The Official Monthly Publication of the Society for Information Display

INFORMATION DISPLAY

FEBRUARY 1997
VOLUME 13
NUMBER 2

Getting A Grip On Miniature Displays

Flat-Panel Issue

Inside:

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COVER: Miniature displays leverage semiconductor and optical technology to produce displays with relatively low material and capital costs. Miniaturists are enthusiastically preparing to "put displays where no displays have ever gone before."

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- SID '97 Preview
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INFORMATION DISPLAY (ISSN 0362-0972) is published eleven times a year for the Society for Information Display by Palisades Institute for Research Services, Inc., 201 Varick Street, New York, NY 10014; David Slater, Chief Executive Officer; Leonard H. Klein, President; Laura Manganiello, Secretary/Treasurer. EDITORIAL AND BUSINESS OFFICES: Jay Morreale, Managing Editor, Palisades Institute for Research Services, Inc., 201 Varick Street, New York, NY 10014; telephone 212/620-3371. Send manuscripts to the attention of the Editor, ID. Director of Sales: Erika Targum, Palisades Institute for Research Services, Inc., 201 Varick Street, Suite 1006, New York, NY 10014; 212/620-3375. SID HEADQUARTERS, for correspondence on subscriptions and membership: Society for Information Display, 1526 Brookhollow Drive, Suite 82, Santa Ana, CA 92705-5421; telephone 714/545-1526; fax 714/545-1547. SUBSCRIPTIONS: Information Display is distributed without charge to those qualified and to SID members as a benefit of membership (annual dues $55.00). Subscriptions to others: U.S. & Canada: $36.00 one year, $5.00 single copy; elsewhere: $72.00 one year, $6.50 single copy. PRINTED by Sheridan Printing Company, Alpha, NJ 08865. Third-class postage paid at Easton, PA.

Official Monthly Publication of the Society for Information Display
INFORMATION DISPLAY

Lessons from Black Friday

I am writing this at the beginning of the 1996 holiday shopping season, which is, I will mention for *ID*'s non-U.S. readers, a frenetic time here. The first day of that season - the Friday after Thanksgiving, which is always the last Thursday in November - is called "Black Friday" in the retailing trade. If you are a retailer, it's a hopeful expression that the season will produce black ink. It may also suggest some of the paradoxical gloom many people feel in the midst of our overhyped seasonal jollity.

Is there any useful display-related information to be gleaned from the welter of advertisements and four-color supplements we see at this time of the year, not to mention the occasional news stories that still manage to find a little space between the newspaper ads and TV commercials? Let's see.

A New York City electronics discounter advertised a Samsung 13-in. "personal video-game TV" with "hyper-amplified sound," "low-emission CRT ... safe for close-up viewing," stereo surround with built-in subwoofer, and 181-channel tuner with dBx noise reduction. The accompanying photo showed large speaker "wings" on the set, each of which appeared to be nearly half the size of the set itself.

The same discounter advertised Sony's new WebTV™ Internet adaptor. "Access the Internet on your family TV. Built-in modem attaches to standard phone line. E-mail capability. Requires WebTV™ service. Remote."

A story in the *New York Times*: "Embarrassed, France Halts Thomson Sale; A Deal With Daewoo Only Stirred Resentment. The French Government, bowing to a wave of Gallic pride touched off by its attempt to sell Thomson S.A., the heavily indebted, state-owned electronics company, to French and South Korean investors, temporarily suspended the entire plan today ... The sales had been arranged for the symbolic price of one franc each ... Lagardère [the designated French purchaser for the military and professional side of Thomson] said it would keep trying. 'The acquisition of Thomson remains a strategic objective for us.' ... Daewoo's chairman, Soon Hoon Bae, said he was 'shocked and scandalized' by the suspension."

In an *EE Times* story entitled "Intel aims to cut cost of multimedia PC": "The fact that most consumers lack high-speed Internet connections is seen as a serious roadblock to the mass deployment of truly interactive entertainments ... Here, satellites are seen as a potential savior. [Microsoft's Carl Stork] pointed to DirectPC, a satellite service from DirectTV and Microsoft that's just moving into the market."

And, in late November, we finally saw the long-awaited compromise among the computer, consumer-electronics, and entertainments industries that is paving the way for a terrestrial digital TV broadcast standard for the U.S. The "compromise" was settled pretty much on the terms of the computer industry, but the TV folks may wind up as the biggest winners.

An article in the *New York Times* quoted Intel's Andy Grove saying at Comdex that the computer industry "must look outside our own backyard for new users," and enter the TV business in "a war for eyeballs." The same article later quoted Gary Shapiro, head of the Consumer Electronics Manufacturers

continued on page 40

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Circle no. 2

the display continuum

The Street of Dreams ...

by Aris Silzars

Not more than a few days after I had put the finishing touches on my August column entitled, "Eventually HDTV Happened ...," and while vivid HDTV-like images were still dancing in my head, I had the opportunity to visit Seattle's annual "Street of Dreams." What I saw in one of the homes there almost turned this event into a "Bad-and-Scary Dream Street."

For a few very long minutes, while looking at the video projection system installed in a home theater, I had the sinking feeling that I was going to have to make an emergency call to Ken Werner (*Information Display*'s esteemed editor-in-chief) and try to perform major last-minute surgery on my already-at-the-printer's column. But, before I tell you what caused this moment of sweaty-palms panic, allow me to describe the setting.

For those of you who may not have encountered a "Street of Dreams" in your own city (which I suspect is highly likely for many of our non-U.S.A. readers), let me explain this interesting home-building phenomenon.

Each year, in the Seattle metropolitan area, the local home-builders association selects one street in a new housing development on which anywhere from eight to twelve new homes are constructed using (presumably) the latest architectural concepts and construction methods. These houses are typically done in different styles and decorated in a variety of interesting "themes." Then, for a period of approximately six weeks during the nicest part of summer, people have the opportunity to tour these homes by paying an admission fee of typically eight to ten dollars. It has all the flavor of an adult version of a Disneyland theme park, without the rides. The Disneyland mood is reinforced by the long lines of people patiently waiting to have their chance to examine each architect's and decorator's dream theme.

In order to do justice to this "Dream Street" concept, the houses are typically near the upper end of the home-price spectrum, incorporating the newest gadgets, and the decorating styles push the limits of what most people are likely to accept. In a few cases, I had to wonder if the decorators didn't develop their concepts in a dream after overly sumptuous meals - you know, the kind of dreams that start out all right and then get a bit weird.

Some of these dream houses get sold even before the show opens, while others may sit unsold for months after. This year's prices were in the $700,000 to $900,000 range *without* the fancy furniture and accessories: definitely above the affordability index of most of the visitors.

Although I always find great entertainment in seeing how these displays of conspicuous consumption are implemented, my real interest in attending is that I have found these events to be good leading indicators of where video and audio technologies may be headed in the coming years. It allows one to do a real-life analysis of what may integrate well into future residential lifestyles - or what is likely to be a fad that will never find serious acceptance.

A major and growing trend for the last several years has been the ***home theater.*** And it was in one of these that I had my moment of "Uh-oh, I think I've made a mistake!" As I walked into the darkened room and started observing the

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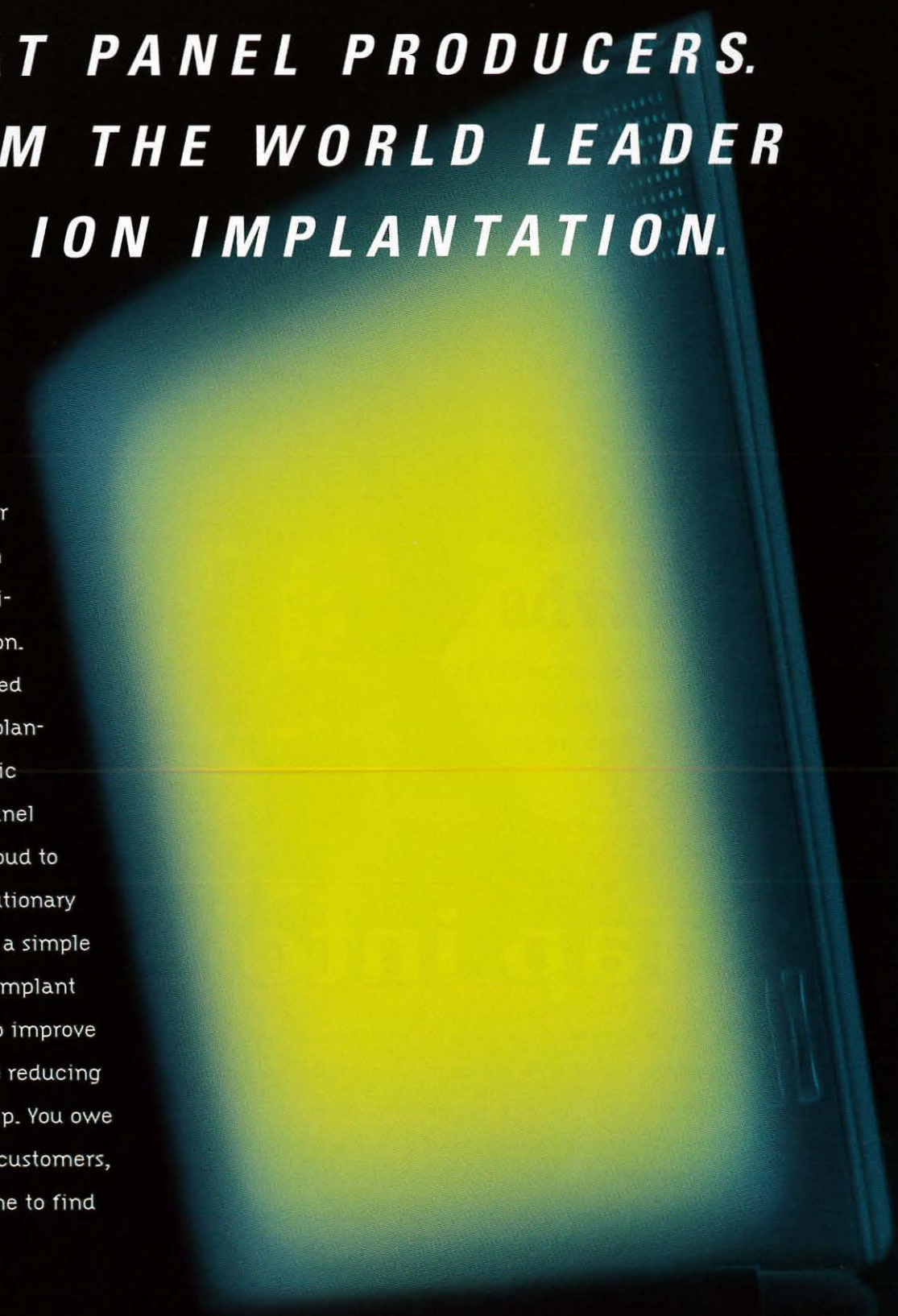

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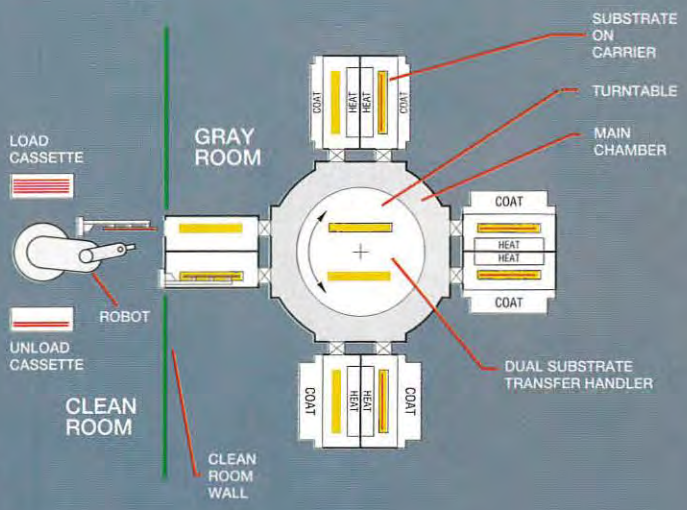

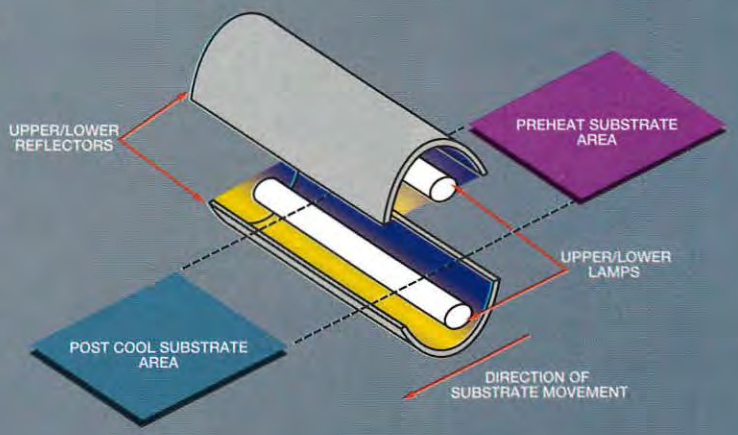

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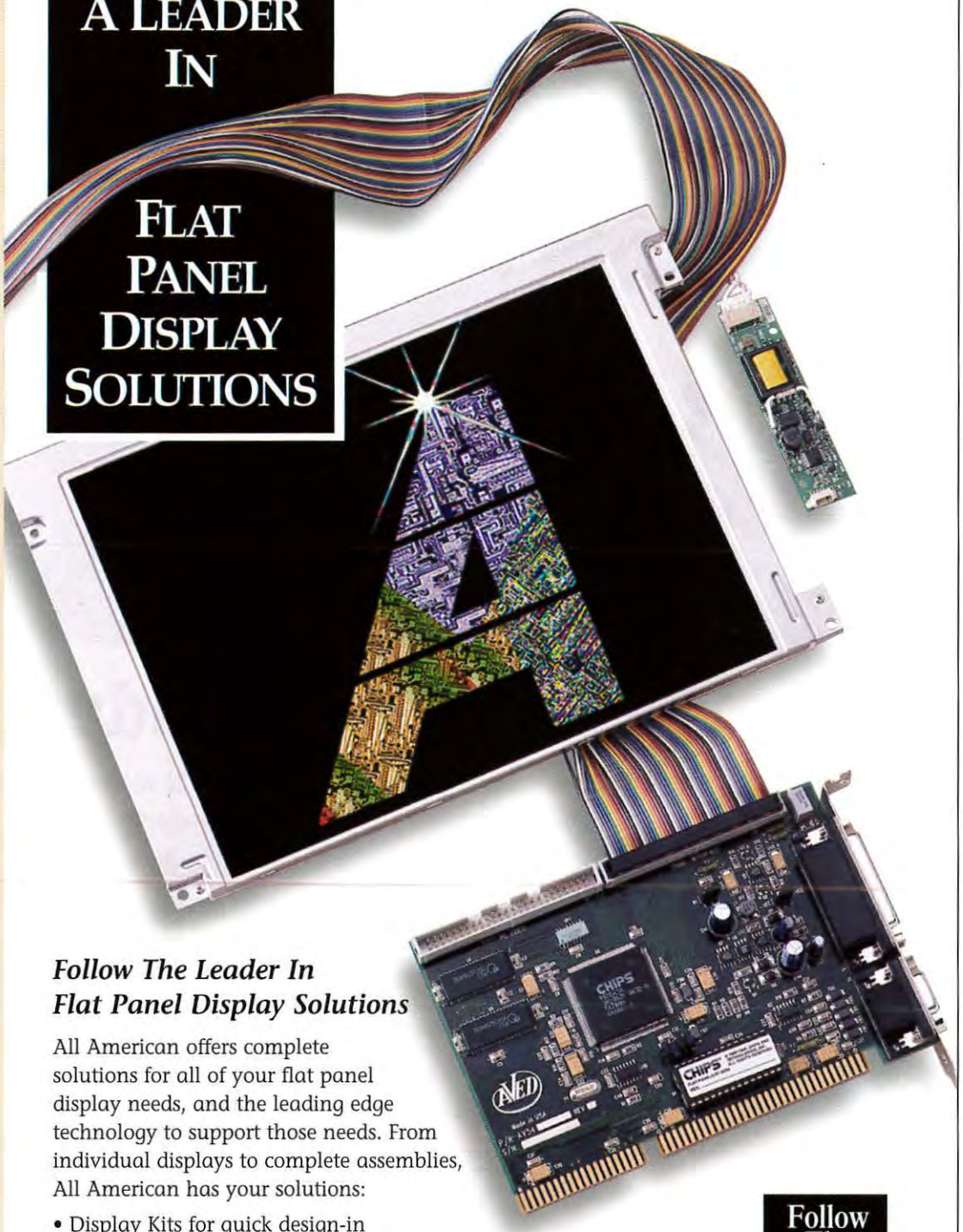

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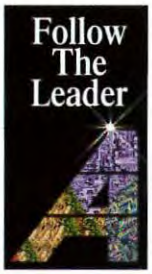

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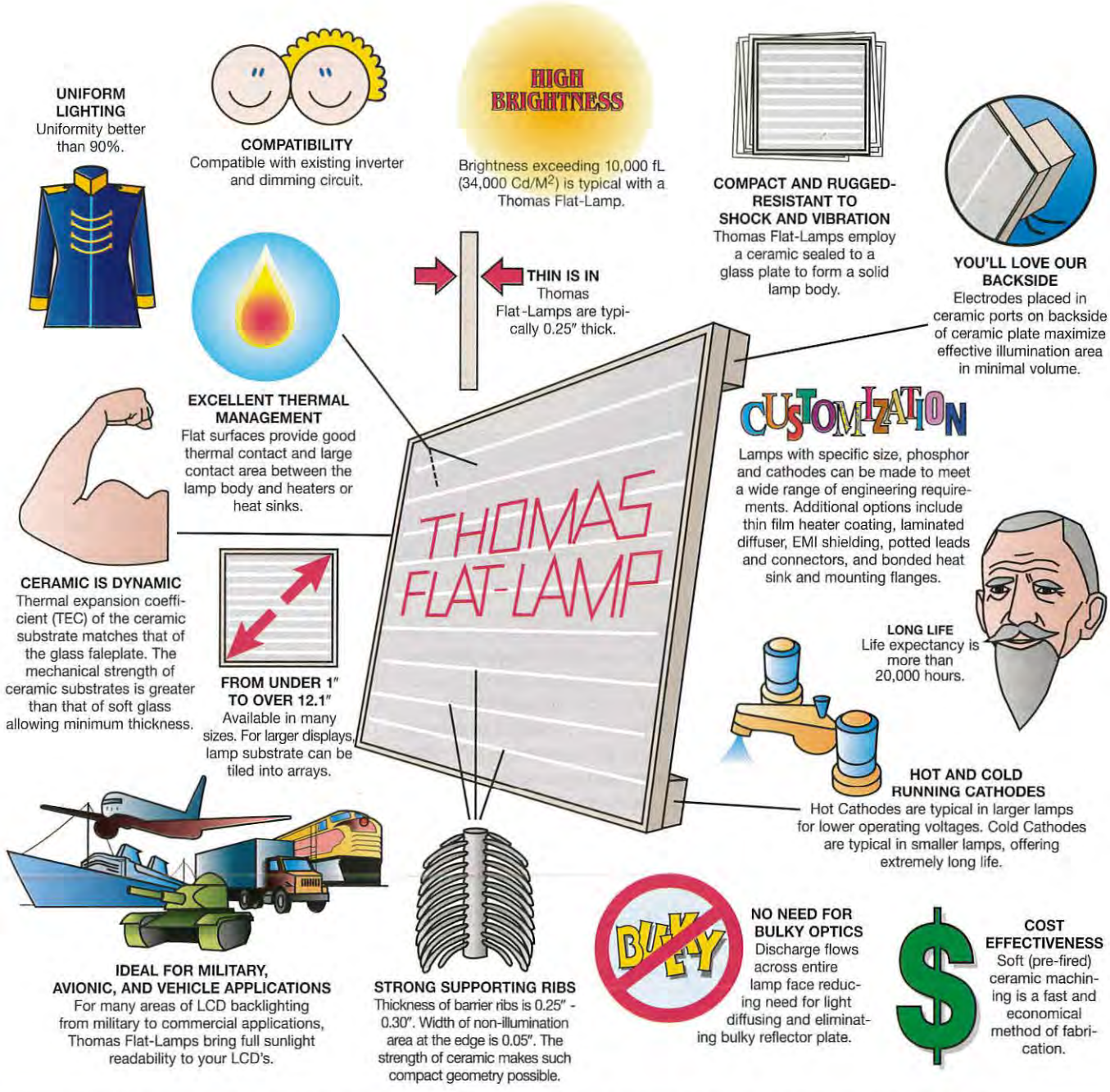

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THOMAS FLAT-LAMPS BACKLIGHTS TO THE FUTURE

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Circle no. 7

Thick Dielectrics Give EL a New Spin

*Screen-printable high-*k *materials enable economical and high-performance electroluminescent structures.*

by Don Carkner

COMMERCIAL EL PRODUCTS have taken a variety of forms since Destriau's work on ZnS in 1936 launched the modern era of electroluminescent (EL) technology. Among these have been ac powder, dc powder, dc thin film, and ac thin film. All of these technologies have inherent advantages and disadvantages that define the markets they are able to address. Now, products have entered the market based on a new EL variation: thick-dielectric EL (TDEL) displays and light sources.

The sole producer of these devices is The Westaim Corporation of Fort Saskatchewan, Alberta, Canada – an area known primarily for its natural resources and agricultural industries. The company began developing its EL technology in the summer of 1991 when Xingwei Wu realized it might be possible to expand an existing thick-film hybrid-circuit project into displays. In September 1996, the first commercial panels rolled out of a new production facility. In the intervening 5 years, a complete manufacturing process had been developed, from bare substrate to electronics and packaging. The resulting product line includes monochrome and red-green (RG, also called "multicolor") quarter-VGA (320 × 240) panels in a 120-mm-diagonal format, as well as large-pixel numeric, alphanumeric, matrix, and fixed-format displays (Fig. 1).

***Don Carkner** is TDEL Displays Applications Engineer at The Westaim Corporation, 1010 114th St., Fort Saskatchewan, Alberta, Canada T8L 3W4; telephone 403/992-5320; fax: 403/992-5325; e-mail: dcarkner@viridianinc.com.*

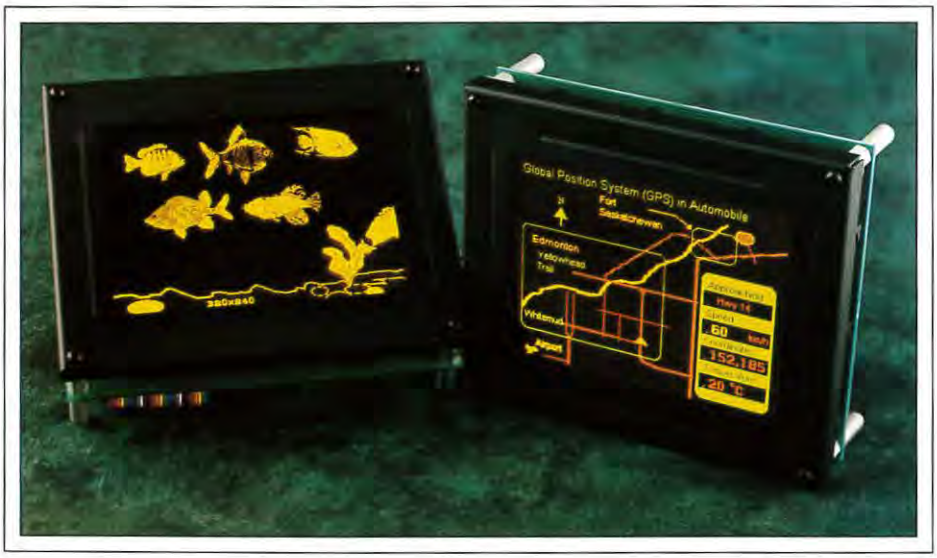
Worldwide sales of EL were about $100 million in 1995 – not much compared to the $10 billion market for all flat panels, but EL sales are growing faster than the flat-panel market as a whole – 20% compound annual growth rate (CAGR) compared to 15%. The bulk of EL's growth has occurred in the industrial, medical, and instrumentation sectors, where its ruggedness, wide temperature range, wide viewing angle, high brightness, fast response, and long life are highly valued.

Processed through Thick and Thin

The key to the TDEL structure is the use of a proprietary combination of screen-printed thick films, sol-gel processing, and vacuum-deposited thin films. TDEL technology utilizes essentially the same structure as the well-known ac thin-film panels, but with a few important exceptions.

First, the substrate is ceramic, typically 96% alumina, instead of glass. This material is widely used in the hybrid-circuit industry, so it is readily available. While alumina is more expensive (at $ 0.10 a square inch) than glass substrates, it allows higher-temperature processes to be used.

Second, one of the dielectric layers is a screen-printed high-dielectric-constant (or high-k) material based on $PbNb_2O_6$, $BaTiO_3$,



The Westaim Corporation

Fig. 1: Thick-dielectric electroluminescent (TDEL) displays – the new technology on the EL block – are now being produced in monochrome and multicolor (red-green) varieties.

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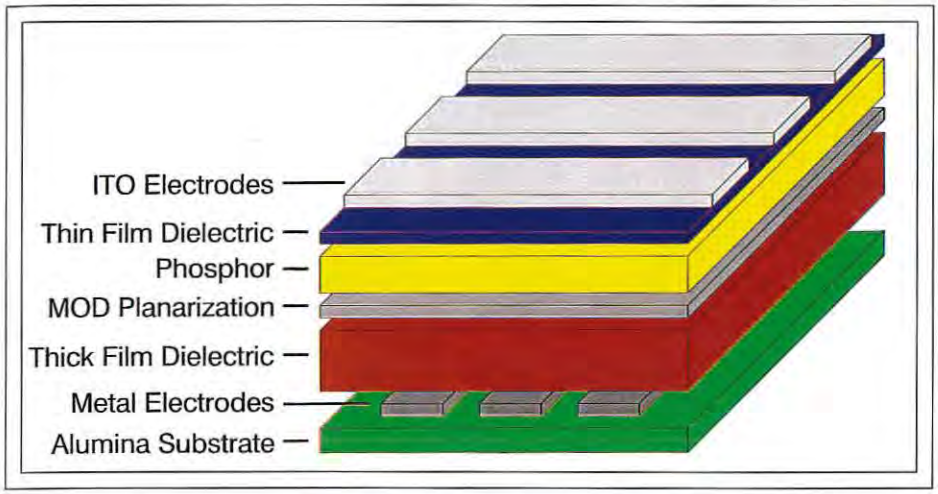

Fig. 2: TDEL displays use an "inverted" structure in which the emitted light travels away from the substrate rather than through it. The first two layers – the metal electrodes and thick-film dielectric – are screen-printed.

or a similar material. (These materials are well-known in hybrid-circuit manufacturing, where they are used to make capacitors in multichip modules.)

These two differences result in a display with some unique characteristics.

Making a TDEL

As can be seen from the structural schematic of a typical device, TDEL displays use an "inverted" structure in which the emitted light travels away from the substrate rather than through it (Fig. 2). The first two layers - the metal electrodes and thick-film dielectric - are screen-printed. Screen printing is well-suited to display fabrication because it is inexpensive, has high yield, and is applicable to large areas. But a glass substrate would not survive the firing profiles of the screen-printed materials, so an alumina substrate, which is capable of withstanding very-high-temperature processing, is substituted.

After the metal electrode has been put down and patterned, and the thick-dielectric screen printing is complete, the surface is too rough for thin-film deposition. To planarize the thick-film/thin-film interface, sol-gel processing - or metal-organic decomposition (MOD) - is used. In this process, a metal-organic solution is applied in the liquid phase, then fired to create a lead zirconium titanate (PZT) ceramic. The MOD material fills in the voids between the relatively large particles of the thick film and provides a smooth surface for thin-film deposition. A thin-film phosphor (the well-known ZnS:Mn for monochrome and RG displays), a thin-film dielectric, and the upper transparent electrodes complete the device.

This structure permits the thin films to benefit from performance-enhancing heat treatments at higher temperatures than a glass substrate would allow. Rapid thermal processing (RTP), which is meant to heat the stack more than the substrate, is not required, so simple furnace annealing can be used. When all the films are finished, the columns are defined by laser scribing, and the display is sealed with plain glass for monochrome or a pre-patterned color filter on glass for RG.

The use of screen printing for some of the layers of the stack significantly simplifies the manufacturing process. Because of the dielectric's thickness, the danger of particulate defects is significantly reduced. And because of the dielectric's high breakdown strength, the potential for pinhole-related breakdowns in the thin films is eliminated. These inherent advantages result in higher yield and lower capital equipment costs because one can use less-expensive air handling and filtration systems and because screen printers can be substituted for vacuum systems.

Performance

The operation of the TDEL device resembles that of thin-film EL. TDEL is driven with a symmetric ac waveform. Once the peak voltage of that waveform is high enough, elec-

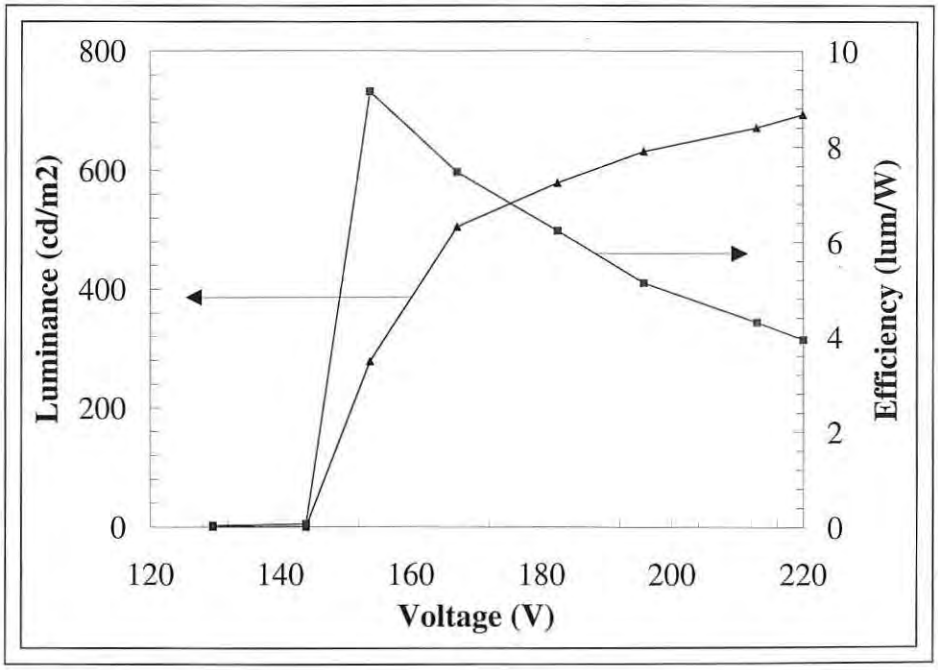

Fig. 3: TDEL devices can produce substantial luminance at very respectable luminous efficiencies. It is possible to attain a pixel L_{40} (luminance at 40 V above threshold) of 600 cd/m² at 30 Hz.

trons begin to flow back and forth through the phosphor, exciting the dopants. When the dopants relax to their ground state, they emit a photon of light.

The dielectric layers ensure that the dc current is limited to levels that will not damage the structure. The thick-dielectric material provides excellent breakdown strength and a natural self-healing characteristic. (Breakdowns create a hole in the stack, but the dielectric is thick enough to prevent propagation.) Consequently, the phosphor can be driven quite aggressively, if required.

TDEL devices can produce substantial luminance at very respectable luminous efficiencies (Fig. 3). Pixel L_{40} (luminance at 40 V above threshold) of 600 cd/m^2 at 30 Hz is attainable. The high-*k* dielectric maximizes the portion of the applied voltage that is applied to the phosphor, producing a steep L/V curve with relatively modest high-modulation saturation.

Measurements done by independent labs on single-pixel devices confirm that the monochrome TDEL structure can exhibit luminous efficiencies of more than 7 lm/W. In an addressed panel, the total power-conversion efficiency (including electronics) is 1–2 lm/W, depending on the luminance and type of drive circuitry used.

In addition to its beneficial electrical characteristics, the thick-film dielectric provides some optical advantages. Because the thick-film layer is somewhat absorbing and is not optically flat, wave-guiding within the stack is prevented. This means that "blooming" – the apparent increase in the size of a bright ON pixel because light "leaks" from the ON pixel to adjacent OFF pixels – is minimized. TDEL displays have extremely sharp, crisp transitions.

The Westaim Corporation

Fig. 4: *TDEL technology can be used in markets where EL is not traditionally applied, such as very-large high-brightness modules for multi-segment and fixed-format displays.*

This type of processing is not without drawbacks, however. The thick-dielectric stack does not lend itself well to very-high-resolution applications. Since the dielectric is quite thick, small geometries approaching the stack thickness lead to significant field distortion at electrode edges, which results in the partial lighting of adjacent pixels. Because of this, TDEL panels are limited to sub-pixel pitches of about 0.1 mm, or 250 lpi, which is not fine enough for head-up-display or viewfinder applications.

Another characteristic of TDEL technology is that the high-*k* dielectric imparts an unusually high active capacitance. The passive, or OFF, capacitance of the panel is determined mainly by the thin films, but when the phosphor begins to conduct in high fields, it is the thick-film-dielectric capacitor that must be charged. Because q = CV, a high capacitance means higher charge transfer per voltage increment. Since the phosphor is in series with the dielectric, it sees the same high level of charge transfer, resulting in high device efficiency.

Unfortunately, this high charge transfer translates to a high current demand on the panel drivers, which were designed for thin-film technology in which the active-to-passive capacitance ratio is smaller. Initially, this impeded commercialization because it

From Fertilizer to Flat Panels

The Westaim Corporation grew out of a cooperative effort between the governments of Alberta and Canada, and Viridian Inc., a large fertilizer producer with a background in refined nickel and cobalt products. In 1990, these three players launched the Westaim Initiative, the objective of which was to take advantage of Viridian's advanced materials experience to develop high-technology businesses in Alberta. Now an independent, publicly owned company, Westaim develops, commercializes, produces, and markets products based on advanced industrial materials.

Westaim's portfolio of products includes biomedical coatings for burn-wound dressings, structural and electronic ceramics, industrial pipe coatings, fine metal powders, and battery materials – as well as EL displays. Westaim's market capitalization is about $240 million, and its approximately 440 employees are deployed at locations which include its headquarters in Fort Saskatchewan, Alberta; production facilities in Leduc, Alberta, and Manchester, U.K.; and marketing offices in Edmonton, London, and Amsterdam.

– Don Carkner

required the development of specialized drivers. Fortunately, the TDEL panel can be driven at a lower voltage than thin-film EL devices, so the overall power dissipation in the chips need not increase dramatically.

The White at the End of the Tunnel

A major obstacle to the penetration of EL technology into broader markets has been the absence of a phosphor that provides bright, stable, blue light. The common ZnS:Mn phosphor can be filtered to obtain red and green, but without a blue component it is not possible to obtain either a white light or a true full-color display. In recent years, a number of host materials – most notably SrS and $SrGa_2S_4$ – and structures have been used in prototypes to produce full color, but no commercial product has yet appeared on the market.

The increased luminance and efficiency offered by the TDEL structure can be used to enhance the performance of known blue-emitting phosphors. In addition, the high-temperature capability of the structure makes it possible to investigate other phosphor systems that require deposition or annealing conditions that a glass substrate would not withstand. White-pixel L_{40}'s of over 350 cd/m^2 at 60 Hz, with CIE coordinates of 0.40, 0.43, have been achieved. This has encouraged Westaim's R&D team to focus on color-phosphor development since the commissioning of the production facility for monochrome and RG panels. Westaim plans to introduce a commercial full-color product based on the color-by-white approach by the end of 1997.

New Markets for EL

The screen-printed dielectric layer in a TDEL device is about two orders of magnitude thicker than a thin-film dielectric, which makes the dielectric process relatively insensitive to particulate defects under a few microns in size. Together with the high breakdown strength and self-healing properties of the material, this feature makes it possible for TDEL technology to be used in markets where EL is not traditionally applied: very-large high-brightness modules for multi-segment and fixed-format displays (Fig. 4).

The four-digit numeric display with 90-mm characters shown in the figure produces about 1000 cd/m^2 (unfiltered) when driven at 160 V and 40 Hz. As previously mentioned, the bright yellow light can be filtered to produce red or green displays, or for increased contrast. Because there is no need for a high level of multiplexing, these displays can be refreshed at higher rates to obtain increased luminance. (Light output is roughly linear with refresh rate up to about 500 Hz.) In addition, because discrete components can be substituted for integrated drivers in this type of application, there is little constraint on the voltage or current levels used, which allows the overall luminance to be increased further when needed. These displays are being sold into the transportation sector for train and bus destination indicators and station information boards; into the commercial sector for weigh stations, auction houses, and decorative uses; and into industrial sectors that require sunlight readability and long-distance legibility.

Looking Forward

EL displays have ridden a roller coaster of expectations, from visions of ubiquity in the 50s and 60s, through the relative exile of the 70s, and now to the reserved optimism of the 80s and 90s. Markets for high-information-content thin-film EL displays are well-established and growing rapidly, and there are now potential new growth areas in larger-format signage and color displays. EL may be a relatively small slice of the flat-panel-display pie, but it now seems to be a very tasty one. ■

Small Is Hot

If people thought very small displays could be the long-awaited "leapfrog technology," wouldn't they be excited? They are.

by Susan S. Eustes

A NEW INDUSTRY is emerging in flat-panel displays: an industry based on miniature electronic displays built upon silicon chips. These displays are so small that they are commercially worthless without magnifying optics or some means of projection. But when correctly magnified or projected, miniature displays – also known as "virtual displays" – have the ability to change the way people view and retrieve information.

"An entire range of new products is possible with this technology," said Mark Handschy, president of Displaytech, Inc., maker of ferroelectric liquid-crystal (FLC) miniature displays (Fig. 1).

Phillip Alvelda, president of the MicroDisplay Corporation, puts it this way: "Our customers will literally put displays where no displays have ever gone before." MicroDisplay is developing miniaturized liquid-crystal displays (LCDs) that use triads of diffraction gratings to produce color.

As with most display technologies, miniature displays first produced low-resolution monochrome images. These first-generation devices, however, are rapidly giving way to more refined displays that produce high-resolution full-color images. Many of the miniature-display companies are accomplishing this feat with a rather broad range of proprietary technologies.

***Susan S. Eustes** is a freelance writer and business-communications consultant located at 9764 North Iris Street, Westminster, CO 80021; telephone 303/424-8480; fax: 303/456-5451. Displaytech, Inc., is one of her clients.*

Under development for several years, miniature displays are moving beyond the "interesting technology" stage and into the commercial realm, where they are finding their place in portable communications devices, computing tools, and toys. Figments of product designers' fevered imaginations – such as portable web browsers capable of displaying full pages of text and graphics, cellular telephones that can be used for video conferences, and head-mounted display systems no bigger and no more obtrusive than a pair of eyeglasses – are becoming realities with miniature displays.

Shorter, Lower, Narrower

In electronics, everything gets smaller except the display. This truism has limited designers in their efforts to produce a full range of portable communications, computing, and entertainment devices. But now, high-resolution color miniature displays capable of repro-

Displaytech, Inc.

Fig. 1: Miniature displays will make possible a number of new products in computing and communications. Shown is an artist's conception.

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Reflection Technology, Inc.

Fig. 2: Reflection Technology's FaxView - a portable paperless fax machine that connects to a cellular or landline telephone and stores and displays faxes - incorporates the company's LED-based miniature display.

ducing graphics and video promise to resolve this dilemma. No longer will a consumer have to choose between a large colorful display and a small truly portable product. The resulting product-development opportunities could be a boon for the portable communications and computing industries.

Besides the obvious advantages of being very lightweight and small, miniature displays are also touted as consuming very little power. Displaytech, for example, uses reflective illumination for its displays, which eliminates the absorption of light inherent in most backlit AMLCDs. According to Displaytech, a standard AMLCD transmits about 8% of the light produced by its fluorescent backlight and wastes the other 92%. Thus, AMLCDs on laptop computers generally require 2-4 W of power compared to 0.2 W for Displaytech's reflective miniature display.

Micron Display estimates a 9-V battery will operate its 0.7-in. color field-emission display (FED) for 44 hours. In comparison, the company estimates the same type of battery will operate a 0.5-in. CRT for 4.9 hours and a 0.5-in. backlit AMLCD for 8.8 hours.

The fate of miniature displays would seem to be inextricably linked to the future of portable electronics, so part of the excitement in the miniature-display industry stems from market-research results that predict rapidly growing increases in the use of portable computing and communications devices. World Market Strategies, a market-development company, has identified portable computing and communications as a major area of market development. The company, which seeks to bring together users and producers of portable computing and communications devices, began its market-development efforts with a PDA Forum in January 1995. The event drew 300 people.

Since then, World Market Strategies has divided its PDA Forum into four industry segments - utility, health care, transportation, and public safety - each of which draws 300-400 participants.

The potential of personal information tools will not be realized, however, with three-line displays, text-only displays, or even miniature graphic monochrome displays. If there is going to be a revolution in highly portable devices, we need miniature high-resolution color displays capable of displaying text, graphics, and video.

Early Applications Hit the Market

Companies large and small are getting into the miniature-display business. Some are developing miniature displays that can be sold to OEMs for incorporation into their new products. Other companies are planning to build commercial products with their own technology.

Reflection Technology, Inc., has fabricated a miniature display based on arrays of light-emitting diodes (LEDs) and is building its business around wireless communications. The company has already released its first miniature-display product: FaxView, a hand-held paperless fax machine (Fig. 2). Reflection Technology products are used in Nintendo's Virtual Boy, and the company has announced strategic relationships with Motorola and Nokia.

Kopin Corporation produces a high-resolution SMART SLIDE™ miniature imaging device, a miniature AMLCD using single-crystal-silicon thin-film-transistor arrays. Forte Technologies, Inc., a Kopin subsidiary, is building head-mounted virtual-reality (VR) systems for the personal-computer and entertainment markets using Kopin's display. Kopin has also announced it is developing a display for military applications.

Virtual i-O made its name by building VR game headsets using electroluminescent displays. Although these early headsets had limitations, this pioneering work in miniature-display technology was largely responsible for whetting the public's appetite for miniature-display products. Now, Virtual i-O is making 8-oz. headsets using standard 0.7-in. AMLCDs.

Perhaps the most advanced and most publicized miniature-display technology to date is Texas Instruments' Digital Light Processing™ (DLP™) technology. DLP technology uses hundreds of thousands of digitally controlled tiltable micromirrors to reflect light from a projection lamp directly onto the screen in a pattern of bright and dark pixels. Several companies have created projection products using TI's DLP (Fig. 3). Electrohome Ltd. has produced an all-digital projector for professional display applications such as large conference rooms, auditoriums, churches, and entertainment venues. Proxima® Corporation has produced a desktop projector weighing 26 lbs. that has been designed for mobile presentations and multi-departmental use.

The Thorns on the Roses

Miniature displays are not without their problems. The magnifying optics used in handheld products – such as Reflection Technology's portable telefax receiver – have to be held close to the eye, which many people find annoying.

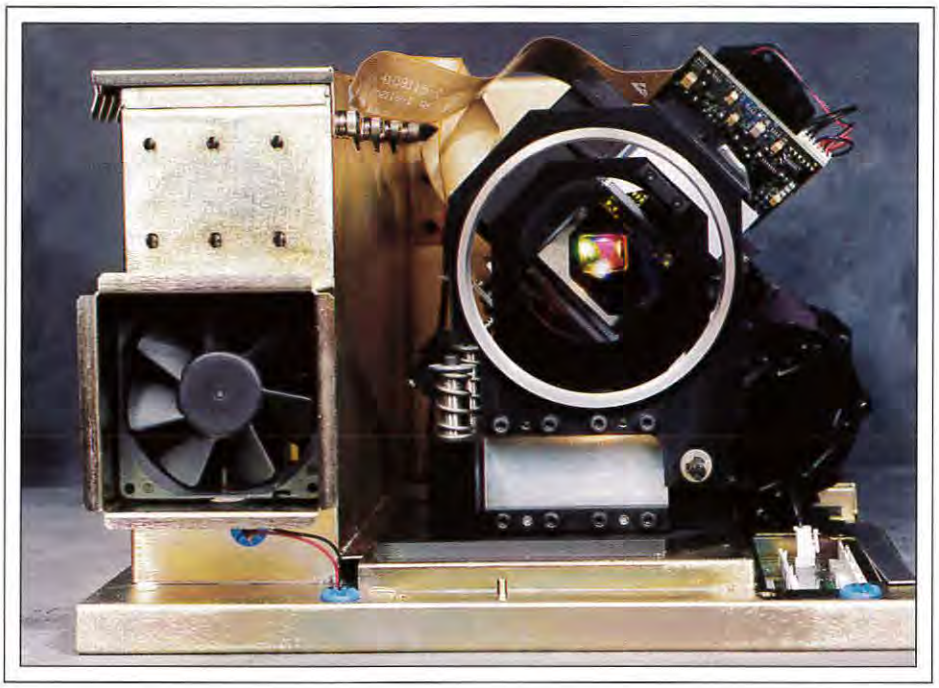
An issue with head-mounted displays is the need to maintain peripheral vision. Do you want to be able to look around the room when using a head-mounted display? Can only touch typists make good use of a head-mounted display for laptops, or will there be a way for users to see the keyboard? Motion sickness is another issue for users of head-mounted displays – especially when they are used with systems designed for VR. And simple eyestrain may be an issue for applications requiring extensive use of these displays.

For most miniature displays used in projectors, issues such as brightness, portability, and cost remain. With the exception of TI's reflective DLP, the projected image is not nearly as bright as that of a standard slide projector; for good viewing, a room has to be kept so dark that convenient note taking is precluded. Generally weighing in at 17–20 lbs. – although some newer models are in the 10-lb. range – portable projectors are not yet sufficiently light in weight for true portability. And desktop projectors based on small displays currently cost about $10,000 each, a prohibitive price for broad consumer acceptance.

An even more pressing issue is whether manufacturers have the ability to produce cost-competitive miniature displays. The major cost in producing a miniature display is usually the price of the silicon backplane. The smaller a manufacturer can make the display, the more displays he can produce from a single silicon wafer and the lower the cost will be.

The arithmetic is simple, but the issue isn't. The problem lies with the yield from each wafer. Yield is lost both in processing the wafer and in building a display on top of each chip on the wafer. So even with a strong 80% yield from the wafer and an 80% yield from the display processing, the total yield from the original silicon backplane is only 64%.

David Mentley, display analyst at Stanford Resources, says that to penetrate a very large commercial market, miniature displays must be available to OEMs for under $25. If he's right, a low-cost manufacturing capability could be the criterion that separates successful from unsuccessful miniature-display producers.



TI Digital Imaging

Fig. 3: Texas Instruments' three-chip engine provides OEMs with the highest luminance available from a DLP-based projection subsystem. Here the lens has been removed to show the prism that combines the images from the red, green, and blue digital micromirror display (DMD) chips for projection.

Beyond these issues lies the marketing element. "Technology throughout history is not readily accepted," says Jon Covington, president of World Market Strategies and PDA, Inc. "We have to train people to accept it, grasp it, and love it."

Case Study

Under development at Displaytech are its ChronoColor™ miniature displays, which are reflective active-matrix FLC color miniature displays with resolutions up to 1280 × 1040 pixels. The company has built prototypes of 256 × 256, 640 × 480, and 1280 × 1024 displays which measure less than 0.5 in. diagonally. Named for its ability to produce sequential color, the ChronoColor™ is one of the new generation of miniature displays that achieves both the high resolution and color quality now standard in large electronic displays.

FLCs are known for their fast switching: they can turn a pixel ON or OFF in roughly 35 µsec. The reflective sequential color is produced by turning red, green, and blue LED frontlights on in rapid sequence. There are no color polarizers or other devices that absorb light. The approach produces full field-sequential color on every pixel, and eliminates the reduction in apparent resolution inherent with color subpixels. The overall switching speed is easily sufficient for the production of video images.

The ChronoColor™ display incorporates a thin layer of FLC material in contact with a custom-made CMOS silicon chip. On the chip are metal pads – or mirrors – that form each pixel. The FLC material serves as a shutter to control whether or not the light provided by the LEDs is reflected from the mirror. The simplicity of the CMOS design and the characteristics of the FLC material allow for extremely small pixels – less than 8 µm – on the display chip.

Because the light comes from the front of the display, a larger portion of the display surface can be used for light control than is possible with transmissive displays, where a substantial portion of the display surface is taken

up by circuitry. The aperture ratio of the ChronoColor™ is 75%, which compares with a typical value of 35% for miniature color AMLCDs.

Displaytech expects commercial production of ChronoColor™ displays to begin by late summer 1997. Meanwhile, the company is selling developers' kits consisting of a VGA miniature display, optics, and drive electronics. This display can plug into any VGA port.

Displaytech is in the process of finalizing its commercial manufacturing process. While declining to comment on exact production costs, Haviland Wright, CEO, states that Displaytech will be able to produce its ChronoColor™ displays at a cost that will allow OEMs to produce display products which are "at least competitive" with those on the market today. Fulfilling that pledge is essential if Displaytech's promising technology is to prosper in the marketplace. The same is true for the miniature-display industry as a whole. ■

Italian Economy Cloudy; SMAU Sunny

The sun shone on Milan, SMAU, and an IT market that was booming despite an unsettled forecast for the Italian economy as a whole.

by Bryan Norris

ONCE AGAIN, fine weather helped Milan's prestigious International Information and Communications Technology Exhibition draw another record attendance: 387,000 visitors for this 33rd running of the event from October 18–22, 1996 – up 37% from 1995.

The SMAU show, as it is universally known, is the second-largest IT exhibition in Europe, with the booths of 2300 exhibitors occupying 79,000 m^2 in 20 of the halls of the permanent Fiera site. The numerous conferences taking place during the show attracted around 7500 participants.

In character, SMAU is decidedly and enjoyably Italian. But the presence of visitors, official delegations, or national pavilions from Armenia, Brazil, Canada, China, Denmark, France, Greece, Hong Kong, India, Russia, Switzerland, Taiwan, Turkey, Ukraine, the U.K., and the U.S.A. served as conclusive proof of SMAU's international importance. Despite reports of the slowing down and uncertainty of the Italian economy, and the threat of new taxes, exhibitors at the show were nearly all enthusiastic about a booming IT market – especially from a displays viewpoint.

***Bryan Norris** is the Senior Partner and founder of Bryan Norris Associates, Consultants in Electronics, 7 Biddenham Turn, Biddenham, Bedford MK40 4AT, U.K.; telephone +44-(0)-1234-26-7988, fax: +44-(0)-1234-26-2345; e-mail: bnorris@kbnet.co.uk. Before establishing Bryan Norris Associates, he created and managed the Monitor Information Program at BIS Strategic Decisions. He is a contributing editor to* Information Display Magazine.

Complicated Local Distribution

SMAU is, of course, the ideal place to learn about the local monitor producers and the highly complex – perhaps unique – sales channels. First, there are the little-known outside-Italy monitor makers. The "three-brothers" company ***CA&G*** of Cornedo (near Vicenca) will again have made nearly 200,000 (mainly 14-in.) monitors in 1996. At SMAU, ***CA&G*** was again heavily promoting its large-

LG Electronics

***Fig. 1:** LG Electronics' lively stand showed a product line well focused for the Italian market.*

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screen (28-, 29-, and 34-in.) multimedia public-information monitors. Meanwhile, with 30 years of experience behind it, ***Sambers*** of Cinisello (near Milan) showed that it continues to upgrade its very extensive range of 21–42-in. all-purpose large-screen monitors. ***Sambers***, a $20.5 million company, is the manufacturer that provides ***Hantarex UK*** with product, and as of July 1996 ***Sambers*** has been the owner of the ***Hantarex Electronics*** brand name for Italy and other countries. ***Sambers*** had a hang-on-the-wall 42-in. plasma-display-panel (PDP) monitor (based on a Fujitsu panel) which was attracting a great deal of attention in Hall 21. This pre-production unit had everything built in, including the power supply, which is normally separate with these huge plasma displays. The much smaller – but still large – stand-or-hang-alone 21-in. PDP monitor alongside it was completely overshadowed.

In another hall, ***Seleco,*** the TV maker from Pordenone (north of Venice), also showed its 28-in. wide-wall information monitors. In yet another location, the relatively unknown Florentine monitor supplier ***Semio*** exhibited its range of (Taiwanese-made) "Boxer" 10.5-, 14-, 15-, and 17-in. monitors.

Many international monitor suppliers were also keen to promote their new models, often on sections of large and impressive stands that showed off their complete product spectra. ***LG Electronics (Goldstar)***, for example, has recently become much more focused and successful in the Italian marketplace, and a significant area of its stand in Hall 9/1 was devoted to displaying monitors (Fig. 1).

Monitors employing the new finer-dot-pitch Diamondtron® tubes were to be seen on the ***Mitsubishi*** stand in the main hardware hall (11). ***Mitsubishi***'s 30–86-kHz 87 TXM has the 0.25-mm-dot-pitch 17-in. aperture-grille tube, and the 30–95-kHz 91 TXM – which is not yet on the Italian data sheet – is fitted with the latest 21-in. Diamondtron® tube with 0.28-mm pixel pitch.

On the ***NEC*** stand were the first of its new monitors. The XV17 has been upgraded to the XV17+, which has a horizontal frequency range extended to 82 kHz and retails at 1,690,000 Lire (US$1100). And the first of the new "P" series, the 31–94-kHz 17-in. P750, was on display and already selling at 2,390,000 Lire (US$1550). It was explained that existing 21-in. models were shortly to be replaced by new 21-in. models, notably the P1100 and the P1150.

Nokia

Fig. 2: *Nokia's 17-in. videoconferencing station is a combination TV/monitor.*

NEC's two LCD monitors, the 12.1-in. LCD 200 and the 13-in. LCD 300, received plenty of interest from the dense crowds – until, that is, their prices of 6.9 million Lire (US$4400) and 9.4 million Lire (US$6000) were revealed. Then the interest just seemed to melt away.

Nokia – in its own modest stand in Hall 12 this year – showed some of its updated high-end (mostly TCO '95) monitor range, and announced that its new authorized Italian distributors were ***Gruppo Eletec/Discom*** and ***SBF Elettronica*** (Fig. 2). That ***Nokia*** had recently parted company with ***Actebis Italia*** was not surprising to the trade. ***Actebis***'s prime aim seemed to be the promotion of its own ***Targa*** brand.

In the business of selling monitors, ***Océ*** is unique. In just three countries (Italy, France, and Spain), ***Océ*** offers a small range of highly specified monitors to complement its comprehensive printer products, and it is in Italy where this policy has been most successful. Of the new five-model OEMed series with screens ranging from 17 to 21 in., two are from ***Taxan*** and three are from ***Philips***.

Philips itself occupied half of Hall 10. Although this was one of the smaller halls, nobody could say that space for the entire gamut of ***Philips***' products was limited! Spread around were the new four-model "Brilliance" line of monitors and examples of the other ***Philips*** models – shown with their new non-controversial numbering system. (It seems amazing that virtually all of the world's monitor suppliers are having to take account of an obtuse court ruling in a small town in California over permitted screen-size designations. Back to confusion!) Not to be outdone, perhaps, the lofty ***Panasonic*** stand covering a large area in Hall 21 had a small section devoted to displaying its latest range of TCO '92-approved monitors.

Samsung, on its Hall 9/2 stand, introduced two new 15-in. multimedia monitors. The "SyncMaster 15Me" has a horizontal scan frequency range of 30–50 kHz, dual 1.5-W built-in speakers, Plug & Play, okay-for-Italy MPR-II, and a cost of 840,000 Lire (US$538). For 920,000 Lire (US$589), the higher-spec 30–65-kHz "SyncMaster 15M" adds OSD.

show report

Over the last year, Samsung has done particularly well in Italy, especially selling its 14-in. 38- *and* 48-kHz models.

A well-known and well-respected brand name, ***Sony*** is another company whose monitors sell well in Italy. The large ***Sony*** stand in Hall 11 was extensively stocked with a multitude of different products, and it was a little difficult to spot ***Sony***'s "bright-picture" professional monitors.

When is a distributor really a large dealer, or a large dealer a distributor? In Italy it's hard to tell. Suffice to say that many of the local dealers/distributors also handle some well-known monitor brands. ***Computer House*** now sells ***LG*** and ***Samsung*** monitors, plus ***Princeton*** models when it can get them, and was displaying a brand new label on its jam-packed stand: ***Eclipse*** from Taiwanese ***AmTran***. ***Datapool*** promoted a typical line-up of Korean ***Hyundai*** monitors, and its catalog also offered monitors from ***Eizo, NEC, AST,*** and ***Siemens.***

Datamatic still sells ***Samtron*** monitors, although what will happen in 1997 when ***Samtron*** is fully integrated with ***Samsung*** was not clear. ***Digitronica***'s main monitor brand is ***ADI***, and the company also handles ***Hitachi*** and ***NEC*** models. The up-and-thrusting Turkish ***Karma*** is now handling ***Tatung*** monitors in Italy. ***Ready Informatica*** is the long-time outlet for ***Wyse*** monitors.

PC Assemblers Get into the Act

The Italian "big-boy" – or should it be big-person? – distributors seem to be endeavoring to perform all functions nowadays. At SMAU it appeared that distributing all kinds of hardware and software and assembling own-brand PCs is now the norm. Number-one distributor ***Computer Discount (CDC)***, targeting a 1996 turnover of 400 billion Lire (US$250 million), with about 30% in PCs, distributes monitors from ***NEC, Philips,*** and ***Sony. Executive,*** aiming for about 20,000 PCs in 1996, promoted ***Sampo, Eizo,*** and ***Daewoo*** monitors, and let its own-brand ***Timeline*** take a back seat.

Eizo's long-time exclusive monitor distributor in Italy, ***Epson,*** also appeared to be moving from strength to strength and showed off, among other products, the latest ***Eizo*** range of high-end monitors. ***Athena,*** also into making PCs, advertised its "Athena Vision" monitors. Although its 17-in. model still comes from ***Hyundai,*** the 14- and 15-in. models are now sourced from ***Compal.***

Not to be outdone, the smaller local PC assemblers were also selling monitors. ***ASEM*** had a "new" range of own-branded 14-, 15-, and 17-in. 64-kHz monitors. ***DMD*** sells ***Philips*** models. On the ***Lemon (Jen Electronics)*** stand, monitors were being promoted almost as heavily as the PCs. In yet another hall, ***Modo*** was making itself known as the Italian outlet for ***Pacific Media***'s "Art Media" Trinitron®-tubed monitors.

In an effort to stay competitive on the international market, Italy's largest PC house, ***Olivetti,*** was found to have completely revamped its monitor range. ***Olivetti*** no longer provides a monochrome monitor, or even an "entry-level" 38-kHz 14-in. model! Its range now starts with a 50-kHz 14-in. screen for 530,000 Lire (US$340), and peaks with a 107-kHz 21-in. model. One of ***Olivetti***'s 17-in. models even uses a 0.25-mm-pixel-pitch Diamondtron® tube and will run 1280 × 1024 at a flicker-free 75 Hz. In addition, Italy's second-largest PC maker ***Olidata,*** no longer produces any "down-market" monitors, although its market is firmly in Italy.

So What Did We See?

Well, not the sea, but almost everything else, it seemed. Even the prototype for ***IBM***'s $700 network computer was at SMAU. (The good news is that this reduced-functionality device still needs a monitor!) SMAU proved again to be just the right show for getting a comprehensive flavor of how the year has progressed in Europe, with more than a hint of what to expect in the year to come. The next SMAU is scheduled for October 2–6, 1997. ■

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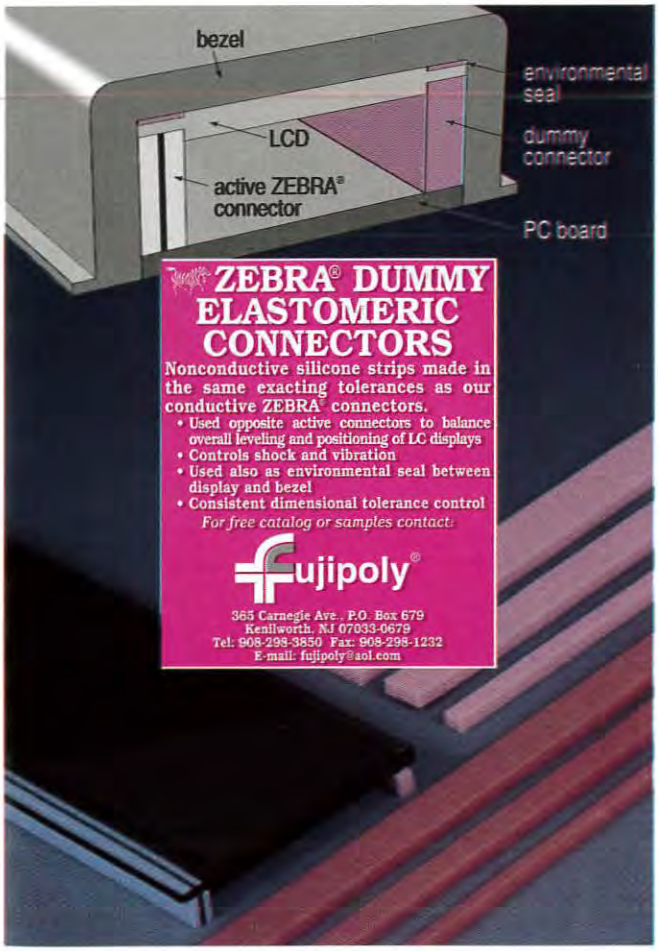

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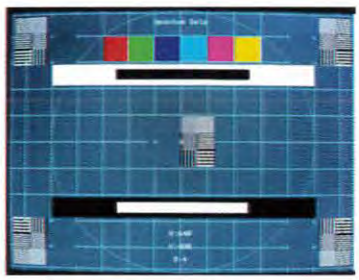

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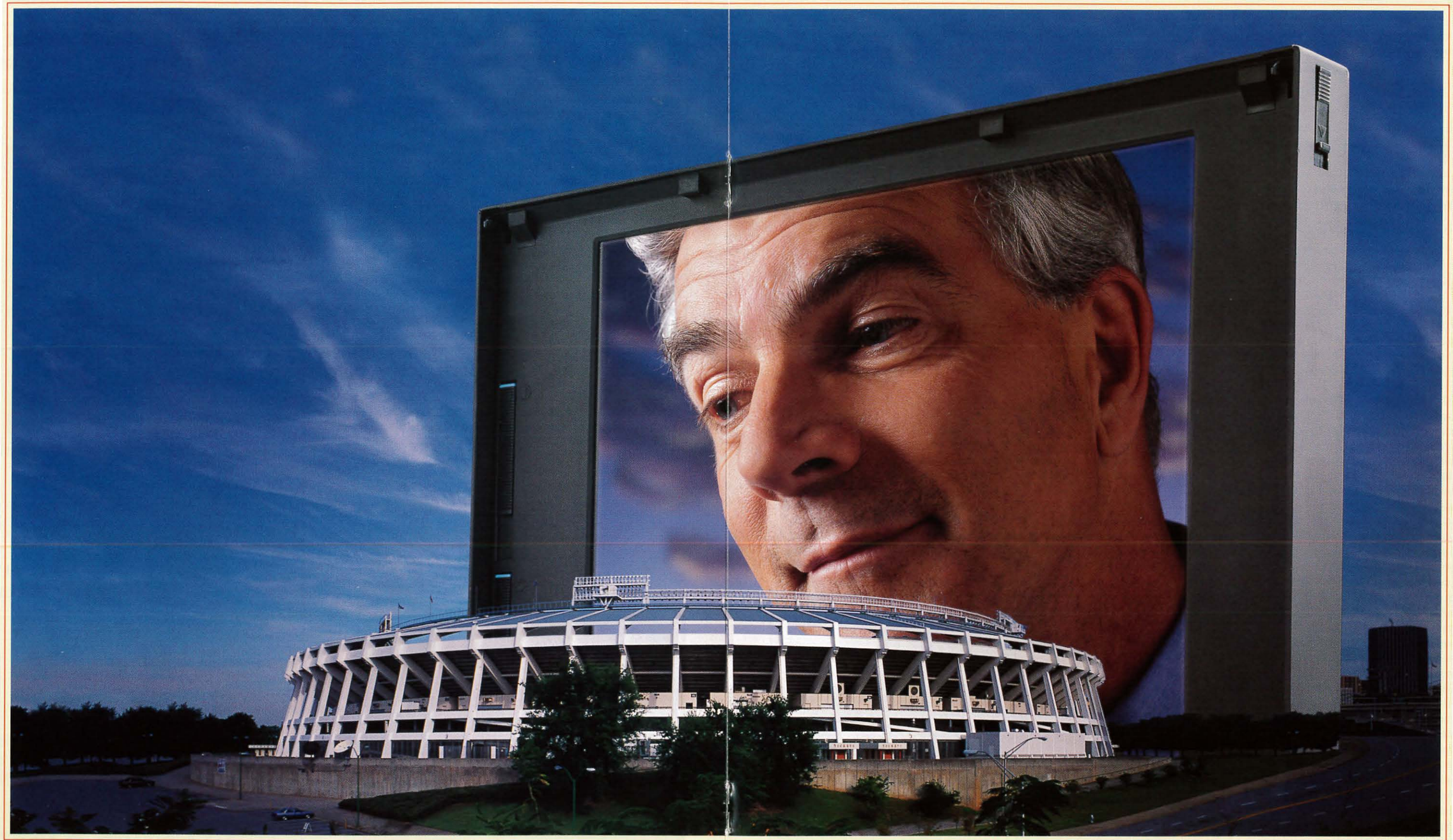

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conference report

The Lisbon Seminar

Following EuroDisplay, an intimate LCD seminar with a regional mission attracted an international delegation and well-known invited speakers.

by Ken Werner

NOT COINCIDENTALLY, the Second Ibero-American Seminar on Liquid Crystal Display Technology (II Seminário Iberoamericano em Tecnologia de Mostradores de Cristal Líquido) began on the Monday immediately following EID and EuroDisplay in Costa da Caparica, Portugal, just outside of Lisbon. "The Lisbon seminar," as the conference has become known, met from October 7–9, 1996.

The seminar is sponsored by the liquid-crystal section of the Ibero-American Program for Science and Technology for Development – Programa Iberoamericano de Ciencia y Tecnologia para el Desarrollo, or CYTED – one of four "thematic networks" in the microelectronics sub-program. The other 15 CYTED sub-programs cover areas ranging from aquaculture to R&D management.

In an introductory presentation, Carlos Mammana, Director of the Microelectronics Institute at the Fundação Centro Tecnológico par Informática (CTI) in Campinas, Brazil, explained that CYTED is a multinational program comprised of the 21 countries from Mexico in the north to Argentina and Chile in the south. It is intended to

- Help modernize production and improve the quality of life in the Ibero-American countries.
- Provide a bridge for cooperation between Latin America, Europe, North America, and other countries outside the region.
- Promote cooperation in the fields of applied research and technological development to obtain results transferrable to the production systems and social policies of the Ibero-American countries.

In the following presentation, Alaide Pellegrini Mammana – also of CTI in Campinas, and Coordinator of the LCD Thematic Network – said the specific objectives of the network included developing an understanding of the limitations and opportunities of LCD technology; disseminating knowledge and information concerning LCD technology; identifying the available competencies in universities, R&D centers, and companies in the region; promoting joint projects; and fostering the introduction of LCD technology in products of the regional electronics industry.

In support of these goals, the Lisbon seminar had a strong tutorial component, particularly in the papers invited from some well-known international contributors. Martin Schadt (ROLIC, Ltd., Basel, Switzerland) led off the technical program with "Liquid Crys-

Ken Werner

The Second Ibero-American Seminar on Liquid Crystal Display Technology was held in the modern Hotel Costa da Caparica (background) in Costa da Caparica, Portugal, overlooking a beach shared by pleasure seekers and traditional wooden fishing boats.

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

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Ken Werner

Fishermen used tractors to drag their traditional wooden boats over the beach opposite the conference hotel. The upswept bows are more than decorative. The boats are launched directly into the surf, where the bow design ensures that they ride up over the surf instead of being swamped by it.

tals: Status and Perspectives." Schadt reviewed the properties of nematic liquid-crystal materials that determine the operability of displays. He then presented the recent results demonstrating that large cell-gap ferroelectric displays are feasible, and discussed the recent LCD-projection concept in which all of the functional elements consist of liquid crystals.

In "Electro-Optics of Liquid-Crystal Displays," José Otón (Polytechnic University of Madrid, Madrid, Spain) reviewed the electro-optic characteristics of today's commercial displays, and went on to describe the alternative electro-optic approaches that are attracting substantial attention: scattering control in liquid-crystal dispersions, variable birefringence in ECB and ferroelectric materials, and selective absorption in dye-doped Heilmeier and dichroic LCDs.

In "Reflective LCDs: Technology, Status, and Applications," Bill Doane (Kent Displays) said the "ideal reflective display should afford the reader the clarity and pleasurable ease of reading ink on paper." He compared the various reflective technologies and their characteristics, spending the most time on cholesteric LCDs (Ch-LCDs) because of this technology's bistability, switching characteristics, and ability to reflect color.

Ernst Lueder (University of Stuttgart, Stuttgart, Germany) in "New Developments for Active-Matrix LCDs" discussed a variety of AMLCD innovations: a four-mask process for a-Si TFTs; novel pixel layouts that produce very high aperture ratios; recrystallized ITO with low sheet resistance; one-shot laser annealing for producing homogeneous poly-Si TFTs over large areas; economical top-electrode MIM structures with high aperture ratios; and PDLC displays driven with low-temperature-process MIMs that make displays on plastic substrates feasible.

In "Ferro- and Anti-Ferroelectric Liquid Crystals: Materials, Displays, and Devices," Dirk Kilian and his colleagues (Technische Hochschule, Darmstadt, Germany) outlined the properties of ferro- and anti-ferroelectric LC - high optical modulation, fast electro-optical response, low driving voltage, low power consumption, and large-area capability - that now make them attractive for a variety of applications, including displays.

Ken Werner of *Information Display Magazine* (Norwalk, Connecticut) provided a broad view of the status of commercial displays and near-commercial display technologies in "Flat Panel Displays: Status and Perspectives." The presentation included many slides of displays exhibited at the SID Symposium in San Diego and EID in Birmingham. The presentation concluded with a section discussing business opportunities for companies that do not have the equivalent of a billion U.S. dollars to invest in technology development and building a high-volume AMLCD-manufacturing facility.

Ernst Lueder returned to the podium with "The Schemes and ICs for the Addressing of Flat-Panel Liquid-Crystal Displays," which discussed the methods for addressing LCDs with TFTs and MIMs, along with schemes for the compensation of parasitic capacitive couplings. From there, he went on to discuss the IC requirements for addressing the rows and columns of displays in formats ranging from VGA to EWS and HDTV, and to discuss suitable ICs that are commercially available.

A second presentation by Martin Schadt, "Photo-Alignment and Photo-Patterning of Liquid Crystals," discussed the advantages of replacing mechanical rubbing for the alignment of liquid-crystal molecules in TN and STN displays with photopolymerization techniques. Photo-aligning allows the economical creation of multi-domain pixels for dramatically improved viewing angle, and also permits the generation of optically patterned optical retarders and polarization interference filters on single substrates.

Shigeo Mikoshiba (University of Electro-Communications, Tokyo, Japan) prepared the presentation "Plasma Display Technology: Status and Perspectives." (The presentation was delivered by Ken Werner because Prof. Mikoshiba was in a Tokyo hospital with a flare-up of a chronic back problem.) After a long gestation period, color plasma displays from several manufacturers will be commercially available in late 1996/early 1997. The presentation described current PDP designs, along with associated display characteristics and limitations. Large investments in PDP technology are intended to increase the size of commercial PDPs to at least 55 in. on the diagonal, lower the price to $40 per diagonal inch, improve resolution to EWS/HDTV levels, double the maximum luminance to 700 cd/m^2, increase luminous efficiency to 2 lm/W, reduce power consumption and drive voltage, and develop high-voltage ICs. Many

conference report

of these improvements will be implemented over the next 5 years, but the luminance and luminous-efficiency goals may take up to 15 years because they depend, at least in part, on improving the quantum efficiency of the ignited plasma. PDPs, says Mikoshiba, are likely to complement LCDs rather than compete with them directly.

Altamiro Suzim (Federal University of the Rio Grande do Sul, Porto Alegre, Brazil) presented the paper "Architecture of LCD Drivers." Suzim viewed these drivers as intelligent controllers that format and present information through an LCD, and concluded with a consideration of the best partitioning of controller functions within an IC or chip set, along with two architectural options: master-slave and modular.

In "Novel Display Effects in Spin-Coated Films of Liquid-Crystalline Polymers," Kent Skarp (Chalmers University of Technology, Goteborg, Sweden) discussed the characteristics of liquid-crystalline polymers and how they can be precisely and broadly tailored by adjusting both the backbone and side-chain structures. Skarp's laboratory has prepared films that exhibit ferroelectricity, antiferroelectricity, pyroelectricity, piezoelectricity, and dichroic color-switching capabilities. He described his lab's recent development of a method for spin-coating smectic films of 1–10-μm thickness. Annealing produces a well-aligned homeotropic polymer film that exhibits electroclinic and ferroelectric switching. Applications of the technology include thin-film displays, sensors, active optical gratings, and smart coatings for military uses. Skarp showed a video demonstrating some of the optical effects in spin-coated films. In conversation, he cheerfully commented on how much fun it is to make a display with a total processing time of a minute. Skarp's laboratory is currently looking for partners to help commercialize the technology.

Rodrigo Martins, who, with Manuela Vieira, coordinated the seminar, spoke on materials and processes for the deposition of thin films. Later, Martins guided a tour around his large, well-equipped laboratory complex at Cemop/Uninova in Campinas, where various thin-film devices are fabricated for both research purposes and low-volume customers.

The formal presentations were supplemented by a lively poster session dominated by papers on liquid-crystal materials. Materials poster papers came from institutions such as the University of Barcelona, Samsung Display Devices, the University of Havana, the University of São Paulo, Napier University, E.T.S.I. Telecomunicación, the State University of Londrina, University of Sussex, National University of Córdoba, the Technical University of Munich, the Bulgarian Academy of Sciences, and Cemop/Uninova, among many others.

In addition, there was a paper on a low-cost cell-filling system from E.T.S.I. Telecomunicación; a paper on an LCD for a neurostimulator by Joaquin Remolina (CINVESTAV, Mexico City, Mexico); a paper on polysilicon TFTs from the University of Rennes; a paper on bright twin guest-host LCDs from the Spanish LCD manufacturer Dicryl (in conjunction with E.T.S.I.); and a clever paper from P. Datta and a team from E.T.S.I. and the Public University of Navarra (Pamplona, Spain) on using the optical coupling between two unclad optical fibers embedded in a liquid-crystal cell to measure the optical state of the cell. This information can then be used for the closed-loop control of the cell to compensate for environmental factors such as ambient light and temperature.

To the great pleasure of the organizers, 103 attendees from 17 countries participated in the seminar. Papers were delivered in English, Portuguese, and Spanish, but the primary language of communication was English. Next year's seminar will be held in either Brazil or Argentina.

There is a unique flavor to these seminars. The emphasis is on appropriate and practical technology – often pursued with sharply limited resources. Not infrequently, this seems to have stimulated the ingenuity of the developers and given rise to inventive approaches that could have broad applicability. Perhaps these characteristics – along with the enthusiasm of the organizers and the sense of participating in a true scientific community – contribute to the seminars having won the support of some leading figures in the display world. ■

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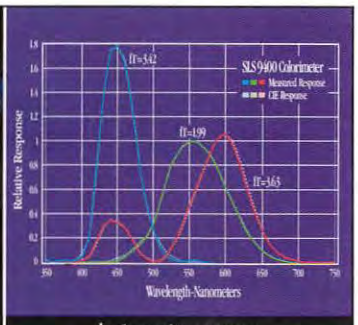

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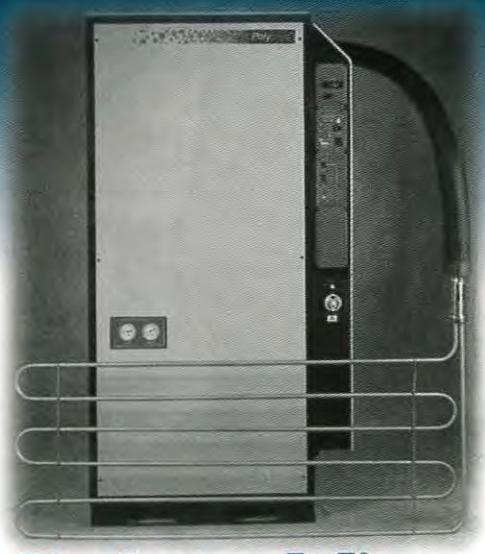

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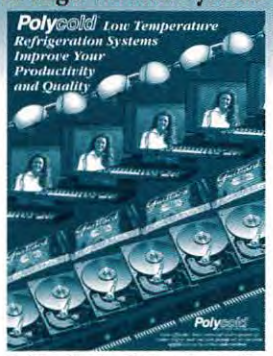

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Circle no. 19

In Conjunction with EuroDisplay, EID Does Even Better

A show with many displays that are made elsewhere also celebrates British skill at display customization and systems integration.

by Bryan Norris

THIS YEAR, the annual Electronic Information Displays (EID) Exhibition moved from south London to the National Exhibition Centre near Birmingham, to be held in conjunction with the Society for Information Display's (SID's) prestigious triennial EuroDisplay Conference.

EID is a relatively small but highly focused displays exhibition that concentrates on state-of-the-art flat-panel-display (FPD) products and niche industrial CRT monitors. The show proved its worth yet again. From October 1–3, 1996, EID provided a forum for about 70 companies to demonstrate and promote their products to 1661 mostly professional visitors – up 13% over 1995. Many of the exhibitors were U.K. distributors with products bearing world-famous names. Thus, an additional 166 firms were represented on the exhibitors' stands.

FPD Desktop Monitors and ...

A number of the LCD panels seen at last year's EID appeared this year incorporated into desktop monitors. Attracting a great deal of attention on the ***Hitachi*** stand were three of

Bryan Norris *is the Senior Partner and founder of Bryan Norris Associates, Consultants in Electronics, 7 Biddenham Turn, Biddenham, Bedford MK40 4AT, U.K.; telephone +44-(0)-1234-26-7988, fax: +44-(0)-1234-26-2345; e-mail: bnorris@kbnet.co.uk. Before establishing Bryan Norris Associates, he created and managed the Monitor Information Program at BIS Strategic Decisions. He is a contributing editor to* Information Display Magazine.

Microvitec

Fig. 1: *At EID, Microvitec launched its Proteus 31S 12.1-in. SVGA color LCD monitor retailing at £1299 (US$1950).*

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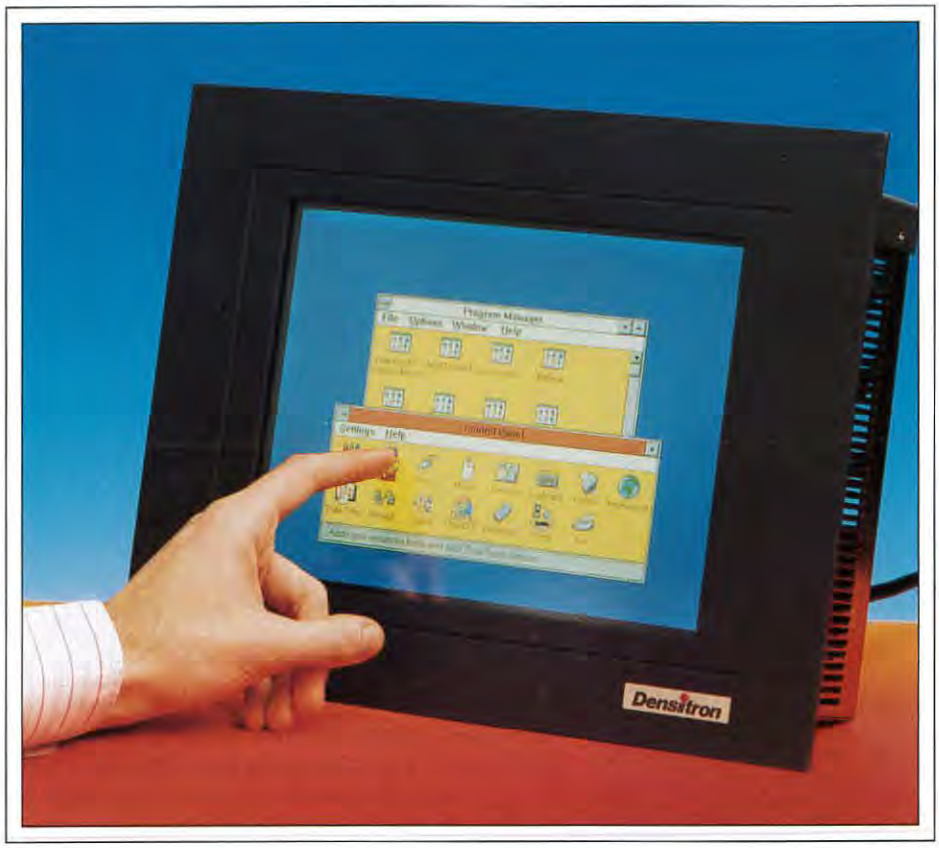

Densitron

Fig. 2: *The touch screen acts as both keyboard and mouse in Densitron's industrial and clean-room PC with 12.1-in. SVGA LCD.*

Microvitec's soon-to-be-released 34-cm (13.3-in.) XGA (1024 × 768) desktop LCD monitors. These formed the centerpiece of a very impressive ***Syntegra*** "concept" dealer-room layout that was linked "live" to the London Stock Exchange. The ***Microvitec*** monitors employ ***Hitachi***'s 13.3-in. wide-viewing-angle (140°) super-TFT panels, and were shown in British Telecom colors (***Syntegra*** being the systems-integration business of ***BT***). On its own stand, ***Microvitec*** was displaying its newly launched Proteus 31S 12.1-in. SVGA 256k-color LCD desktop unit retailing at £1299 (US$1950) (Fig. 1), and the established Proteus 26V 10.4-in. VGA monitor in both conventional cabinet and industrial version. (The price of this unit dropped to £799 (US$1200) during the show.) All of the desktop LCD monitors made by ***Microvitec*** use its driver card, which allows just-plug-in-to-PC-and-run. (Many of the modern LCD monitors are fitted with an integral driver card that takes standard VGA/SVGA/XGA analog signals as input and converts them to 24-bit-color digital data using three 8-bit A/D converters. This enables the monitor to be simply plugged into, and completely controlled by, the PC.)

Other LCD monitors at the show included ***CTX***'s now-familiar and extensive (9.4- to 12.1-in.) "Panaview" range on the ***Kent Modular Electronics (KME)*** and ***Kestronics*** stands, and ***iiyama***'s forthcoming 35-cm (13.8-in.) XGA model displayed among the graphics and video/MPEG cards on the ***Imagine Graphics*** stand. ***Datalux*** showed its U.S.-made LMV10 10.4-in. AMLCD monitor, which is VGA-compatible and directly connectable to the VGA port on any PC. With a price of £1100 (US$1650) and a thickness of only 1.36 in., the monitor is intended for industrial use, and features a rugged sealed housing, four mounting positions, and touch-screen options.

Densitron chose a 12.1-in. SVGA (or, optionally, XGA) panel from its extensive selection of industrial LCD modules to form the key part of its latest DT59 industrial/clean-room 486/586 PC, in which the touch screen acts as both keyboard and mouse (Fig. 2). ***Digital View***'s extensive desktop-LCD-monitor portfolio extended from £450 (US$675) STN VGA color and monochrome models to interactive information/multimedia touch-screen kiosks with full video support employing 13.8-in. TFT-LCD panels and costing around £8000 (US$12,000).

Emco was again showing its sunlight-readable LCD 8.4- and 10.4-in. VGA monitors. The 8.4-in. model has a brightness of 5800 cd/m^2 at 100 hours and 4660 cd/m^2 at 10,000 hours and is now used in automatic-teller machines (ATMs) from NCR and Wells Fargo, among others.

IBM's 16.1-in. TFT-LCD monitor was incorporated in an "added-value" ruggedized casing on the ***Racal*** stand, while ***Trident*** launched the new "Halo" 16.1-in. monitor from ***IBM*** that runs from an 18-V dc power supply, accepts a VGA or SXGA (1280 × 1024) input directly from the PC, and has a one-off price of about £5700 (US$8850). The ***Trident***-supplied ***IBM*** 16.1-in. panel is being retrofitted by ***GEC-Marconi*** into a display console on HMS *Edinburgh,* a Royal Navy type-42 destroyer. As the display unit is only 400 × 333 × 44 mm (15.7 × 13.1 × 1.7 in.), it saves valuable space on the destroyer (Fig. 3). ***Trident***'s catalog also includes some smaller-screen-sized ***IBM*** LCD monitors, including the soon-to-be-released "Sofia" 12.1-in. SVGA and VGA 16.7-million-color model, which costs £1350 (US$2025).

The ***Lucas/Deeco*** SealTouch® (touch-screen) 10.4-in. rugged aluminum-cased LCD monitor was to be seen among the large variety of displays on the ***Review Display Systems (RDS)*** stand. The completely sealed Deeco ST4230 is designed to be used in applications ranging from harsh industrial environments such as steel mills to particle-free clean rooms.

Industrial LCD monitors were also on offer from some small, traditional industrial CRT-monitor makers and suppliers, notably ***KME, Calibre, Densitron, Sascal,*** and ***Sabre***.

Another "show-stopper" was the ***NEC*** 20-in. LCD monitor – 16.7 million colors and wide viewing angle – being shown for the first time in Europe on the ***Sunrise Electronics*** stand. Production samples of both the panel and monitor are promised for May 1997.

Trident

Fig. 3: The Trident-supplied IBM 16.1-in. AMLCD panel is being retrofitted by GEC-Marconi into a display console on HMS Edinburgh, *a Royal Navy type-42 destroyer.*

The number of readily available LCD panels well suited to desktop monitors has increased dramatically. ***Computer Dynamics, Inc.***'s new displays are specifically designed for OEMs and systems integrators, particularly for use in military, industrial, process, and machine-control applications. Featured this year on the ***Dicoll Electronics*** stand were two of ***CD***'s 13.8-in. TFT panels with 45° viewing angles and 256k-color compatibility – one with VGA resolution and the other with XGA resolution – along with a 12.1-in. XGA unit with similar specifications. The "Ultra-HiBrite" range (6.4-, 8.4-, and 10.4-in.; VGA; and 256k color) has new panel backlighting that gives up to four times the luminance of normal TFT displays and three times that of CRTs, according to the manufacturer.

To its 5.1- and 5.8-in. thin-film-diode (TFD) LCD panels, ***FPD*** now has added an 11.3-in. 256k-color LCD that is fitted with a backlight having a claimed 40,000-hour lifetime. All of ***FPD***'s units, which were shown on U.K. distributor ***Farnell Mercator***'s stand, are suitable for use outdoors and in harsh industrial and automotive environments.

In addition to its Super-TFT 13.3-in. LCD module, ***Hitachi*** was promoting its 12.1- and 15.5-in. XGA STN modules as ideal for monitor applications. Both were fitted with long-life field-replaceable CFL backlight tubes.

The ***LG Electronics (Goldstar)*** TFT-LCD panel range, seen on the ***Anders Electronics*** and ***Craft Data*** stands, now includes a 256k-color SVGA 12.1-in. panel in addition to a wide range of 10.4-in. SVGA and VGA units with wide viewing angles. ***LG*** also provides 9.5-in. VGA 512-color panels. The ***Kyocera*** range of STN panels, from 8.5- to 14.2-in. VGA and SVGA models, was also on the ***Craft Data*** stand.

Samsung's new lightweight (500 g) low-power low-profile TFT-LCD VGA 262k-color panel was exhibited on the ***Selectronic*** stand along with other ***Samsung*** products and a selection of VFDs and PDPs.

Three-Five Systems exhibited its TN-, STN-, FSTN-, and DSTN-LC panels. ***Three-Five*** claims to operate the largest-capacity – 100 14 × 16-in. sheets per hour – LCD manufacturing line in North America, but its high-volume module assembly is completed in the "cost-effective" Philippines.

AMLCD panels designed primarily for military and industrial applications and ranging from a 5-in. square unit to a new 11 × 8-in. model were found to be on offer from an unexpected source: ***Planar,*** the electroluminescent-panel maker. A full range of ***Planar***'s latest EL panels could be seen on the ***Manhattan Skyline*** and ***RDS*** stands. ***Planar***'s VGA 10.4-in. EL monitors are now available in monochrome with 16 gray levels or multicolor – eight different hues of red, green, and yellow. ***Planar***'s EL displays are now used in the passenger-information-system units located in the boarding vestibules of Germany's high-speed Inter City Express trains. Canadian ***Westaim*** introduced to Europe its ac-driven thick-dielectric electroluminescent (TDEL) panels. Products of 4.2 × 3.4 in. are now being made in a small pre-production facility.

The highlight of the plasma exhibits was the prototype 42-in. 16:9 plasma monitor on the ***Hantarex UK*** stand (Fig. 4). This unit, which is based on Fujitsu's panel, is built for Hantarex by ***Sambers*** of Milan, has its own neat built-in power supply, and is planned to be available commercially by the second quarter of 1997. Desktop and wall-hung PDP units were also to be seen in the ***Hantarex*** and ***Densitron*** booths. ***Thomson Electronics***

Ken Werner

Fig. 4: *The highlight of the plasma exhibits, shown on the Hantarex UK stand, was the prototype 42-in. 16:9 plasma monitor based on Fujitsu's panel.*

Components, in its booth, introduced 19- and 24-in. color PDPs with resolutions up to 1280 × 1024.

The French company ***PixTech*** had its first commercial monochrome field-emission-display (FED) products on show, as well as prototypes of its full-color 5.2- and 6-in. rack-mount-ready panels, versions of which will be available in 1997.

Industrial CRT monitors

Calibre, as well as selling ***Aydin*** monitors, offers a versatile range of bespoke industrial monitors mostly based on ***Microvitec*** rack-mount, frame, and metal-case units. ***Clinton Electronics Corporation*** – the U.S. manufacturer of an extensive range of monochrome tubes from 3 to 23 in. – introduced to Europe its new set of high-resolution (up to 2048 × 1536), 31–105-kHz microprocessor-controlled monitors. These have 19-in. standard-radius, 20-in. flat-profile, or 21-in. flat-square tubes, and still have a niche market in applications such as document management.

Hantarex Ltd., a leading supplier of large-screen (21-, 25-, 28-, and 34-in.) monitors for passenger and information-display applications, showed its new range of monitors, which now extends to a 42-in. model. Many employ RS-232 control and offer full remote control of all screen adjustments. The "videowall" monitor demonstrations featured new 21- and 34-in. models. ***Hantarex***'s new RP42IDTV 42-in. videowall cube monitor accepts VGA and SVGA sources, as well as composite video/PAL/SECAM/NTSC/SVHS and RGB signals, has scan-doubling circuitry to give flicker-free images, and costs around £6000 (US$9000).

The ***Delta/Vivatek*** liquid-crystal color shutter (LCCS) technology applied to a 10-in. monochrome monitor was shown off to good effect on the ***Kestronics*** stand. A clever but simple demonstration involved moving a frame containing the shutter in front of and away from the monochrome screen, thus showing clearly how the extra-fine monochrome definition is transferred to color. The LCCS technology gives excellent image quality with no misconvergence, moiré pattern, or degaussing need. It has high (>100:1) contrast, good color uniformity and saturation, and sharp and clear text – even with small fonts. (For more information on this technology, see the Computex Taipei report in the October 1996 issue of *Information Display.*)

The 20-year-old U.K. industrial monitor maker ***KME*** unveiled a ruggedized black-metal-cased 30–64-kHz 17-in. monitor and a 21-in. chassis monitor that is also designed for scanning frequencies up to 64 kHz. ***KME***'s core products – open-frame and metal-cased color and monochrome CRT monitors from 5 to 17 in. – include models employing the rare 13V FS tube.

Microvitec had added a new 17-in. metal-frame 15–64-kHz monitor to its extensive series of industrial and dealer-room models. Also on the stand was a military-style round 23-in. high-definition monochrome CRT air-traffic-control monitor, which ***Microvitec*** showed to promote further market interest.

PD Systems' second generation of "colour-master" information-display monitors now consists of three models, including a 32-in. 16:9 model with 30–38-kHz horizontal scan frequencies and 1120 pixels horizontally.

Sascal, a small U.K. producer of 10-, 14-, 17-, and 20-in. monitors with 15–45-kHz scan frequencies – primarily for military use – now also offers 29-in. models with high frequency (15–80 kHz) or very high frequency (64–96 kHz), allowing resolutions up to 2048 × 1536.

The Italian monitor maker ***Selti***'s range of industrial, mostly open-frame, 10-, 12-, 14-, and 28-in. monitors were to be seen on the ***Sabre*** stand. ***Sabre***'s own-brand "Pygmy" 10-in. VGA/SVGA monitors are made by a Taiwanese supplier. Since this supplier is ***Samsung Tubes***' second-largest 10-in. CRT customer, ***Sabre*** has been able to secure a guaranteed supply of this now-in-demand tube.

Finally, no display show nowadays would be complete without a demonstration of ***Texas Instruments***' ubiquitous digital micromirror device (DMD). One-, two-, or three-chip DMD engines are now employed in projection display systems from ***ASK*** and ***Davis*** (Norway), ***Electrohome, In Focus, nView, Liesegang*** (Germany), ***Proxima, Runco, Sony, Vidikron*** (Italy), and ***Digital Projection*** (U.K.). ***Digital Projection*** was the only ***Rank Brimar*** high-technology hardware company not sold and made part of the newly named Brimar group – an announcement made at EID. As this article is being written, there are reports of ***Rank Brimar*** putting ***Digital Projection*** up for sale despite the successful development of its high-end DMD-based projector. ■

SID Conference Calendar

Next Show!

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  - Applications and LC Technology
  - CRTs and Emissive Displays
  - Applied Vision, Human Factors, Display Measurement, and Hardcopy/Imaging Systems
  - Large-Area Displays and Display Systems
- The Seminar Program will once again draw on industry leaders for three days dedicated to short courses, technology overviews, and display applications.
- Over 200 vendors will demonstrate the latest in displays, components, and equipment.
- Evening Panel Discussions, an Exhibitor Reception, a Conference Luncheon, and an evening Social Event will complement the technical program.

11 MAY 97

SID '97

BOSTON, MASSACHUSETTS
MAY 11 – 16, 1997

- SID's MAJOR ANNUAL EVENT
- An International Symposium, Seminar, and Exhibition – Featuring:
  - Technical Sessions – Poster Session
  - Author Interviews – Evening Panels
  - Short Courses – Applications Seminars
  - Technical Seminars – Applications Sessions
  - Product Exhibits.

15 SEPTEMBER 97

17th International Display Research Conference

TORONTO, CANADA
SEPTEMBER 15 – 17, 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 16 – 19, 1997

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

For additional information:
Lauren Kinsey
Society for Information Display
1526 Brookhollow Drive
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- **Computers** - laptop LCD backlighting, plus replacement lamps & accessories
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- **Machine Vision** - aperture lamps plus special phosphors
- **Medical Instruments** - scanning & illumination lamps
- **Copiers** - aperture & reflector lamps

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Circle no. 20

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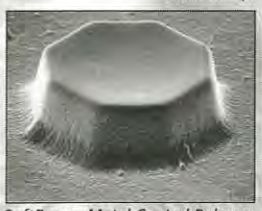
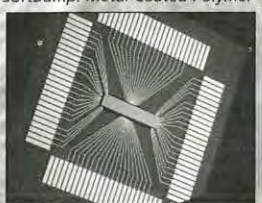


SoftBump: Metal Coated Polymer



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Circle no. 21

FPD MANUFACTURING PROGRAM STATUS (Fall 1996)

To date, USDC's Technical Council has selected 36 priority programs covering various areas of process technology used in manufacturing FPDs. These include programs for establishing a U.S.-based supply of equipment, materials, or process technology, using existing technical know-how, as well as both evolutionary and revolutionary technology advancements. Twenty-four of these programs have been brought under contract and development has begun. The others are in various stages as summarized below.

Topic/Contractor	Program Cost ($M)	USDC ß-site	Status	Current Milestone
Color filters *Rohm & Haas, Shipley Co., Clarkson University*	1.8	Several	Development under way; 9/1/94 start	Contract completion; phase III extension decision 9/96
Color filter fabrication			Canceled	
Pre-assembly test & inspection *Photon Dynamics*	2.4	dpiX	Development under way; 3/23/94 start	ß-site testing initiated 10/96
Treated substrates *Applied Films Corp.*	2.5	Several	Contract completed 7/96	Commercial supply in place
Polymer coating *Candescent, FAS Technologies*	2.7	Planar	Development under way; 7/12/94 start	β-site delivery 10/96
Dry etching *Lam Research, Lawrence Livermore National Labs, University of Wisconsin*	15.1	dpiX	Development under way; 6/20/94 start	Contract completion 1/97
Glass supply *TBA*			On hold	
Glass inspection *Display Inspection Systems*	1.4	OIS	Development under way; 6/11/94 start	β-site delivery & factory integration 11/96
Automated interconnect *Anorad*	4.4	Planar	Development under way; 10/28/95 start	Initial servoglide testing completed 11/96
Spacer application & cleaning *Accudyne*	1.7	Standish, Photonics, Candescent	Development under way; 6/13/94 start	β-site testing initiated 9/96
Handling (benchmarking) *Competitive Strategies*	0.2	N/A	Study completed 10/1/94	Final report issued 3/95
Handling (cassette design) *Progressive System Technologies, H-Square*	0.7	Several	Development under way; 7/10/95 start	Deliver prototype and extraction tools 12/96
Handling (tracking) *PRI Automation, Florod*	2.5	Candescent	Development under way; 7/7/95 start	Define new laser source 11/96
Factory modeling *IDC*	1.1	Candescent	Development under way; 2/9/96 start	β-site evaluations (LCD & FED) begin 11/96
Handling (storage & retrieval) *PRI Automation*	1.6	Candescent	Development under way; 5/13/96 start	50% design review 10/96
Handling (manually guided transporer/loader) *PST*	0.35	Candescent	Development under way; 6/1/96 start	First prototype fabrication 10/96
Large-area lithography *Tamarack Scientific*	2.1	Photonics Imaging	Development under way; 3/1/95 start	Installation at β-site 2/97
Large-area mask fabrication and blanks			Contract negotiation	Contract signing 12/96
Direct laser imaging			Contract negotiation	Contract signing
Wet processing (etching) *CFM Technologies*	4.1	dpiX	Development under way; 2/12/96 start	Systems control and software design 2/97
Polarizers, UV & retardation films *Polaroid*	10.9	Several	Development under way; 3/1/95 start	K-polarizer samples from production equipment 12/96
Literature translation & database management *InterLingua*	0.4	N/A	Development under way; 2/15/96	Identify additional documents

Topic/Contractor	Program Cost (SM)	USDC ß-site	Status	Current Milestone
Backlighting				
SAIT/BHK	4.5	Several	Development under way; 10/25/95 start	Demonstrate 500-unit/month capacity 10/96
Flat Candle	0.2	Several	Development under way; 12/15/95 start	Delivery of prototype lamps 10/96
Hughes Power Products	1.8	Several	Development under way; 4/1/96 start	Demonstration of concept 12/96
Glass cutting			RFP preparation for rebidding	Issued in 1997
Driver infrastructure				
Driver chips *Supertex*	1.1	Several	Development under way; 9/5/96 start	Mask tooling completed 2/97
High-voltage TAB *Supertex*	0.4	Several	Development under way; 9/5/96 start	Handler development and fabrication 3/97
Dielectric isolation wafers *Supertex, Bondtronix*	0.9	Planar	Development under way; 9/5/96 start	Procure manufacturing equipment 12/96
ac/dc converters/inverters			Project canceled	
Plastic substrates	3.5	Several	Contract negotiation	Expected program start 9/96
Reactive ion etching *Plasma-Therm*	4.8	FED	Development under way; 7/3/95 start	Adapt modified control software 6/97
High-resolution pattern lithography			Contract negotiation	Contract signing
LC processing and alignment			Proposal selection	Proposal approval 11/96
Large-area vacuum sealing			Proposal evaluation	Proposal selection 11/96
Inorganic planarization layers			RFP preparation	Issued in 1996
Patterned glass plate inspection & repair			Proposal evaluation	Proposal selection 11/96
Thin-film vacuum coating			RFP development	
Cleaning technology			RFP development	
Glass sealing materials			RFP development	
FED getters and activation			RFP development	

Source: USDC News, Vol. III, No. 4, Fall 1996

continued from page 4

movie being front-projected onto the approximately fifty-inch screen, ***I couldn't see the scan lines!*** The picture was in a wide-screen format and looked about the quality of mediocre 35mm film. My thoughts raced roughly along the following path, "Oh my gosh, where did they get the HDTV projector? And if it is HDTV, where did they get the source material? And if so, what kind of player are they using? And how could I have missed the availability of this equipment to the consumer market?"

At warp speed, I got myself up close and intimate with the screen to check out the image details. "Wow! It's good but it's not HDTV. OK, then what is it?" The only thing I could come up with on short notice was the possibility that these guys were using a line-doubler, like one I had recently seen at Infocomm in Philadelphia. After additional examination and admiration of the quality of the wide-screen projected image - those scan lines really are hard to see - I noticed a studious-looking gentleman sitting off to one side, engrossed in an electronics text illuminated by a minuscule reading lamp. It seemed a good guess that maybe he would be able to tell me something about this system. Sure enough, he told me they were indeed using a line-doubler. Further discussion led to a quick appreciation of common technical interests and an invite to go visit the home-theater integrator's shop to get into more of the technical details of what they were doing - and also to get a better overview of the home-theater business.

And what an interesting and eye-opening visit it turned out to be! While the politicians, business types, and technologists have been fighting over standards and spectrum allocations for HDTV, a whole new industry has sprung up with hardly any fanfare at all. And while everyone is concerned about the cost of implementing HDTV, home-theater systems costing well over $50,000 are being installed, albeit in relatively small numbers.

My discussions with ***David Herbig*** of ***AVA Northwest*** began with a look through several catalogs of home-theater *room* designs. There are now several companies that specialize in doing just the room interiors - no electronics. The rooms are like miniature theaters with red velvet seats (or other colors if you wish), heavy electrically operated drapes in matching colors for the screen area, theater-style columns with dimmable lighting, and entrance foyers with "ticket booths" and custom-made neon signs. Popcorn machines and other such necessary amenities are also available. The cost for a typical room interior is in the $25,000 to $35,000 range. If you would like the personalized entrance lobby, it's an additional $5,000 to $10,000. The feel of these rooms is similar to what I would imagine the

major film studios and wealthy movie stars have always had. I had to admit that the ambiance was every bit as nice as that of the fanciest movie theaters and provided an environment where one could truly escape from reality, should that be one's objective. Would I like to have one? Sure. Could I afford one? No!

Thus, just the "container" for our video system has so far set us back on the order of $60,000. (Remember, we also had to build the dedicated room at about one hundred dollars per square foot for typical U.S.A. home-construction costs.) So, what should we install into this plush container to make it worth the investment?

This question led me to another eye-opener. Once the typical semi-wealthy customer has become "comfortable" with this level of investment, the price of the video and audio system can go way beyond what we three-hundred-dollar television-set buyers are willing to consider. The total for a laser-disk player, front-projector, screen, line-doubler, plus other necessary video-signal processing gear can easily run the package up to and over $20,000. And then, "Oh by the way, you did want audio too, didn't you?" An "acceptable" quality surround-sound system will come in just shy of $10,000. And to think I just spent my last weekend trying to decide between a $200 and $400 CD player.

Obviously, not everyone is able or willing to go for the full-package deal. Some folks will decide that perhaps an existing family room or bonus room can be converted into a media room. Others may opt for a more modest decorator package. Nevertheless, the existence of these upper-end products tends to set a level of acceptance for a higher level of spending, particularly if the investment can be made as part of the home-construction package and paid for out of the typical thirty-year mortgage - which never gets paid off anyway. Never mind that the electronics will be obsolete in less than five years. At least they are not being irretrievably hard-wired into the house.

So where is all this leading us? Well, I don't think it's particularly good news for HDTV. After all these years, ***line-doubler and line-quadrupler technologies are finally bringing out the full capabilities of the NTSC signal*** - capabilities of which most of us were unaware. The intelligent and real-time processing of that signal can now provide a picture that, while not quite as good as HDTV, looks much better than conventional interlace-scanned TV. The result, even at this stage of technology development, is a very nice display for large-screen applications that is mostly unaffected by compression or processing artifacts. Costs for line-doubler and line-quadrupler technology should drop dramatically from today's $3,000 to $15,000 into the under-hundred-dollar range once the

demand is there for volume production. Conventional front-projection, rear-projection, and even larger-screen direct-view television sets will benefit from implementation of this technology.

The availability of laser-disk players, which already provide programs in wide-screen formats, have for all practical purposes resolved the controversy over which is the best wide-screen picture format.

The imminent introduction of DVD (Digital Video Disk) may also influence the acceptance of one standard or another. But here again, it seems that HDTV is not in the best position to win out. From what I have been able to learn, the image quality of DVD is going to be about the same as laser disk, at least in the first-generation products. And since playing time is always an important consideration, the greater amount of information that must be stored per frame in the HDTV format becomes a significant impediment.

Did we technologists overshoot when we picked the standards for HDTV? Did we really need to select a level of performance that was *better* than 35mm film? And thereby did we make the implementation challenges so difficult that the HDTV standard may become overwhelmed by more modest but easier-to-implement technologies?

While we are pondering all this, the world is moving ahead. The home-theater concept is becoming a reality. More and more businesses are springing up to serve customers with products that are appealing to this specialized but growing market segment. During this year's "Street of Dreams" event in Seattle, several hundred thousand people were exposed to these home-theater demonstrations, while not one of them had the opportunity to see HDTV.

Finally, an increasing amount of program material is becoming available on laser disk and could really proliferate when DVD becomes available. How will HDTV be able to overcome this infrastructure, the installed base of existing equipment, and the availability of program material? And if so, when?

If ever there was a "Display Continuum" column that could benefit from reader responses, this one has to be it. The answers to the questions I have posed will have a huge impact on what we display technologists get to work on in the next ten to twenty years. If we can understand and interpret the technological, economic, political, and sociological forces and how they are exerting their influence, we may be able to arrive at some reasonably accurate answers about our future. So, here's my offer. If you communicate your thoughts to me, I will share them with other colleagues and then try to integrate them into a holistic picture of the future. And all this I will do in this column. What a deal!

You can reach me by phone at 206/557-8850 or by fax at 206/557-8983 or you can contact me through Jay Morreale at Palisades Institute, 201 Varick Street, Suite 1006, New York, NY 10014. ■

Edited by JOAN GORMAN

General News

Cooperation agreement between USDC and EDIRAK

The United States Display Consortium (USDC), San Jose, California, and the Electronic Display Industrial Research Association of Korea (EDIRAK) have signed a Memorandum of Understanding (MOU) that will facilitate cooperation between the two flat-panel-display organizations. The agreement was signed on October 8, 1996, in Seoul, Korea, during a trade mission sponsored by USDC. The MOU calls for the establishment of industry standards and a strong manufacturing infrastructure to be addressed at semi-yearly industry sessions. The agreement also sets up working groups to examine cooperative research into emissive and non-emissive FPD technology. The new MOU is expected to encourage formalized consultation between member companies of the two organizations.

Company News

CELCO acquires DISCOM's deflection-yoke line

CELCO, Mahwah, New Jersey, a leader in state-of-the-art special-purpose CRT deflection-yoke manufacturing, has announced the completion of its acquisition of DISCOM, Inc.'s CRT deflection-yoke and related-components line. This acquisition will allow CELCO to provide continuing service and products to DISCOM's customers.

For further information, contact Art Weirgin, CELCO's yoke-engineering sales manager at 201/327-1123, fax 201/327-7047.

New company provides holographic lithography

Holographic Lithography Systems (HLS), Inc., Bedford, Massachusetts, announced the formation of their company on September 11, 1996. HLS has developed a manufacturing tool and process, the HLS System 1000, intended for use in the production of field-emission displays (FEDs). The system enables FED manufacturers to effectively utilize holographic lithography, a technology capable of producing sub-half-micron emitter holes and tips, in a high-throughput production-environment process featuring large-field high-resolution patterning. HLS is currently in the process of investigating other applications for this new technology within the semiconductor and LCD industries. For further information, contact Dan Sullivan at 617/276-4060, fax 617/276-4074.

Driver chip design and packaging contract to Supertex

The United States Display Consortium (USDC), San Jose, California, has awarded a multi program contract to Supertex, Inc., Sunnyvale, California, for driver-chip design and packaging. Under the terms of the agreement, USDC will provide $1.2 million, matching the $1.2 million being provided by Supertex, to establish a fast-turn operation for the design, prototyping, and fabrication of specialty driver chips; to reduce the cost and size of these chips by fabrication on silicon-on-insulator (SOI) substrates; and to advance packaging capability from plastic-leaded chip carriers to TAB for size reduction.

LCD backlight technology contract to Hughes Power Products

The United States Display Consortium (USDC), San Jose, California, has awarded Hughes Power Products (HPP), Inc., El Segundo, California, a contract to develop high-performance backlights. Under the terms of the agreement, USDC will provide $881,000 as a match to the $950,000 being provided by HPP to implement this R&D program. HPP's approach affords the opportunity for much greater efficiency in the utilization of available light and, from a systems point of view, can reduce the number of components required to provide the illumination function, thereby favorably impacting unit cost. The project includes the development of prototype hardware as well as software modeling tools to more efficiently optimize the technology.

Philips to replace diodes with TFTs

Philips FPD, Eindhoven, The Netherlands, has announced that, over the course of the year, the company intends to replace diode technology with TFT technology in its production of flat-panel displays based on active-matrix LCDs. The transfer to TFT technology will be supported by the Hosiden and Philips Display Corp., a new joint venture established in October 1996. Philips FPD's sales activities in Europe and the U.S. will remain unchanged, and Philips Research will continue to support the development of AMLCDs. The continuity of deliveries to existing customers will be protected as much as possible by the gradual changeover to TFT technology.

Eaton Semiconductor forms flat-panel equipment group

Eaton Semiconductor Equipment Operations, Beverly, Massachusetts, announced the formation of Eaton Flat Panel Equipment, a group dedicated to the development, manufacture and marketing of products specifically designed for the flat-panel manufacturing industry. The new group will apply Eaton's ion-implantation technology to provide a cost-effective alternative to existing flat-panel manufacturing processes. ■

continued from page 2

Association, as saying, "... we will still have separate worlds - a TV world and a computer world." But, he said, "Frankly, I think the [newly digital] TV industry will be a bigger threat to the computer world than vice versa."

These items give rise to some metatechnological musings:

1. It is the user's experience that counts, not the display technology. Samsung is attempting to create a more intense experience for game-system users by combining an old-hat TV with the kind of sound system now common on "multimedia" PCs. The company may not have guessed right about there being a sizable market niche here, but its focus on the user's experience is right on.

2. As PC and TV technologies (in some sense) converge, we must remember Samsung's "video-game TV" and focus on the user. The ideal Internet computer may well be an integrated digital version of WebTV™ and not a traditional computer at all. And that may be the case even if the WebTV™ lives on your desk or in your briefcase instead of in the living room.

With TV manufacturers intent on implementing all 18 of the Grand Alliance formats (even though the PC manufacturers will not), sufficient resolution for e-mail, graphics, and applet-based word processing and spreadsheet analysis on a relatively small screen - or a large one - should be no problem at all. Put that together with the fact that computers have become too complex and too expensive (in terms of life-cycle costs) for many users, and it is not difficult to see substantial opportunities for consumer-electronics companies - and their display suppliers. Of course, the PC folks are not going to sit still. The result is likely to be a breakdown of cherished product-category paradigms. I look forward to an exciting period in which innovative product designers will redefine the very meaning of "personal computer" and "television set," and display makers will have to keep up.

3. People, organizations, and governments do not always act "rationally," at least not as engineers and business planners understand the word. "French rationalism" - although famous, admirable, and of long standing - is dominant only on alternate Thursdays. The rest of the time it competes with, and is often vanquished by, French nationalism. (This is not necessarily bad. Those of us who love France do not love it because the entire population walks around quoting Descartes.)

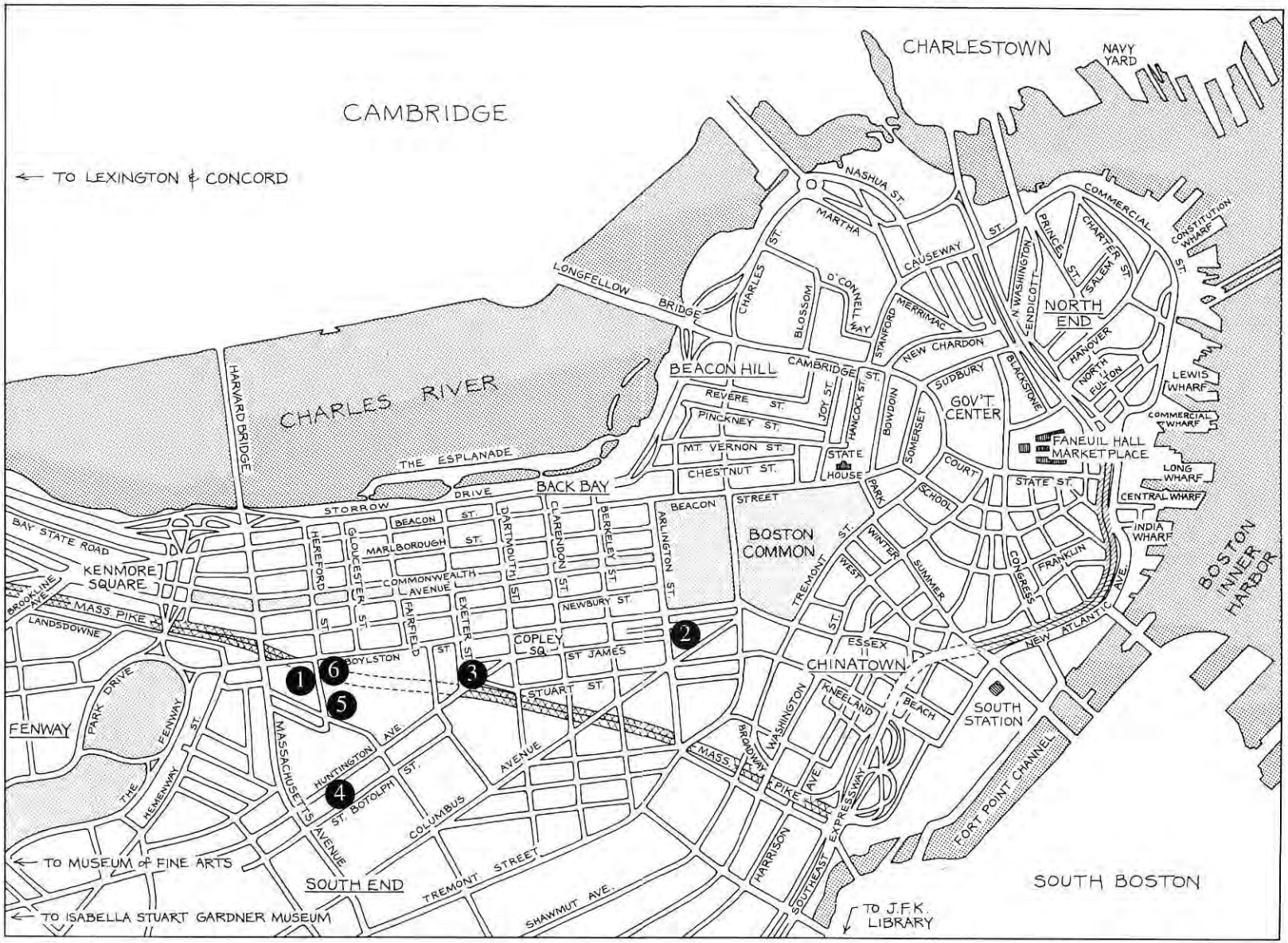
Is there a concise synthesis for my holiday potpourri of ads and articles? Perhaps there is. First, the user's experience is paramount. And the user's experience is what the user experiences: not what I think he or she *should* experience. The experience will be determined as much by the user's individual, cultural, and political background as by the display technology.

Similarly, the actions of your business partners are determined by culture and politics, as well as by the expected business considerations. Ask Soon Hoon Bae, who did not get the Christmas present he was expecting.

- Ken Werner

Convention Center and Convention Hotel Map List

1. Back Bay Hilton
2. Boston Park Plaza Hotel & Towers
3. Copley Square Hotel
4. MidTown Hotel
5. Sheraton Boston Hotel & Towers
6. **John B. Hynes Convention Center**



SID '97

May 11–16, 1997 Boston Massachusetts

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sustaining members

Acer Peripherals
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Advance Reproductions Corp.
AlliedSignal, Inc./
MicroOptic Devices
Arconium
Brewer Science, Inc.
Brimar Ltd.
Canon, Inc.
Capetronic Computer USA (HK), Inc.
Celco
Cherry Electrical Products
Chunghwa Picture Tubes, Ltd.
Clinton Electronics Corp.
Corning Inc.
Corning Japan K.K.
Dale Electronics, Inc.
David Sarnoff Research Center
Diagnostic/Retrieval Systems, Inc.
Display Inspection Systems
Display Laboratories
DNP Denmark
dpiX, A Xerox Company
Electronic Designs, Inc.
Electro-Plasma, Inc.
Endicott Research Group, Inc.
Epson America
FED Corp.
F-P Electronics
Flat Panel Display Co. (FPD) B.V.
Futaba Corp.
Gerome Manufacturing
GE Plastics Japan Ltd.
Graseby Optronics
Grimes Aerospace Company
Hewlett-Packard Co.
Hitachi, Ltd.
F. Hoffmann-La Roche
Honeywell, Inc.
Hoya Corporation USA
Hughes Lexington
IBM Corp.
Imaging & Sensing Technology
Incom, Inc.
Industrial Electronic Engineers, Inc.
Industrial Technology Research Institute
In Focus Systems, Inc.
Infodex, Inc.
Innotec Group, Inc.
Interface Products, Inc.
Interserv Corp.
Interstate Electronics Corp.
ISE Electronics Corp.
Kent Display Systems
Libbey-Owens-Ford Co.
Linfinity Microelectronics
Litton Systems Canada Ltd. (2)
Loral Librascope
Man & Machine, Inc.
Micron Display Technology, Inc.
Micronic Laser Systems AB
Microvision Corp.
Minolta Corp.
Minolta Hong Kong Ltd.
Mitsubishi Electronics America
Motif, Inc.
MRS Technology, Inc.
NEC Corp., Japan
Nippon Seiki Co., Ltd.
Norden Systems Westinghouse
OIS Optical Imaging Systems, Inc.
OKI Electric Industry Co., Ltd.
Optical Coating Lab., Inc.
Photonics Systems, Inc.
Photo Research
Photronics, Inc.
Pilkington Micronics Ltd.
Planar Systems, Inc.
Plasmaco, Inc.
Polytronix, Inc.
Progressive Systems Technology, Inc.
Q.C. Optics, Inc.
Quantum Data Inc.
Raytheon Company
Regisbrook Group, Ltd.
Rockwell International
ROLIC Liquid Crystals R&D Co.
Schott Corp.
Semiconductor Systems, Inc.
Sharp Corp. - Japan
SI Diamond Technology
Sony Corp. of America
Sony Corp./Corporate Research Labs
Standish Industries, Inc.
Stanford Resources, Inc.
Steag MicroTech, Inc.
Supertex, Inc.
Syntronic Instruments, Inc.
Tamarack Scientific Co., Inc.
TEAM Systems
Techneglas, Inc.
Teledyne Electronic Technologies
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Palisades Institute for Research Services, Inc.
201 Varick Street, Suite 1006
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Jay Morreale, Managing Editor
212/620-3371 Fax: 212/620-3379

Sales Office
Palisades Institute for Research Services, Inc.
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- Single analog dimming control input, 0 to 2.5 volts
- Logic controlled sleep mode

Part No.	V_{IN}	V_{LAMP}	I_{DLAMP}	Efficiency
LXM1596	7.0V - 30V	240 - 600V_{rms}	Up to 7mA	90%
LXM1597	4.5V - 6.5V	240 - 600V_{rms}	Up to 7mA	90%
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*OEM model, customizable electronics and form factor

- Patent pending CS-ZVS technology provides high-efficiency and low noise
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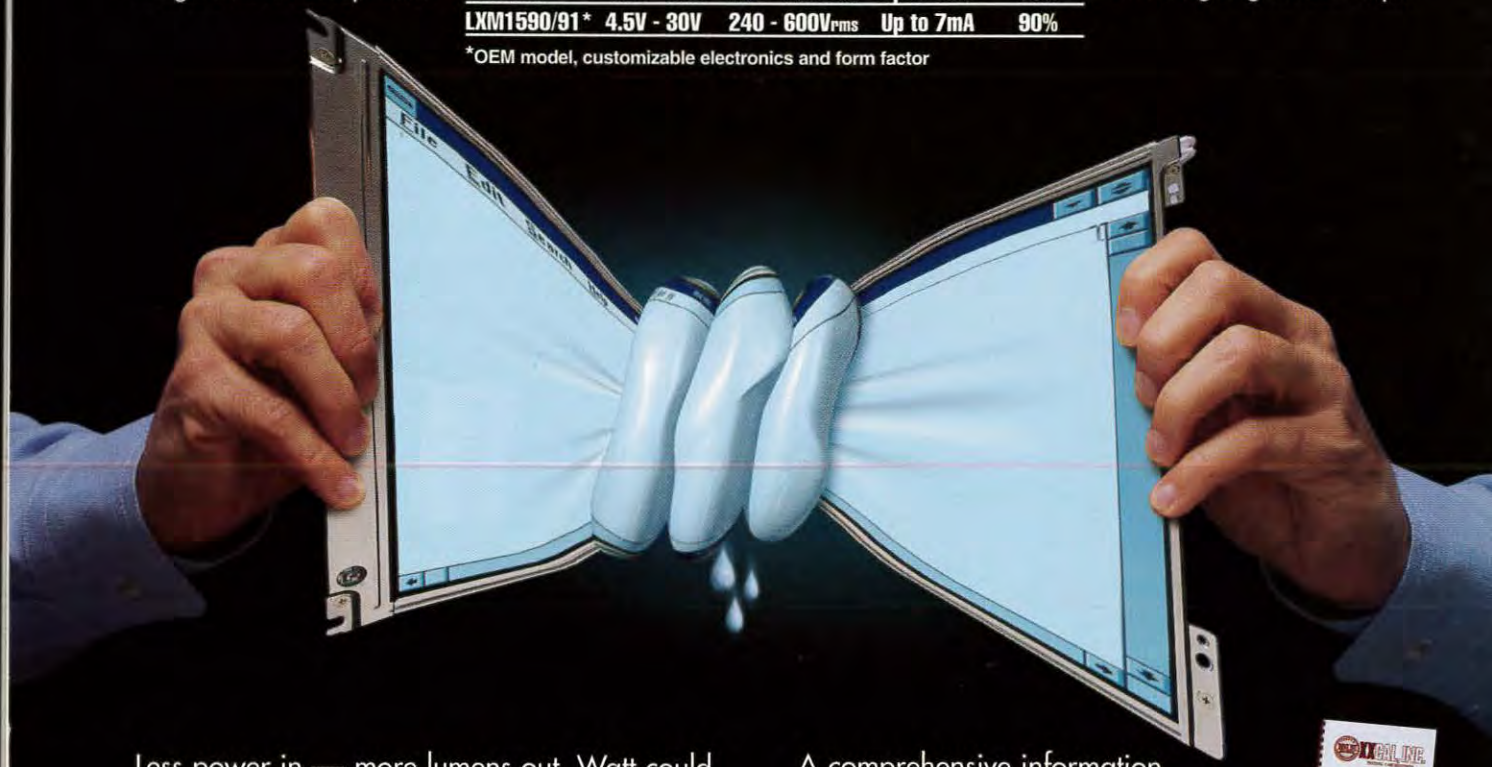

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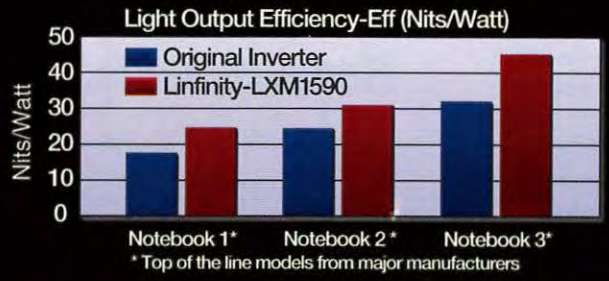

* Top of the line models from major manufacturers

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