-nit color XGA STN panel on display will be at that 2× price point.

Sharp's 5.5-in. diode-matrix twisted-nematic (DMTN) transflective display is now making the transition to production. The unit has 480 × 380 pixels, 25:1 CR transmissive and 15:1 CR reflective, 80-ms response time, and consumes only 50 mW with the backlight off. The backlight is a blue LED whose light is conducted to a white phosphor through a lightguide.

Also on display was a 6.4-in. color TFT for airline seat-back entertainment, and there may be some application to portable devices.

This may be the year that multi-line addressing (MLA) takes off. First developed by Terry Scheffer and his colleagues as "active addressing" at In Focus, and further developed by the now-defunct Motif, MLA gives STN-LCDs some of the characteristics of the more expensive AMLCDs at only a modest increase in cost. Sharp's version of the technology is called high-contrast addressing (HCA).

Sharp's LM12SO2 is the first MLA display to go into production (Fig. 3). This SVGA module with 40:1 CR, 80 cd/m^2, and 150-ms response time ($t_{on} + t_{off}$) is now available in a non-Sharp laptop computer for the Japanese market. The unit carries a 30% price premium over a standard STN display. The display was running in the Sharp booth, and video in a window was quite acceptable. Sharp will be bringing this technology to 15-in. and other sizes.

The HCA technology could also be seen in a good-looking 5.5-in. QVGA display with 200-ms response time (80 ms to come), 30:1 CR, and 200 cd/m^2. Pollack said it is possible to make really low-cost QVGA panels – perhaps half the price of equivalent TFT panels – with this technology.

A 21.4-in. XGA STN-LCD on display was generating orders for desktop-replacement applications, said Pollack. The 300-ms, 250-nit, 25:1-CR unit is well below half the price of the equivalent TFT. Sharp is at prototype/sample run stage and expects to be in production by year's end. The bleached-band problem – contrast fall-off at top and bottom – has been solved.

Hitachi, the company that rescued Günter Bauer's 1971 invention of in-plane switching from obscurity, is now calling its implementation of the architecture "Super TFT." The

company was showing a very nice 13.3-in. XGA Super TFT module. But all current implementations of in-plane switching, as effective as they are for WVA, consume a bit too much power for portable applications. Here, Hitachi is climbing onto the rollicking MLA bandwagon, calling its version Enhanced High Addressing.

A 12.1-in. SVGA STN-LCD with Enhanced High Addressing had an optical response of 120 ms ($t_{on} + t_{off}$), a 50:1 CR, and consumed a reasonable 2.8 W to produce 70 nits. This good-looking display exhibited no ghosting. You can take 'em home for $320 each if you buy 1000 or more per month. Units are available now.

Hitachi also showed a 15.5-in. XGA STN-LCD for monitors at $600 each in quantities of 1000+/month. There was some ghosting but Hitachi will be bringing Enhanced High Addressing to this product soon.

Epson showed the latest version of its 6.3-in. reflective color VGA LCD using MIMs instead of TFTs as the active elements. The display's colors are still a bit muddy but pretty good in direct light. Specs: 512 colors, 3-bit RGB, low power consumption, 10:1 CR.

Epson also showed a 5.7-in. bistable twisted-nematic (BTN) VGA LCD with 4-ms response time, 50:1 CR, and viewing angles of 160° (H) and 140° (V). The display is a prototype, but Epson will commercialize it in a year for hand-held applications and oscilloscopes.

Optrex America showed a SpectraVue-enhanced small LCD, a huge assortment of custom OEM displays, and a 12.1-in. MLA "Super STN" SVGA LCD with 40:1 CR and 70 nits at 3.5 W or 100 nits at 4 W.

Image Quest Technologies is moving from the engineering phase to full-production phase. The company is delivering 230–250 panels per month, some of them based on IQT's own glass, some on commercial off-the-shelf (COTS) glass. A COTS display with NEC glass was in the booth. IQT is developing 10.4-, 12.1-, and 14-in. COTS displays, and is talking to IBM about its 16-in. glass and to NEC about its 20-in. glass. The 12.1- and 14-in. displays will be available in Q4. Current products are 4 × 4-in. avionics displays with 120 pixels/in. and a 10.4-in. military/avionics VGA display. The company is also developing a 2.4-in. 3ATI device and showed an operating 4 × 4-in. horizontal situation indicator. IQT is growing, and the company is looking for a few good men and women, including production people, EEs, and a product-marketing engineer.

Kent Displays was showing its new dynamic VGA 133-dpi prototype with 0.5-ms/line refresh. Kent's Joel Domino said the company is now selling hundreds of small signs (up to 2 × 12 in.) a week, with most sales in Europe so far.

Kent rival ***Advanced Display Systems*** showed a plastic 480 × 480 display and a 20-in.-diagonal technology-demo display that was not working in the booth but was claimed to be operational. A good-looking small multistable LCD was definitely working.

Sony was showing the current version of its plasma-addressed Plasmatron LCD. This good-looking 25-in. 16:9 display had snappy whites, 250 nits, a 70:1 CR, and 8-bit color.

Kyocera showed new 13.8- and 15-in. XGA STN displays with 200-ms ($t_{on} + t_{off}$) response. A nice-looking new 6.5-in. half-VGA featured low power consumption.

Datalux showed an AMLCD monitor with a 10.4-in. VGA touch screen and ruggedized flexible mounting for industrial, medical, mobile, marine, POS, and internal banking terminals. There is also a 12.1-in. XGA version.

Marshall was promoting its integration services, as well as showing the wide range of displays, panels, and controllers it distributes, including a 42-in. plasma monitor.

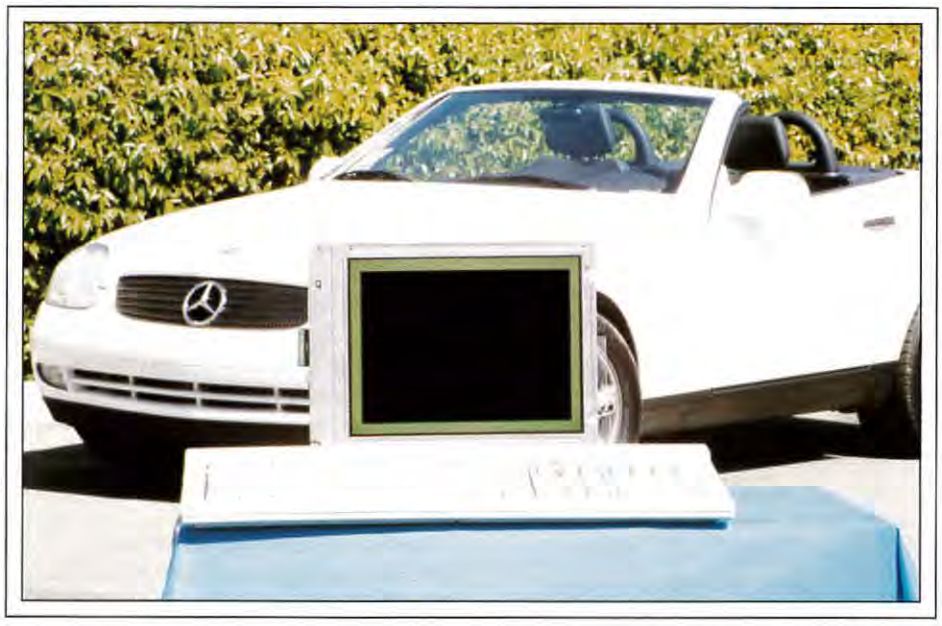
DERA, which performs research for the U.K. Ministry of Defence, and has the largest displays group in Europe, was at SID publicizing its efforts and looking for partnerships that would benefit the Ministry. In a technical paper, Guy Bryan-Brown and his DERA colleagues described a clever bistable display that supported two stable pre-tilt configurations with a carefully formed alignment grating.

EDI introduced a ruggedized sunlight-readable navigation and communications computer system with a 5-in. color AMLCD with WVA. Originally developed for use in light-aircraft cockpits, the computer's applications include GPS navigation, engine monitoring, weather maps, and radar indicators.

Design Automation and Systems Considerations

There were more companies exhibiting display- and system-design software and services at SID '97 than ever before.

SID veteran ***autronic-Melchers*** was showing its display-modeling software and measurement systems. The company was also showing the Dr. Seufert rear-projection XGA LCD panel (with associated software) that can be tiled for large situation-room displays. A



Landmark Technology

Fig. 4: *Landmark Technology's 10-CCFT 1800-nit backlight can make displays such as this 10.4-in. Sharp LQ10D346 TFT-LCD sunlight-readable. The luminance measured from a standard white plaque was 33,000 cd/m², which converts to a sunlight illuminance of 9600 fC.*

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Circle no. 21

LCD review

50-in.-diagonal module that produces 75 ANSI lumens is available now; a 70-in. version is under development.

TMA was showing the latest version of its Liquid display modeling and simulation software. Liquid features a module that simulates the appearance of an LCD image from any viewing angle, so you can look at the image on your CRT and see what the image on a yet-to-be-built LCD would look like from 30° right and 22° up from the normal.

Shintech's LCD Master software calculates the LC director under different fields and presents the optical specifications of an LCD, such as viewing angle. It is the only package to combine circuit design and physical dynamics, said Shintech director Michio Kitamura. The package runs on Windows NT and Windows 95.

Applied Simulation Technology showed ApSimLCD, which emphasizes the electrical characteristics of an LCD. The software plugs into a circuit simulator like SPICE. Given the LCD's physical parameters, ApSimLCD produces a SPICE TFT model.

Breault Research Organization was showing the new version of its Advanced Systems Analysis Program (ASAP). An early form of the program written by then graduate student Robert Breault became famous in optical-design circles when it detected and corrected errors in the first designs for the Hubbell Space Telescope 20-odd years ago, said marketing director Kathleen Perkins. Version 5.1 of the innovative optical-design program incorporates more powerful ray-tracing features for projection systems, LCD backlighting, head-up displays, and photometric performance. Response at the show was excellent, said Perkins.

POC light-shaping diffusers are now in larger sizes. The company showed a 20-in. sheet; a 30-in. version is due next month. Also new is a homogeneous collimated backlight which can be made in standard and all custom sizes. An eye-popping 25,000-nit unit was on display. The company says it can make a million a month.

Landmark Technology showed its CO53HE high-efficiency backlight that uses 3M's DBEF reflective polarizing film with its transmission axis parallel to the transmission axis of the LCD's back polarizer. "As a result, light normally absorbed by the LCD polarizer is reflected back by the DBEF to the backlight cavity," said Landmark president Sun Lu. This produces 1800 nits (525 fL) from 23 W of backlight power – almost twice the optical output as conventional systems with the same input power. The backlight uses 10 CCFTs and produces a sunlight-readable display (Fig. 4). Single units will be available in Q4 '97 for about $550. One of them looked very nice running behind a Sharp LQ10D346 VGA LCD.

TEAM Systems saw the most interest in its VG827 video generator with analog, LVDS, and 3.3/5.0-V switchable digital outputs, all for under $7000.

Klein Instruments, maker of the famous optical Klein gauge for measuring CRT convergence, took a courageous leap with a major line extension: the new VPG 250 video generator with a frequency of 170 MHz for $2400 or 250 MHz for $3800. The instrument has full remote control and a PC interface, and the software works under Windows. Klein staffers were visibly delighted that the company's gamble at SID paid off. Response at the show, said one, was "great." ■

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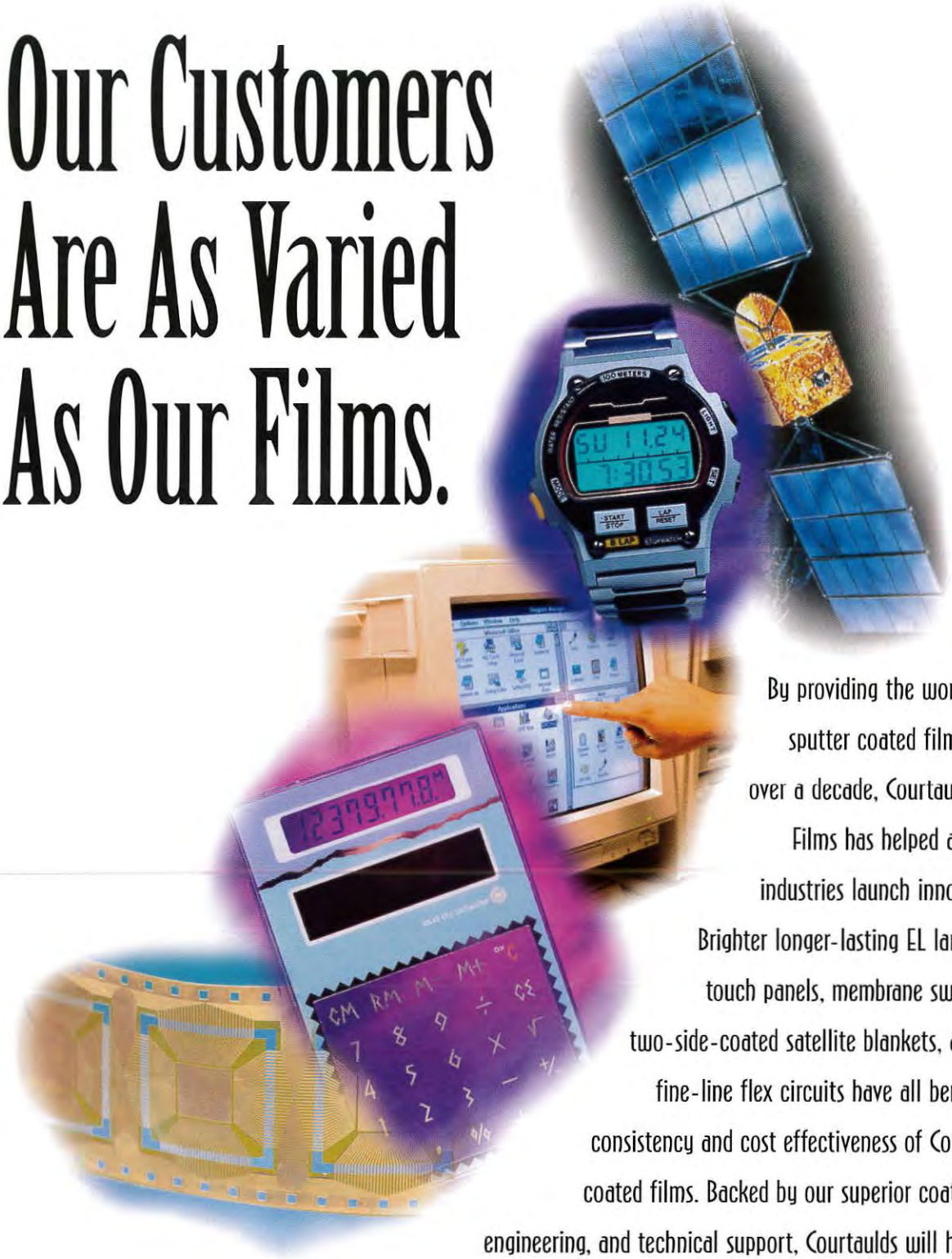

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Circle no. 22

Displays for Network Appliances

Flat-panel promotion resembles that for American cars of the late 1950s – "longer, lower, wider" – but a contrarian movement is pushing smaller and denser.

by Charles W. McLaughlin

TODAY'S SPOTLIGHT is often focused on the flat panel's quest for dominance over the CRT, but we are also seeing remarkable innovation in segmented and small graphics displays - a diverse arena. The portable and mobile systems markets are frequently the proving grounds for new technologies that subsequently find their way into the computer market.

The energetic activity in small displays is being driven by a combination of developing technology and emerging markets. New families of handheld and palmtop communications, computing, and entertainment appliances are being developed at price points ranging from $100 to $2000. These products share a common requirement: better, cheaper, full-color, low-power graphics displays.

Portability dictates that the flat-panel displays (FPDs) for these appliances be less than 5-6 in. on the diagonal and operate at well under 1 W. Target pricing for displays ranges from less than $5 for pagers to as high as $200 for a network appliance capable of displaying full-color VGA Web-page graphics.

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Evidence of the display industry's response to these new requirements was pervasive at SID '97, with both evolutionary and revolutionary developments. Numerous technical papers described improvements in color reflective LCDs and low-power emissive flat panels for improved palmtop displays. But the most revolutionary innovation by far is the personal microdisplay, which potentially offers the imaging capability of a desktop monitor (VGA full-color video) in a highly portable package (1 in.^{2} and less than 500 mW) for under $100.

The Competitive Landscape

The battle of the handheld-display technologies is being conducted on a terrain defined by power consumption and screen resolution (Fig. 1). Passive-matrix LCDs (PMLCDs) dominate current applications. Low-power reflective models are used in pagers, organizers, and handheld personal computers (HPCs).

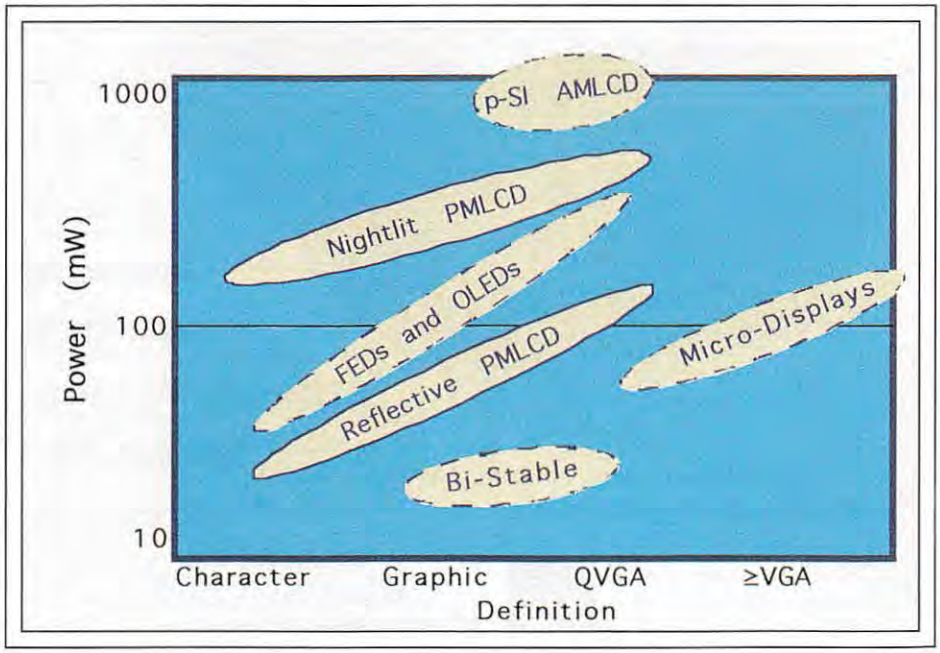


***Fig. 1:** The competitive landscape for handheld displays is defined by power consumption and screen definition.*

0362-0972/97/1309-026$1.00 + .00 © SID 1997

Fig. 2: *Uniax Corp. premiered its organic light-emitting polymer (OLED) character and graphics displays at SID '97.*

Nightlit LCDs are favored in cell-phones and, increasingly, in other applications.

The maximum display size of 5–6 in. limits the display definition to 320 × 240 – referred to as quarter-VGA or QVGA – given the computer industry's current quasi-standard pixel pitch of 0.3 mm. As a result, direct-view VGA-definition displays are larger than 8 in. on the diagonal and simply won't fit in palmtops.

The dominant PMLCD faces competition on all fronts. Bistable LCDs offer much lower power requirements. Emissive FEDs and organic light-emitting polymers (OLEDs) offer bright, colorful displays at power levels intermediate between reflective and nightlit LCDs. Recently introduced backlit full-color video LCDs based on low-temperature poly-Si active-matrix backplanes offer laptop-like imaging, albeit limited to QVGA definition. And microdisplays based on integrated-circuit backplanes offer a breakthrough to high definition, bringing Web-page capability to handheld appliances.

PMLCDs Are the Benchmark

Before becoming enamored of new technologies, designers should first appreciate the continuous improvements in market-leading PMLCDs. Here, as in laptop displays, the leading suppliers continue to improve the performance and lower the price of market-leading designs. There are several key themes of these continuous improvement efforts.

High-Gain Reflectors. Just as brightness-enhancement films have boosted laptop performance, gain reflectors can pump up the brightness of a reflective LCD. ***Polaroid*** continues its leadership with its Imagix™ holographic reflectors. In addition to the green reflectors now widely available in watches and pagers, a high-brightness white version was shown this year.

Improved Backlighting. Several innovations were on display, including: (1) LED lamps integrated into molded light pipes, shown by ***Lumitex,*** (2) a proprietary LED-backlit LCD graphics module called LCiD™ from ***Three-Five Systems,*** and (3) faceted light pipes for both back and front lighting, demonstrated by ***BriteView Technologies.***

Direct-View Displays

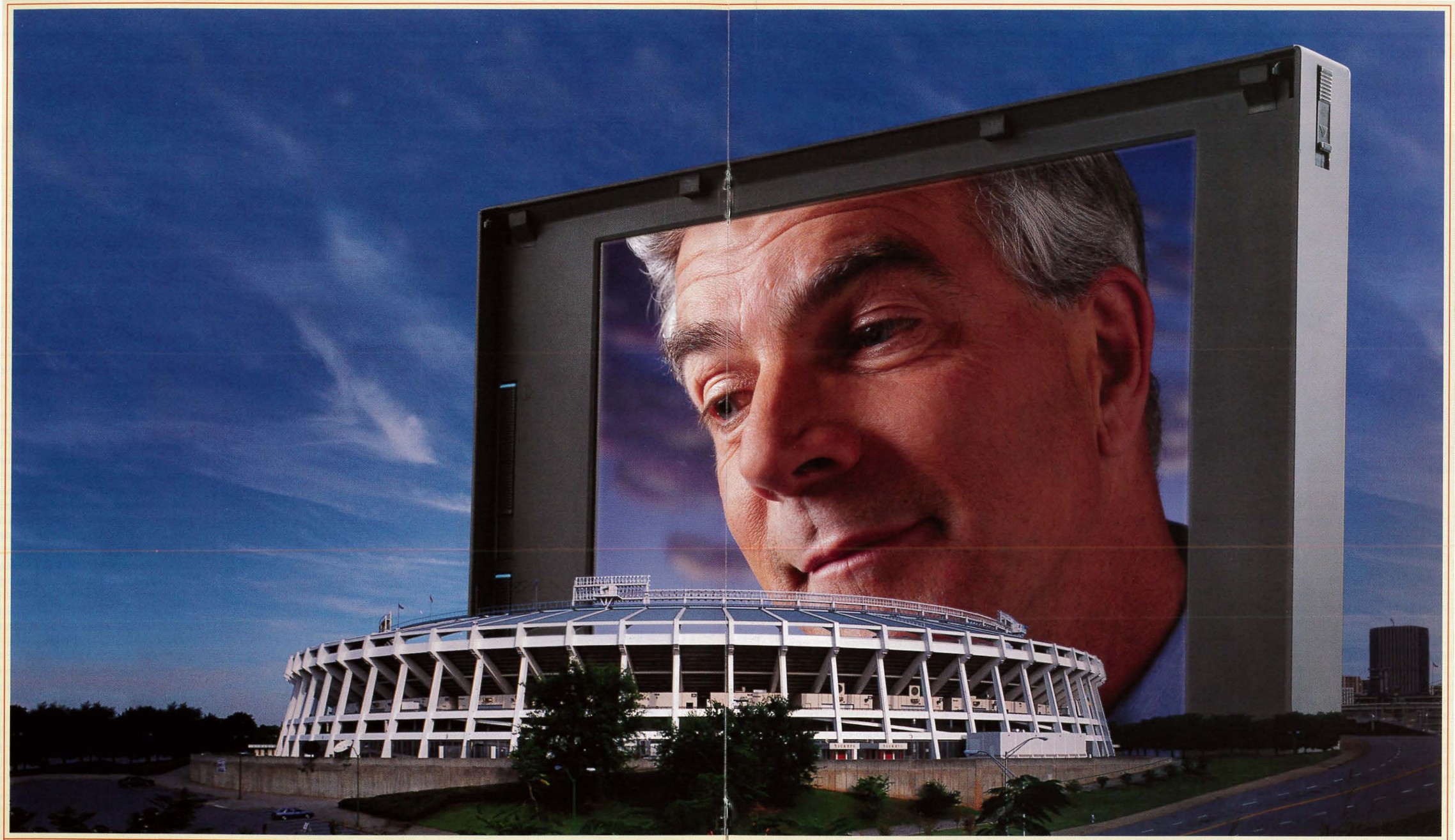
Innovations in direct-view displays for mobile devices were discussed in technical papers and shown in exhibition booths at SID '97. Four new technology classes are all aimed at carving out a share of the mobile market.

Low-Power Color Displays. The first class is low-power color, in which development continues on several fronts in the quest for a newspaper-quality reflective color display. To achieve this lofty goal, a reflected white luminance equivalent to 60% of incoming light is targeted, and to date few working prototypes have been shown that exceed 40%.

Unfortunately, the 40% barrier has not yet been broken by displays that OEMs can actually buy. Most of the innovations were discussed in technical and poster sessions; reflective color displays shown on the exhibit floor were largely monochrome or low-brightness multicolor systems.

Polarized devices are an important subcategory. The reflective color polarized devices shown, both on the floor and during the poster sessions, did not yet show acceptable brightness. Luminance, when reported, was equivalent to less than 20% of incoming light. Despite the slow progress, work continues at universities and some company research labs on polarized reflective color systems.

The guest-host nematic system is the basis for the second subcategory of mobile direct-view displays. This shows more promise, even though contrast-brightness tradeoffs in spatial color designs have historically led to uncompetitive performance. The guest-host system also requires an active-matrix drive.



Our LCD's *have grown.*

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As you may know, we already offer a line of TFTs 20% brighter and with 30% more color saturation than the closest competitors.

We'll be following up soon with more products that are—well—larger than life. Including a 13.3″ XGA notebook panel, and XGA and SXGA panels actually designed for desktop monitors—in a whopping 14″ and 15.1″.

And hey, with the desktop impending, can the coliseum really be far behind?

Onward and upward, guys.

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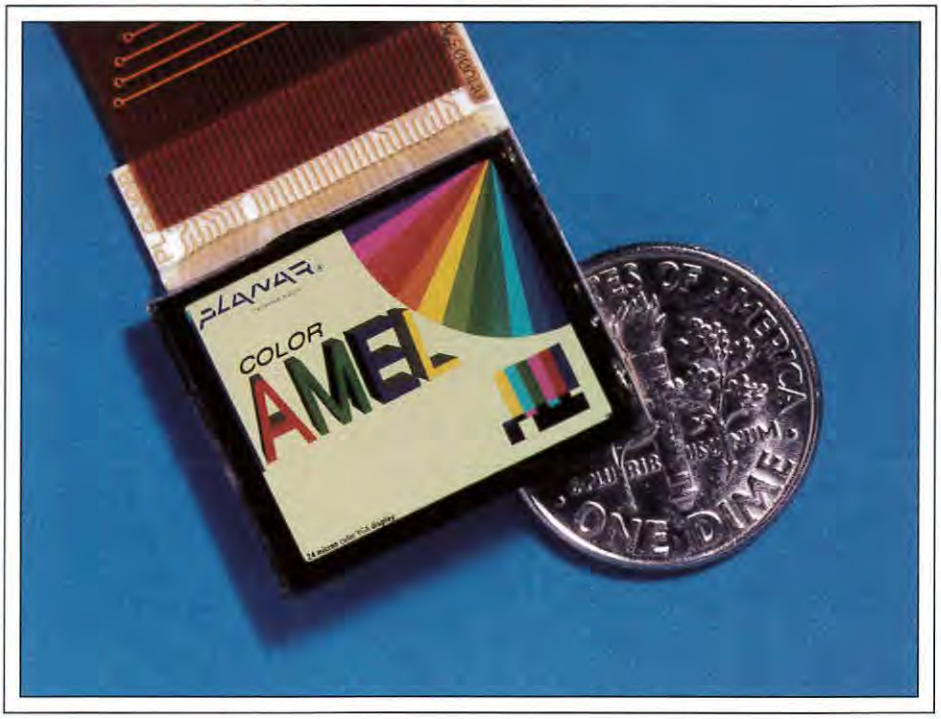

Fig. 3: Planar showed the color VGA version of its 0.75-in. 1000-lpi electroluminescent microdisplay. General sampling was scheduled for September.

This year at SID, ***Toshiba Corp.*** reported on a three-layer subtractive active-matrix guest-host system with a reflected luminance greater than 30% and a contrast ratio of 4:1. Toshiba stacks three active-matrix guest-host cells with a back reflector, and it is no small feat to achieve 30% reflectivity with the light passing twice through six ITO layers, three color guest-host layers, and three active-matrix backplanes. But performance is still well below target levels, and the complex multilayer design would require a substantial price premium.

A third subcategory is polymer-dispersed LC systems. The reflective guest-host PDLC system was demonstrated at monochrome brightness levels in the 40% range several years ago, but commercialization has been limited by the direct-drive requirement. ***Seiko-Epson Corp.*** presented an interesting twist (pun intended) on a polymer liquid-crystal system in their ISIS™ system. The device uses a polymer-stabilized surface-aligned nematic liquid crystal that is clear when unpowered and forward-scatters in the ON state. The display was demonstrated in an analog/digital watch. The digital display is incorporated into the glass face of the analog watch and is normally clear (invisible). It can be switched on to show a white digital display in front of the analog dial – a novel dual-display approach.

A fourth subcategory of low-power color mobile display technologies is not really a single grouping at all, but a composite of all the new technologies that don't fit into subcategories 1, 2, and 3. One of the more promising new reflective technologies was introduced by ***Etalon, Inc. (Iridigm Display Corp.).*** A technical paper described the Interferrometric Modulator™, a microelectromechanical (MEM) display that reflects colors based on optical interference – an approach originally developed at MIT. Based on theoretical analysis and measurements of static models, the technology shows the promise of large-area passive-matrix-addressed reflective color. A white reflectivity of more than 40% is predicted in the paper. While the technology is in its infancy, the rapid development of MEM technologies suggests that progress here should be closely monitored.

Another notable development at MIT is coming out of the Media Lab: an electrically addressable ink. A paper described a bistable microencapsulated electrophoretic system. Data on performance and addressing was sketchy, but veteran observers thought the approach was sound and potentially commercial.

Super-Low-Power Bistable LCDs. The second class of mobile direct-view displays is super-low-power bistable LCDs. Reflective cholesteric LCDs continue to hold the promise of the electronic newspaper: a high-definition bistable display medium that can be written to once and will then retain the image without the application of power. The remaining challenges for commercializing these displays are the reflective brightness, the frame-address time, and the cost of the high-voltage drivers that are usually required.

Two U.S. companies, ***Kent Display Systems*** and ***Advanced Display Systems,*** are leading the commercialization efforts. Both companies were on the exhibit floor with their latest offerings of reflective monochrome displays. The focus at ADS, according to Ken Richardson, Strategic Planning Director, is "to reduce the address time with our proprietary cell and addressing system." A fast-response 5-in. QVGA display was demonstrated.

The displays that were demonstrated by Kent also had improved addressing times, but the focus, said Mike Lambie, Marketing Manager, is on larger displays: "We continue our pursuit of the development of a display medium for the electronic newspaper." Both companies promise systems that can use conventional STN drivers. Neither company demonstrated substantial improvement in reflective brightness.

Eight papers in two technical sessions were devoted to new bistable LCDs. While half of the papers dealt with improved cholesteric effects, the other papers presented various nematic bistable approaches promising low-voltage operation.

Low-Temperature Poly-Si AMLCDs. The third class of mobile displays vying for a share of the palmtop market are the low-temperature poly-Si AMLCDs. Such displays are commonly seen as viewers in both camcorders and digital cameras, and range in size from less than 2 in. to nearly 5 in. These displays offer full-color video performance but are power hogs, requiring more than 1 W. Small poly-Si AMLCDs were not on display at SID.

Joel Pollack of ***Sharp Corp.***, a major supplier, reported, "Sharp is not actively promot-

ing the displays for broad application yet since interfacing solutions are not broadly available." Typically, the interface is integrated with the systems electronics in high-volume-market applications.

Low-Power Emissive Displays. Our fourth and final class of mobile displays consists of new low-power emissive displays. While mobile systems have historically been the sole province of LCDs, two emissive displays are emerging that could compete in segments of the small portable-systems market. Several makers are now showing 5-in. QVGA FEDs, and developers of OLED technology are now showing prototype character and graphics displays.

Both ***Futaba*** and ***PixTech*** showed 5-in. QVGA FEDs in both monochrome and color. PixTech pegged their display's power consumption at 1 W. Given the superior operating temperature range and wide viewing angle of FEDs, look for them to be adopted in mobile systems without stringent power requirements. A luminance of 70 nits, however, is unacceptable for uncontrolled ambient lighting.

Uniax Corp. premiered its OLED character and graphics displays (Fig. 2). President Jim Long said, "We are promoting applications in small mobile systems as well as automotive and line-powered applications." Uniax showed a range of small, bright prototypes.

Fig. 4: *A very impressive personal viewer/magnifier was exhibited in a cell-phone application by newcomer Siliscape.*

Price-Performance Breakthrough in Miniature Imagers

One of the highlights of the SID conference was the dramatic progress in microdisplays. The continuous improvements in market-leading poly-Si AMLCD imagers used in desktop projection systems and camcorder viewfinders are being challenged by a host of developers. While Texas Instruments is carving out a share of the projection market with its Digital Micromirror Device™ (DMD), both CMOS-backplane liquid-crystal and emissive microdisplays are now available to challenge the dominance of Asian-supplied poly-Si imagers in the newly emerging mobile Internet-appliance market.

High-Temperature Polysilicon and the DMD Challenge. The leading suppliers of microdisplays, ***Epson America*** and ***Sony,*** both employ a polysilicon-on-quartz active-matrix backplane and a transmissive nematic frontplane. Typically, three monochrome 35-mm SVGA imagers are employed in a projector, while spatial-color 200-line 20-mm video-configured imagers are used in viewfinders.

Epson America showed a range of projection and viewer imagers in its booth. Epson market manager Eugen Munteanu discussed the product road map: "Epson now has developed a prototype XGA 35-mm imager for projection that will be available next year." The aperture ratio was not quoted.

Hitachi chose the SID exhibition to introduce its line of poly-Si imagers, becoming the third major Japanese supplier. A 35-mm color VGA imager was shown, and it is certainly state of the art. A dark note was news of the restructuring of ***Sarif*** - the In Focus/Sarnoff joint venture that was the sole U.S. developer of poly-Si devices - pointing out the risks in challenging the dominant suppliers.

Texas Instruments was absent from the SID show floor after several years of spectacular exhibits, choosing instead to focus their attention on the Infocomm conference in early June. A representative appearing at the microdisplay press conference/roundtable reported that TI is continuing its vigorous commercialization of the DMD and has already captured a 25% share of the desktop projection market. The picture he painted differed sharply from the rumors that have circulated around the industry for the past months that TI was suffering from low yields and was unable to meet demand.

CMOS-Based Miniature Imaging Devices (MIDs). The list of developers of CMOS-based AMLCD microdisplays continues to grow. ***Kopin Corp.*** and ***Displaytech*** were most prominent on the exhibit floor, showing pre-production personal viewers. Both are based on field-sequential-color devices. Kopin uses a backlit nematic approach, while Displaytech employs a reflective approach with a faster-switching ferroelectric liquid crystal. Kopin's initial offering is a 7-mm QVGA device, while Displaytech offers a full-VGA display with a 10-mm diagonal. Both do full-color video and are quite impressive, but only the Displaytech display has the definition and magnification to present a virtual image of a Web page that is equivalent to a laptop computer. Glen Kephart, marketing VP of Kopin, was aggressive, saying, "We can supply our microdisplay for $35 in volume."

National Semiconductor Corp. tipped its hand, presenting a paper showing the design of an imager made with a 0.8-mm EEPROM process. National joins ***Hitachi*** and ***Raychem*** in using PDLC for its frontplane. Project leader Russell Flack said later, "The PDLC device reported in the paper is one of several designs being developed at National."

Emissive MIDs. We've been discussing various flavors of LCDs, but the microdisplay is far from an LCD-only game. ***Planar Systems*** showed the color VGA version of its 0.75-in. 1000-lpi EL microdisplay (Fig. 3), and put two of them in a pair of data glasses for a press conference. In this display, a broadband phosphor replaces the amber of the monochrome version, and a single-cell liquid-crystal shutter provides 3-bit-per-primary field-sequential color. The display is intended for applications ranging from military to consumer. If high-volume consumer applications materialize, the price could be less than $100 per unit, said Planar's Bill Sproull. General sampling of the color Microbrite™ display was scheduled for late August or early September.

Refection Technology presented a paper describing the latest developments of its scanned LED: a full-color VGA microdisplay. The prototype was not available for inspection in their exhibit booth.

Motorola appeared at the microdisplay press roundtable and demonstrated its monochrome (amber) 1/8-VGA LED array device, dubbed VirtuoVue™. This is a true integrated array of 34,560 AlGaInAs LED junctions (240 columns × 144 rows) and is the first commercial integrated LED array. As such, it qualifies as a genuine technology breakthrough. Pixel pitch is about 20 μm, and the array's overall dimensions are 7 × 4 mm. A Motorola representative said that full color was under development. The company did not exhibit either their microdisplay or their FEDs on the floor.

Personal Viewer Optics. While most developers continue to focus their attention on imaging technology, the success of the personal viewer is also dependent on the development of magnifying optics. A single-stage low-cost magnifier is limited to about 10X. Optics capable of higher magnification will have substantial leverage on system performance and cost.

A very impressive personal viewer/magnifier was exhibited by newcomer ***Siliscape.*** A monochrome SVGA viewer with 35-mm eye relief and a 25-mm pupil size was demonstrated with a static image in a cell-phone application (Fig. 4). President Al Hildebrand says, "Magnification of up to 30X can be achieved with our low-cost small-form-factor optical system."

The macro trends of the mobile marketplace are obvious, but their implications for the competitive balance of the various display technologies remains to be seen. The availability of the contents of the World Wide Web, the huge investment in expanding the digital bandwidth of worldwide cellular networks, and the demand pull of the mobile work force are the forces that will drive the dramatic growth of mobile communications, information, and entertainment systems.

A full-color VGA-definition display is a minimum requirement for Web compatibility. The mobile power and form-factor requirements dictate a microdisplay. The issue remains as to whether there is enough market pull for mobile Web access to overcome the unknown ergonomics of the personal display. ■

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Circle no. 25

FPD Manufacturing Equipment and Materials

A record number of equipment and materials vendors guessed that SID '97 would be a lively place to display their new wares. They were right.

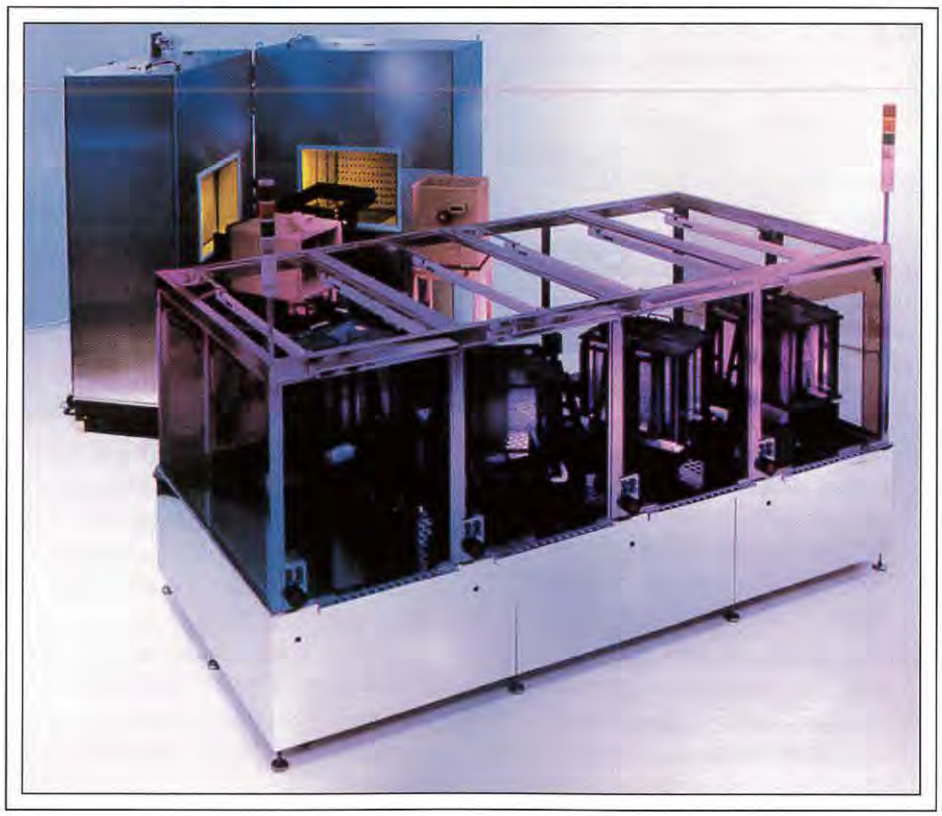
by Ross Young

More than 80 manufacturers of flat-panel-display (FPD) manufacturing equipment and materials exhibited their latest products at SID '97 in Boston, up 60% from last year. This dramatic increase reflects the overall rapid growth of the FPD industry, as well as the anticipated near-term buying activity from Asian display manufacturers. In fact, at DisplaySearch, we expect 17 new a-Si TFT, six new low-temperature poly-Si TFT, four new plasma, and two new FED lines to begin production between the beginning of 1997 and the end of 1998. Of the 29 new lines, only the two FED lines are expected to operate in the United States.

With all of this near-term fab activity, most U.S. manufacturers of FPD-manufacturing equipment could not pass up the opportunity to display their latest developments to visiting potential customers from the Far East.

Many of the exhibiting FPD equipment and materials suppliers introduced new products to meet next-generation requirements. Equipment suppliers are being asked to provide equipment that processes larger substrate sizes to boost fab productivity and increases precision so that smaller-design rules can be used to maximize aperture ratios and minimize total average cycle time (TACT) - resulting in higher equipment prices. Exhibiting equipment makers announced new products capable of accommodating 590 × 670-, 600 × 720-, and 650 × 830-mm substrates for the a-Si and low-temperature poly-Si TFT markets.

In the case of plasma displays, equipment capable of handling 1000 × 1350-mm substrates was introduced. In most cases, the equipment for larger substrates was scaled up, which implies TACT increases, while in a few cases the tools were re-engineered and redesigned so that the TACT for larger substrates was reduced, maximizing the productivity benefits at the larger sizes.



CFM Technologies

Fig. 1: *CFM Technologies' FPD Full Flow System provides wet-etch strip-and-clean processing for substrates up to 600 × 720 mm. The company was promoting a low cost of ownership.*

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Minolta Instrument Systems Division

Fig. 2: Minolta's CA-110 LCD color analyzer provides fast and accurate non-contact color display measurements.

FPD-equipment companies hope they guessed right regarding substrate size because it takes 24 months to develop next-generation manufacturing equipment but just 12 months to build a fab. Selecting the wrong size could cause equipment companies to lose a significant amount of business and not get a return on large R&D expenses.

Materials manufacturers introduced new products that support display manufacturers' efforts to improve display performance. New products were introduced which enable FPD manufacturers to minimize power consumption, increase gray scale and brightness, widen viewing angles, reduce glare, provide multisync, and lower the costs of displays ranging in size from 1 to more than 40 in. diagonally. In some cases, products were introduced that lowered costs as well as increased performance.

We can't include the offerings of the more than 80 equipment and materials suppliers in this article, so we will focus on the companies (in alphabetical order) announcing new developments, introducing new products, or disclosing new orders.

Equipment Makers

FPD equipment exhibited at the show targeted a wide range of display technologies, including a-Si TFT, low-temperature poly-Si TFT, STN, plasma, and FED. Many of the equipment makers targeting FEDs were pleased to announce deliveries to Motorola's FED fab in Arizona, which is expected to begin production in early 1998. A number of the other equipment manufacturers expect to win business in Asia.

Applied Films Corp., a leading coated-glass and sputtering-equipment supplier for LCDs, revealed a new patent-pending sputtering approach for depositing MgO films in plasma-display production. Currently, MgO is deposited by evaporation, which produces excellent film quality but is considered slow and expensive. Applied Films believes their sputtering approach results in film characteristics equivalent to those produced by evaporation but with a lower cost of ownership. They expect to begin shipping MgO sputtering machines capable of accommodating 640 × 854-mm (42-in.-diagonal) glass by next January.

BOC Coating Technology announced the completion of the first phase of its multimillion-dollar contract to Motorola. BOC is providing Motorola with a sequential-layer electron-beam evaporation system to deposit the refractory metals used in the FED cone-formation process. According to Frank Engle, BOC Program Manager, the system is the culmination of a multi-year process and equipment development effort between Motorola and BOC. The first phase is a process module for R&D purposes; a 7.5-sided cluster tool for production use accommodating a maximum substrate size of 550 × 650 mm will be shipped in the third quarter.

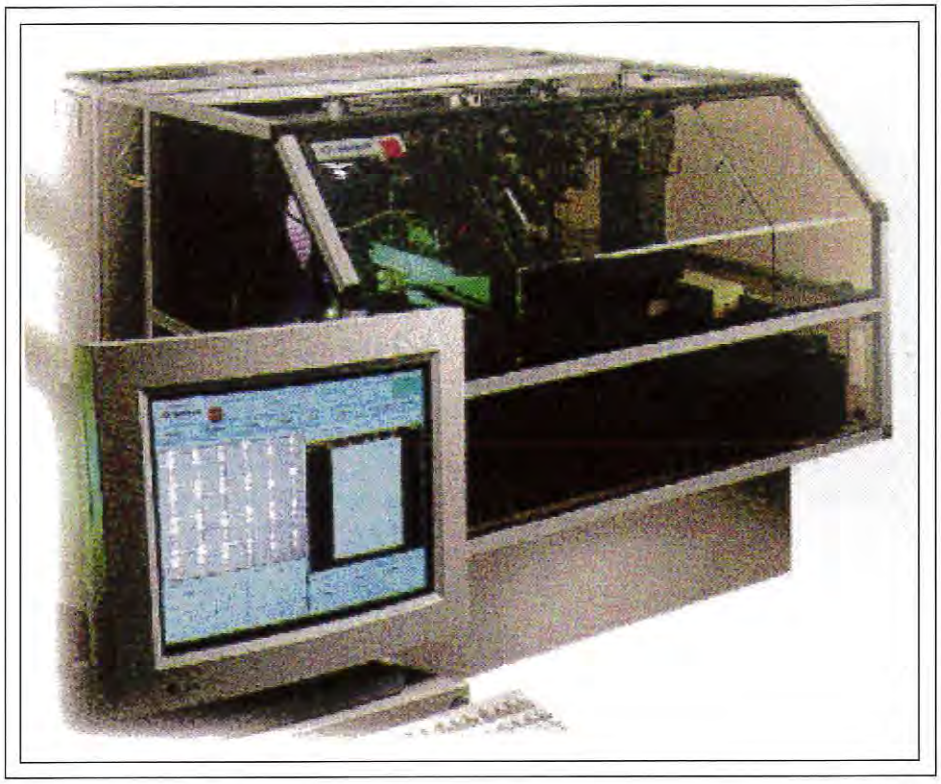
Balzers increased the maximum size of their single-substrate cluster tool for sputtering applications to 600 × 720 mm, and renamed the tool the SSP700. It will maintain its 6.5-sided configuration. They also introduced a new dry-etch platform capable of handling sizes up to 550 × 650 mm or larger that is based on the company's PE-RIE technology.

Brooks Automation revealed it has shipped vacuum cluster-tool systems and robots capable of handling substrates as large as 650 × 830 mm. According to Jim Jenson, FPD Product Manager, they are now developing systems capable of accommodating even larger sizes. Brooks currently has customers in Japan, the U.S., and Europe for dry etch, CVD, sputtering, laser annealing, and evaporation equipment.

CFM Technologies, a leading wet-etch strip-and-clean manufacturer, announced that its unique FPD Full Flow System is now available on substrates as large as 600 × 720 mm (Fig. 1). CFM says the system provides the industry's lowest cost of ownership, smallest footprint, and best uniformity for wet-processing equipment. CFM, which successfully completed a USDC development contract, scaled up, manufactured, and delivered a 590 × 670-mm tool to a Korean manufacturer within 5 months.

FAS Technologies has developed two coating methods that dramatically increase the efficiency of coating photoresists and dielectrics on FPDs, multichip modules, and semiconductors. While a traditional spin coater wastes up to 95% of deposited material, FAS's extrusion and extrude-and-spin coating methods utilize up to 95 and 75% of the deposited material, respectively. The increased efficiency allows significantly less material to be deposited, reducing consumable costs and cost of ownership. FAS has licensed its technology to four of the world's top five coater manufacturers, and TOK has signed an exclusive licensing agreement for FPD extrude-and-spin in Asia.

Gerber Systems Corp. and ***Heidelberg Instruments Mikrotechnik*** jointly developed and introduced the MaskWrite 1550 flatbed laser imager – the world's largest high-resolution direct-imaging system. Targeting the plasma-display mask market, this direct-write



Orbotech

Fig. 3: Orbotech's fully automated LC-3090 optical inspection system inspects TFT-LCDs and color filters on substrates up to 600 × 720 mm.

laser system can image glass plates up to 1100 × 1550 mm. The first unit was purchased by Nakanuma Artscreen in Kyoto, Japan, a leading photomask company for PDPs, LCDs, and leadframes.

Intevac announced the first FPD order for its D-Star Sputtering System. The system will be delivered to an Asian FPD manufacturer by the end of the year and will be able to accommodate 1000 × 1350-mm substrates. The D-Star is the industry's only vertical cluster tool in which the substrates remain in the vertical orientation throughout the handling and sputtering process.

Kurdex increased the maximum substrate size of its in-line sputtering, PECVD, etch, and strip tools to 600 × 750 mm.

MRS Technology exhibited its 1-μm photolithography system for the low-temperature poly-Si TFT and FED markets. MRS also revealed that it expects to introduce a high-throughput system with a wide-field lens for the a-Si TFT market by the end of the year. This system will be capable of handling substrates up to 590 × 670 mm.

Meissner & Wurst is the world's leader in semiconductor-facility design and construction, said John Hedlund, the company's *Abteilungsdirektor.* M&W was at SID '97 to announce the application of its expertise to turn-key display fabs, and Hedlund was clearly delighted with the "incredible response."

Minolta Instrument Systems Division announced the introduction of the world's first LCD color analyzer, the CA-110 (Fig. 2). It is designed for highly accurate white-balance adjustment and inspection of color LCDs. Accurate measurements of ±2%/±1 digit for luminance and ±0.002 for chromaticity are made five times per second. The luminance range is 0.29–292 fL. The measuring probe allows for non-contact measurements.

Nikon quietly promoted its FX-602K stepper for FED and low-temperature poly-Si applications. It has a minimum resolution of 1 μm and a field size of 44 μm square. Motorola will reportedly receive the first unit shipped in the U.S. sometime this summer. Motorola has already received an FX-601F and is expected to receive one more FX-602K by the end of the year.

Orbotech demonstrated its fully automated optical inspection systems for TFTs and color filters (Fig. 3). The LC-3000 series provides highly accurate detection of all critical defects in the TFT-array and color-filter processes, providing on-the-fly defect inspection and classification after each step. The LC-3090 can accommodate substrates up to 600 × 720 mm, and the company expects to have a version capable of accommodating larger sizes by mid-1998. The system provides a graphical defect map, trend chart, repetitive-defects report, and stacking comparison.

Photon Dynamics added two new products to its In Process Test (IPT) and Integrated Laser and Weld (ILW) product lines that improve equipment productivity. The new products, the ArrayChecker and ArraySaver, can each accommodate substrate sizes up to 650 × 830 mm. The ArrayChecker incorporates machine vision, which increases defect detection, reduces TACT, and increases throughput. According to C. J. Meurell, V.P. of Marketing and Technology, "Previous test-time benchmarks were 60 sec for a 10.4-in. VGA panel. The ArrayChecker can test six 13.3-in. panels in 4 min.

ULVAC Technologies introduced the CMD 450B Poly, a seven-sided CVD cluster tool that now incorporates a laser-annealing chamber. The 450B features a low-hydrogen-content (less than 1%) a-Si deposition process that eliminates the dehydrogenation step. ULVAC claims the tool contributes to higher mobilities by eliminating contamination at grain boundaries and on the surface. The system is available for 400 × 500-mm substrates.

Materials Producers

FPD materials continue to account for a significant share of display costs and are critical to improving performance. A wide variety of materials producers were at the SID '97 show, including backlight, color-filter, driver-IC, electronics-interface, glass-substrate, graphics-controller, inverter, and polarizer producers.

Dolch Computer introduced a new digital video image-magnification system called AutoScale, which allows Dolch's monitors to automatically zoom small-format images to fill the entire screen up to XGA. Dolch's new analog video adapter employs a proprietary

Vivid Semiconductor

Fig. 4: *Vivid Semiconductor's new charge-sharing dot-inversion column drivers consume much less power than conventional dot inversion drivers.*

image-magnification chip to provide zoom scaling, display synchronization, and overlay control in a single device.

Endicott Research Group introduced a new plug-and-play backlight inverter that can power LCDs with up to ten cold-cathode fluorescent tubes (CCFTs). The new IB series offers one of ERG's MT inverters on an interface board that contains two output connectors, on-board timing circuitry, and a right-angle header. Each output connector can accommodate up to five CCFTs.

Genesis Microchip demonstrated the gmZ1 advanced image-magnification chip for true multisync capability. Developed in partnership with Apple, this highly integrated IC provides crisp graphics and professional-quality video at resolutions up to XGA, eliminating the aliasing and jaggy-line artifacts often seen in scaling and line-doubling controllers. The gmZ1 provides de-interlacing, zoom scaling, display synchronization, and overlay control in one integrated package, and permits the display of both interlaced full-motion video and progressively scanned computer graphics simultaneously on the same digital, non-interlaced display. The chip is housed in a 208-pin PQFP package and can accommodate 8- and 6-bit images.

Linfinity Microelectronics announced its LXM1640 backlight inverter, which can support LCDs with up to four CCFLs. This inverter is intended for large LCDs targeted at the desktop-monitor and other markets.

Nippon Electric Glass revealed that its OA-2 borosilicate glass for TFT applications is now available in Japan in sizes up to 650 × 830 mm. NEG expects to begin delivery of 600 × 720-mm substrates this summer.

Nitto Denko revealed its new reflective polarizers that boost panel transmissivity from 40 to 70% compared to traditional polarizers. Volume production is expected by Q3 of '98.

Schott Glass exhibited its AF 45 and D263 borosilicate-glass substrates, which can be produced in sizes up to 700 mm in width, with thicknesses ranging from 0.03 to 1.9 mm. Schott also announced a wide-ranging development and supply agreement with Candescent Technologies for display glass and glass-related technologies. Schott has acquired an undisclosed equity stake in Candescent and will establish a high-volume glass-processing plant in the U.S. to support Candescent's efforts. The companies will also jointly invest in a final processing facility adjacent to Candescent's manufacturing plant, eliminating the duplicate costs associated with cleaning and inspecting finished glass.

Finally, ***Vivid Semiconductor*** demonstrated a low-power improvement to its line of high-

voltage column-driver ICs (Fig. 4). Column drivers typically account for 30–40% of the total power consumed by notebook-sized LCDs. Vivid's patented charge-sharing technology reduces power consumption up to 67% compared to previous high-voltage column drivers. In charge sharing, the energy used to create a polarity shift at each row is captured and used to drive the next column load. Vivid compared charge sharing on a 12.1-in. SVGA TFT-LCD and a 14.1-in. XGA TFT-LCD panel to similar-sized panels with traditional dot-inversion drivers.

In the case of the 12.1-in. displays, the charge-sharing display without the backlight consumed 0.6 W compared to 1.8 W for the traditional dot-inversion display. In the case of the larger and denser 14.1-in. XGA displays, Vivid's charge-sharing approach consumed just 1.8 W compared to 6.3 W for the traditional approach.

Vivid has now won driver business at five of the top 15 display producers, with seven of their 18 design wins in notebooks. Vivid, a fabless design firm, has acquired significant production capacity through a licensing agreement with LG Semiconductor.

The Bottom Line

Real gains are being made by a number of equipment and materials suppliers in terms of productivity and performance. At the same time, explosive growth is expected in the equipment and materials market as 29 new fab lines begin production by the end of 1998. As a result, there exists a significant opportunity for equipment and materials manufacturers with good technology, manufacturing capability, distribution, and service. ■

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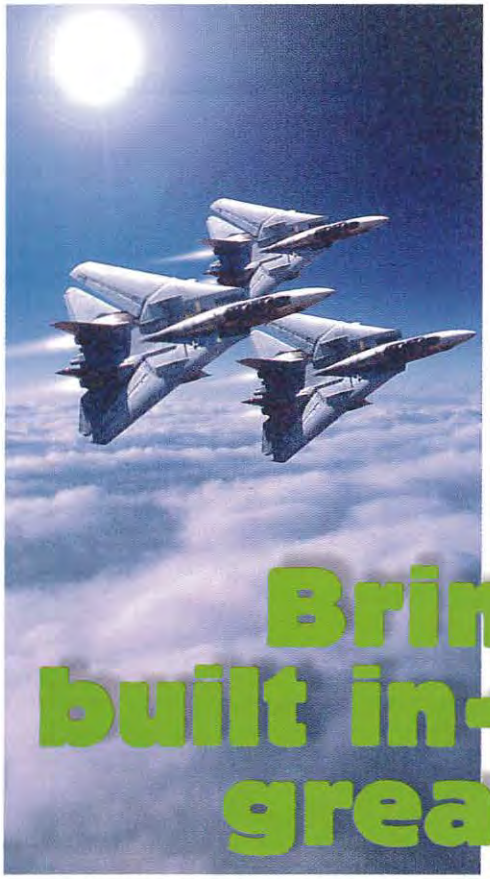

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Circle no. 28

Emissive Displays

Forty-inch PDPs, EL displays, and FEDs proliferated, while the molecular glow of organics could be seen in the wings.

by Ken Werner

LARGE plasma display panels (PDPs) were a rarity at SID '96. At SID '97 they seemed ubiquitous. Since the exhibition at SID is a professional and industry show, it leads – and predicts – what ultimately appears in the consumer marketplace. It is therefore not surprising that the first and – so far – only limited-edition plasma TV receiver went on sale in February but that several consumer-electronics companies plan to introduce less expensive sets in their fall line-up. What could be learned about the gathering wave of PDPs at SID '97?

Plasmaco showed 42-in. panels in 4:3 and 16:9 aspect ratios (Fig. 1). The 16:9 AC-PDP was made by Plasmaco parent Matsushita, and produced a bright 450 nits with 200:1 CR. One 4:3 was running with a digital interface and another with a "DVD interface" for NTSC. The 16:9 will be built on Matsushita's Takasugi line, which had just produced the first panel for testing, and will be available in Japan in Q4. The 4:3 will be available in the U.S. in 1998.

Said Plasmaco's Larry Weber: "We have to find dirt-cheap processes before we can reach the mass market. We need TV sets that will sell for $2500 retail, but the industry has not yet found the ideal way to make barrier ribs and other elements of a plasma panel."

Mitsubishi showed its plasma monitor prototype XP015C. The 40-in. 4:3 monitor featured the expected VGA format, analog RGB interface, NTSC/PAL/SECAM/S-VHS compatibility, and internal twin 1.6-W speakers. The various things people like to do to a monitor can be done via side-panel controls and wireless remote control. "Swimming" and motion artifacts were more obvious than on panels that have been in development longer, but Mitsubishi has some time to work out the details. The monitor will be available from the Display Products Group on October 4th at an MRSP of about $12,000. Mitsubishi's consumer-electronics group is working on a TV solution. It's worth noting that the analog-to-digital conversion in analog-interface PDPs tends to aggravate swimming artifacts, which could be seen by the legendary "careful observer" in Plasmaco's side-by-side analog

Plasmaco

Fig. 1: *Plasmaco's 42-in. PDP with 4:3 aspect ratio and digital interface was shown next to one with a 16:9 aspect ratio and analog interface.*

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Planar

Fig. 2: Planar's IceBrite™ and ColorBrite™ electroluminescent displays looked huge next to the new 0.7-in. MicroBrite™ color AMEL (not shown in this photo).

and digital panels. The electronics are not trivial.

NEC's Dave Schultz and Alison Niday proudly showed the company's 42-in. PDP with an encapsulated color filter for more brilliant colors, 300:1 CR, 200 cd/m^2, 8-bit digital interface, 10,000-hour life to half luminance, and 1.08-mm pixel pitch – today's standard pitch for 42-in. 16:9 plasma panels. The panel is available as a module from NEC Electronics or as a TV/monitor from NEC Technologies. Five months of development can do a lot. NEC's panel needed work when shown at Display Works in January; it was stunning at SID. Engineering samples will be available in Q4 at about $10,000, with mass production in April '98 at everybody's standard price: "competitive with Fujitsu."

NEC's next product will be about 50 in. on the diagonal, in "wide-XGA" format for HDTV, said Schultz. (That is, the portion of the screen that has a 4:3 aspect ratio will have 1024 × 768 pixels, with additional pixels added horizontally on the same pitch to make the screen 16:9.) Prototypes are expected to be available at the beginning of '98.

NEC's goal is to be selling an HDTV receiver in the year 2000 for $100 per diagonal inch for the full product. For that to happen, the PDP must cost 30% of the total price or less, said Tsuyoshi Takasaki, Product Marketing Manager, Flat Panel Display Products, at NEC Electronics.

Electro Plasma collaborated with LG Electronics on a paper describing a more economical color PDP structure, but a showable device was not quite ready for the show, said David Olin. That left Electro Plasma as the only PDP company exhibiting nothing but monochrome displays. Last year, Electro Plasma reported some good business replacing the discontinued monochrome panels made by other companies, but monochrome sales are now slacking off, said Olin, although there is still some military business.

Thomson Components and Tubes' Jeff Ohstrom was showing the 19-in. 1024 × 768 prototype with 0.38-mm pixel pitch. A 1280 × 1024 version was to be available for demonstration in June and a 1280 × 1024 24-in. in Q4. All three panels should be in production before mid-98. The small cell size of the high-resolution workstation-type PDPs made by Thomson and Photonics inherently limit their luminance. Thomson's 19-in. XGA panel has a luminance of 15 fL (50 cd/m^2). As a result, Thomson and Photonics compete with each other, but not with the likes of Fujitsu, Mitsubishi, and NEC. The panels of the former don't have the brightness for entertainment applications, and those of the latter don't have the screen resolution needed for certain military and industrial applications.

Photonics Systems showed the latest iteration of its 21-in. 1280 × 1024 color PDP. At 0.33 mm, this panel's pixel pitch is the finest

Genesis Microchip

Fig. 3: A controller based on Genesis Microchip's DICE line-doubler chip and gm833x3F scaling chip zoomed a digital video source to fill the screen of this Fujitsu 42-in. PDP.

to be found on any full-color PDP. This panel has been under evaluation by potential military customers for 2 years, and the company felt it was time to give it more general exposure, said Photonics' Peter Friedman. The panel was running video with a 7-bit gray scale. Also on display were a couple of 30-in. 1024 × 768 color PDPs, a couple of 10-in. QVGA color panels, and a 19-in. high-brightness (200 cd/m^2) VGA panel.

Non-Plasma Displays Also Glow

Electroluminescence was represented on the show floor by ***Planar,*** the leading supplier worldwide, and ***Luxell.*** (If No. 2 vendor ***Sharp*** had an EL display in its booth, it was swamped by the wealth of LCDs.)

In addition to its MicroBrite™ color AMEL microdisplay (see accompanying article by Chuck McLaughlin), ***Planar*** showed its more traditionally sized monochrome IceBrite™ and color ColorBrite™ EL displays (Fig. 2).

Luxell, one of the new contingent of Canadian display companies, showed the handsome sunlight-readable monochrome TFEL displays for military/industrial/aerospace applications first seen at Display Works in January. "We weren't ready to come to SID last year; now, we're anxious to show the world that we have what we say we have," said Fred Prins, International Marketing Manager. The displays are being used in the Pilot Entry Data Panel in the P3C *Orion* upgrade program, for which Lockheed Martin is the prime contractor.

Futaba showed the monochrome and multicolored vacuum-fluorescent displays (VFDs) for which they are famous and blue-green, gray-scale QVGA monochrome FED modules with 5-in. diagonals. Engineering samples will be available mid-year. A color prototype was shown at the author interviews, said Futaba's Nick Price.

PixTech showed its now-familiar 5.2-in. blue-green FED, effectively installed in a Tek TDS 210 oscilloscope, next to a standard TDS 210 with the original-equipment LCD. The device is ready for mass production, said Tom Holzel. Short runs will be produced in Montpellier, France, large runs in Taiwan. Engineering samples of a 5.2-in. color FED will be available in Q3, with production in '98.

Raytheon showed its very bright FED, which is intended for the military/aerospace/industrial market. "The technology has been proved viable," said Principal Scientist Alan Palevsky. Now, Raytheon is looking for a few good customers.

With the departure of Howard Schmidt from its board of directors, ***SI Diamond*** is firmly in the hands of its new management, and you no longer hear intemperate promises about full-color VGA FEDs based on diamond-like carbon (DLC) film emitters. The company is using the DLC emitter in high-voltage lamp modules intended for outdoor signage. New is an RGB tripixel in a single vacuum envelope and a triode structure.

Teledyne was touting its LED Alphalight™. Like electric guitars, Alphalights can be had with hollow or solid bodies (with a light guide). They are 2–15 mm thick, and can be used for applications such as backlights and LCD imaging, said Teledyne's Bill Kennedy. A particularly interesting application is a field-sequential-color backlight that permits a color display without a color-matrix filter; it's essentially a monochrome display with color from the backlight. Speaking at a press conference, Dave Pelka said the lights have 10–100-ns transition times, which would permit a 70-Hz field-sequential-color display. Amber and red luminous efficiency is 17 lm/W; GaN blue is 10 lm/W. The price is $1.50 in quantities of 1000.

Integration

Genesis Microchip, maker of the highly integrated gmZ1 graphics controller chip, was demonstrating controllers based on its less-expensive zoom-only chip. The controller can scale up images to fill any screen, and was impressive in filling an XGA screen with VGA source material. It can zoom to an arbitrary format, limited only by its 84-Mpixels/sec maximum speed, said marketing director Jordan Du Val. In real time, the gmZ1-based controller was taking video, performing spatial de-interlacing, and zooming to fill the screen, stretching 4:3 to 16:9 nicely. A one-chip solution for the PDP market is coming. The controller was driving a Fujitsu 42-in. PDP (Fig. 3).

AVED was showing its PCI/ISA controller boards and was driving a Fujitsu 42 in. with its new digital LVDS panel subsystem controller. Windows 95 applications were running on the Fujitsu, the first time this had been done, said director of engineering Todd Collin. Off-the-shelf product is available now. The price for a PCI/LVDS controller and cable is $500 in small quantities. ■

calendar

Display Technology

The 17th International Display Research Conference and Workshops (IDRC '97). Co-sponsored by SID and the Advisory Group on Electron Devices (AGED) in co-operation with the IEEE Electron Devices Society. Contact: Ralph Nadell, Palisades Institute for Research Services, Inc., 201 Varick Street, Suite 1006, New York, NY 10014; 212/620-3341, fax -3379, e-mail: rnadell@newyork.palisades.org.
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.
Nov. 17-20, 1997 Scottsdale, AZ

Electronic Information Displays (EID '97). In association with the Society for Information Display. Contact: Association Exhibitors; +44-1822-614671, fax -614818.
Nov. 18-20, 1997 Surrey, U.K.

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 ■

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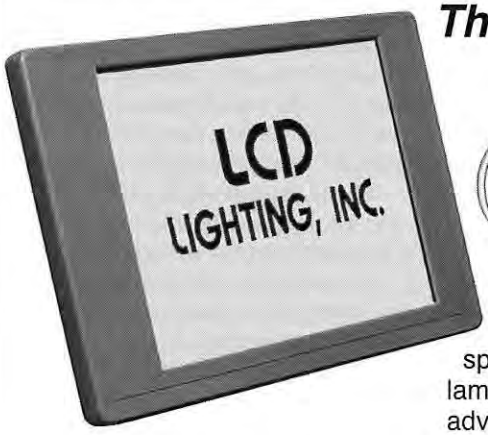

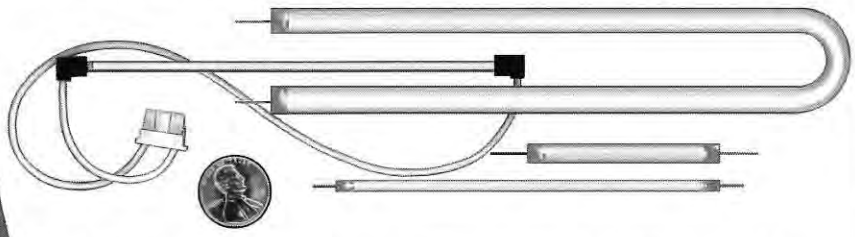

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continued from page 4

feel quite important driving down the road with that small but prestigious-look-ing back-window antenna and the handset mounted on the center console. Now, all that is gone. Everyone is on their cell-phones no matter where they are. And since I don't like being like everyone, I now try to avoid using a cell-phone as much as possible.

I read an article in the paper recently about a busy Information Age business type who was driving to his next appointment while conducting a telephone conference call on his cell-phone, while simultaneously listening to a motivational tape on his cassette player, all while eating a fast-food meal. He crashed his car. The bits were doing great - until the atoms ended up in disarray. Is this carrying parallel processing and multi-tasking a bit too far?

If we can't have an Information Society without keeping our atoms together, how do we bring the atoms and bits into some kind of functioning harmony? I'm not sure I have the complete answer yet. Actually, I'm afraid the problem will get worse before it gets better. Consider the following scenario.

It is a few years from now, let's say September of 2001. There is no space station, there is no moon base, and there is no talking computer. There are, however, a "jillion" satellites orbiting the earth for worldwide cell-phone coverage and the average desktop computer can beat any human at chess. The new "in thing" is constant communication person-to-person. The form that the communications devices have taken is now known to have first been revealed at the 1997 SID Symposium in Boston. Having been rather abruptly transported into this world, we are somewhat startled by what we see. Everywhere we look, people are looking into their cell-phones, peeping into their pagers, or gazing into small mirror-like units attached to their eyeglasses.

In this new Information Society, walking down the street has become quite hazardous. People haven't yet gotten the hang of walking while looking into their communicators. Audible signals have been added at street crossings, and most light poles have now been padded with a material similar to that used for football goal posts. Nevertheless, there are numerous bumps and bruises being inflicted as the busier downtown areas try to learn how to cope with this new trend in combining business activities with moving about. A new medical practice has sprung up to treat what has become called "communicator's black-eye." There has even been some talk about making these communications devices illegal - or at least restricting their use. SID has responded with a special study group on how to establish standards for safety while using small viewing devices. The recommendation has already come from this highly competent group that driving while peeping should be restricted to "stuck-in-traffic" situations only, or while waiting for a light to change. Pedestrians will be required to keep their heads at no more than a 22.5° tilt from vertical. A safety feature will be built into every viewer that will disable the display if the head tips more than that while walking.

Business for some of the companies that exhibited the first versions of these miniature displays at SID '97 has boomed. These products now routinely provide full-VGA and greater resolution on a chip no larger than a centimeter. As usual, the companies that did best in understanding the markets and that developed the technologies which were most cost effective to manufacture have been the big winners. Some of the early technology innovators did wonderfully for a few years but then lost out to those who could provide the more cost-effective products.

And even now in September of 2001, those of us who attended the SID 1997 Symposium in Boston continue to relish the memories of having been there when it all started. What fun it was to see the booths showing the early versions of these small displays and to see the first concept sketches of the products that we now see everywhere we go. (See "Displays for Network Appliances" in this issue for more details.) Even the satellite-communications business moved ahead faster once people realized that they could transmit written documents to anyone anywhere using viewers based on these small high-resolution displays. No longer were we limited by the low information content of 1997's telephone and pager displays. Portability, outdoor viewability, and

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battery life were also no longer limitations, as they had been with 1997's laptop computers.

But what about the bumps, bruises, and more serious accidents? In spite of medical advances, life expectancy was no longer increasing. Yes, information has velocity, it has acceleration, and it acquires mass whenever it is being "processed" or is in "storage." Thus, the most dangerous situation is when information, during processing or in storage, is also being moved about. Then it has momentum and energy and the potential for doing real damage. Unfortunately, it is only this dangerous situation that is of any practical use. What good is transmitting information into space if there is no one to receive it or do anything with it? Are we doomed, then, to live in a society where the quest for ever more information causes us to self-destruct?

Only if we ignore the Unified Theory of the Information Age. The most powerful conclusion from this theory is that the upper limit of bits is the number of atoms those bits can couple with. The next most important conclusion is that information processing generates heat and other random events that cause entropy to increase. Thus, processing information at an ever faster rate will cause atoms to go into disarray and accidents will increase.

I have recently received information from a future and unnamed source that, based on this fundamental law of nature, the Information Society, in the second decade of the twenty-first century, eventually realized that there was more to life than just processing information at an ever faster rate. Thus, the boating and recreation equipment businesses enjoyed a great revival. The great new display-related product of 2010 was a combination GPS, 3-D underwater mechanical scuba-diver and fish-finder.

Let us now gently return to the present, thoroughly refreshed by this intriguing glimpse into the first decade of the twenty-first century.

The 1997 SID Symposium will, I believe, also be remembered for the great-looking forty-inch plasma panels and for the innovative flat-CRT that Philips described during the technical sessions. The Philips technology could provide interesting competition for plasma panels should the company decide to continue technical development and manufacturing implementation.

In the meantime, plasma panels appear nearly ready for commercial introduction. In fact, some of them were so good that I came home and tried to imagine where I would put one when they do become available and affordable. Whoops! I couldn't find a place. Our TV sits in the corner of the family room as part of a built-in bookshelf complex. The other two corners are occupied by my rather large corner-horn speakers. Then I tried to imagine how and where others might place a plasma panel. Making major holes in the wall to hang something much heavier than a typical picture doesn't seem so great. Putting a plasma panel at picture height doesn't seem right either. Putting one in the corner on a stand would be all right if there is a corner available. But where will all the electronics go? Hmmm... This may be harder than I thought and may take adjusting to some new ways of thinking. Could this limit or slow down the large-scale acceptance of this technology? Perhaps we shouldn't underestimate such "minor" considerations. What effect has this already had on existing projection TV sales?

Plasma technology itself has pretty much arrived. It just may end up being implemented in ways that are different from those currently anticipated.

As always, if you would like to discuss these or other topics, you can reach me by e-mail at silzars@ibm.net, by telephone at 425/557-8850, by fax at 425/557-8983, or by a low-information-velocity medium using the Post Office at 22513 S.E. 47th Place, Issaquah, WA 98029. ■

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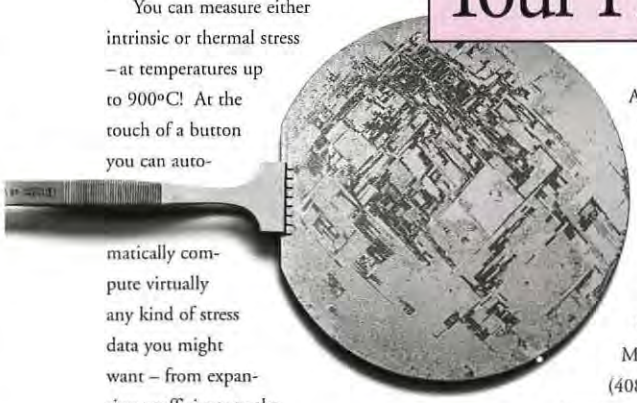

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SID Conference Calendar

Next Show!

The 1997 International Display Research Conference

The 17th edition of the International Display Research Conference will be held at the Sheraton Centre Toronto Hotel in Toronto, Canada on September 15–19, 1997. The conference will emphasize research and fundamental development activities in display technology and related human interfaces. Full-day workshops on September 15 and 19 will focus on passive LCDs and materials; AMLCDs; and light-emitting materials and devices. Invited talks for these workshops will be presented in a format designed to stimulate discussion on recent advances and future directions of display research. Papers relevant to the advancement of the state of the art of electronic displays will be presented September 16–18, 1997.

15 SEPTEMBER 97

17th International Display Research Conference

TORONTO, CANADA
SEPTEMBER 15 – 19, 1997

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

3 NOVEMBER 97

Third International Conference on the Science and Technology of Display Phosphors

HUNTINGTON BEACH, CALIFORNIA
NOVEMBER 3 – 5, 1997

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

16 NOVEMBER 97

Fifth Color Imaging Conference: Color Science, Systems & Applications

SCOTTSDALE, ARIZONA
NOVEMBER 17 – 20, 1997

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

20 JANUARY 98

Display Works 98:

SAN JOSE, CALIFORNIA
JANUARY 20–22, 1998

- An international conference addressing all aspects of Display Manufacturing including:
- Flat Panel and CRT Manufacturing
- Display Materials
- Manufacturing Equipment
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editorial

continued from page 2

ability of people to emigrate to the United States, and would limit the rights of immigrants who are already here. At a time when the display industry cannot find enough educated and energetic people, these actions would deprive us of our most valuable resource. They would also diminish the richness of the U.S. display community – and betray one of the ideals we in the U.S. celebrate on the Fourth of July.

– Ken Werner

Information Display Magazine invites comments on this editorial or other subjects from members of the international display community. The opinions expressed in this editorial do not necessarily reflect the opinions of the publisher of *Information Display Magazine,* nor do they necessarily reflect the position of the Society for Information Display. Your comments and suggestions are welcome. You can reach me by e-mail at kwerner@netaxis.com, by fax at 203/855-9769, or by phone at 203/853-7069. The contents of upcoming issues of ID are available on the *ID* page at the SID Web site (http://www.sid.org).

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.

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Circle no. 37

letters to the editor

To the Editor:

Dr. Doane's reply to my letter (both appeared in *Information Display*, Vol. 13, No. 4&5, pp. 85-86) regarding the article "Reflective Cholesteric Displays" by J. W. Doane and M. E. Stefanov, *Information Display*, Vol. 12, No. 12, p. 18, elegantly sidesteps two key issues raised, namely:

(1) The fact that the elements of cholesteric texture change displays, including: multistable states, a color-reflecting stable state, a scattering focal-conic state, memory, electrical switching between the two states, a transient planar texture, gray scale, low power consumption, and dark background, were all well known since the seventies, and:

(2) The fact that this knowledge preceded the use of polymer additives in liquid-crystal displays, by many years.

Being retained as an expert witness in the patent litigation case alluded to by Dr. Doane led me to review many patents and papers regarding cholesterics, and sensitized me to the issues, hence my first "letter to the editor."

To augment the record initiated by Dr. Doane, I noted that

(a) Dr. Doane is co-founder of Kent Displays, Inc. and has a financial interest in that company.

(b) Kent Displays, Inc. is a party in the mentioned patent litigation.

(c) Presumably, because of my publications record and expertise in the field, I was contacted for my services by both parties in the litigation.

Finally, my wife, who has a degree in Romantic Philology, pointed out to me that in the 19th century, in Europe, poets and writers used to exchange acerbic published letters about each other's work. Those letters later became a treasured part of the literary legacy.

Since my expectations are not that high, exempting unforeseen circumstances, this letter will be my last one on the subject.

– Werner E. Haas
Fellow, SID
Webster, NY

To the Editor:

First, let me thank you for your excellent publication. I'm an optical engineer doing electrical engineering, but I joined SID a couple of years ago when we were looking for miniature CRTs. Even though I do no display engineering, I keep subscribing because of the excellent quality of *Information Display*. (The quarterly SID technical publication [*Journal of the SID*] is also far better than most in being well focused, technically relevant, and clearly written.)

I agree with [Aris Silzars'] column "The End of an Era," or at least the point that technical innovation in PCs passed the needs of most consumers long ago. I need a basic communications center, not a high-end creative toy.

However, it's worth pointing out that [Dr. Silzars'] call for an appliance-type computer was answered, for the most part, a decade ago, with the early Macintosh computers. In fact, I believe that when developing the Macintosh, Apple asked the same questions you posed: what does the basic computer user really need, and how much should they have to know in order to get that? The answer, it turns out, meant very rigid developer guidelines and tight control over architecture, so that nonconforming variants didn't start proliferating. This, in turn, impacted cost, development time, and variety of products.

I think the penetration which Apple achieved in the educational markets was due in part to their concentration on minimizing the skill level needed to use their products, although there was certainly savvy marketing going on as well. However, the overall market response was, "We'd rather have to work a little harder and learn more in order to pay less for the package," which was what the open-architecture, non-coordinated applications development PC environment offered.

– Brian D. McCary

To the Editor:

Re: "CRT Monitors Repel the FPD Challenge," by Rhoda Alexander and Brian Fedrow, January 1997, p. 10.

We should first like to bring to your attention an error that we're sure many of your readers noticed - the pie chart shown in Figs. 2 and 3 have been transposed.

We should also like to make some comments on the information provided in the article, with particular reference to the monitor markets in Europe. As analysts of these numerous and highly diverse monitor markets, we, at Bryan Norris Associates, collect detailed sales figures on a quarterly basis, by screen size and often model number, from a vast number of monitor suppliers directly. (At present, we provide our clients with the collated data for the sixteen major countries of Western Europe as part of our 'VDU Vision' service, but in the future plan to extend our reporting to include the larger countries of Eastern Europe.) Based on this extensive research, our findings show that European shipments in 1996 far exceeded the 16.1 million units quoted in Fig. 3. In the sixteen countries of ***Western*** Europe ***alone,*** shipments in the first half of 1996 exceeded 9.7 million units. And, at the time of writing this letter with just a few suppliers still to 'come in' with their sales figures, the W. Europe total 1996 shipments alone look like being around 20 million units.

The article also states that the TCO label is "a standard requirement in Scandinavian countries and Germany, an increasingly popular option in England and France, and virtually unheard of in Italy." From our findings, TCO is extensively demanded only in Sweden, Germany, Switzerland and to some extent Austria. Moreover, in England and France, the only time TCO is popular is when it comes at no extra charge; other than this, there is still very little demand for this label here, as is also the case for the countries of Southern Europe.

– Bryan Norris and Michelle Barnes
Senior Partner and Partner
Bryan Norris Associates

The transposition of Figs. 2 and 3 resulted from a production error. – Ed. ■

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Edited by JOAN GORMAN

Flat-panel 3-D overlay

StereoGraphics, San Rafael, California, has announced the Monitor Z-Screen™, a flat-panel overlay for workstation displays that provides true stereoscopic 3-D visualization capabilities. Similar in appearance to an anti-glare screen mounted on the front of a computer monitor, the Z-Screen enables on-screen images to be displayed with realistic depth, making objects appear to have a presence in the user's physical environment. The Z-Screen is compatible with all stereo-ready software currently on the market and operates with all major UNIX platforms, 16- and 32-bit Windows environments, DOS, and Macintosh computers. It is also used in conjunction with lightweight passive polarized glasses and is optimized to yield the highest-definition stereoscopic images of any passive 3-D system on the market. The Monitor Z-Screen, including the panel, electronic control box, and three pairs of polarized glasses, carries a suggested list price of $2195. The interlace adapter is available for $295 and additional polarized glasses for $49 per pair.

Information: Andy Ramm, Product Manager, StereoGraphics Corp., 2171 East Francisco Blvd., San Rafael, CA 94901. 415/459-4500, fax 415/459-3020.

Circle no. 1

Smallest narrow-spectrum UV lamp

JKL Components, Pacoima, California, has introduced the BF325-UV1, the world's smallest narrow-spectrum UV lamp, designed for portable, stationary, and handheld applications in the food processing, pharmaceutical, public health, environmental sciences, medicine, security and verification, and spectral characterization industries. The BF325-UV1 subminiature UV black light is only 3 mm in diameter and just 25 mm long, with an operating voltage and current of 140 Vrms and 2.5 mArms, respectively, a lamp wattage of 0.35 W typically, a peak wavelength of 365 nm, a lamp output of 0.25 $\mu W/cm^2$ at 25.4 mm, and a lamp life estimated at 5000 hours. Prices for the BF325-UV1 fluorescent lamps are as low as $3.50 in quantities of 1000.

Information: Joseph S. Velas, President, JKL Components Corp., 13343 Paxton St., Pacoima, CA 91331. 818/896-0019; fax 818/897-3056; e-mail: jkl@jkllamps.com.

Circle no. 2

Bright flat-panel monitors

National Display Systems, Los Gatos, California, has announced the Helios™, a slimline monitor series specifically designed for the direct replacement of CRTs operating in the highest-ambient lighting conditions, where typical LCD monitors are unreadable. The model H103NV, a 10.4-in. VGA (640 × 480) version, and the H163NSX, a 16.1-in. SXGA (1280 × 1024) version, both have a brightness of 300 nits, twice as bright as typical LCD monitors. The 10.4-in. VGA model H108NV and the 13.8-in. VGA model H148NV both have a brightness of 800 nits, nearly six times as bright as typical flat-panel monitors. Flicker-free and immune to magnetic interference, Helios monitors feature plug-and-play compatibility, are equipped with a universal power supply with auto-switching power management for 110 or 220 V, and are packaged in an aluminum enclosure that can be wall- or pedestal-mounted. Helios display systems are available for delivery in 2–5 weeks ARO. At OEM or quantity pricing, the H103NV is $2010 and the H108NV is $2760.

Information: National Display Systems, Inc., 761-A University Ave., Los Gatos, CA 95030. 408/395-8688, fax 408/395-5288.

Circle no. 3

Industry's brightest LED lamps

Hewlett-Packard Co., Palo Alto, California, has announced a line of 5-mm (T-1¾) aluminum indium gallium phosphide (AlInGaP) LEDs featuring the highest intensities of any LED lamps currently in production. These second-generation precision optical performance lamps offer reliable, weather-resistant, bright light sources for traffic signals, roadside variable-message signs, marquees, and moving-message signs for commercial outdoor advertising. The LED lamps are available in three viewing angles, making them optimal for traffic signals and road signs, and three colors (amber, 592 nm; reddish-orange, 617 nm; and red, 630 nm). Pricing is about $0.36 each in quantities of 1 million. Sample quantities of most colors and configurations are available from stock.

Information: Hewlett-Packard Co., Inquiries, 5301 Stevens Creek Blvd., P.O. Box 58059, Santa Clara, CA 95052-8059.

Circle no. 4

Compact dc/dc converter

TDK Corporation of America, Mt. Prospect, Illinois, has introduced the CFK series of low-cost low-profile surface-mounted dc/dc converters designed for applications requiring 1.2 W of power. The CFK series is a standard molded surface-mounted package with a low 3.5-mm profile. The package material consists of a unique "composite ferrite" material that significantly reduces EMI and magnetic leakage. The high-efficiency design delivers 1.2 W of power with a minimum efficiency of 85% in load ranges of 20–100%. The CFK series features an energy-saving power consumption of 2% typical at no load. The input voltage is +5 V, with four output options: -5, +12, -12, or -24 V. Full-rated output power is available up to 50°C with derating to 70°C. All four versions come with a 2-year warranty. Prices start at under $15.00 in lots of 1000.

Information: TDK Corporation of America, 1600 Feehanville Dr., Mt. Prospect, IL 60056. 847/390-4478, e-mail: power@tdktca.com.

Circle no. 5

Circle no. 6

Ultrabright sunlight-readable monitors

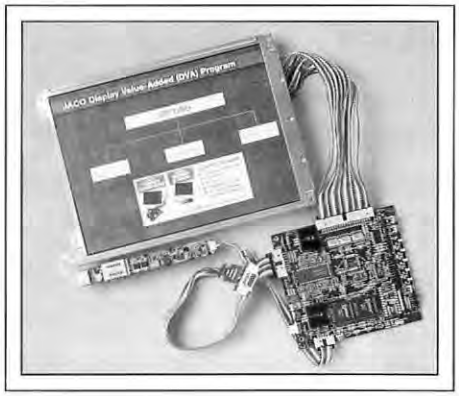
Computer Dynamics, Greenville, South Carolina, has introduced its Ultra-HiBrite-14 line of large-format sunlight-readable FPD systems. Utilizing a new flat-panel backlighting system, the Ultra-HiBrite-14 is the first OEM FPD system that combines the superior visibility of a 13.8-in. color TFT-LCD with 800-nit brightness. The display is available in XGA (1024 × 768) resolution with 256,000 colors or VGA (640 × 480) with 16.7 million colors. The system can be configured as a complete Pentium-based flat-panel computer or in a choice of two flat-panel monitor platforms. The video analog monitor panel (VAMP) plugs directly into any standard VGA output. Specially ordered VAMPS accept NTSC, synch-on-green, or other customized signals. The FP-Kit, designed for PC bus systems, provides a digital connection to the display through Computer Dynamics' ISA or PCI bus flat-panel driver cards. Both VAMP and FP-Kit systems are available with optional touch input, enclosures, and mounting arms. All systems are offered as enclosed units or open frame, with or without touch screens, and are suitable for a wide variety of high-ambient-light applications, such as outdoor kiosks, air-traffic control, and oil-drilling platforms. Pricing for the VAMP Ultra-HiBrite-14 VGA system, including guided-wave touch screen, is $4790 in OEM quantities.

Information: Sales Department, Computer Dynamics, 7640 Pelham Road, Greenville, SC 29615. 864/627-8800; fax 864/675-0106; e-mail: sales@cdynamics.com.

Price breakthrough for TFT-AMLCD kits

JACO Electronics, Hauppauge, New York, has announced breakthrough pricing on their flat-panel kits in 10.4-in. VGA and 12.1-in. SVGA display sizes. The plug-and-play kits make it possible to quickly and simply integrate TFT active-matrix technology into a broad range of designs for medical, financial, legal, and military applications. The kits include a choice of color displays, controller boards, backlight inverter, and cables. Prices start as low as $839 in quantities of 25 or more for the 10.4-in. VGA (ISA or in-line controller) kit, and there are additional savings for quantities over 100.

Information: Rick Walsh, Director of LCDs, JACO Electronics, FPD Marketing Group, 145 Oser Ave., Hauppauge, NY 11788. 516/273-5500, fax 516/273-5506.

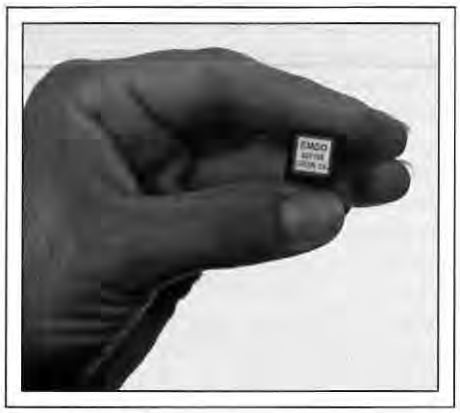


Circle no. 7

Ultra-miniature power supply

EMCO High Voltage Co., Sutter Creek, California, has developed the Q Series of ultra-miniature dc to high-voltage dc power supplies that convert 5 Vdc to 3000 Vdc in a 1/8-in.^{3} (0.5 × 0.5 × 0.5-in.) package, smaller than a sugar cube. These units are 10 times smaller than any other 3-kV converter currently on the market and are ideal for portable battery-powered equipment. The isolated output is proportional to the input voltage and linear from approximately 15% to maximum output voltage, allowing the output voltage to be controlled. The specifications include a typical turn-on voltage of approximately 0.7 V, an isolation voltage of 3500 V, an output power of 0.5 W with no external components or minimum load required, and an output ripple as low as 0.1% typical.

Information: David McGreenery, EMCO High Voltage Co., 11126 Ridge Rd., Sutter Creek, CA 95685. 1-800/546-3680, 209/223-3626; fax 209/223-2779; e-mail: sales@emcohighvoltage.com.



Circle no. 8

Fiber-optic large-screen display

Advance Display Technologies, dba Display Optics, Denver, Colorado, has developed FiberVision™, the first 9 × 12-ft. fiber-optic large-screen display, designed for sports arenas and other advertising and commercial applications. The screen is made up of 442,368 optical fibers, each representing a pixel, ordered coherently in production and resulting in a product which has much higher resolution than any other competitive bulb-matrix, LED, or CRT displays. Maintenance and operating costs are much lower because the only bulb illuminating the hundreds of thousands of pixels is the projection light source itself, and the fibers never burn out or need replacement. FiberVision has a viewing angle that easily exceeds 170° in every direction. The projection system has a very small input matrix, 24 × 18 in., which eliminates long throw distances and maintains the projected image's original light-intensity level. The image display is magnified 36 times from the matrix to the screen surface. The cost per square foot is less than $2000, or less than $0.50 per pixel. The first installation of FiberVision was at The National Western Event Center in Denver, Colorado.

Information: John Kilgore, V.P. Sales and Marketing, Display Optics, 1251 S. Huron St., Unit C, Denver, CO 80223. 303/733-5339, fax 303/733-5363.

Circle no. 9

Set-top box pattern generator

DynaColor, Inc., Taipei, Taiwan, has announced the D5100, a digital MPEG-II transport-stream generator designed to test set-top box and digital TV receivers in development or in production. Containing over 20 built-in test-pattern sequences, the portable D5100 emits digital signals that can be converted to analog signals by the set-top box for analog audio/video performance testing. The D5100 also includes many test sequences for digital performance, such as multiple program decoding, synchronization of audio and video, decoding error correction, and timing jitter tolerance. Based on a 32-bit RISC embedded controller, the D5100 offers instant-on pattern generation. An LCD conveys status information to the user. Two RS-232 ports are used for back-channel control, console hot debugging, and data upload and download. A memory card interface is also included for expansion and custom pattern support. As a transport stream generator, the D5100 is useful in other digital video applications, such as MPEG IC testing and as a headend standby signal source.

Information: DynaColor, Inc., 4F, No. 10, Lane 609, Sec. 5, Chung Hsin Road, Sanchung City, Taipei, Hsien, Taiwan. +886-2-278-1938, fax +886-2-278-1817.

Circle no. 10

5000+ ANSI lumen projector

Digital Projection, Inc., Kennesaw, Georgia, a newly formed subsidiary of Digital Projection, Ltd., Manchester, U.K., has introduced the POWER 5dv, a 5000+ ANSI lumen projector based on a combination of their proprietary extended-life xenon arc lamp and Texas Instruments' three-chip digital micromirror device (DMD™) technology. The POWER 5dv features non-pixelated film-like images, factory pre-converged light valves, luminance uniformity greater than 90%, and stable color reproduction throughout the lamp's lifetime. The projector includes three independently configurable input ports, all accessible via remote control. Source compatibility includes PAL, SECAM, NTSC, VGA, SVGA, XGA, and Mac sources up to 1024 × 768 resolution. Interchangeable lenses provide optical solutions for the most demanding arena, stadium, large-venue, or rear-screen applications.

Information: Digital Projection, Inc., 55 Chastain Rd., Suite 115, Kennesaw, GA 30144. 770/420-1350, fax 770/420-1360.

Circle no. 11 ■

Dear Members and Friends of the SID:

As the newly appointed chair of the SID Honors and Awards Committee, I am appealing to you for your active participation in the nomination of deserving individuals for the various honors and awards bestowed by the SID. These include the prestigious major professional prizes (the Johann Gutenberg prize, the Karl Ferdinand Braun prize, and the Jan Rajchman prize), the major society prize (the Lewis and Beatrice Winner award), the SID Fellow awards (five endorsements are needed), and the SID Special Recognition awards. The selection and nomination process is relatively simple, but requires that you and perhaps some of your colleagues together devote some time to prepare the supporting material that the Honors and Awards Committee needs in order to evaluate each nomination for its merit. A complete description of each of the prizes and awards, and a detailed description of the information that is asked for in support of each nomination, can be found in the accompanying text box.

During the past several years, the Honors and Awards Committee has received a good selection of nominees for the Fellow and Special Recognition awards, but there were very few nominees for the Gutenberg, Braun, and Rajchman prizes. I am especially appealing to you and urging you to nominate worthy candidates for these major prizes as well as candidates for the Fellow and Special Recognition awards.

In our professional lives, there are few greater rewards than recognition by our peers. For an individual in the field of displays, an award or prize from the SID, that represents her or his peers worldwide, is a most significant, happy, and satisfying event. In addition, the overall reputation of the SID depends on the quality of the individuals whom it has collected into its Hall of Fame. When you nominate a person for an award or prize, you are bringing happiness to an individual, to his or her family and friends, and you are also benefiting the SID as a whole.

Thank you in advance for your nominations.

– Andras I. Lakatos, Chairman
SID Honors & Awards Committee

SID honors and awards nominations

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

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

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

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

2. Award being recommended:
   Fellow*
   Jan Rajchman Prize
   Karl Ferdinand Braun Prize
   Johann Gutenberg Prize
   Beatrice Winner Award
   Special Recognition Award
*Fellow nominations must be supported and signed by at least five SID members.

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

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

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

6. 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 by **October 1, 1997** – to the Honors and Awards Chairman, Dr. Andras I. Lakatos, Xerox Corp., Joseph C. Wilson Center for Research & Technology, 800 Phillips Rd., M/S 0105-73C, Webster, NY 14580; telephone 716/422-1617; fax -7760; e-mail: alakatos@wb.xerox.com.

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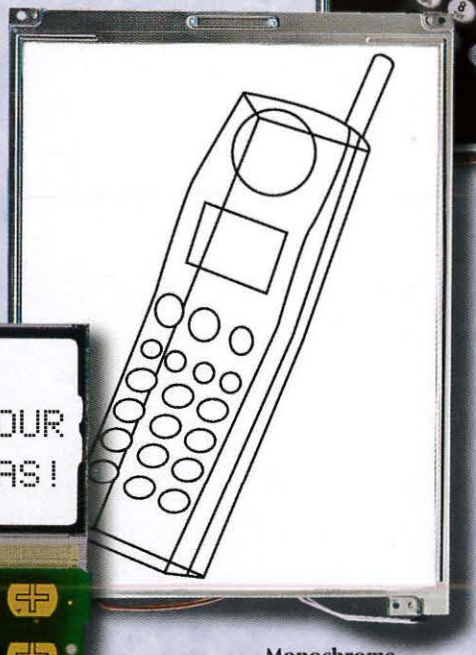

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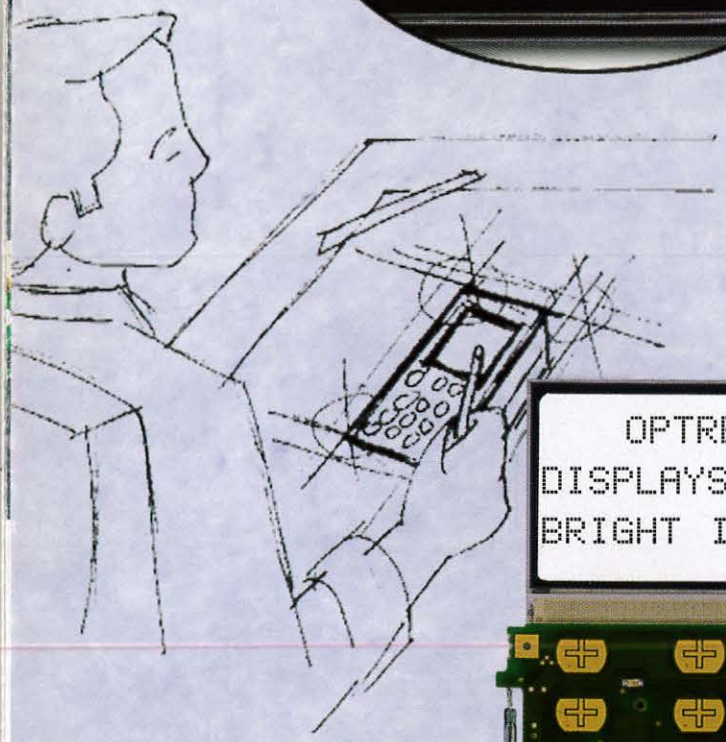

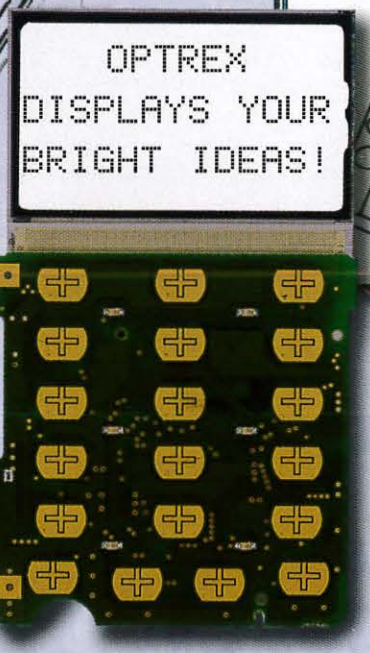

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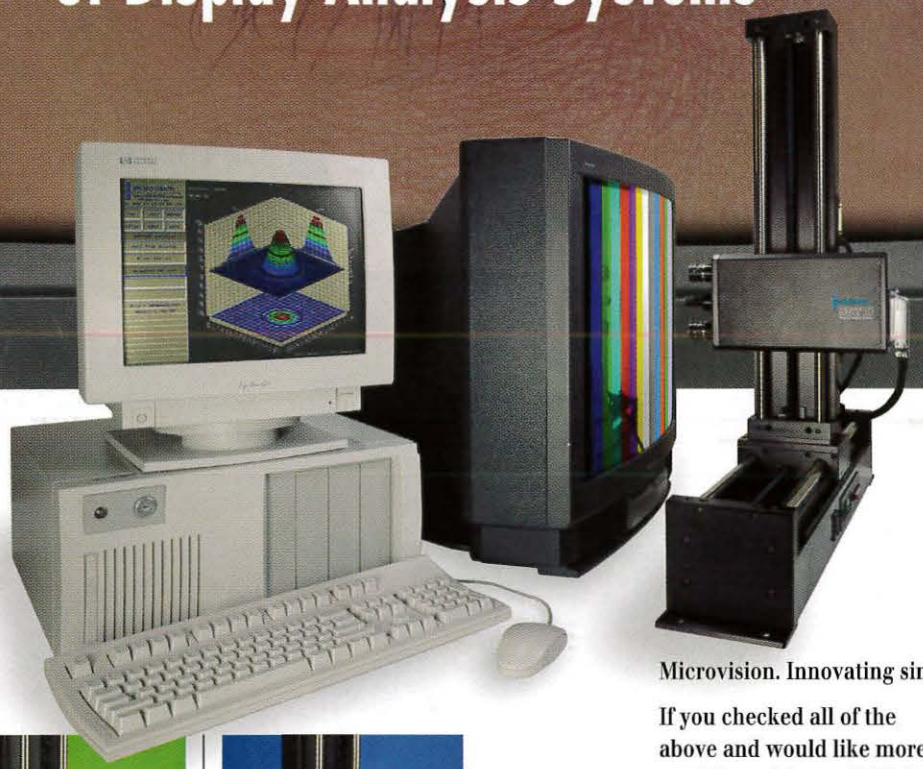
If you checked all of the above, you have chosen the Microvision SS200 Family of Display Analysis Systems



With the SS200 family, you can precisely, automatically, and completely measure display performance—and that includes flat panels.

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If you checked all of the above and would like more information, call Microvision at (800) 931-3188.

SS200
Complete turnkey system with computer, 6-axis positioner, monitor, software, and SS200 camera system. Automatically performs spatial and luminance measurements.

SS210
You can easily field upgrade to the more powerful SS210 package, which provides all SS200 functions, plus an integrated spectrometer for spectral analysis and color measurements. Includes response time measurement capability.

SS220
For flat panel testing, a field upgrade to the SS220 is easy. The SS220 provides spectrometer-based off-axis measurement, color analysis, color shift and luminance testing. Coupled with the SS210, this is the most comprehensive test system ever offered—at a fraction of the cost of individual test instruments. All tests are performed at NIST-traceable accuracy.

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