SID 2000 SHOW ISSUE

Information DISPLAY

SID

April/May 2000
Vol. 16, No. 4/5

Official Monthly Publication of the Society for Information Display

Large Poly-Si TFT-LCDs Now Available to OEMs

- *SID 2000 Products on Display*
- *FED Life and Reliability*
- *Low-Temp Poly-Si TFT-LCDs*
- *Military Integration of a COTS AMLCD*
- *IDW and SMAU Reports*

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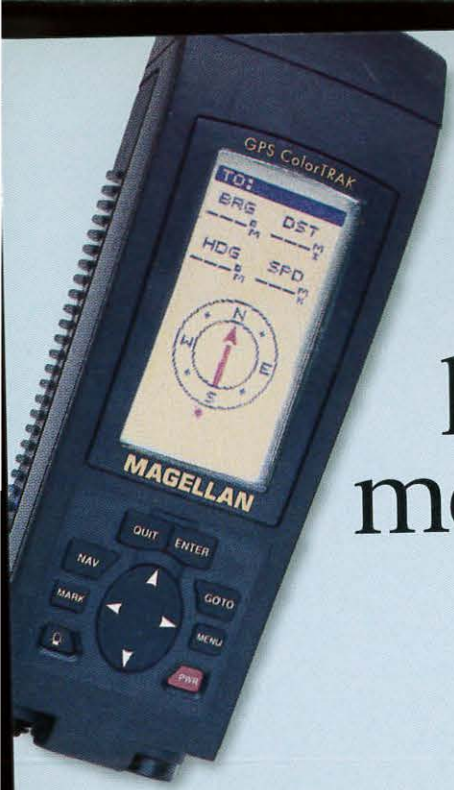

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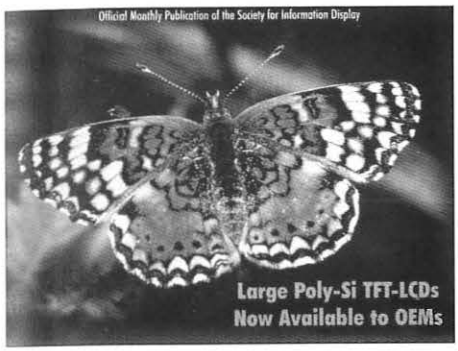
COVER: This Toshiba 6.3-in. XGA low-temperature-polysilicon (LTPS) TFT-LCD – with a pixel density of 202 pixels/in. – is displaying a photographic image of a Monarch butterfly. The photo is not a composite and has not been retouched.



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Next Month in *Information Display*

CRT Issue
- Using FEAs as CRT Cathodes
- Printable Large-Area FEDs
- Displays and Computer Entertainment
- Image-Quality Metrics
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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., 411 Lafayette Street, 2nd Floor, New York, NY 10003; Leonard H. Klein, President and CEO. EDITORIAL AND BUSINESS OFFICES: Jay Morreale, Managing Editor, Palisades Institute for Research Services, Inc., 411 Lafayette Street, 2nd Floor, New York, NY 10003; telephone 212/460-9700. Send manuscripts to the attention of the Editor, ID. Director of Sales: Michele Klein, Palisades Institute for Research Services, Inc., 411 Lafayette Street, 2nd Floor, New York, NY 10003; 212/460-9700. SID HEADQUARTERS, for correspondence on subscriptions and membership: Society for Information Display, 31 East Julian Street, San Jose, CA 95112; telephone 408/977-1013, fax -1531. SUBSCRIPTIONS: Information Display is distributed without charge to those qualified and to SID members as a benefit of membership (annual dues $75.00). Subscriptions to others: U.S. & Canada: $36.00 one year, $7.50 single copy; elsewhere: $72.00 one year, $7.50 single copy. PRINTED by Sheridan Printing Company, Alpha, NJ 08865. Third-class postage paid at Easton, PA.

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editorial

The Next Big Thing

We are once again on the brink of a new SID International Symposium. While assessing the international display industry is a year-round activity, the SID International Symposium – being held this year May 14–19 in Long Beach, California – offers a unique opportunity to take the industry's pulse, view current technology, and get more than a small peak into the future. (For a preview, please see "Products on Display at SID 2000" in this issue.)

But what kind of broad-brush speculations can we make about the future of display technology before the abundance of papers and hardware at SID 2000 draws us too deeply into the concrete and specific. Such speculation is worthwhile because, if we look only at specifics, we will only spot "the next big thing" after it is speeding toward us like one of Nolan Ryan's fastballs. But if we step back, we may at least be able to predict which side of the rubber the ball will come from.

First, we have a pretty good idea of what displays look like: there are emissive and non-emissive direct-view flat panels, there are CRTs for direct view and projection, and there are transmissive and reflective imagers for front and rear projectors. The last two big flat-panel "things" were FEDs and OLEDs.

A FED is essentially a thin CRT with a more-or-less flat cold cathode. It was made possible by an excellent understanding of the physics of field emission and the development of precision processing to create the cathode. The bloom, at least temporarily, is off the FED rose because rapidly falling AMLCD prices invalidated initial business models and because life and reliability issues raised their ugly heads when attempts were made to scale-up manufacturing (but see the article in this issue documenting impressive life and reliability improvements).

OLEDs are the current big flat-panel thing because organic phosphors promise high efficiency along with economical fabrication of large displays, and the technology is enjoying extremely rapid development. The pace of the development is being limited (to this still-rapid rate) by the need to develop and characterize better OLED materials and the need to develop active-matrix driving schemes for large panels that are not too power-hungry.

The enabler for FEDs was the ability to process Spindt tips for the cathodes. The impediment was making the transition from R&D to mass production. The enablers for OLEDs were materials development and easy processing. Materials and processes: one or both are almost certain to be at the heart of the next big thing, at least if flat panels are involved.

FEDs and OLEDs were both based on partially new electro-optical mechanisms. But there are other ways to blaze interesting new pathways. LCoS microdisplays and polysilicon TFT-LCDs are both LCDs. Materials and processing are essential to both, but what makes these approaches particularly interesting is that they embody new approaches to system partitioning and packaging.

Alien Technology, as reported previously in *ID*, is working on a scheme to fabricate pixel switches in single-crystal-silicon chips molded in NanoBlocks™, which would be floated in a suspending liquid for deposition into matching

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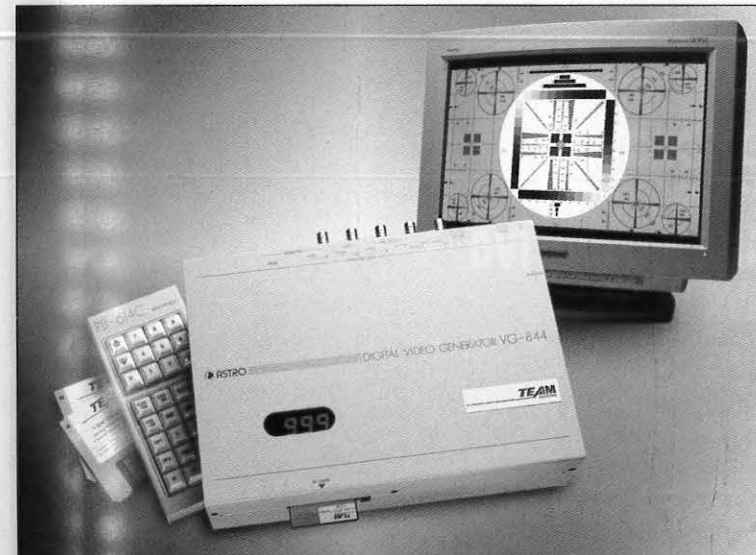

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a view from the hill

There's Something New and Different Here ...

by Aris Silzars

Perhaps some of you will remember that six years ago you elected me to be the Secretary of SID. Then, four years ago, you decided that I should become your Treasurer. Two years later, the nominating committee asked, I agreed, and you concurred that I should be the next President-Elect. Finally, one year ago, you were asked to re-confirm your earlier decision that starting in May 2000 I would, in fact, get the opportunity to serve as your President.

It is now May 2000 and I have been told that the time has come for me to act more "Presidential" – hinting, I suppose, that the column I have been writing in this space for the last seven and one-half years wasn't quite presidential enough. So we have decided that I will continue to do a monthly column, but with an emphasis on those people, management, and technology issues that can contribute to the increased effectiveness of SID and to enhancing the building of those relationships that provide value to all of us as members of this society. Can I do this and still keep the column interesting? There's only one way to find out. Let's begin.

To get you into the proper frame of mind for what is likely to come over the next year or two in these new-style columns, let us open the discussion by considering why the functioning of groups such as the SID is going to be of ever-growing worldwide importance in the 21st century. You may wish to view this as creating the vision for a "grand cathedral" that we intend to build.

Since the days of cave dwellers, control of land and natural resources has been the primary path to growth and survival. Those who controlled the most territory, had the greatest abundance of critical materials, and could most effectively exploit the people inhabiting their fiefdoms were the most powerful and richest. It was only in the last few centuries of the second millennium that a few groups of people found they could do even better if everyone participated in and shared more equitably in the creation of wealth. However, these people groupings were associated with certain land masses with well-defined borders – called countries, kingdoms, or states – and they continue to be.

Toward the end of the second millennium, some of the wiser countries realized that such government-imposed boundaries were an unnecessary impediment to economic growth. They took a bold step and removed the border-control points and began to allow for the free movement of people and goods. Some others had to overcome more difficult challenges because their barriers had been so severe. Yet, in spite of that, they made great strides in learning how to become more comfortable as "citizens of the world." A few laggards continued in their stubborn and old-fashioned ways of tightly controlling the activities of their inhabitants and even trying to expand their influence by the use of military force.

In the meantime (about one hundred and sixty years ago), we technologists gave birth to electronic communications. First there was the telegraph, then the telephone, then radio, and then television. Worldwide communications grew from radio, to transoceanic telephone cables, to communications satellites, to long-distance fiber-optic links. Then came computers, the Internet, the World

continued on page 92

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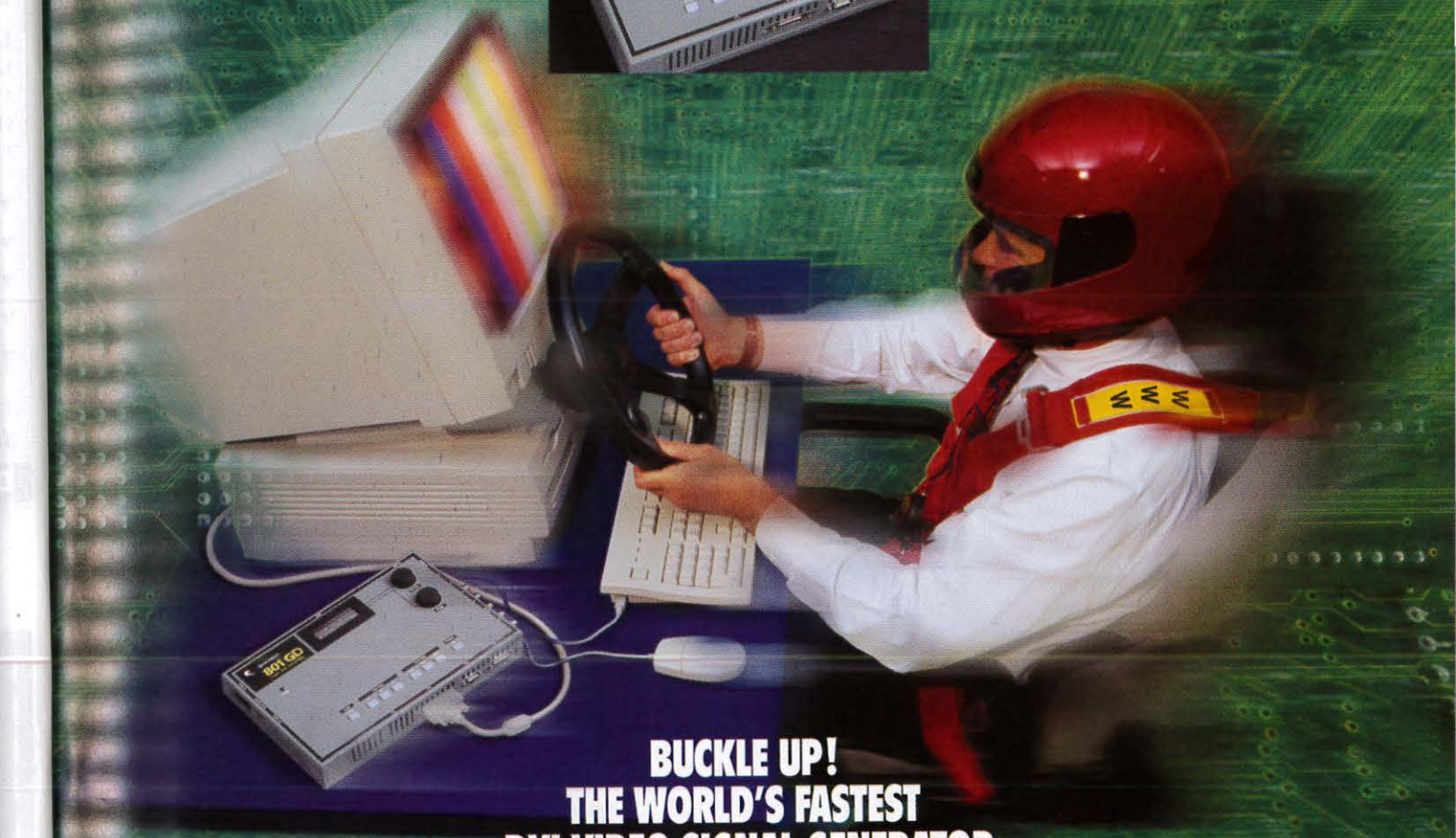

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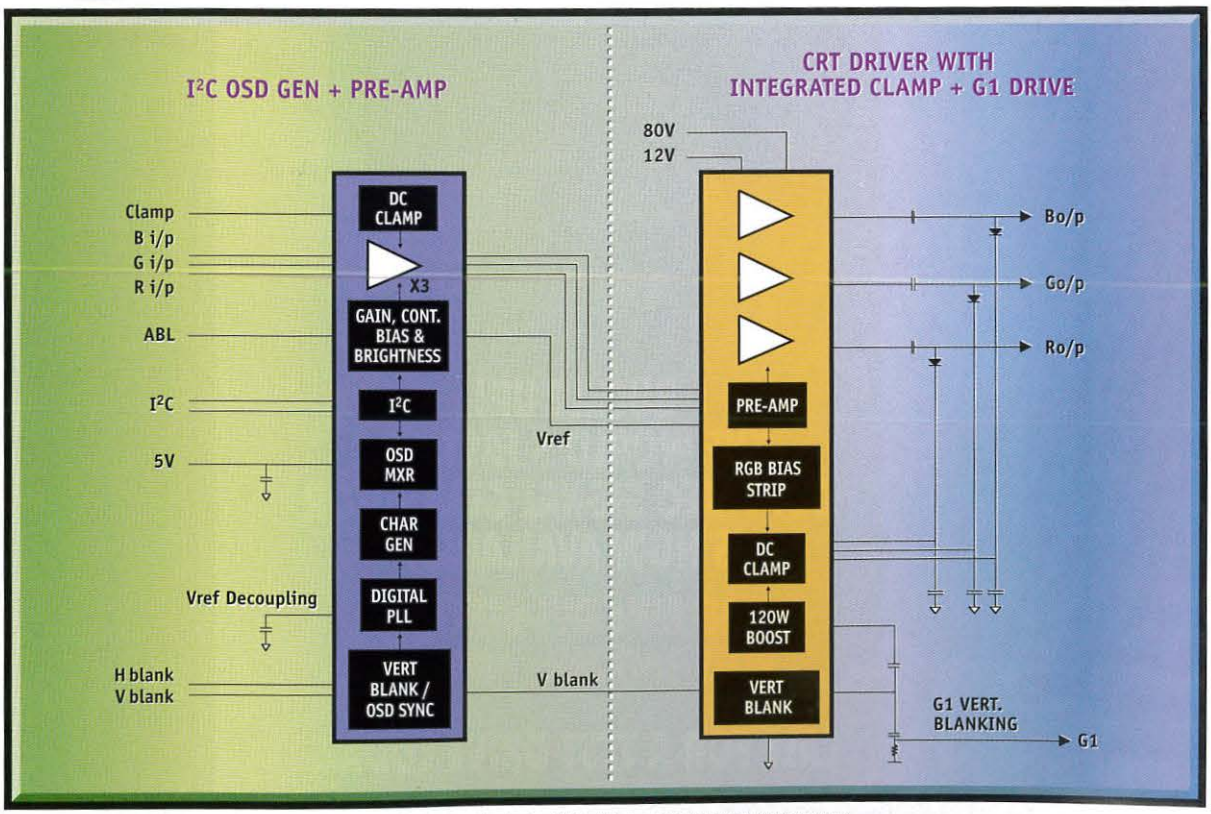

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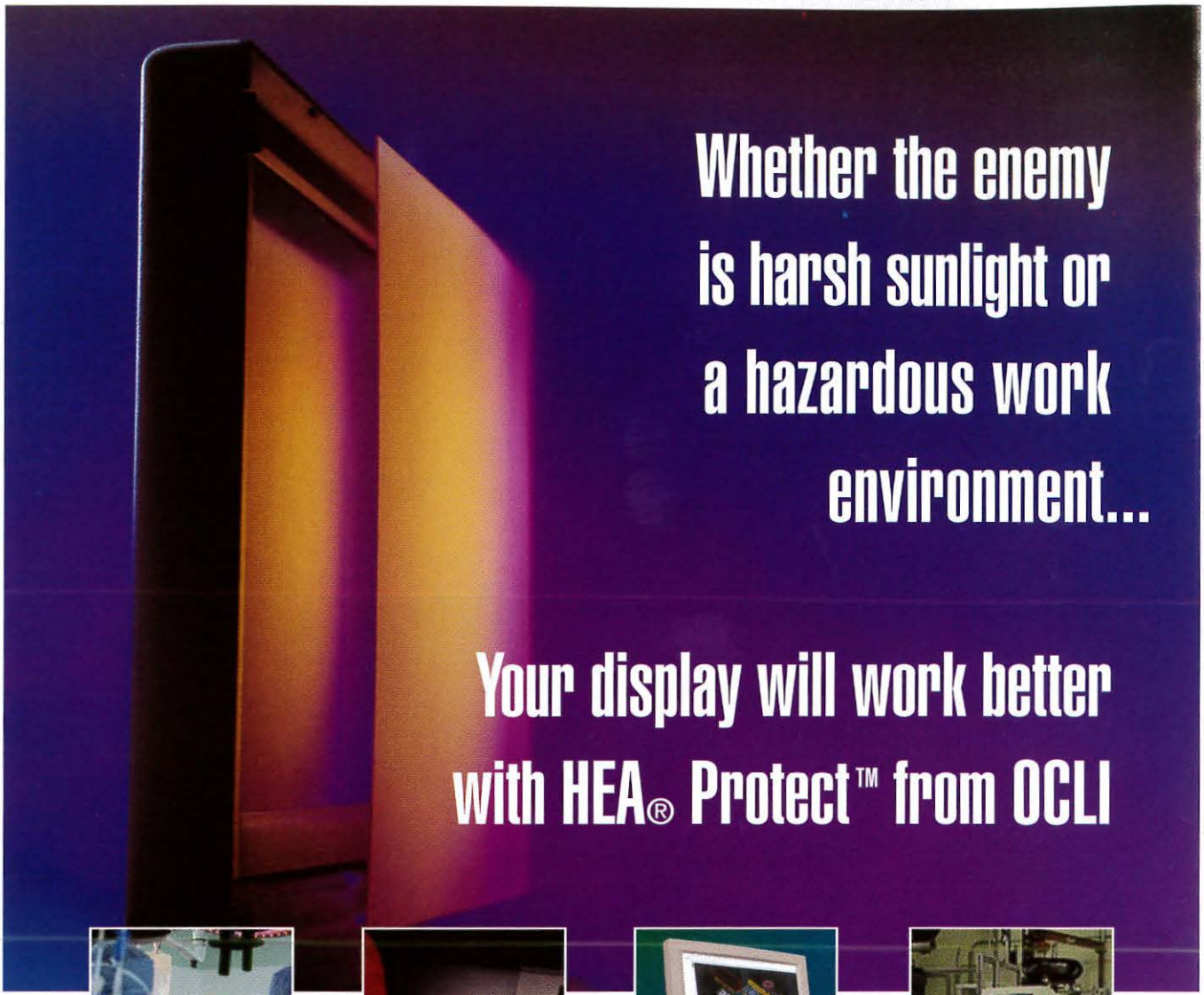

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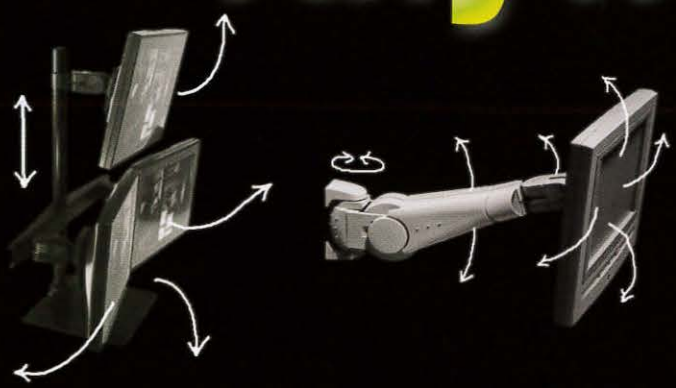

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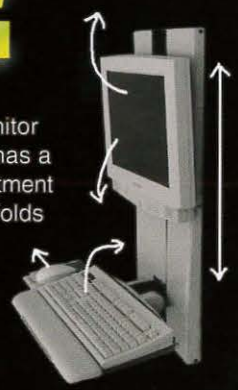

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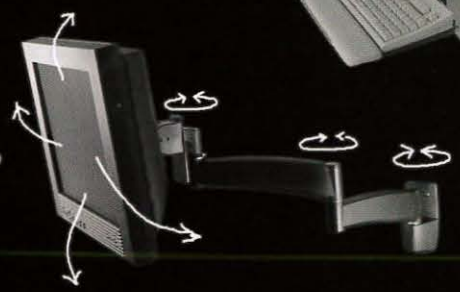

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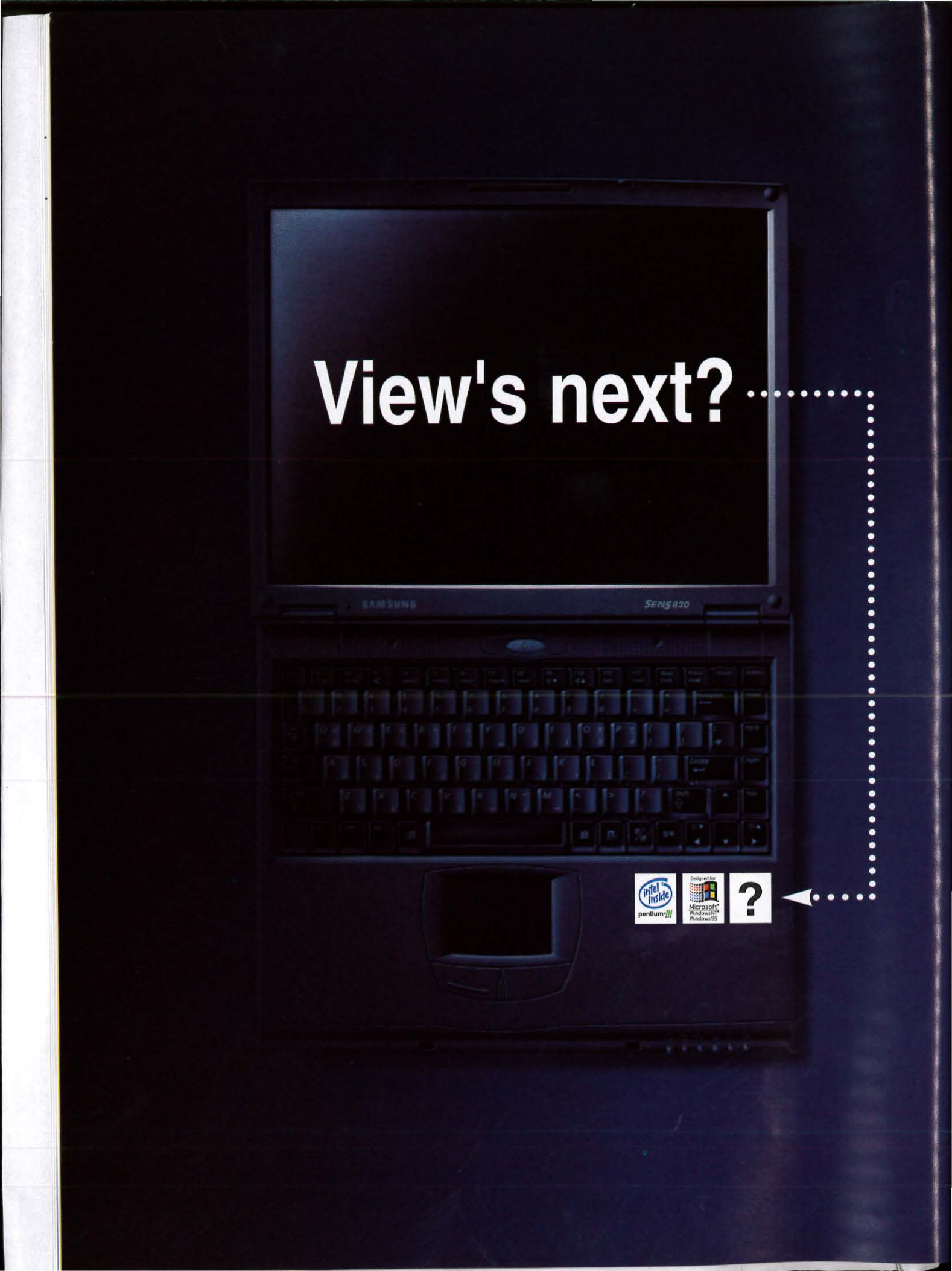
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Toshiba's Low-Temperature-Polysilicon TFT-LCDs

LTPS offers an impressive array of advantages for medium- and large-format TFT-LCDs – which are now available to OEMs in quantity.

by Steven Vrablik

THE LIQUID-CRYSTAL-DISPLAY industry thrives on technology advances as manufacturers continually come up with ways to improve image quality, brightness, production yields, or other important factors. It is rare, however, for a single development to make dramatic improvements across a wide range of attributes to the point where it allows designers to enable entirely new applications.

Low-temperature-polysilicon (LTPS) technology is one of those rare steps forward. It enables the complete elimination of the row-and-column driver IC chips used in the amorphous-silicon (a-Si) TFT-LCDs commonly found in today's notebook, desktop, and industrial LCD applications. LTPS displays offer high-resolution formats – up to 300 pixels/in. (ppi) – and are simple to assemble, light in weight, low in power consumption, high in brightness, durable, and highly reliable. They are well suited for current applications, as well as for a new class of emerging applications such as information appliances, electronic books, and electronic photo viewers.

***Steven Vrablik** is Business Development Director for the Tubes/LCD/Battery/Materials Business Unit of Toshiba America Electronic Components, Inc., One Parkway North, Suite 500, Deerfield, IL 60015; telephone 847/945-1500, fax 847/945-1044, e-mail: steve.vrablik @taec.toshiba.com.*

Independent studies show that high screen resolution translates into increased productivity and legibility. James Larimer, a member of NASA's Ames Research Center, concluded that pixel densities of 130 ppi or higher are desirable for reading the small 6–10-point fonts that are used in everyday printed materials. Larimer also concluded that pixel densities of 130 ppi or higher were also beneficial for displaying high-quality lifelike images.

Another study conducted jointly between the NASA Ames Research Center and the IBM T. J. Watson Research Center determined that "for many computer applications, displaying more information on a single screen improves user efficiency and utility." They further stated, "displays are needed that can render two full pages of text (and images) with paperlike quality. With increased information content, productivity improvements in the range of 20–30% have been obtained in CAD drawing tasks by simply reducing the amount of scrolling and zooming necessary to perform a specific task." Thus, basic human ergonomic factors create a need for high-resolution displays, and LTPS technology can deliver them.

Comparing LTPS with a-Si

On the glass substrate of a typical a-Si TFT-LCD, the silicon grains are very small and the grain structure is random, which greatly inhibits electron mobility in the substrate (Fig. 1). On a polysilicon (poly-Si) TFT-LCD

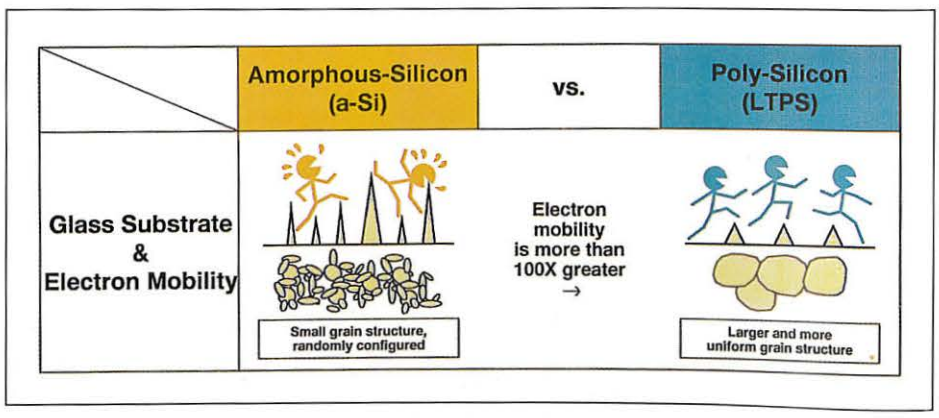

***Fig. 1:** The larger and more uniform grain structure of LTPS increases electron mobility.*

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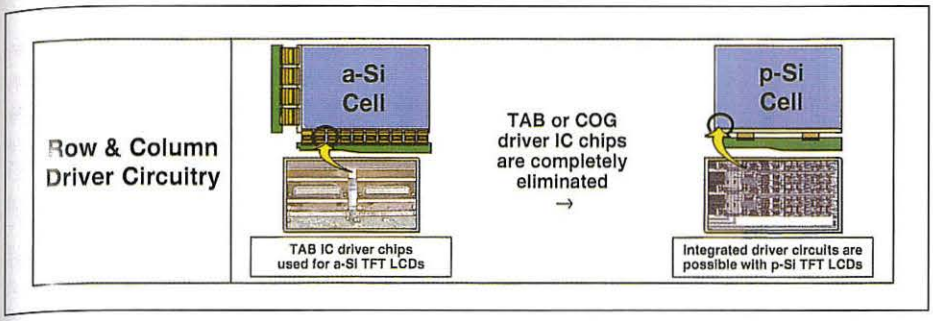

Fig. 2: Increased electron mobility makes it possible to fabricate row-and-column driver circuitry directly on the LTPS substrate.

substrate, the silicon grain structure is much larger and more uniform, permitting electrons to flow much more freely – more than 100 times faster than in an a-Si substrate.

The electron mobility in the LTPS substrate is high enough to permit the fabrication of the row-and-column driver circuitry *directly* on the glass substrate itself during the same processing steps used during the formation of the thin-film transistors (TFTs) (Fig. 2). LTPS technology makes it possible to completely eliminate the tape-automated-bond (TAB) or chip-on-glass (COG) row-and-column driver IC chips that normally surround the periphery of a-Si TFT-LCDs. As a result, the cell and array construction of an LTPS 10.4-in. XGA TFT-LCD is much simpler than that of a typical a-Si 10.4-in. SVGA TFT-LCD, even though the LTPS panel has 64% more pixels (Fig. 3).

By eliminating the TAB or COG driver chips, it is possible to reduce the number of row-and-column display connections in a typical XGA display from more than 4000 to roughly 200. In addition, 13 other driver chips can be eliminated, substantially reducing component material and assembly costs compared with an a-Si TFT-LCD. In the LTPS array, the row-and-column trace lines are routed along the edges to one side of the display, at which point a flat, flexible ribbon cable is connected directly to the glass. This flex cable then connects to the printed-circuit board located on the back of the display, which in turn is connected to the graphics system.

LTPS Advantages

By eliminating TAB or COG driver IC chips, LTPS panels are more reliable. The most common cause of field failures in portable a-Si TFT-LCD notebooks is breaks in the driver IC bonds caused by the severe mechanical stresses from dropping or other abuse. LTPS eliminates this problem because the driver circuitry is fabricated directly onto the glass – there are no bonds to break.

The elimination of TAB or COG driver IC chips, and their connections, provides even more benefits. In any complex system, electronic or otherwise, reliability increases if components are eliminated. The reduced number of connections and components inherent in LTPS results in improved product reliability. The reduction in connections and components also reduces the electromagnetic emissions from an LTPS display, typically by as much as 5 dB when compared to an a-Si display. It is easier to control electromagnetic emissions in the system design.

The elimination of the TAB or COG driver IC chips has one other important benefit: LTPS displays are inherently thinner and lighter than a-Si panels. And since all the driver trace lines emanate from only one side of the display – where the flex ribbon cable is connected to the glass – LTPS displays make it possible to use very narrow bezels and a three-sides-free design approach. Such panels may be of interest for tiling and other multiple-display applications typically found in financial markets today.

These advantages mean that design engineers can focus more on enhancing system functionality, improving design aesthetics, and achieving their time-to-market goals, rather than on durability, emissions, size, and weight-reduction issues.

Smaller Is Better

Due to the greater electron mobility in poly-Si substrates, each individual transistor in each individual sub-pixel is physically smaller than it would be if fabricated using an a-Si substrate. This produces an increased aperture ratio, which in turn provides increased bright-

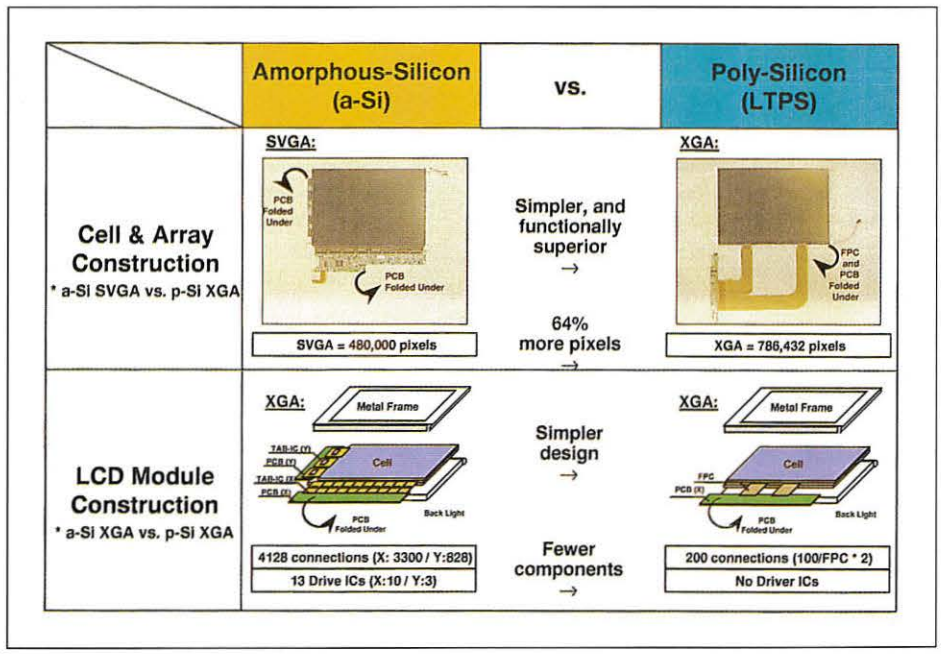

Fig. 3: An LTPS XGA panel has far fewer components and connections than an a-Si SVGA panel, even with 64% more pixels.

Fig. 4: LTPS technology may make it practical to put all computing components on the display glass substrate, which could lead to new products and applications.

ness and lower power consumption. Higher brightness improves legibility, and lower power consumption translates to extended battery life or lighter weight in portable systems.

LTPS technology can achieve very high pixel densities of up to 300 ppi and beyond. At 200 ppi, text is very sharp, four-point text fonts are legible, and electronically generated computer images appear photographic and lifelike (see cover).

How LTPS Displays Are Made

Toshiba has taken 10 years to develop its LTPS TFT-LCD technology. The process starts with a common glass substrate. An a-Si layer is initially formed on the glass substrate, and then a laser-annealing process transforms this layer into poly-Si, creating the much larger and more uniform grain structure. The laser-annealing process is extremely difficult to control in a production environment, especially for large-sized – 4 in. on the diagonal or greater – high-resolution displays. The power of the laser, the stability of the laser waveform, and the duration of the laser exposure all must be controlled precisely.

This process differs sharply from high-temperature-polysilicon (HTPS) fabrication. These displays tend to be small – 3 in. on the diagonal or less – and are typically used in camcorder viewfinders, digital still cameras, and data projectors. HTPS displays are manufactured using special high-cost crystalline-quartz substrates. The special substrate material is required to prevent melting during the high-temperature manufacturing process, which can reach about 1800°F (1000°C). Since the crystalline-quartz material is very expensive, the HTPS process is used to manufacture only relatively small displays on small-sized substrates.

In contrast, the LTPS process works with commonly available low-cost large-sized glass substrates. As a result, it is possible to make relatively large displays ranging in size from 4 to 20 in. or more at an affordable cost.

Toshiba began commercialization of the LTPS technology in 1997 with the construction of a production pilot line at the company's Fukaya Works in Saitama Prefecture, Japan. As with any pilot line, it was used to initiate production and "work out all the kinks" as the company established the manufacturing know-how for LTPS technology. In the fourth quarter of 1998, Toshiba began production on this pilot line, manufacturing 8.4-in. SVGA and 10.4-in. XGA poly-Si single-lamp TFT-LCD modules designed for the portable-computing marketplace.

Even before all of the kinks were worked out, Toshiba began an aggressive plan to establish a new facility specifically designed for the high-efficiency manufacture of LTPS displays. Plans for the new facility were completed in 1998 and construction was started. By April 1999, manufacturing operations had begun. The new facility is also located in Fukaya and is based on the same motherglass size (400 × 500 mm) used by the pilot line. It is approximately 95 × 105 m in size, and incorporates state-of-the-art processing equipment. The first phase added a capacity of 50,000 LCDs per month (based on a 10.4-in. LCD size).

During the fourth quarter of 1999, a second phase was installed in the new facility which added a capacity of another 50,000 LCDs per month (again based on a 10.4-in. LCD size). By the end of 1999, Toshiba's total manufacturing capacity dedicated to LTPS TFT-LCDs had reached 150,000 10.4-in. LCDs per month (on an input basis) with a total investment exceeding $430 million.

Toshiba's LTPS Displays

Since the inception of our large-sized LTPS manufacturing capability, Toshiba has brought many TFT-LCD products to market. The first LTPS TFT-LCDs were an 8.4-in. SVGA single-lamp display with a pixel density of 119 ppi and a 10.4-in. XGA single-lamp display with a pixel density of 124 ppi. Both of these products were introduced in the fall of 1998 and were initially used in thin, lightweight, portable PC systems.

In the spring of 1999, Toshiba introduced a 4-in. VGA TFT- LCD with a pixel density of 202 ppi that was initially used in a personal digital assistant (PDA). This display has photolike image quality and was the first TFT-LCD on the market to provide over 200 ppi without incorporating any peripheral driver IC chips.

In the fourth quarter of 1999, Toshiba introduced three new LTPS TFT-LCDs:

- A 15-in. UXGA single-lamp TFT-LCD with a pixel density of 133 ppi, targeted for the large-screen high-resolution desktop-replacement portable PC market.
- A 5.8-in. wide-VGA-format (800 × 480) TFT-LCD with 160 ppi, designed for emerging portable DVD video applications.
- A 6.3-in. XGA TFT-LCD with 202 ppi, designed for very compact portable computing and/or imaging products.

Earlier this year, Toshiba introduced an 8.4-in. dual-lamp display (119 ppi) for "industrial" high-brightness applications. More recently, the company introduced a 7-in. wide-SVGA-format (1024 × 600) single-lamp TFT-LCD with 169 ppi, targeted again for portable notebook applications.

Future LTPS Products

Toshiba sees a wide variety of new and exciting applications for which LTPS TFT-LCDs are ideal candidates. Today, demand is growing to use LTPS TFT-LCDs in lightweight ultra-mobile portable computing systems. We also see a fast-growing demand from emerging portable applications such as PDAs, information appliances, and electronic books. Other potential applications may include electronic photo image viewers, ultra-high-resolution desktop monitors for CAD/CAM or desktop-publishing applications, pen-based tablet PCs, various consumer devices, and computers with unique designs or features.

In addition, the higher electron mobility of LTPS may make it feasible to integrate even more system functionality directly onto the glass substrate during the fabrication process. It is our dream to someday integrate functions such as touch screen, camera, or voice-recognition technology *directly* onto the glass substrate, thereby putting the entire system on glass (Fig. 4).

Industry Recognition

The commercialization of large high-resolution LTPS displays is a remarkable achievement, which has been recognized throughout the display industry. In December 1999, the Society for Information Display (SID) and *Information Display* Magazine awarded their 1999 Display of the Year Gold Award to Toshiba's LTPS displays. These products provide many unique features and benefits that can enable an entirely new world of electronic display-based applications and products. Toshiba intends to remain the leading provider of LTPS displays and to extend this exciting display technology. ■

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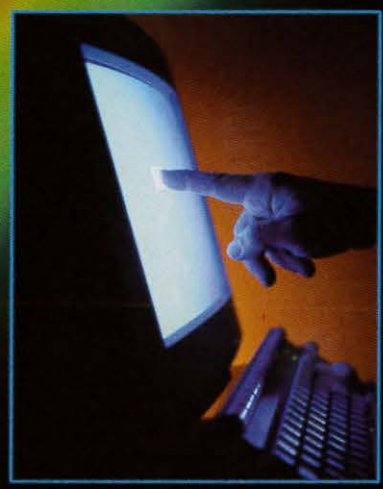

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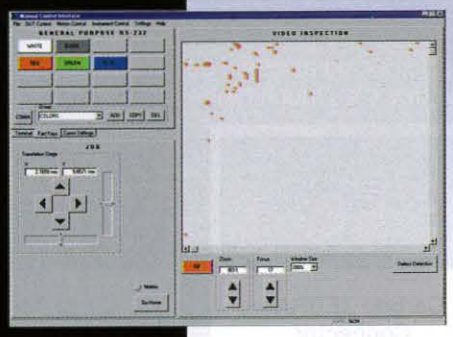

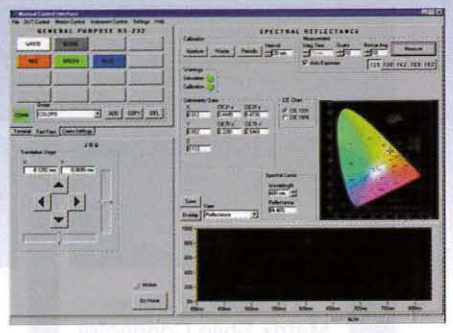

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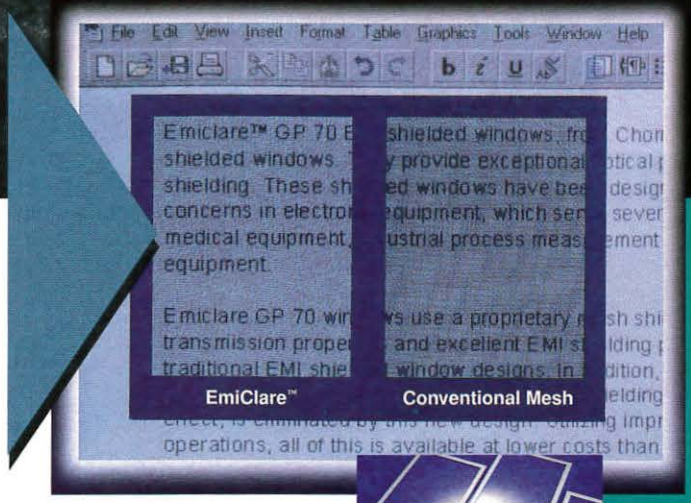

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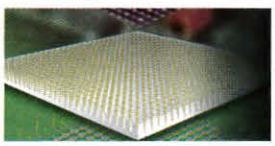

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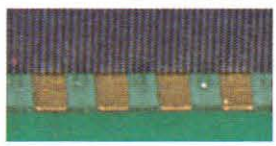

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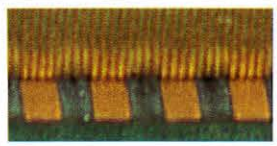

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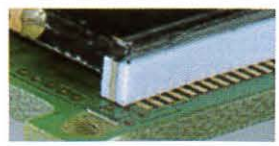

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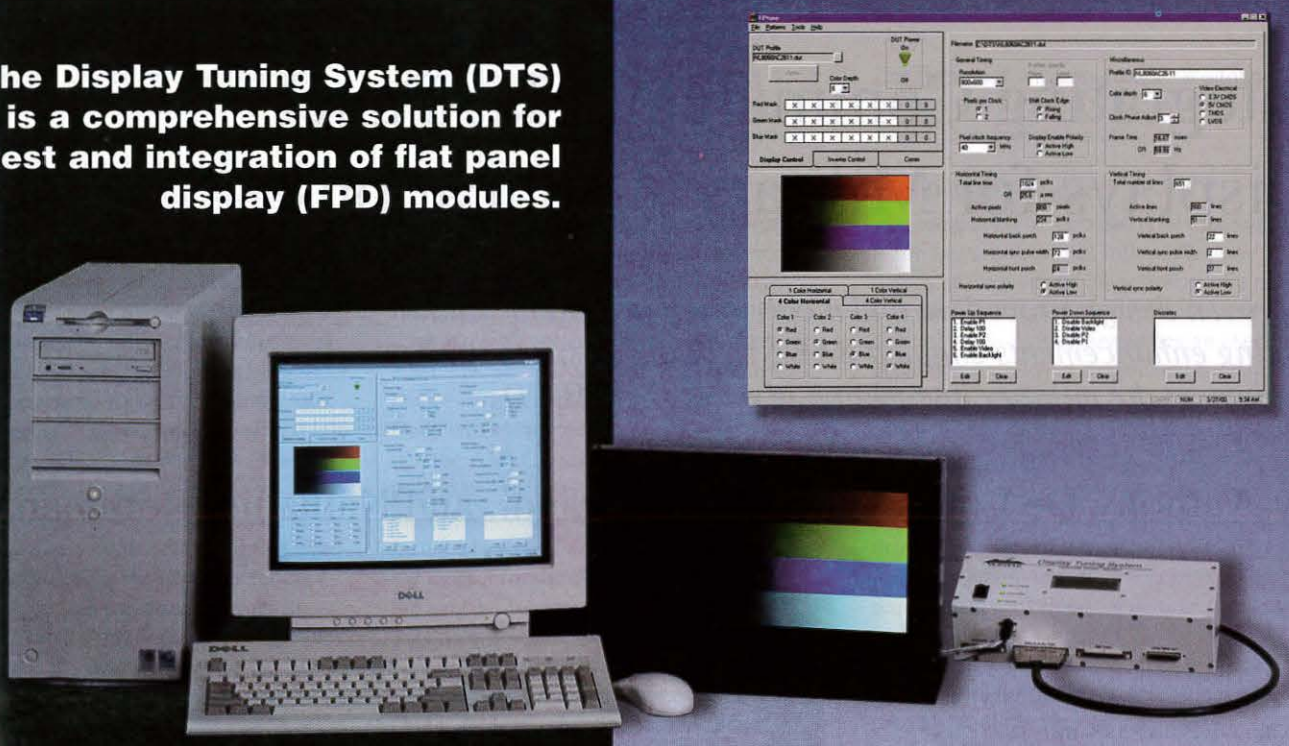

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Circle no. 72

Integrating Commercial Flat-Panel Displays for Military Applications

A proven design procedure and a core set of inviolable value-adding enhancements enabled BAE SYSTEMS to successfully implement the military integration of a COTS AMLCD.

by Anthony De Lorenzo, Richard Librandi, and Nathaniel Rothman

FOR OVER 40 YEARS, BAE SYSTEMS, Advanced Systems Group, formerly Marconi Aerospace, has been providing display monitors for command-and-control applications to the military. With the commercial introduction of large-area (18–21-in. diagonal) flat-panel monitors (FPMs) in the late 1990s, we saw an opportunity to provide our customers with a rugged display product that would consume one-third the volume, weight, and power of a comparable CRT monitor while improving reliability by a factor of 3 (Fig. 1).

The challenge was how best to take a monitor developed for the commercial marketplace and adapt it for military applications so that it could meet the required electro-optical performance over the extended environmental conditions required by each Service.

Setting the Bar

Based on our long-term involvement in the displays business and our supporting market research, we were convinced that there was a strong military demand for this type of prod-

Anthony De Lorenzo *is Director, Displays Systems Engineering, at BAE SYSTEMS, Advanced Systems Group, 450 Pulaski Rd., Greenlawn, NY 11740; telephone 631/262-8102, fax 631/262-8002, e-mail: rothman @hazeltine.com.* ***Richard Librandi*** *is Senior Member, Technical Staff, and* ***Nathaniel Rothman*** *is Director, Business Development, Display Systems, at BAE SYSTEMS.*

BAE SYSTEMS

Fig. 1*: BAE SYSTEMS has integrated NEC Technologies' commercial AMLCD into a rugged 20-in. flat-panel monitor for military applications.*

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uct for new and, even more, for retrofit programs. The technical benefits an FPM brings, along with the potential cost savings from employing a commercially based monitor off a high-volume production line, make this an attractive opportunity for military users.

BAE Systems, as a value-added integrator, had to establish a set of essential objectives for such a product family. These objectives would have to be achieved before the product could be considered a successful integration of a commercial flat-panel display (FPD) into a monitor for military applications. The objectives were

- To be able to select one flat-panel technology that provides the required technical and business attributes, including electro-optical performance, robustness of commercial product designs, production capacity, and long-term product stability.
- To develop a close working relationship with a known leading provider of the chosen commercial flat-panel technology.
- To retain the maximum amount possible of the commercial monitor's design and components.
- To create a family of open-architecture modular flat-panel products that satisfy all military-Service requirements and can be put into volume manufacturing with confidence that manufacturing cost objectives will be met.
- To maintain flexibility in product design to accommodate the variability of the retrofit market without compromising product cost objectives.

Selecting a Technology and a Supplier

Since we were focused on command-and-control systems requiring 18–21-in. high-resolution monitors, we had a limited field of technology entrants to consider. Only AMLCD, plasma, and digital micromirror devices offered potentially suitable solutions. Once we investigated, it became obvious to us that the AMLCD solution offered the greatest potential: excellent electro-optical performance, an ever-growing product and manufacturer base, and a projected steadily increasing market for the commercial product over the next 5–10 years.

Having selected the technology, our next task was to find a manufacturer that was a leader in AMLCD technology, was committed to the technology for the long haul, had robust designs, and would work with us as we applied its designs to our significantly more demanding environmental requirements.

Robustness of the electronic and mechanical designs, and of the manufacturing processes, became key characteristics and an important discriminator. The commercial off-the-shelf (COTS) product we wanted had to be very conservative in design. It also had to have a stable design and exceptional field performance, as well as exceed its published characteristics on many fronts. We found such designs in the NEC Technologies AMLCD flat-panel monitors.

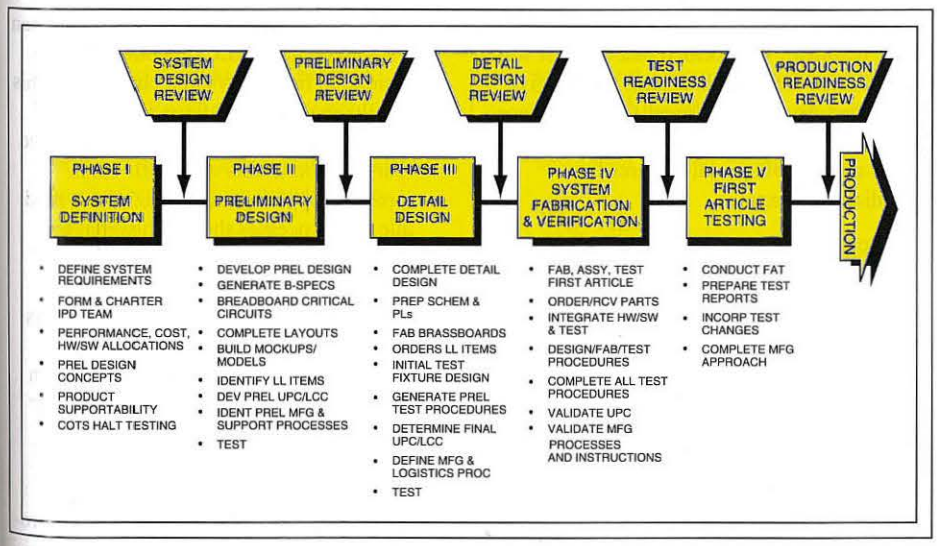

Fig. 2: A proven design process is the key to successfully integrating a commercial product for military applications.

The Design Process

The integration of a commercial monitor into a military product must follow the same design process as any other design of a military product. The key is to use a proven design process with inherent design checks and balances, such as the process used by BAE SYSTEMS (Fig. 2). For COTS-derived products, this process is augmented by significant testing in the early phases of the design, including a highly accelerated life test (HALT) program. HALT is a process of determining the robustness of a design by testing to environmental limits beyond the requirements envelope for parameters such as temperature and vibration.

HALT is a key component of the process because it helps the ruggedizer assess the robustness of the various parts of the COTS product. With this knowledge, the ruggedizer can preserve the greatest possible portion of the original COTS product, thereby obtaining the maximum benefit from the original manufacturer's higher-volume lower-cost production.

Deciding how much ruggedizing a COTS product needs requires a review of existing and anticipated customer needs. A range of customers and programs have to be taken into account because the ruggedized product must meet the needs of many programs with little or no modification. This review results in an "equipment-requirements document" that contains the electro-optical, environmental, design, and logistical (maintainability, reliability, and life) requirements of all forecasted programs. The equipment-requirements document is then coupled with the results of the HALT program to establish the ruggedization requirements for the new product (Fig. 3).

LCD Glass

The LCD monitor's weakest link is the susceptibility of the LCD glass to vibration, shock, temperature, humidity, fogging, sand, dust, salt fog, and explosive decompression. The problem is that LCD glass is made for desktop use. When we tested it under vibration or shock, the glass was damaged and the glass spacer beads behind the glass shifted, causing permanent brightness non-uniformities. In addition, pressure differentials that

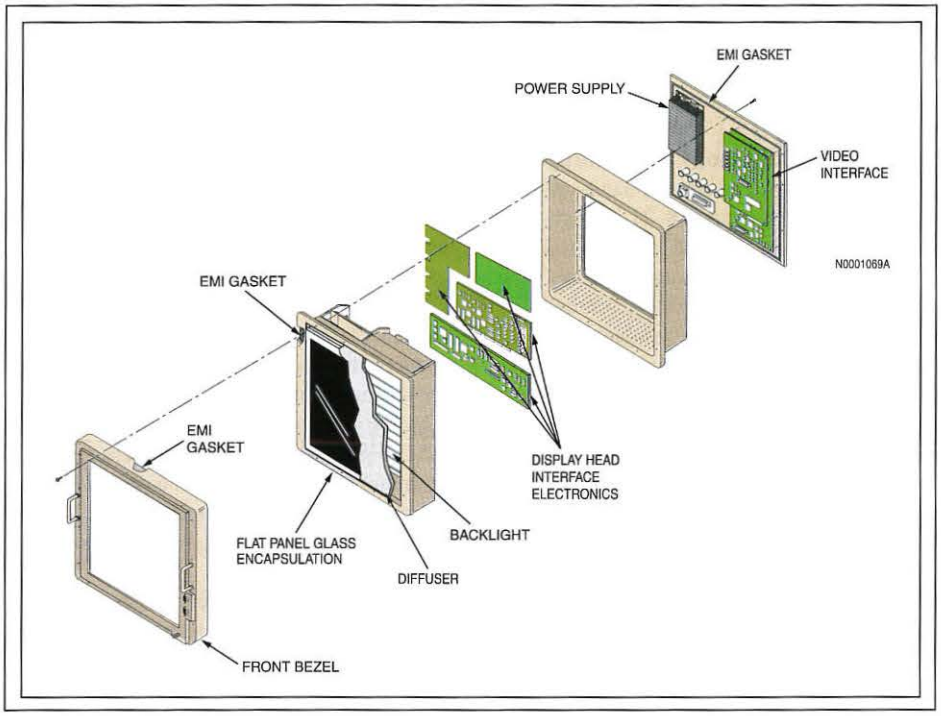

Fig. 3: The design approach for the ruggedized monitor retains the field-proven electro-optical performance of NEC Technologies' 20.1-in. commercial flat-panel display.

arise between LCD layers during rapid altitude changes can produce explosive decompression.

Humidity and glass fogging also posed serious problems for LCD glass. Humidity caused the front and rear polarizers to peel from their glass substrates, and glass fogging occurred behind the inner surface of the nonbonded glass sheet.

Based on these test results, we decided that a fully bonded, encapsulated LCD glass was needed to eliminate the environmental problems. Our unique process sandwiches the LCD glass between two panes of optical glass, and completely bonds them together with an optical-quality silicone material, making the entire assembly into a one-piece totally encapsulated module. Testing verified that this robust approach to ruggedization and protection of the LCD glass solved all of the noted environmental problems.

The single-piece construction also provides a secondary benefit: There is no light reflection from or refraction at the internal surfaces of the glass and the silicone encapsulant because all have matched indices of refraction. This provides faithful color rendition and enhanced contrast ratio.

Video Interface, Power, and EMI

The other two areas requiring ruggedization for the military environment are the video interface and the power supply. Video interfaces for military programs, particularly retrofit programs for existing equipment, require varied video inputs, built-in testing and reporting, and enhanced image-performance features. We decided that the best way to implement these requirements was to give our product its own intelligent video interface and controller module. This approach provides a number of special features in a ruggedized package:

- Storage of up to 16 independent video-input formats.
- Automatic luminance adjustment based on ambient illumination.
- Automatic control of backlight output based on backlight life.
- Automatic gain control.
- Automatic color control.
- DC restoration.
- Serial communication.
- Built-in-test-equipment (BITE) software.

When the functions implemented by this video interface are coupled to the video-control capability already embedded in the COTS monitor, they provide the customer with exceptional performance and flexibility.

Military power systems, particularly those in retrofit programs, are stressful for display electronics. We therefore designed our own power supply so that the monitor can comply with power-supply specifications such as MIL-STD-704E, MIL-STD-461, and their equivalents.

EMI protection is dealt with by using the customary approaches for thoroughly sealing the box from electromagnetic interference (Fig. 3).

Test programs were run throughout all phases of the design process. As each area was addressed, design testing was performed. Successful completion of the design-validation testing gave us and our potential customers confidence in the product performance.

Varying the Product

We realized that one "universal" monitor design could not possibly meet all the needs of our military customers. But we did believe that a fairly broad core product could be designed with a modular open-architecture framework that lends itself to the addition of features that are unique to certain applications. Here are three examples:

- ***Sonar acoustic waterfall grams***. Certain Naval applications require displays that are slowly updated at rates of approximately 1–10 times per second. This causes perceptible "jumping" or "blinking" of the image upon each update when viewed on an AMLCD, a phenomenon unique to liquid-crystal technology. This results in operator fatigue and other human-factors problems. We developed our solution to this waterfall "blink" problem by designing a mezzanine module that processes the video signal for the liquid-crystal panel; the module simply attaches to the video-interface controller module. It thereby maintains all of the elements of the ruggedized monitor design. [For more information on waterfall gram blink, see "Bringing the NEC 20-in. LCD to Military Customers," *Information Display*, 32 (March 2000.)]
- ***Touch screens.*** We have developed processes that permit the addition of capacitive and acoustic touch screens to the product without violating the integrity of

our one-piece laminated LCD glass structure.

- ***Low-profile 19-in. drawer-mounted package.*** We saw the need in military applications such as ground mobile and submarines, where rack space is at a premium, for a 20-in. monitor that could be horizontally recessed into a 19-in. 3U rack for storage. Because of the monitor's modularity, we were able to design a variant that fits in a 19-in. rack 3U tray while preserving the landscape orientation of the 20-in. flat panel (Fig. 4). The user merely opens the drawer and tilts the monitor to the desired vertical orientation for comfortable viewing. There is no need to physically rotate the 20-in. panel to achieve the landscape orientation. We also developed a 19-in. rack 2U tray variant. Ruggedization is preserved and all elements of the original monitor design are used.

Lessons Learned

This integration effort taught us that successful integration of a commercial FPD for military applications does not involve much more than good engineering practices. The key is to establish those practices, know them, and use them. The practices are

- *To treat the ruggedization of a commercial product for military applications as one would the development of any unique product for the military.* The customers' operational requirements and needs do not change just because we start with a commercial product as a baseline.
- *To use a proven design process for the product development.* This provides a comparison and checklist that has been used successfully on other military applications.
- *To know the commercial product design in detail, either through the supplier relationship and/or extensive testing.* That product design is the heart of the integrated product.
- *To make the most of the commercial product.* Although we may not believe it, the commercial world does design products to last. When supplying hundreds of thousands of units to the mass market, product recalls are not wanted.
- *To have a core set of value-added attributes that are inviolate.* An example is the encapsulation of the AMLCD substrate for the required environmental protection. Without this core set, it is questionable whether a product will deliver any added value to customers.

BAE SYSTEMS

Fig. 4: *The flexibility of an open-architecture modular design permitted the 20-in. monitor to be adapted for installation in a drawer for a 19-in. rack.*

The Way Ahead

The integration effort described here has resulted in a rugged 20-in. FPM product that has been accepted in the military marketplace. The monitor has been selected for use on the U.K.'s Nimrod Maritime Patrol Aircraft and the Canadian Victoria Class Submarine, as well as other platforms. We are now using the design process proven on the 20-in. monitor to create rugged 18- and 21-in. FPMs. The first deployment of the 21-in. FPM will be on Australia's new 737 AEW Aircraft.

We are convinced that AMLCD-monitor products such as those described, along with ensuing variations, will fill the military market's need for large-area FPDs for the next 5–10 years as the installed CRT base becomes less and less supportable. ■

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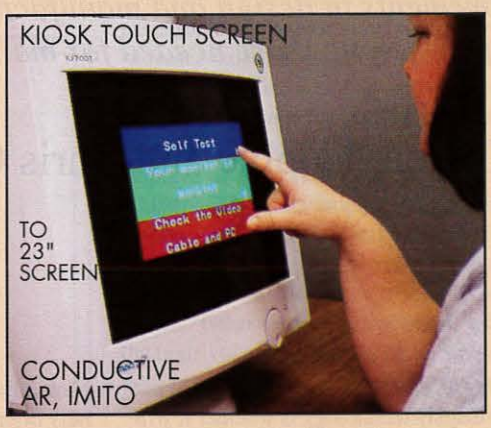

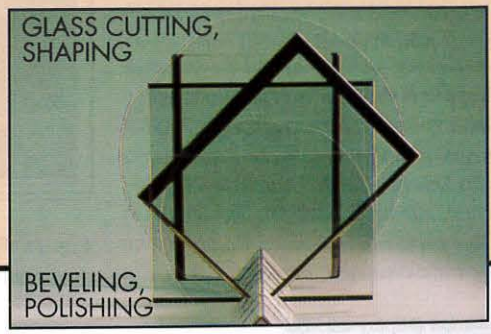

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FED Life and Reliability

Candescent's display life and reliability research has produced improvements in design and manufacturing – and values that are approaching those needed for mainstream consumer products.

by George Hopple and Chris Curtin

ONE OF THE MAJOR CONCERNS about any new display technology is whether it will stand up to the rigors of long-term use in typical conditions. Candescent Technologies Corp. has developed an emissive flat-panel display, the ThinCRT™, based on low-voltage field-emission cathodes and high-voltage aluminized phosphors, which offers the visual advantages of cathode-ray-tube (CRT) displays without their disadvantages of bulk and high input power. Questions have been raised recently about the longevity of some field-emission-display (FED) implementations. Candescent's ThinCRT architecture is designed to meet the commercial market demands for life and reliability, and research has demonstrated its success.

Candescent's ThinCRT display technology, which operates at low switching voltages and high phosphor efficiency, is intrinsically power efficient, and being an emissive display, its power consumption scales in direct relation to brightness and image content (Fig. 1). Each of these factors directly affects life and reliability.

The ThinCRT consists of a 1.1-mm-thick glass backplate onto which is deposited the cathode structure and a 1.1-mm-thick glass faceplate onto which are deposited color phosphors. Internal support structures (horizontally oriented walls) keep atmospheric pressure from collapsing the display (Fig. 2). The two glass plates are separated by 1.25 mm and hermetically sealed around their perimeters with solder glass. The resulting "tube" is evacuated to about 10^{-7} torr prior to final tipoff. A getter to adsorb residual gases from the vacuum enclosure is located either along an inside border of the display or in an auxiliary chamber attached to the back of the display.

The majority of the technology development at Candescent has been done on small test displays of 2.3–5.3 in. on the diagonal. Some 13.2-in. SVGA ThinCRTs have also

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Candescent Technologies Corp.

Fig. 1: *FED picture content is increasing. This 13.2-in.-diagonal ThinCRT™ has 800 × 600 pixels with a 200-cd/m² luminance and 200:1 contrast ratio.*

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been built to demonstrate the scalability of the technology, but this article will focus on the results from the 5.3-in. quarter-VGA-format (QVGA) devices.

Life and Reliability

The life and reliability requirements of the ThinCRT are divided into two separate specifications. "Life" is used to describe the time to half-luminance, and "reliability" describes the mean time to failure (MTTF).

The time it takes for the luminance (or, in the case of front projectors, luminous flux) to decrease to 50% of its initial value has historically been used by display technologists as a measure of lifetime. This applies to emissive displays – such as television receivers and PC monitors – as well as projector lamps and LCD backlights. Candescent's goal has been greater than 20,000 hours to 50% degradation.

MTTF is a probabilistic measure of sudden catastrophic failures in which a device becomes inoperable during the intended lifetime. The catastrophic failure rate is a summation of the rates for each of the various types of failures that result in an inoperable display. Candescent's goal for MTTF is 50,000 hours. Catastrophic failures for these displays include arcing and phosphor loss from high-voltage breakdown, or a row-to-column short that causes a black line on the screen. Other display components, such as the high-voltage power supply, TAB connections, and PC-board components typically have failure rates that are low enough not to significantly influence the ThinCRT failure rate.

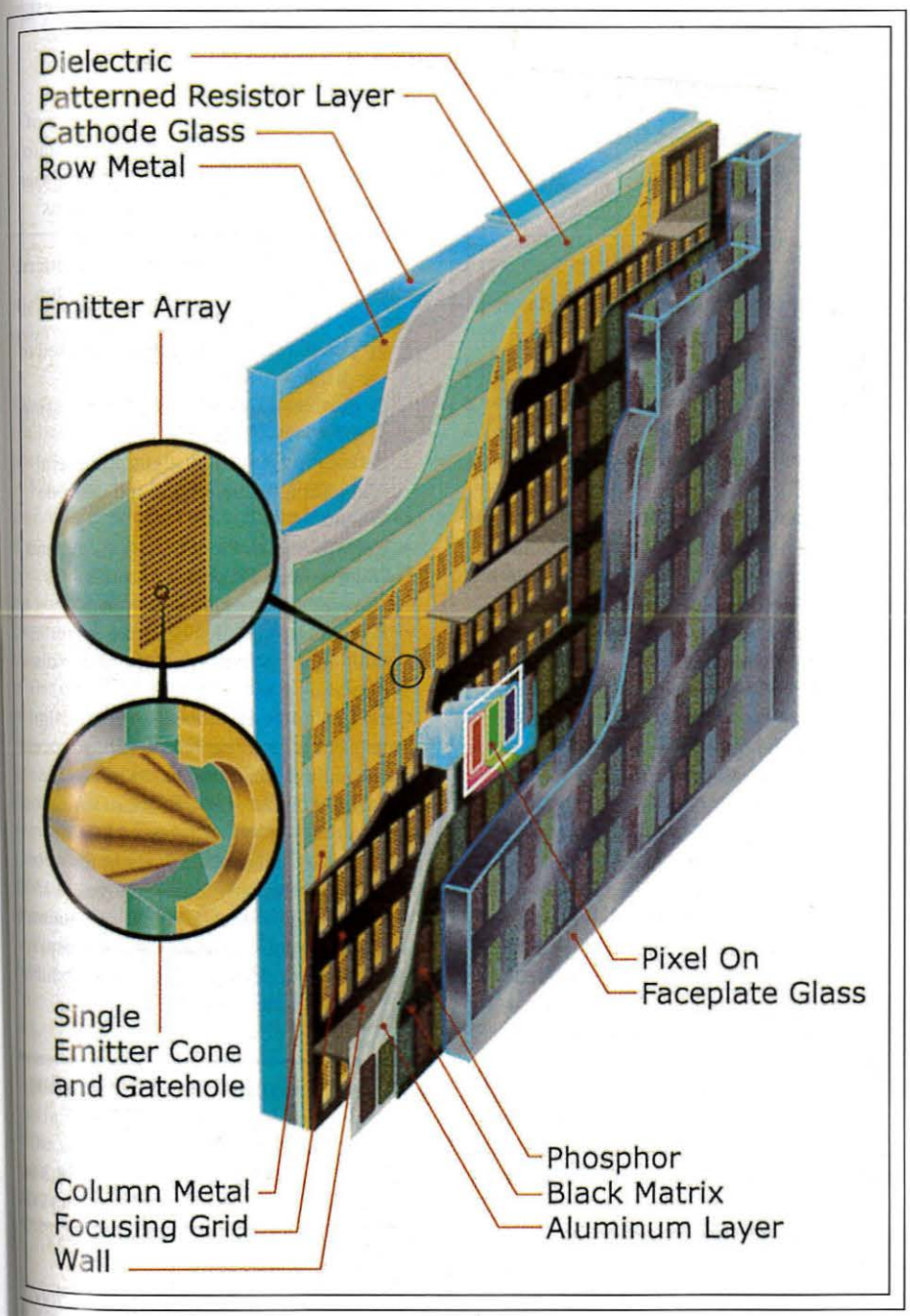

Fig. 2: *FEDs have a very thin cross section, as indicated by the structure of Candescent's ThinCRT™.*

Luminance Degradation

The primary cause of the gradual loss of luminance in the ThinCRT is "wearing out" of the phosphor, or phosphor aging. The rate of this phosphor aging was first measured in 1996 at Candescent in special tubes operating at 6000 V. The last of these tubes was recently retired after 25,000 hours of continuous operation. The electron dose to half-brightness ranged from 120 coulombs/cm^2 (C/cm^2) for the blue (ZnS:Ag) phosphor to 390 C/cm^2 for the red (Y_2O_3:Eu), with green (ZnS:Cu) in between at 260 C/cm^2. These phosphor aging rates are similar to those reported in the literature for monitors and TV sets, with blue aging the quickest and red the slowest (Fig. 3).

It is customary to report phosphor aging in electron dose to half-brightness rather than time because of the design trade-off between luminance and lifetime. In other words, a display operated at a fixed luminance would degrade to 50% of its initial brightness twice as fast as a display operated at half that luminance. It is predicted that operation at higher voltages – 8 kV and 200 cd/m^2, for example – with expected phosphor screen improvements will increase the time to 50% degradation to greater than 33,000 hours in office or home use. Proper white color balance (color temperature) will be maintained by the use of column-driver ICs with independent control of red, green, and blue output voltages. By vary-

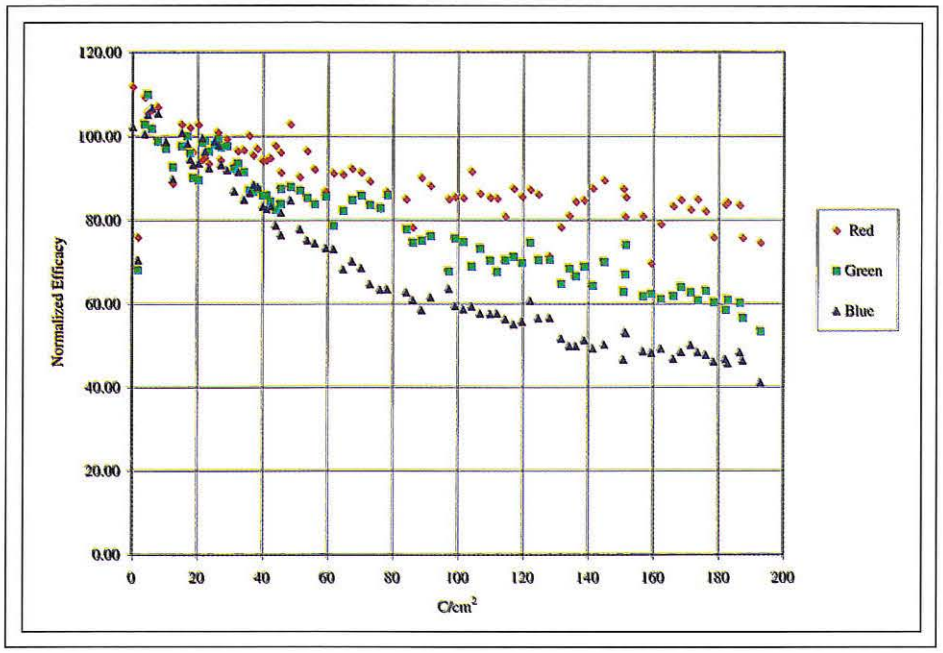

Fig. 3: *Phosphor efficacy is a function of electron dose in coulombs/cm².*

ing the current to each phosphor, the luminance of each primary color can be independently controlled, both initially and throughout the life of the display.

The use of high voltage – more than 4 kV – is a key design feature of the ThinCRT, providing several advantages over "low-voltage" field-emitter displays. Among them is that standard P22 phosphors can be used with their known good color gamut and ready commercial availability. Because the life of color phosphors is, in general, inversely proportional to coulombs of charge deposited, the lower the excitation current and the greater the voltage for a given power input, the longer the phosphor life. Also, the efficiency of high-voltage phosphors is intrinsically greater than that of low-voltage (less than 1 kV) phosphors. In addition, at voltages greater than 4 kV, the efficiency can be enhanced by adding an aluminum film to the rear surface of the phosphor that reflects light generated in the phosphor back towards the viewer. The higher efficacy – measured in lm/W – results in less current used to achieve a given luminance, hence increased life. Candescent's displays currently use P22 phosphors (Y_2O_2S:Eu for red, ZnS:Cu,Al for green, and ZnS:Ag,Al for blue) and have demonstrated efficacy greater than 12 lm/W at 7 kV.

Catastrophic Failure

While there are a number of failure mechanisms that can result in a catastrophic failure or an inoperable display, the most predominant for our 5.3-in. QVGA ThinCRT has been high-voltage breakdown or arcing.

A number of design and process innovations have increased our initial MTTF for high-voltage breakdown from 100 hours at 5 kV in a 2.3-in.-diagonal display to greater than 36,000 hours for 5.3-in. QVGA displays operating at 6 kV (Table 1). Most notable were design changes associated with our proprietary spacer technology. An important process change was an inspection for defects in the components prior to assembly to determine if subsequent arcing was associated with a particular type of defect. Thorough analysis of failed devices also played an important role in identifying the root causes of arcing failures. Another very important change for arcing reliability was increasing the burn-in/conditioning voltage to a level above the operating voltage. This is similar to the process used for conventional CRTs. Although the tube yield through burn-in was reduced, the reliability of the tubes that survived increased significantly. This was a major improvement that supports the high-voltage-stress screen strategy for improving reliability.

Following initial design and cleanliness improvements, the predicted MTTF increased to 36,000 hours at 6 kV. Preliminary data on current displays with still more design and processing improvements show an MTTF at 7 kV of 24,000 hours. Laboratory tests further indicate that display voltages approaching 10 kV can be sustained with the same basic design.

Other Reliability Concerns

Cathode emission* vs. *time. Emitter life depends on the initial vacuum processing of the display and the vacuum quality maintained during the life of the display. Residual gases left in the display prior to sealing or gases generated during display operation can adversely affect the operation of the emitters. A number of factors can minimize vacuum degradation in the display.

- Proper selection of materials exposed to the display vacuum.
- Proper cleaning and vacuum processing of the components.
- Fabricating a vacuum-tight peripheral seal joining the faceplate and cathode substrate.
- Controlling the thermal outgassing and electron-induced desorption of gases from internal display components.
- Providing a chemically active getter within the vacuum envelope of the display.

Candescent has developed several design features, as well as cleaning, vacuum processing, and sealing technologies, to minimize residual gases in the tube. Proof of emission stability is shown by a number of 2.3-in.-diagonal test displays that have run for over 30,000 hours with only small changes (±15%) in the switching voltage necessary to maintain a constant current. Although current displays have not been operating as long, they exhibit even better stability (Fig. 4). These data

Table 1: Evolution of Operating Voltage and MTTF

Test Vehicle	2.3 in.	5.3 in. QVGA	5.3 in. QVGA
Sample size (displays)	15	48	24
Operating voltage (V)	3500	6000	7000
MTTF (hours)	6300	36,000	24,000

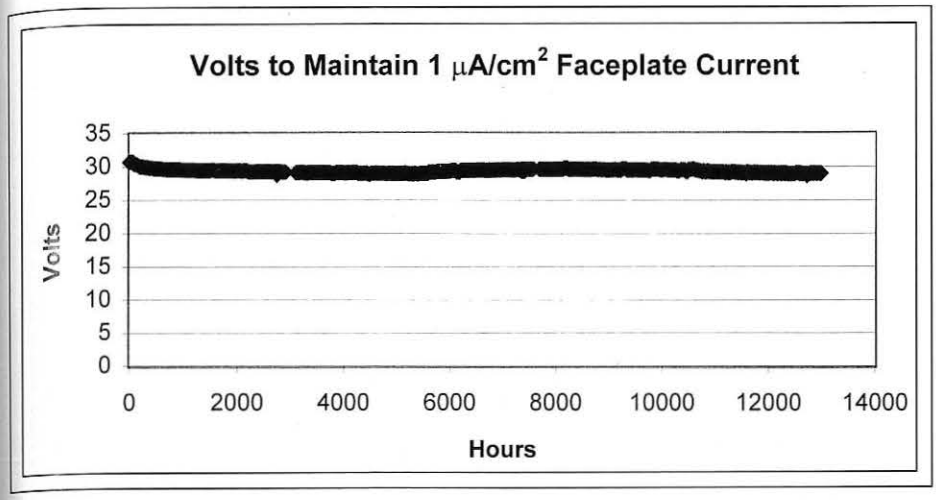

Fig. 4: The emitter-tip–to–gate voltage required to maintain a constant current during life is relatively stable.

demonstrate that cathode-emission aging will not be a serious issue in long-life ThinCRT operation.

Vacuum level. Early research on field-emission cathodes at SRI International was done at very high vacuum levels, and many people were concerned that these vacuum levels would be needed in an operating FED. Experience has shown that the partial pressures of gases that degrade the work function of the emission sites are critical to reliability, not the total pressure. For example, partial pressures of hydrogen and methane can be beneficial, while oxygen, water, and carbon dioxide cause rapid deterioration of the emission process. Operation in pressures of inert gases in the range of 10^{-6}–10^{-7} torr for tens of thousands of hours has been successfully demonstrated at Candescent.

Perimeter-seal leaks. Seal leaks have not been a problem because solder glasses, or "frits," developed for the traditional CRT industry are used. When melted, these materials bond to the cathode and faceplate surfaces and form a hermetic seal. The coefficient of thermal expansion is matched to the substrate glass so that no stress is induced during thermal processing. Leak-rate test systems – to which all displays are subjected at Candescent – are capable of 10^{-11} L-torr/sec detection. Diagnostic systems have been developed to test selected displays to less than 10^{-14} L-torr/sec.

Emitter-tip aging. Many authors have reported severe aging of the field-emission process in the presence of sulfide phosphors. We have not experienced this at Candescent, even though Auger spectroscopy shows the presence of sulfur on the cathode after life test. Data from ThinCRTs containing only oxide phosphors show emitter life identical to those of devices with sulfide phosphors.

Mechanical reliability. In order to use high-voltage phosphors, internal supports having height-to-width ratios of 20:1 or greater are required. The height must be great enough to provide anode/cathode spacing sufficient to prevent arcs, and the width must be narrow enough to fit between rows of pixels. The supports must be quite strong under compression as well as mechanically and electrically invisible, *i.e.*, the supports must not disturb the emitted electrons as they pass from the cathode to the phosphor.

Candescent has developed an engineered ceramic material and a mechanical alignment system to provide and place such supports. The six supports used in a 5.3-in. ThinCRT are in the form of continuous horizontal walls. The faceplate-to-backplate separation (the support height) is approximately 1.25 mm, and the supports are 55 μm thick. The compressive ceramic strength is greater than 18,000 psi. The traditional CRT design guideline of testing to 3-atm overpressure is used, and the 5.3-in. devices typically survive 6–7 atm of pressure in a hydrostatic test. In addition, these displays have proven to be mechanically reliable in shock and vibration testing. A series of operating devices were successfully tested to 5-*g*'s vibration over a range of 10–2000 Hz and shock-tested to 150 *g*'s in all six axes.

Summary

Whenever any new technology is developed, life and reliability are key factors in determining its commercial viability. The ongoing research and testing programs at Candescent have led to a series of design and materials developments that conclusively demonstrate that ThinCRT displays can meet life and reliability requirements, although further development is required. Our work continues in the exploration of materials and processes that can yield further improvements. ■

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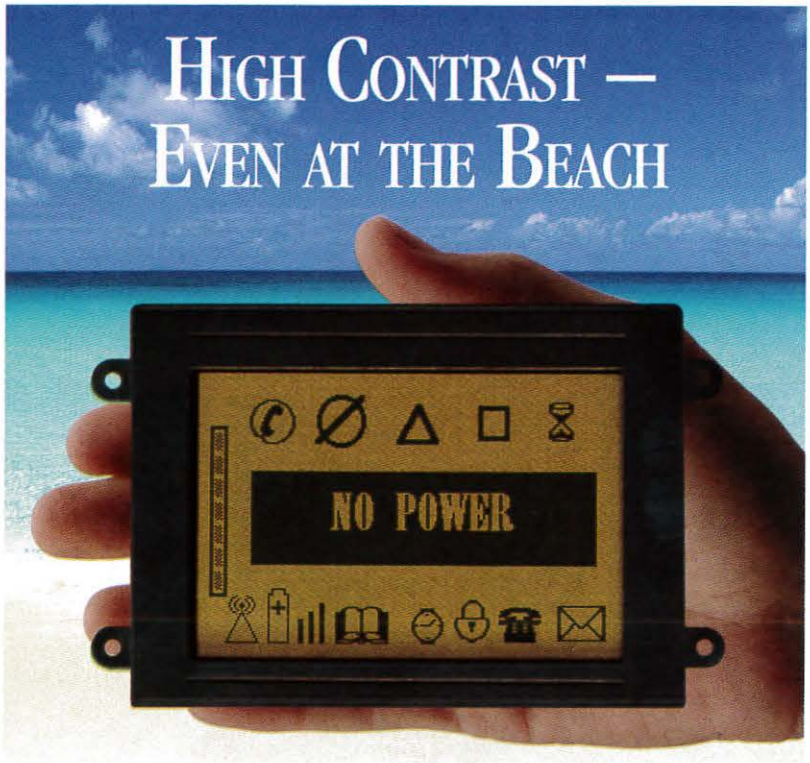

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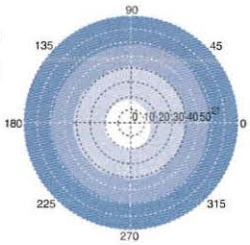

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by Bryan Norris

SMAU is an international event that nevertheless retains a very vibrant Italian flavor: Many of the home-grown PC and display companies seen at SMAU are virtually unknown outside Italy. Therefore, despite being held only a week after the Orbit Show in Switzerland and inevitably duplicating some of the products seen at the earlier show, SMAU is the place to find unique-to-Italy products.

In 1999, SMAU – the International Information and Communication Technology Exhibition – reverted to its traditional timeslot and was held from September 30 to October 4 in Milan. Naturally, it is Italy's premier IT trade fair; surprisingly, it is also the world's second-largest IT show (by visitor numbers). SMAU '99 attracted a record audience of 490,000 visitors – an increase of 18,000 over 1998.

These visitors were able to see the products of nearly 3000 direct and indirect exhibitors, a prospect exciting enough to attract a number of distinguished Italian dignitaries, notably the President of the Republic, Carlo Azeglio Ciampi, and the Prime Minister, Massimo D'Alema.

And just in case visitors had any spare time after touring the exhibits, they could attend over 100 seminars or take part in 27 conferences arranged by the SMAU organizers, in addition to those which had been organized by individual companies. If all that sounded too

Seleco-Formenti

Fig. 1: Seleco-Formenti's 15-in. ego TFT-AMLCD provided a good example of the Italian design that is not often seen in other display markets.

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xhausting, there was always the option of aying at home and visiting the show Web ite, Magellano On Line (www.smau.it/mag-ilano), which registered nearly nine million its during the five exhibiting days.

The "Must-See" Models

In keeping with the times, there were consid-rable numbers of LCD monitors on show rom both the well-known international randed suppliers and smaller indigenous ompanies. Overall, it was the considerable umber of 18-in. LCD monitors that formed he display highlight of SMAU '99.

But other LCD sizes were also worthy of close inspection, such as ***Apple***'s 22-in. Cinema Display, just launched in Europe. This model actually became available to Euro-ean buyers on the Friday during the show October 1) – through Web site orders only – nd sales that morning were reported to be unning at two a minute! And, like last year, ***Panasonic***'s "forthcoming" LC90S 19-in. nodel attracted attention, though this product as again not due for delivery until "the end f the year."

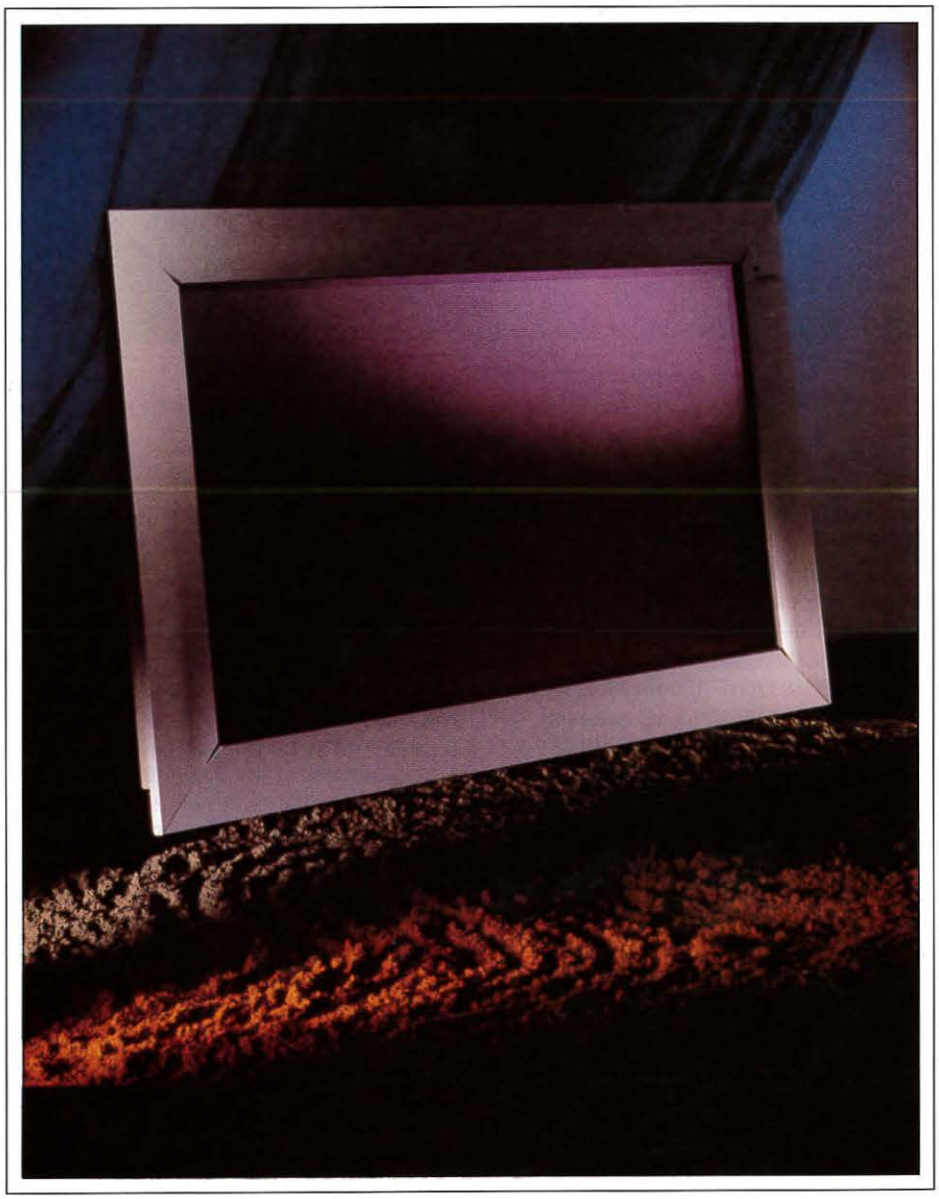
With reference to CRTs, the star exhibits ere definitely the "flats" – stunning new ony FD Trinitron®-tubed monitors on the tands of ***Sony*** (naturally) and ***Nokia***, and Mitsubishi NF DiamondTron™-tubed units rom ***Mitsubishi*** and ***LaCie***. In addition, LG Flatron tubes were seen in new models from *LG*, and ***Samsung*** was showing its Dynaflat™ tubes in two (17- and 19-in.) nodels.

The March of the 15-in. LCD

Fifteen-inch LCD models were everywhere, o it wasn't easy to pick out products from the rowd. But it was interesting to look at the roducts from the local boys – such as PC ssembler ***ASEM***'s Vision 151, the Tango 00 from ***McPerson*** of Pordinone, and the go TFT-AMLCD by ***Seleco-Formenti*** (Fig.). In its press release, ASEM claimed to be he "market leader in selling TFT-LCD moni-rs for office and industrial use, with sales of ver 10,000 units in Italy during 1998"! Many of these were shipped through Bull to ulfill the first phase of a contract with the talian Post Office. McPerson got the second hase of the PO contract and had been busily hipping its McPerson-branded LCD monitors or about a year. These were initially 10.4-in. nodels, then 12.1-in. units.

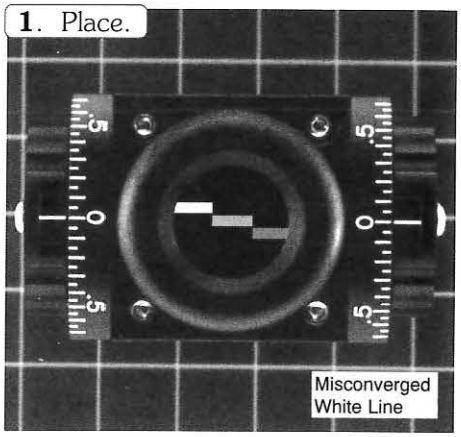
Seleco-Formenti's ego unit was shortlisted for the 1999 SMAU Industrial Award. It had been specially designed so it could function as an Internet surfer and a color TV screen, as well as a PC monitor. Accordingly, the strapline attached to this model was "a TV for the office or a monitor for your home." It was selling for Lire 3120k (US$1715). [All prices quoted here are recommended retail prices (RRPs) excluding local tax (20% in Italy), unless otherwise stated.] The company planned to launch an 18-in. version in January 2000.

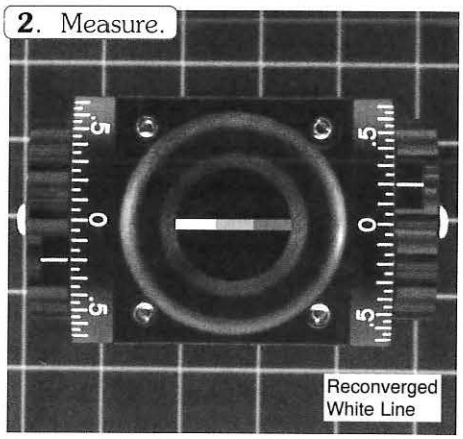
Offerings from the international suppliers included the new 1525H XGA 15-in. model, with both an analog and a digital input, from ***NEC,*** and the company's 15.4-in. LCD15125S, claimed to be the only model of its size to offer a resolution of 1280 × 1024. ***Panasonic*** had its three latest 15-in. models on display at the show, all with viewing angles of 160°. The top-of-the-line LC50SP can be rotated 90° on its axis.



Sambers

Fig. 2: *Sambers introduced the Hantarex PD42 Expansion plasma display, which had been nominated for the SMAU Industrial Design Award.*





those increasingly seen in new airport installations. In addition, Fimi still builds and sells its profitable range of monochrome and color 14–21-in. medical monitors.

CA&G Elettronica continues to manufacture around 200,000, mainly industrial, monitors at its plant in Cornedo, near Venice. Italy is the prime market for CA&G's monitors, though it also sells into other European countries such as Spain, Germany, and the U.K. (Nowadays, however, many of its computer monitors, which sell under the "Vidi" brand name, are brought in from the Far East.) Milanese maker ***Sambers*** reported steady growth of production and sales of its large-screen (CRT and plasma) Hantarex-branded information monitors.

Talking of the once great ***Hantarex***, ***Semio*** of Florence could now be said to be the true successor to this company, which used to make a million monitors a year. Using experience gained at Hantarex, the Semio team has been quite successful selling its Boxer range of mostly industrial monitors on the Italian market. Semio now aims to expand into other European countries. The current Boxer range, designed in Italy and made in China at a factory in which the Semio Group has a share, comprises 10 models from 10 to 19 in. Semio also has the Techno 14- and 17-in. professional open-frame monitors.

Finally, a new brand, Vibrant from ***Tatung***, was displayed on the stand of distributor ***ECC Elettronica***. The range shown included entry-level (54 kHz) and high-end (69 kHz) 15-in. CRT models, a 70-kHz 17-in., a 95-kHz 19-in., and a 15-in. TFT monitor. Distribution of the Vibrant brand started in the U.K. and is planned across most of the European countries. (The product is made in the Far East, not in Tatung's U.K. plant.)

The Italian Fortunes of the International Players

Fujitsu Siemens Computers had a large stand at the show on which all the exhibits (including the Siemens 18-in. LCD monitor) had been overbranded with the new joint-name logo. This new merger, with an official start date of October 1, 1999, had recently been given the go-ahead by the EC competition authorities.

Meanwhile, ***CTX***, which last year celebrated the opening of an office in Italy and had a booth at SMAU for the first time, was absent from this year's show. Unfortunately, the company has been operating under financial constraints during 1999 and the Italian office was closed in June. (The CTX office in France was also closed in June.)

SMAU '99 also witnessed another disappearance from the Italian scene, though this time not a company, but a brand name. The President of NEC Computer Systems Division ***EMEA*** announced that he and his team at ***NEC/Packard Bell/Zenith Data Systems (ZDS)*** had recently decided to stop running the ZDS brand of professional PCs. Henceforth, the NEC brand will be used for professional PCs and peripherals, and the Packard Bell brand will be kept for the consumer products. The ZDS brand of PCs has enjoyed a good name in the Italian corporate market, as well as those of France and Spain.

But if one brand name disappears, there are always plenty of new ones to take its place. ***Toshiba*** was demonstrating its range of Tekbright CRT monitors alongside its Equium desktop PCs introduced to Italy the month before the show. The local Toshiba representatives were promoting the 520 (30–69 kHz) 15-in., the 715 (30–86 kHz) 17-in., and the 920 (30–95 kHz) 19-in. CRT monitors – but no LCD models!

Summing SMAU

So, once again SMAU proved to be a vibrant show with a surprising number of new, previously unseen displays on exhibition, many of them from local companies. Although LCD monitors were everywhere, the cost-conscious Italians have yet to embrace the flat-panel monitor, except for certain buyers in niche markets. Therefore, LCDs accounted for less than 2% of the total monitor market in Italy for the half-year 1999, which is still dominated by the growing CRT market.

The "branded" color CRT-monitor market in Italy, which accounted for just under 8% of total Western European branded shipments in 1998, grew to account for over 9.5% of shipments during the half-year 1999. So prospects for another successful SMAU next year (to be held from October 19–23) look good indeed. ■

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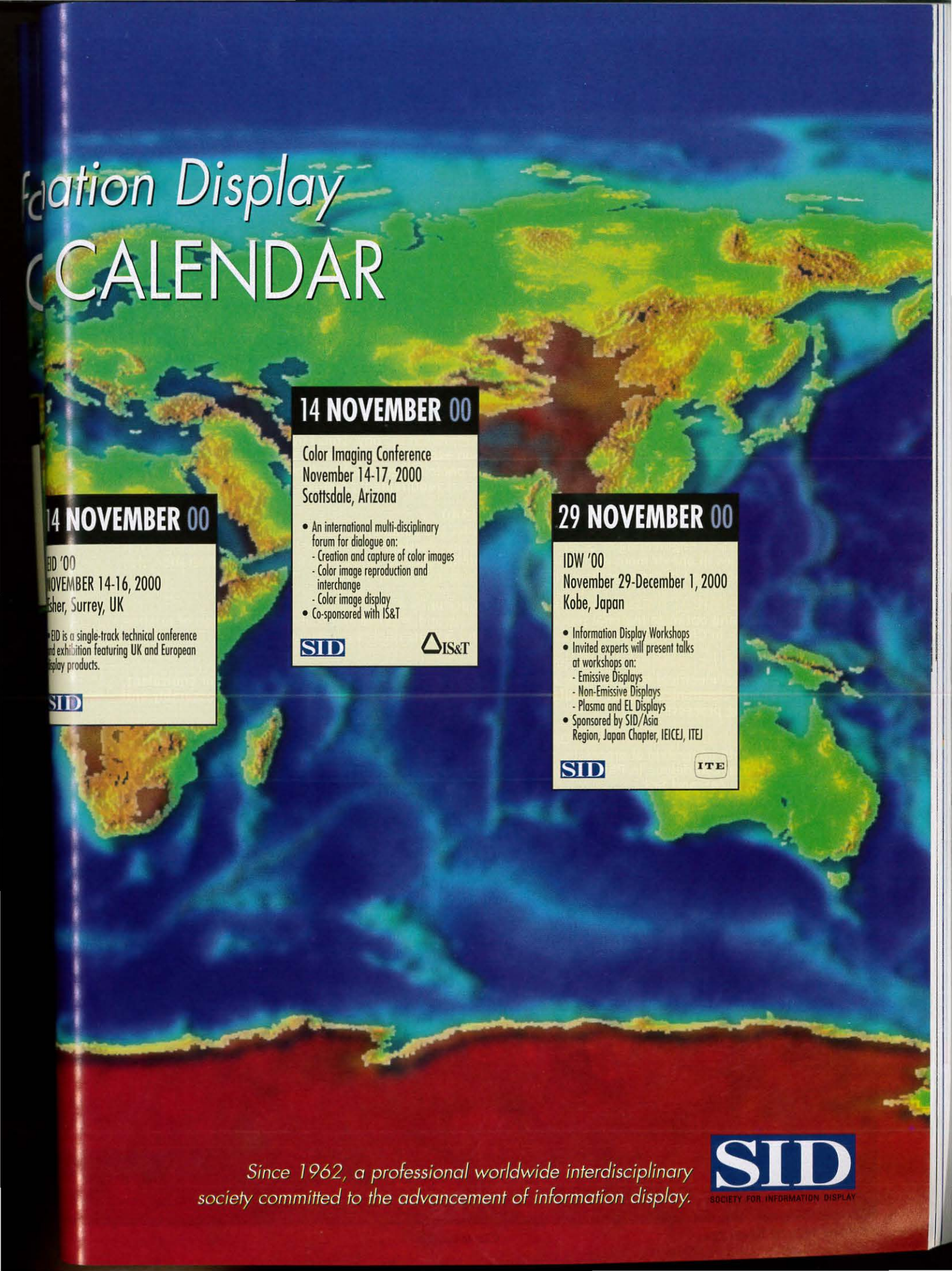
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Sixth International Display Workshops

In the old castle town of Sendai in northern Japan, IDW attendees learned of an explosion in plastic-substrate development and imminent FED commercialization in Taiwan.

by Ken Werner

FROM December 1 to 3, 1999, SID's Japan Chapter and the Institute of Image Information and Television Engineers (ITE) welcomed the last month of the old millennium with a technical conference possessing a unique character. As SID President Aris Silzars (Northlight Displays, Issaquah, Washington) put it: "This is where the people who actually make displays talk to each other."

IDW '99 had 998 registrants, roughly 300 more than IDW '98, owing in part to the presence of 127 registrants from Korea and 44 from Taiwan, said Organizing Chair Shigeo Mikoshiba (University of Electro-Communications, Tokyo, Japan). Two hundred eighty-four technical papers were presented, including 149 from Japan, 58 from Korea, and 26 from the U.S.

The technical program kicked off with a keynote address, "HDTV-Based Digital Broadcasting in Japan," by Toyoaki Hasegawa of Japan's national broadcasting company NHK. Unlike the U.S., which tailored its HDTV standard to the needs of terrestrial broadcasting, NHK began its much earlier efforts with satellite broadcasting in mind.

Japan's MUSE system was developed in 1983, and experimental MUSE broadcasting began in 1989 with 1 hour of broadcasting per day. By the end of 1999, 13 million households were receiving satellite TV signals. NHK and commercial broadcasters are now providing 119 hours of HDTV service per week. More than 1.9 million Japanese households now have HDTV receivers or widescreen TV with MUSE/NTSC converters. Increasing the hours of broadcasting and reducing the prices of receivers are recognized as being critical to growth, said Hasegawa.

NHK plans to launch its BSAT-2a satellite in 2000. It will have channel assignments in the 12-GHz band for seven HDTV programs and three SDTV programs, along with audio and data services, with one HDTV channel and two SDTV channels operational in 2000.

Hasegawa stated strongly that International Satellite Digital Broadcasting (ISDB) should not just be a digitalization of the current TV service. "It must bring new benefits to individuals and society. It must be a new service."

The second keynote address, "Display Technology and Computer Entertainment," was given by Masayoshi Tanaka, Senior Director of R&D, Sony Computer Entertainment, Japan (filling in for S. Okamoto, who was unable to attend).

Tanaka said that the electronic game business, which had $9 billion in sales in Japan in 1997, is in four distinct segments: PC, con-

Ken Werner

The technical sessions and exhibits for ID '99 were held in the Sendai International Center.

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

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Ken Werner

IDW participants frequently crossed paths and discussed papers in the lobby of the Sendai International Center.

sole (such as Sony PlayStation), portable (such as GameBoy), and location-based (arcade) systems. Each segment has a different business model, system technology, and display needs.

Portable game systems are making the transition from monochrome to color, and from standalone to connected systems. Currently, communication is local via IrDA or direct connection, but remote communication via cellular phone is coming. Portable games will have high performance and large memories.

The console segment has an interesting business model. The system maker, who owns the rights to his system's format, generally sells the hardware at such a low price that it is not profitable. However, software publishers pay a format user fee to the format holder, which makes the business profitable overall. Formats typically have a long life before they are replaced, and creating a major game is a big software project that typically has a creative staff of 15 people, takes 12–18 months to complete, and costs $2 million. For many years, the display for such games has been an NTSC/PAL consumer TV monitor. Will digital TV require or inspire breakthroughs on the part of content creators? Probably, said Tanaka, but digital receivers must become widely accepted first.

The new PlayStation 2 console, scheduled for March 2000 release in Japan and autumn 2000 release in North America and Europe, will be a high-performance graphics workstation, although the initial display focus will still be NTSC/PAL. There are two processors in the system: the "Emotion Engine" and a graphics synthesizer (or rendering engine), which can be upgraded independently for future versions. The PlayStation 2's Emotion Engine has 10 million transistors, the same as a Pentium III. Emotion Engine 2, scheduled for 2002, will be built with a 0.12-µm process and have 40 million transistors. The EE3 (in 2005) will be made with a 0.1-µm process and contain 100 million transistors. This growth curve is substantially faster than that for PC processors, Tanaka said.

In an invited paper in the CRT session, Hideki Kofune, formerly chief engineer for Mitsubishi Electric Corp. and now a consultant to LG Electronics, offered some proposals for CRT survival. Although the "last day of the CRT" has been frequently predicted – and just as frequently postponed – the LCD in its current state of development is a real threat, he said, and the price differential between 15-in. AMLCD monitors and 17-in. CRT monitors is decreasing.

Kofune predicted that the CRT's "last day" (as a mass-production product) would be the day when an AMLCD monitor compatible

Ken Werner

A popular place for IDW attendees to visit before and after the conference was the remarkably scenic Matsushima Bay, a half-hour train ride from Sendai. On the main street of the town of Matsushima, a friendly vendor offered Matsushima oysters and freshly grilled local fish.

Mitsubishi showed a large indoor display based on surface-discharge plasma technology rather than LEDs. The 160 × 160-mm modules can be tiled at will to make a display of almost any size. The unit on display had a 64-in. diagonal.

with a 20-in. CRT monitor has a street price less than 50,000¥ (US$420) and one compatible with a 17-in. CRT monitor has a street price less than 35,000¥ (US$290). Kofune based his prediction on the likely premium the market would accept for an AMLCD monitor based on the cost of space in an average Japanese house, but he believes the estimates looks reasonable in general.

However, Kofune listed a variety of things that can be done to extend the competitive lifetime of the CRT. The most critical of these is depth. Objects on a desk must be less than the width of the books on the desk, say 210 mm. Making a 210-mm-deep CRT monitor would be difficult, he said. This is especially true because, after the initial enthusiasm, short-necked tubes have not done well. Kofune had no immediate solution, but appealed to display engineers to do what is necessary to bring CRTs into the 21st century.

H. J. Kim and J. H. Souk (AMLCD Division, Samsung Electronics) presented another invited paper, "Low-Temperature Polycrystalline-Si TFT Technology," in which they described a new half-gate structure that reduces the number of required masks, and provides a self-aligned and symmetrical LCD structure. Using intrinsic silicon for the capacitor instead of embedding the plate would further reduce mask steps. They noted that the choice and preparation of the a-Si precursor is important to the structure and performance of the final polysilicon. Kim said they had made several small displays using the new structure and showed performance data.

In the question and answer session, Ernst Lueder (University of Stuttgart, now "retired" in Arizona and writing a book on LCD addressing) commented that the data showed variability in threshold voltage across the displays. Kim said, "Yes, we have to fix that."

H. Sekiguchi and his colleague from Dai Nippon Printing discussed in "Ultra-High-Contrast Screen" the basic limitation of the currently used double lenticular "black screen" (BS) for rear-projection (RP) displays. The screen offers good absorption of ambient light and, therefore, high contrast, but the lenticular pitch necessarily equals about 70% of the lens, *i.e.*, the screen's thickness. Since, for stability, the screen must be more than 0.5 mm thick, the pitch can't be much less than 0.3 mm. Because the ratio of lenticular pitch to pixel pitch must be at least 2/9 [actually $2/(2N+1)$ with N no less than 4] to keep moiré invisible, double lenticular lenses can not be used for the high-resolution HDTV images.

DNP's solution is the "ultra contrast screen" (UCS), a single-lenticular screen with a tinted surface. Incident ambient light is guided through the tinted portion and is absorbed much more than is the image light, which passes through the tinted portion perpendicularly. The final effect is that the UCS has lower transmittance than a BS, but equal contrast. However, the screen can be used only with projection engines producing a single light source, *i.e.*, that is with an LCD or DLP projector, not a CRT projector.

A member of the audience noted from the presented data that the viewing angle of the UCS seemed to be less than that of the BS. "Can this be improved?" The answer was: The viewing angle seems less from the presented data but it depends on various factors and is not always less.

In the succeeding paper, "Screens for Rear-Projection LCDs," Jeff Shimizu and Jill Goldenberg (Philips Research, Briarcliff Manor, New York) noted that CRT screens are inappropriate for LCD projection displays. Some DMD and LCD light-valve systems now deliver much higher MTF than CRT systems, which makes moiré more of a problem. Another problem with decreasing the pitch of a double lenticular screen and decreasing its thickness is that the number of diffusion particles is reduced, which leads to speckle. (For an explanation of how laser-like speckle can arise from a white-light source, please refer to the original paper, FMC2-3, in the printed or CD-ROM version of the IDW '99 Digest.) Another difference, this one advantageous, in the screens for LCD and DMD projectors is that because of the single light source, a Fresnel lens is not needed for color correction.

The authors feel that rear-projection LCDs are the most cost-effective approach for large-screen television. Screens designed for rear-projection CRT TV receivers are not appropriate for LCD and DMD rear projectors. The screen is a critical component, and solutions are coming – "but perhaps more slowly than we would like."

J. A. M. M. van Haaren and his colleagues from Philips Research (Eindhoven, The Netherlands) provided an extensive survey of various approaches to making reflective LCDs. The potential market for color reflective LCDs is large. Nokia and other customers have told Philips that cellular phones and other portable electronic products will have bright color displays. But a solution that gives a bright and colorful image under all lighting conditions has yet to be found. On the positive side, there are attractive areas for exploration.

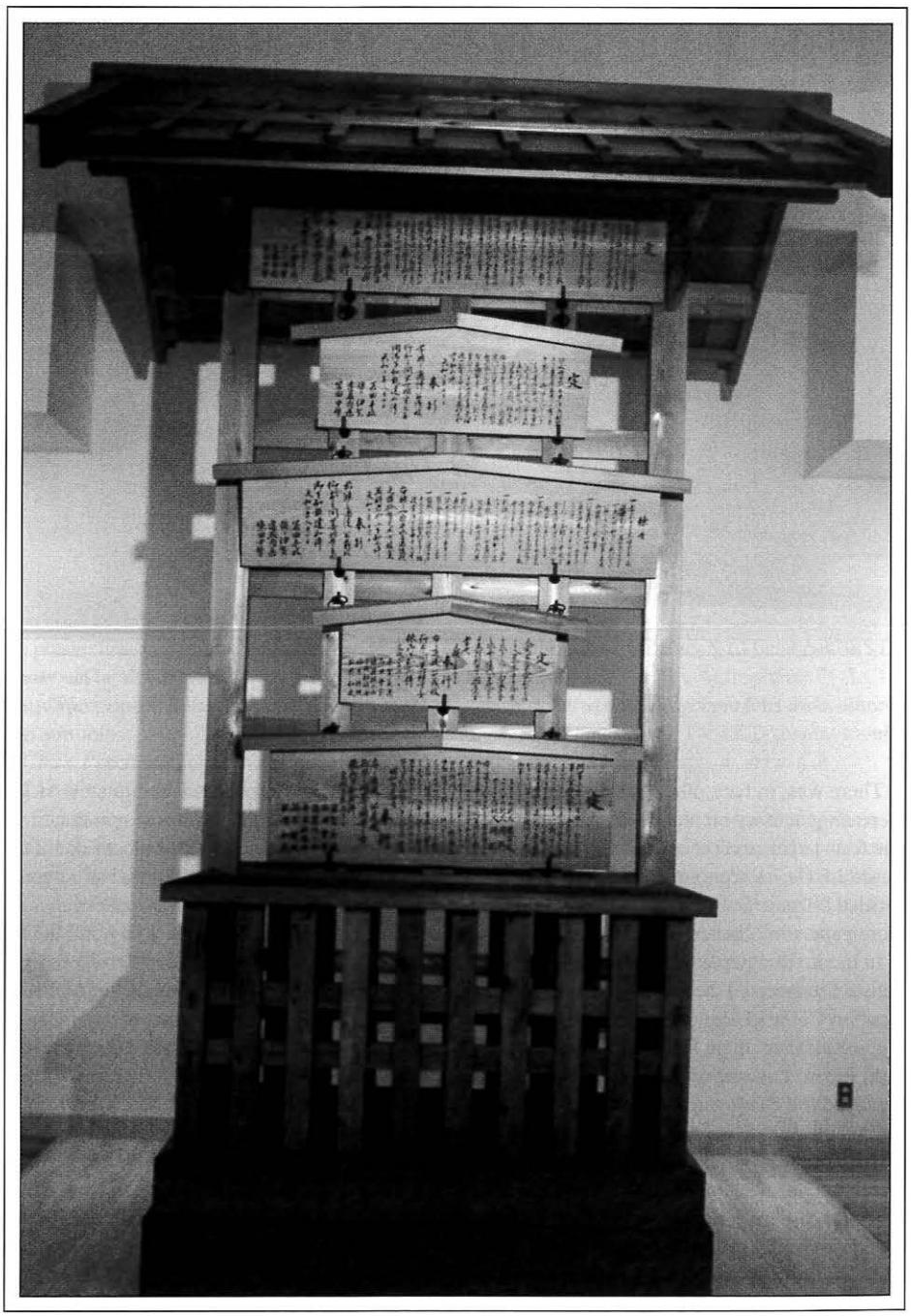
In "Polysilicon TFT Drivers for Light-Emitter Polymer Displays," Simon W-B. Tam of the Epson Cambridge Laboratory and his colleagues presented the advantages of polysilicon driving for LEP displays (LEPDs). Both analog and digital driver circuits are possible, but digital circuits are more appealing because they allow faster driving rates, self-diagnosis, and feedback to compensate for LEPD's inherent luminance fall-off with time. "It is possible to put a lot of functionality into a pixel driver with several transistors and other components, but at the cost of size and aperture ratio." The authors discussed several driver circuits and discussed the pros and cons of each. Among their conclusions is that "digital circuits combined with area dithering can provide a viable alternative for low- to intermediate-resolution displays."

Robert L. Wisnieff's "Super-High-Resolution AMLCD Technology" (IBM Research, Yorktown Heights, New York) made the point that although the goal in high-information-content display development is to allow electronic information to be displayed with the clarity and ease of paper, realizing that goal makes stringent demands on technology. Among the technologies needed for high pixel density are short-channel-length (6-μm) TFTs, high-conductivity row-and-column lines, fine-featured color filters, and tight cell-alignment tolerance.

One Word: Plastics

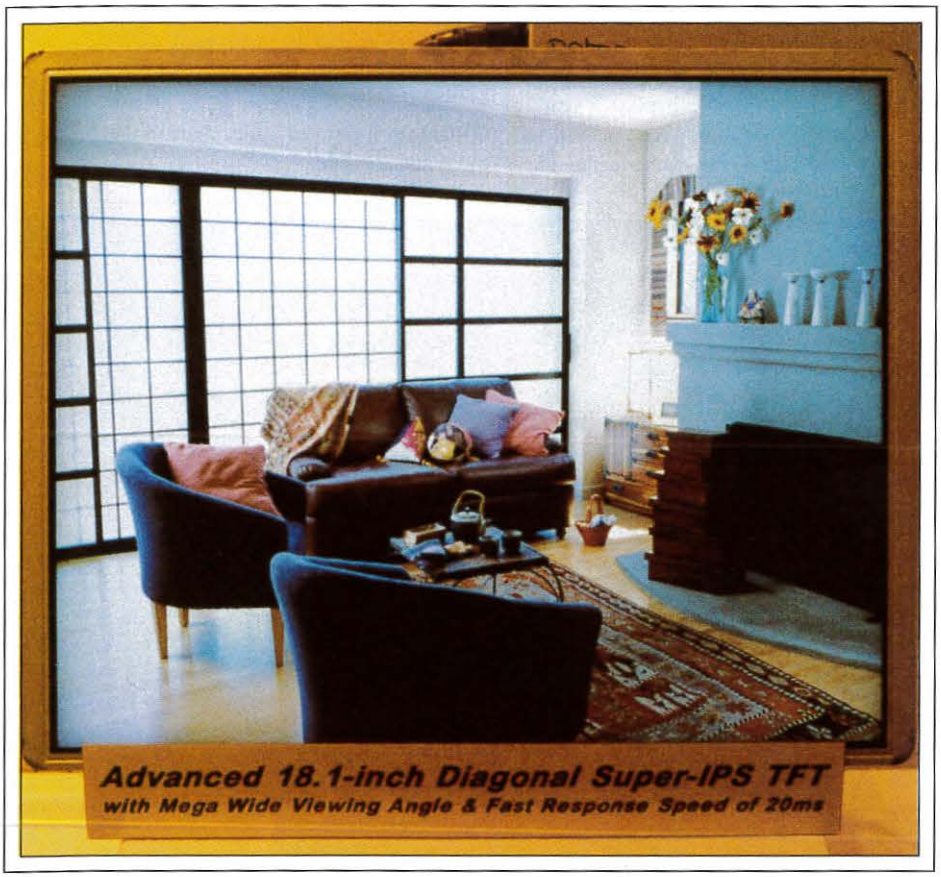
When Motfumi Watanabe began to present "Plastic LCDs for Mobile Applications," written by himself and two colleagues from Sharp Corp. (Nara, Japan), the room was packed. The advantages of plastic substrates, said Watanabe, are that they are half the thickness of glass (0.2 mm instead of 0.4 mm) and one-third the weight. It's 10 times stronger, making it hard to break when dropped. In addition, the thin substrate permits a virtually parallax-free display, so there is no double image in the reflective mode.

In 2000, Sharp will have the capacity to fabricate 4 million plastic displays a year. The company's technology road map includes a second-generation gray-scale display in March 2000, color-technology development in mid-2000, and the technology for a high-speed color display in early 2001. The development of low-birefringence plastic is important for improved optical performance, Watanabe said.



Ken Werner

Display kiosks are not new to Sendai. This style, shown in the Sendai City Museum, was used in the 17th century.



Ken Werner

Hitachi showed its very impressive 18.1-in. SXGA "Super-IPS" TFT-LCD with 20-ms response time.

There was, in fact, other evidence of increasing activity on plastic substrates, with one four-paper session entitled "Polymer-Based LCDs," a separate three-paper session entitled "Plastic Substrates," and at least four more papers in other sessions.

In the invited paper "Present Status and Future Prospects of Technological Development on Color PDPs," Tadatsugu Hirose and Kyoji Kariya (Fujitsu Hitachi Plasma Display Ltd., Japan) covered many design issues and surveyed the characteristics of three current Fujitsu plasma-display panels (PDPs).

To achieve a luminance in high-definition television panels equivalent to that in VGA PDPs, Hirose said, we must either use a high-speed single scan or a dual scan. Dual scan allows more time to display a pixel but needs double the drivers, which raises the cost. So if we stick with traditional technologies, we are stuck with higher cost or reduced luminance.

The solution, Hirose said, is Fujitsu's ALIS structure, in which 512 electrodes produce 1024 lines. Each line gets one electrode, not a pair of electrodes as in a traditional structure. There are no non-luminous areas between cells as in traditional designs, so overall luminance is higher.

FHP began mass production of the ALIS product in mid-1999, and new process ideas for further reducing the cost have been proposed.

"PDP is penetrating the market steadily," said Hirose. "But digital broadcasting must be the trigger for the growth of PDP. It will be brought to life and we will see its capabilities utilized." Two million units are projected for 2003.

Improving luminous efficiency and luminance by a factor of 2 or 3 is the most critical issue now. When achieved, a 42-in. PDP will have a luminance of 500 nits and a power consumption of 150 W.

In the question and answer period, moderator Larry Weber commented that ALIS is a clever approach to interlaced scanning that appears to be a good solution for TV, but may not be good for data applications. If, as projected, people wish to use their large displays for some computer/data functions, ALIS may not be suitable.

On Friday morning, Huang Chung Cheng (National Chiao Tung University, Hsinchu, Taiwan) delivered the paper "Research and Development of Field Emission Diodes and Displays in Taiwan" to a standing-room-only audience. Cheng sketched the history of FEDs from the first observance of field emission from a sharp point by Wood in 1897, through the development of the Fowler-Nordheim equation in 1928, to today's FEDs and FED companies.

Taiwan's ERSO/ITRI research laboratories have committed substantial R&D time to FEDs over the last few years, and they are enthusiastic about the potential. A new development is the carbon nanotube (CNT) FED. The cathode consists of bundles of CNT emitters in a thick-film paste. A high current density of 2000 $\mu A/cm^2$ that is stable with time has been obtained. Other novel emitters under investigation and characterization are chimney-shaped FEDs, diamond-clad silicon tips, and SiCN nanorods.

The Taiwan display industry isn't sitting on the sidelines. Unipac has invested $20 million in PixTech and has entered into an agreement to supply foundry services. Cheng predicts rapid FED industrialization starting now as a result of Taiwan's persistent R&D and existing marketing structure.

Immediately following Cheng's presentation, K. Konuma and his colleagues from NEC's Silicon System Research Lab presented a paper on using field-emission arrays (FEAs) to replace the traditional hot cathode in CRTs. NEC has put 868 emitters within a 50-μm-diameter circle. The FEA features a high current density of 50 A/cm^2, a low modulation voltage that is independent of anode voltage, a precise on-chip focus electrode, and overcurrent protection. Konuma showed a gun structure with an FEA cold-cathode electron gun. The overall structure was similar to the traditional one. It should be possible to get a spot size smaller than one gets with a hot cathode, and the system's low V_{gk} is appropriate for HDTV.

A sizeable team from Polaroid, ColorLink, and ROLIC Research presented a very-well-attended presentation entitled "Integral-Color Plastic Liquid-Crystal Display – The Ultimate Flat-Panel Display." The presenter, Joseph DelPico of Polaroid, described how the three companies have been pooling their expertise: ColorLink's polarizer/retarder/LC color-shutter technology, ROLIC's thin-coated LCP/optical-axis-selectable biaxial retarders, and Polaroid's roll-to-roll precision coating onto thin plastic substrates.

There is still substantial development to be done, but the approach is very appealing for several reasons:

- Because light is controlled by polarization rather than absorption, transmission is six times greater than that of a DSTN display.
- If the entire integrated display is made on a plastic substrate it can be very thin.
- Roll-to-roll processing can make large (and small) displays very inexpensively.

There's room for a new partner to get on board. Troubled Polaroid is pinning its salvation on a "back-to-basics" (back to buggy whips?) approach that gets the company out of high-technology initiatives such as this one.

The preceding sections of this article have just scratched the surface of a very rich, high-quality technical program. If you are interested in digging deeper, I recommend obtaining a copy of the IDW '99 Proceedings in either its hardcopy or CD-ROM version.

Heard in the Hall

Don Carkner (Westaim ADT) had an 8.4-in. thick-dielectric EL display in his room in the Sendai Tokyu Hotel, which was overflowing with interested observers following the conference banquet. The display was running video and pumping out 100 or so nits, said Don. The blue looked very rich, saturated, and quite bright in the subdued lighting of Don's room. It's the old blue phosphor compound but a new preparation. The red was a bit orangey, which was due to a slightly misaligned mask, he said. It wasn't a problem with the phosphor.

On the following day, Xingwei Wu, Westaim ADT's Director of R&D, explained that the company is now using patterned phosphors: cyan under a blue filter and yellow under red and green filters. The two phosphors are well-known, he said. The yellow is very efficient, and the cyan under blue is giving them good results. They did nothing special to the demo unit to get the good CR and anti-reflection seen in the hotel room. The materials are inherently non-reflective, and, below threshold, the phosphor is completely off. Both phosphors have a lifetime of 10,000 hours or more; Westaim has not yet done life testing of the patterned display.

In the lobby of the Sendai International Convention Center, where the technical sessions were being held, Sony's Mike Maeda told *ID* that 70% of Sony CRTs will be completely flat this year; 90% next year. Flat CRTs require 10% more glass than conventional tubes. Now that everyone is jumping into the flat-CRT business, there's a glass shortage. But the glass companies have no plans to produce more CRT glass because investment in other glasses, including LCD glass, promises more return. It's a problem.

Exhibits

A respectable collection of desktop exhibits enhanced IDW '99. ***Hunet LCD*** was showing the latest implementation of its field-sequential-color (FSC) LCD approach – an impressive 1.5-in.-diagonal quarter-VGA display for cellular phones. The refresh time is 2 ms, and the production version will display 260,000 colors. (The demo was displaying eight colors.) The price is $20 each if one buys 1 million a month.

Chuo Precision Industrial Co. was featuring its Optical Measurement System (OMS) for measuring liquid-crystal properties such as pre-tilt angle, retardation, and anchoring energy. The system was developed in cooperation with Prof. Tatsuo Uchida of Tohoku University.

Toyo Corp. showed its liquid-crystal-evaluation system, and ***Otsuka Electronics*** was providing information on its Photal inspection systems for LCD production lines.

Mitsubishi showed the first large full-color indoor text and graphical display device to be based on a surface plasma-discharge structure, which uses two electrodes. The panel will compete with large LED displays, and is not only more efficient than LED modules but is also more efficient than traditional surface-discharge PDPs at 2.5 lm/W. The display is tiled, with each 160 × 160-mm module containing 256 full-color pixels on a 10-mm pitch and weighing 650 grams. The maximum luminance is 2000 cd/m^2; service life is 30,000 hours. A 64-in. assembly was being shown, and the technology was described in late-news paper PDP5-4.

Fujitsu Kyushu System Engineering, Ltd. Software and Service (FQS) was promoting the new seventh edition of the LiqCryst 3.3 database of liquid-crystal compounds.

OSRAM showed the Planon™ mercury-free planar backlight shown at SID '99 and EuroDisplay, and also hosted a reception Thursday evening to discuss the lamp's technology. The lamp's lifetime is very much longer than tube-type backlights, in which the light guide discolors, causing luminance to decrease faster than the lamp output decreases, said Product Manager Udo Custodis. The lamp's luminance is equivalent to a ten-tube backlight. Efficacy is about 35 cd/W.

The lamp is currently in testing with several partners, including Samsung, said System Integration Specialist Hermann Schweizer. The current plant in Germany is being expanded to a capacity of one thousand lamps per month. The next plant, much larger, will probably be located near a major customer. The price in small quantities is $500, which includes an inverter power supply that also supplies the monitor with 12 Vdc. The price in high-volume quantities will be about $250.

Agfa was showing its Agfaspheres™ (LCD spacer spheres) and ***Orgacon*** DIS foil with organic conductors for TN-LCD displays and Orgacon EL for EL lamps, as shown at EuroDisplay in Berlin.

Furuya Metals was enthusiastically showing its new AgPdCu (APC) target that solves the corrosion and etching problems encountered with traditional alloy targets, said Kuni Kanno. APC can be deposited directly on SiO_2 and ITO, with a contact resistivity of 20–25% that of Al alloy, so Kanno regards it as a candidate for replacing Al, Al alloy, Ti, Ta, Cr, and Mo. APC is highly reflective, so Kanno also sees it as a candidate for reflective AMLCDs.

ULVAC Coating Corp. was showing its non-chrome ULCOAT low-reflectance metal film for the black-matrix color filters.

Sumitomo Chemical was presenting its wide range of optical films for LCDs, including SUMIKALAN™ polarizing films (some with additional functions such as anti-reflection, smudge resistance, and anti-static characteristics) and SUMIKALIGHT™ retardation films (including those for wide viewing

angle, temperature compensation, and high-wavelength dispersion).

Hakuto Co. was promoting its PDP photo-processing line. The company has installed six or seven R&D units for most of the leading makers, and has now developed in-line systems for mass production, starting next year.

Seria presented information about its high-precision screen-printing machine from Tokai Seiki Co. (Gifu, Japan). The machine features low printing pressure for fine patterns and high uniformity in PDP fabrication.

Tokyo Cathode Laboratory was featuring its Field Emission Profiler and ***ISE Electronics Corp.*** was showing a range of ***Noritake*** Itron VFDs. ***Shintech*** was showing its "Optipro" retardation measuring device and LCD Master modeling and simulation software. TFTLCD is an additional module that models the transient characteristics of TFT-driven LCD panels. ***Minolta*** was showing its well-known array of display measuring equipment.

Hitachi showed its TFT-LCD with Super-IPS mode that delivers a 20-ms optical response. The 18.1-in. SXGA display delivered a beautiful image. Also shown was the Hitachi Prius Deck 610M monoputer with Hitachi's handsome 15-in. Super-IPS AMLCD. This nicely packaged computer was completely invisible behind the display. Only the slots were visible in front. Video was being shown on the display, and it was beautiful. Here was digital crispness with no artifacts that I could see.

SAES Getters was showing small getters for micromachines, as well as larger getters for CRTs and FPDs. The company's HQ is in Milano, Italy, and has a sales office in Tokyo, Japan. ***Nissho Electronics***, DisplayTech's Japanese distributor, was enthusiastically showing ***DisplayTech***'s quarter-VGA microdisplay for camcorder viewfinders.

Pioneer was showing its 50-in. WXGA PDP-502MX Hi-Vision PDP. From the model number I assume the panel is a product. But if what I saw is typical, commercializing this very promising panel is a bit premature. The panel exhibited swimming artifacts (which have been common in the industry) and subtle more-or-less vertical dark lines that I've never seen before. Except for these artifacts, still images were striking, with good detail and rich colors, but there was also a slight jitter on slow panning.

In contrast, the ***Plasmaco/Panasonic*** 60-in. prototype shown in the author interviews was absolutely beautiful and virtually defect-free. Plasmaco's Larry Weber said the minor artifacts seen at SID '99 are now gone, and that the panel will be a product in 2001. This is the best large PDP I've ever seen, and I would have called it artifact-free. But Shigeo Mikoshiba has a more educated eye than I do. He spotted a subtle green leading edge on black moving objects, which he attributed to the characteristics of the P1 phosphor used by Plasmaco (and virtually all other PDP makers). He agreed that the display was excellent.

The International Display Workshops has become a technical display conference of excellent quality and extraordinary interest. The next IDW will be held from November 29 to December 1, 2000, at the International Conference Center in Kobe, Japan. ■

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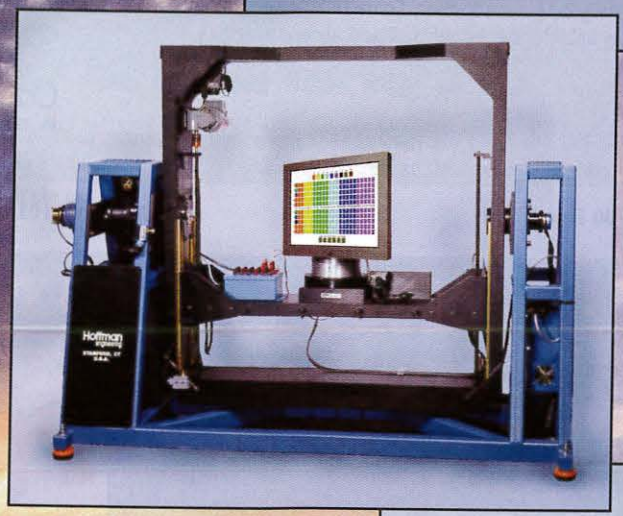

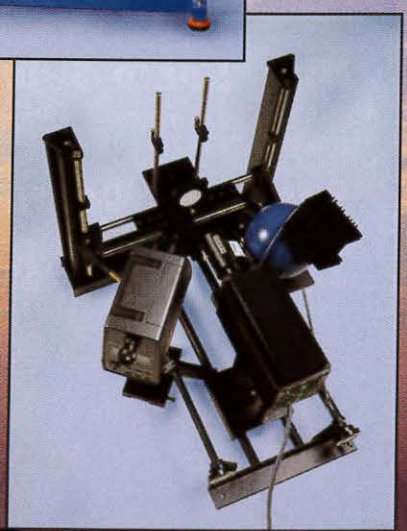

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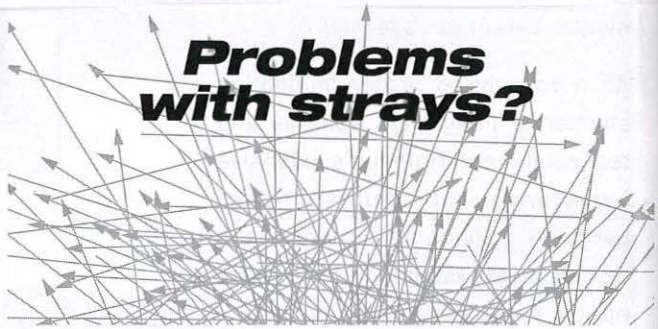

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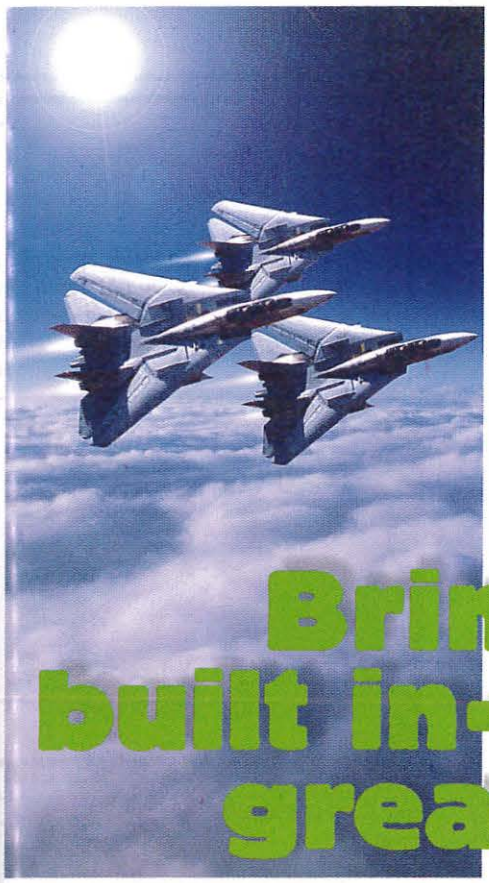

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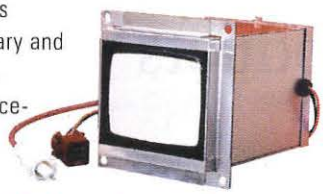

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Products on Display at SID 2000

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

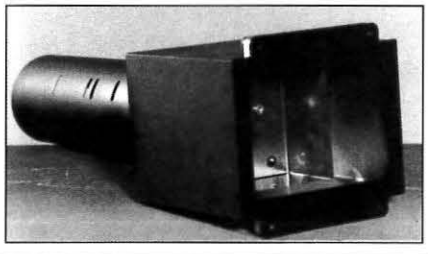
by The Editorial Staff

THE SID 2000 *International Symposium, Seminar & Exhibition will be held at the Long Beach Convention Center in Long Beach, California, the week of May 14. For 3 days, May 16–18, leading manufacturers will present the latest displays, display components, and display systems. To give you a preview of the show, we invited the exhibitors to highlight their offerings. The following is based on their responses.*

AD-VANCE MAGNETICS
Rochester, IN 219/223-2524
Booth 109

Magnetic shield

Ad-Vance Magnetics will feature a magnetic shield that will be used with the Telecine Millennium Machine being produced by Innovation TK, Hertfordshire, England. With its 4K option, the Millennium machine provides the user with total control over resolutions up to 4096 × 4096. As the video production community gears up for both HDTV and high-resolution data scanning of film, this device will become more and more popular.

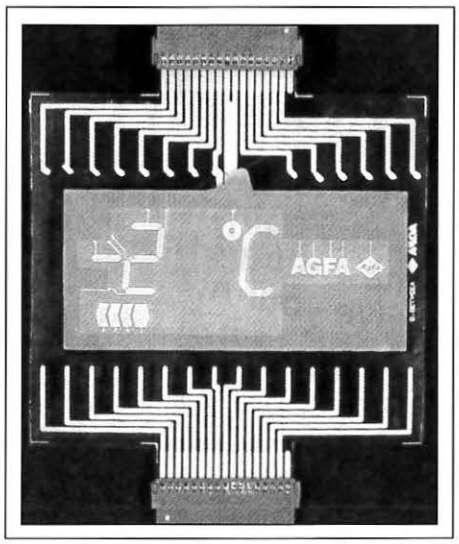


Circle no. 1

AGFA GEVAERT
Mortsel, Belgium +32-3-444-2996
Booth 1003

Polymer alternative to ITO

Agfa Gevaert will feature Orgacon™ EL, a newly developed transparent conductive film for electroluminescent and display applications composed of a PET base coated with PEDOT (polyethylenedioxythiophene) conductive polymer. The film, offering a sheet resistance of 2500 Ω/❑ at a transparency of over 85%, has been validated for EL lamp manufacturing. Orgacon™ EL features a much higher scratch resistance when compared to ITO (no protective liner needed), and it can be embossed. Manufactured in a high-speed wet coating process, the film is stable in water and many solvents. Conductive patterns are easy to create by using a one-step de-activation ink, leaving a smooth surface after patterning.

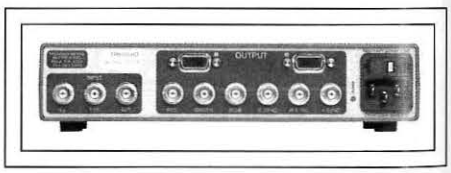


Circle no. 2

ALTINEX, INC.
Brea, CA 714-990-2300
Booth 114

HDTV transcoder

ALTINEX will be exhibiting the TR6102HD, an HDTV transcoder that accepts a component video signal in a Y, Pb, Pr format and converts it to a standard RGBS or RGBHV format. It is capable of handling SMPTE 240, 480p, 720p, and 1080i formats. The TR6102HD also offers a built-in distribution amplifier, providing three simultaneous outputs (two on female 15-pin HD connectors and one on six BNC connectors (RGBSHV).



Circle no. 3

ANTEON CORP.
Mystic, CT 860/572-9600
Booth 932

Automated microdisplay inspection system

Anteon Corp. will feature DisplayCheck-μD™, the latest release in their family of high-performance display-inspection systems. Based on National Instruments' LabVIEW™ and TestStand™ software development tools, DisplayCheck-μD provides a flexible open development environment for inspecting microdisplay devices. The system consists of high-resolution optics, image acquisition, and DUT motion-control hardware, as well as image analysis software for the testing of pixel and line defects, gray-scale uniformity, absolute bright-

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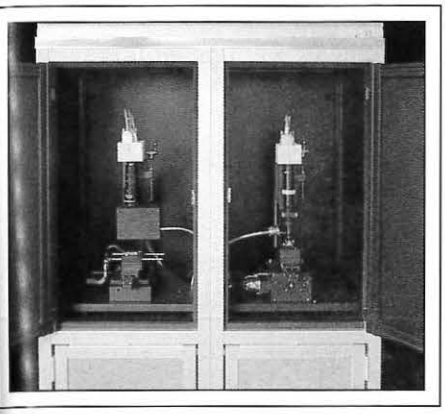
ness, contrast, blemishes, Newton fringes, texture, and crosstalk. A spectrometer can be optionally added for color measurement. The system can also inspect seal and wiring integrity or package labeling.

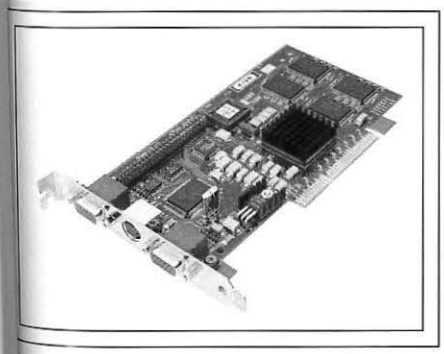


Circle no. 4

APPIAN GRAPHICS
Redmond, WA 425/882-2020
Booth 530

Gemini DVI-I

Appian Graphics' Gemini™ DVI-I is the first card to power two digital flat panels using DVI 1.0 specifications. Offering combined analog and digital support, the card is available in an ATX form factor for AGP or PCI slots and delivers accelerated graphics across multiple displays with resolutions up to 1280 × 1024.

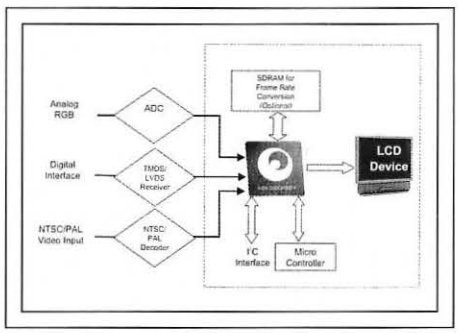


Circle no. 5

AURORA SYSTEMS
San Jose, CA 408/452-5559
Booth 531

Digital processors

Aurora Systems will feature the ASI 320/321, a digital processor that integrates multiple high-performance image components to produce superior image quality. Its principal features include an advanced fully programmable up/down scalar, a frame-rate converter, a frame interlock engine, integrated on-screen display, a Genlock generator, an advanced video processor, integrated video de-interlacer, and embedded systems features support. The scaling engine supports maximum UXGA (1600 x 1200) resolution.

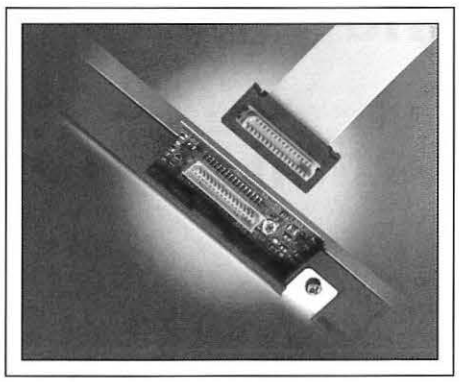


Circle no. 6

AXON' CABLE
Mount Prospect, IL 847/699-8822
Booth 657

Flat cable assemblies

Axon' Cable will feature AXOLINK®, a flat cable assembly that consists of a 0.5-mm flat flexible cable with 31 or 41 conductors connected to a Hirose DF-9 interface at one end and either another DF-9 connector or a ZIF termination on the other end. A molded strain relief mechanically strengthens the DF-9 connector. AXOLINK® can be used for all board to flat-panel-display interconnects where the Video Electronics Standards Association (VESA) Flat Panel Display Interface (FPDI-1) is specified. The main advantages of AXOLINK® is lower cost, reduced dimensions due to the 0.5-mm flat cable, low profile, and narrow-width design. The length of the assembly can be adapted to any application. To resolve any EMI issues, Axon' Cable also offers shielded versions of AXOLINK®.



Circle no. 7

CELCO (CONSTANTINE ENGINEERING LABORATORIES CO.)
Rancho Cucamonga, CA 909/481-4648
Booth 200

High-definition film recorder

CELCO will introduce the *eXtreme HDR*, a high-definition film recorder optimized to image HDTV to film in 5 sec/frame. The *eXtreme HDR* makes feature-length digital motion pictures a reality. It can accommodate 35mm film at up to 2K resolution and image to either camera negative or Eastman 5244 intermediate stock. The *eXtreme* NITRO™ provides all the power for the *HDR* and adds the ability to shoot up to 8K resolution to any format from 16 to 65 mm IMAX.

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Circle no. 108

COLORADO MICRODISPLAY
Boulder, CO 303/546-9700
Booth 757

Microdisplays

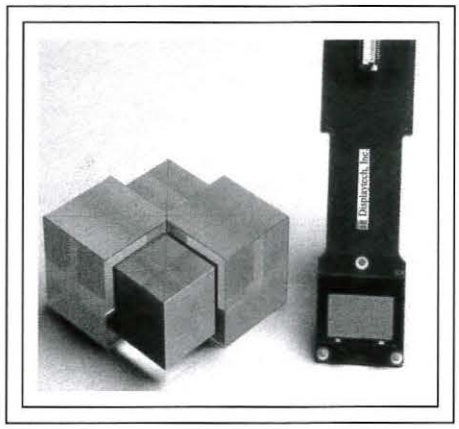
CMD's microdisplays feature high resolution, high refresh rate, full color, and low power at low cost, and are fabricated using a breakthrough liquid-crystal–on–silicon technology referred to as Dynamic Nematic Liquid-Crystal on Silicon™ (DNLCOS). The DNLCOS microdisplay technology and accompanying interface ASICs support a full range of content from text to full-motion video.

Circle no. 9

COLORLINK
Boulder, CO 303/545-5843
Booth 1301

Color-management architecture

ColorLink will introduce ColorQuad™, color-management architecture for three-panel LCoS-based projection systems that achieves contrast in excess of 800:1 at *f*/2.0 and covers the SMPTE 274 color gamut with a UHP lamp. High throughput is achieved with ColorLink's proprietary lossless retarder stack filters, and the novel architecture is insensitive to thermally induced stress birefringence. Lifetime-tested, production-ready, and priced less than market designs currently available, ColorQuad™ will meet the demands of the LCoS-based projection market.



Circle no. 10

CYRO INDUSTRIES
Rockaway, NJ 973/442-6000
Booth 930

Antireflection acrylic sheet

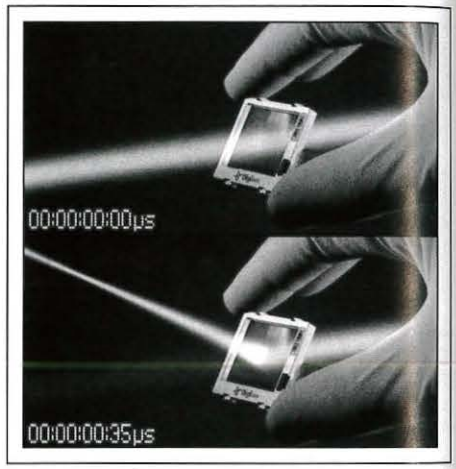
CYRO Industries will introduce ACRYLITE®, an abrasion-resistant AR acrylic sheet for flat-panel-display protection that is lightweight, impact resistant, rigid thermoplastic, and coated with the proprietary 3M 906 abrasion-resistant coating under exclusive license from the 3M Company. ACRYLITE AR sheet is ideal for protecting flat-panel displays in medical, industrial, touch-screen, or rugged military applications, and provides premium optical quality and the chemical and abrasion resistance needed to stand up to frequent cleaning and handling. ACRYLITE AR sheet is available in clear, contrast-enhancing tints, and a matte finish surface to reduce glare.

Circle no. 11

DIGILENS
Sunnyvale, CA 408/737-1100
Booth 845

Application-specific integrated lenses

DigiLens has developed optical switching applications for displays and telecommunications. Components and subsystems are created from multiple, electrically switchable, holographic optical layers that can either encapsulate the prescriptions of multiple lenses or filter light into separate R, G, and B colors. This noiseless miniature component saves space, weight, complexity, and cost. The company packages its technology as application-specific integrated lenses (ASILs) for a variety of display and filtering applications used in front projection, rear projection, TV, and miniature near-eye displays.

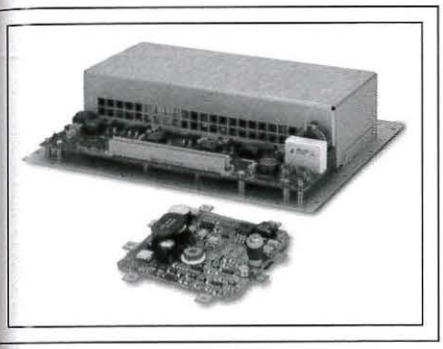


Circle no. 12

ELDEC
Lynnwood, WA 425/743-8301
Booth 136

Power Supplies

ELDEC designs and manufactures high-voltage power supplies for CRT applications, low-voltage power supplies for flat-panel applications, and patented backlight drivers for totally integrated AMLCD power solutions. ELDEC also provides custom and semi-custom power solutions for demanding commercial and military applications where operating under severe conditions is an everyday occurrence.

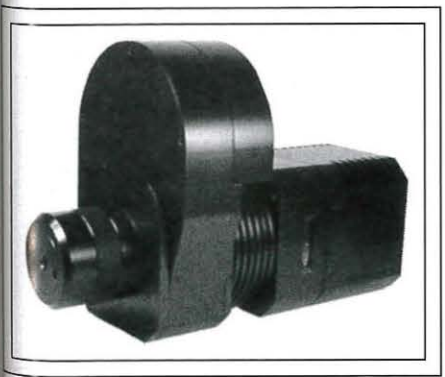


Circle no. 13

ELDIM
St. Clair, France +33-02-31-94-76-00
Booth 557

Video photometer

ELDIM will feature Muratest, a highly sensitive video photometer that examines area uniformity on backlights, FEDs, LCDs, dashboard displays, and microdisplays. The measurement of luminance, contrast, and color, as a function of the position on the sample, is realized in less than a minute, with a resolution of 512 × 768. The 16-bit converter combined with a very low-noise cooled CCD make it the ideal tool for measurements on very dark samples. Various lenses are available.



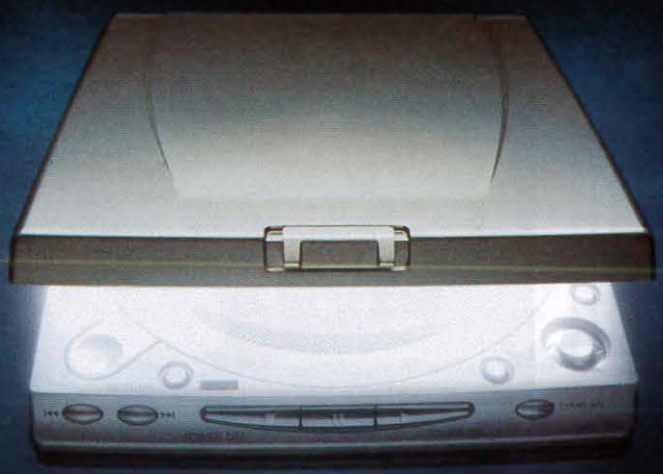
Circle no. 14

EL KOREA CORP.
Taejon, Korea +042-864-0277
Booth 835

High-brightness EL lamps

EL Korea Corp. will feature high-brightness green and white EL lamps with high luminous efficiency, resulting in low current and low power consumption for both high- and low-voltage operations, making them suitable for mobile-phone applications as well

"BRILLIANT."
"UNBELIEVABLE."
"VERY COOL."
"FABULOUS."
"WOW."



When people see OLED Display Technology from Kodak for the first time, their eyes go wide. Then come the praises. And it doesn't take a technical explanation to dazzle them (although they're pretty impressed with that, too). Bright, sharp, full-color images packed into a thin, lightweight display that almost defies reality. That's why companies like Pioneer and Motorola are already putting it into their state-of-the-art products.

We're talking maximum impact. And it's available today.

We can't wait to hear what you think of it, too!

OLED Display Technology from Kodak: See it. Believe it.

See it at SID, booth #914. www.kodak.com/go/OLED

Circle no. 110

SIMULATION SOFTWARE AND CONSULTING FOR LCD AND BACKLIGHTING

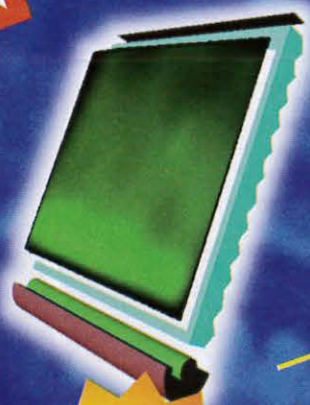
MEET US AT THE SID' 00 • BOOTH 1404

SPEOS

DESIGN

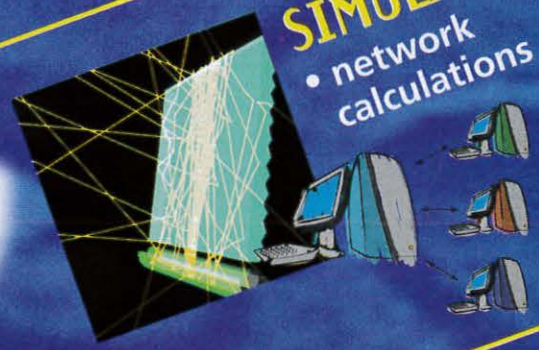
- 3D patterns mapping (texturing)
- CAD import (IGES, STEP, DXF, SAT, CATIA)
- LCD screen design
- simulate any type of lamp and LED

NEW FOR ILLUMINATION DESIGN

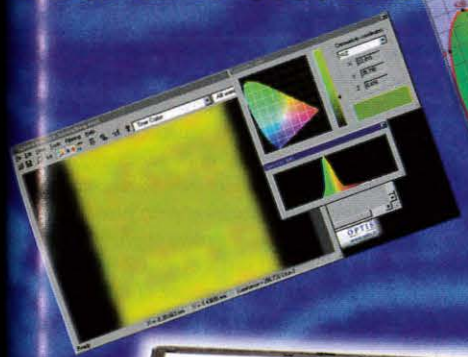


SIMULATION

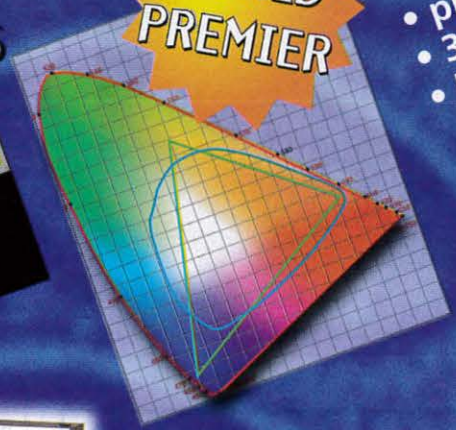
- network calculations



THE FASTEST AND EASIEST WAY TO DESIGN AND OPTIMIZE YOUR DISPLAY SYSTEMS

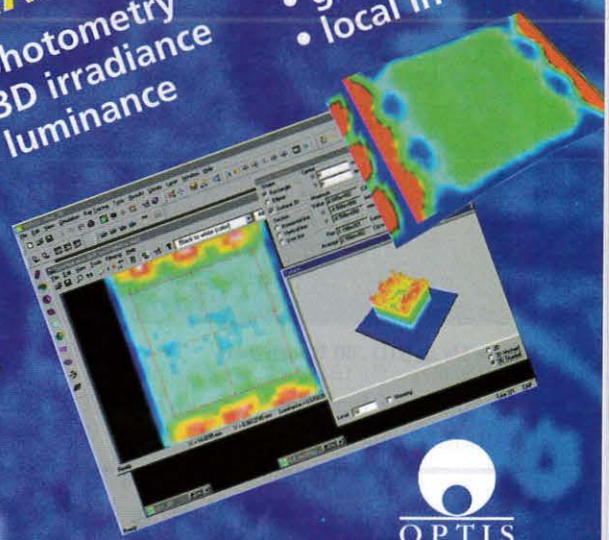


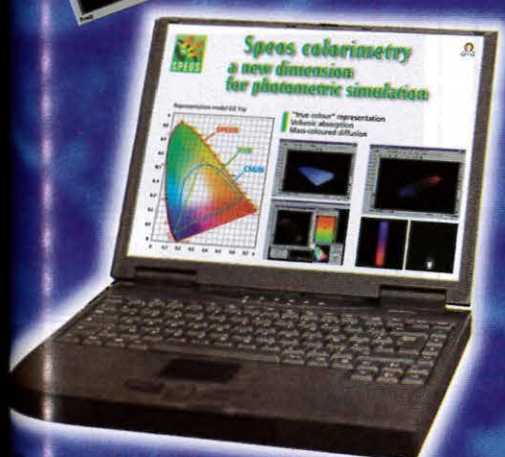
WORLD PREMIER



ANALYSIS & OPTIMISATION

- photometry
- 3D irradiance
- luminance
- colorimetry
- global intensity
- local intensity





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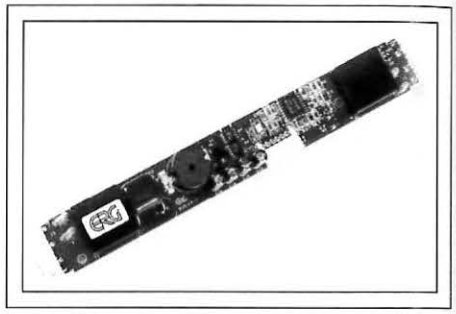
as for any LCD backlighting application. The maximum brightness attainable at 100 V and 400 Hz is in excess of 90 and 100 cd/m^2 for green and white EL lamps, respectively. Current consumption does not exceed 0.2 A/cm^2. Large-sized EL lamps in standard sizes up to a maximum of 420 × 600 mm are also available either in plain or custom design patterns.
Circle no. 15

ENDICOTT RESEARCH GROUP
Endicott, NY 607/754-9187
Booth 434

Closed-loop dc/ac inverter

ERG will feature the DMB Series of closed-loop dc/ac inverters designed to provide reliable, highly efficient power for backlighting large LCDs with up to four cold-cathode fluorescent tubes. The power efficiency when using the DMB Series is as high as 90%, unsurpassed by dc/ac inverters of its type. Brightness can be controlled while remaining "flicker-free" throughout the entire range. An optimized form factor for direct display connection to popular 17- and 18-in. flat-panel displays is included.

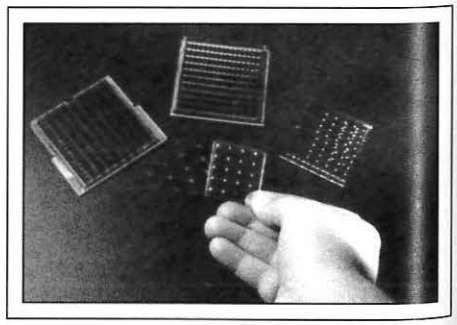


Circle no. 16

FRESNEL OPTICS
Rochester, NY 716/647-1140
Booth 164

Projection-display lens array

Fresnel Optics will exhibit lens arrays used in projection systems as light integrators, traditionally manufactured in glass but now available in a wide variety of optical-grade polymers including high-temperature plastics. Using Fresnel's High Precision Molding (HPM) Processes, these components have improved efficiencies and very low birefringence for polarization-sensitive applications. Specialized coatings and surface treatments are available to enhance the performance of these lens array for dual functionality in a single component.

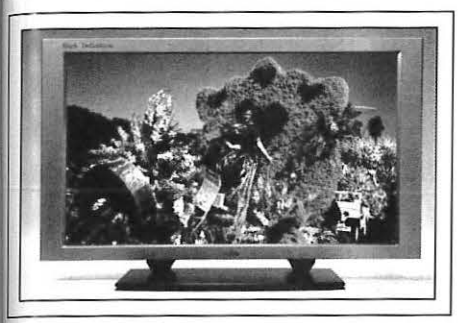


Circle no. 17

FUJITSU MICROELECTRONICS
San Jose, CA 408/922-9000
Booth 312

High-definition plasma displays

Fujitsu Microelectronics will feature ImageSite color plasma displays. System integrators can build their own monitors based on ImageSite color plasma components.



Circle no. 18

HOLTRONIC TECHNOLOGIES
Marin, Switzerland
Booth 540

Lithography systems

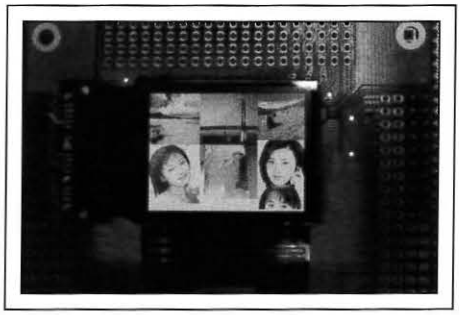
Holtronic Technologies will be presenting the HMA500, a high-precision lithography system for high-resolution flat-panel-display manufacture. The system features Holtronic's patented holographic imaging optics that allows for full-field display patterning up to 14 in. on the diagonal (stitched patterns for larger displays), with resolutions as small as 0.5 μm. The HMA500 is suitable for both R&D and production environments, with fully automated substrate and mask handling. With a 500 × 400 mm substrate capacity, this product provides an important new capability for manufacturers of polysilicon TFT-LCDs and FEDs.

Circle no. 19

HUNET LCD
Tokyo, Japan +81-3-3780-2511
Booth 156

Color filterless LCDs

Hunet LCD will feature 1.5-in. high-density QVGA full-color LCDs without color filters for mobile applications. These LCDs demonstrate less power consumption, lower manufacturing costs, increased information capacity, and higher contrast.

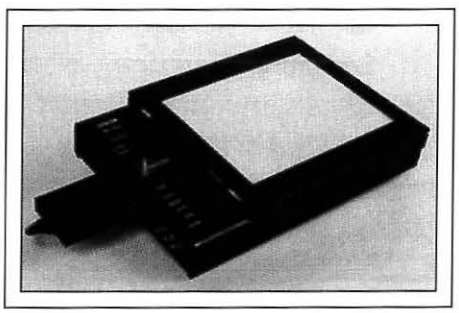


Circle no. 20

INCLINE
Newbury Park, CA 805/376-3300
Booth 651

LCD universal test system

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

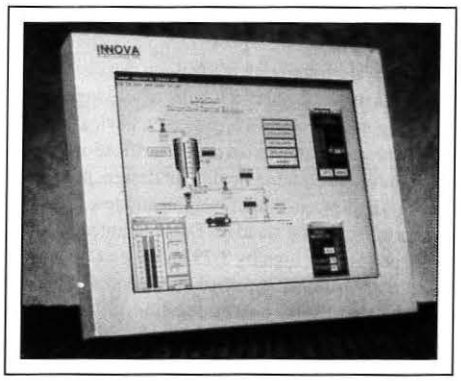


Circle no. 21

INNOVA ELECTRONICS
Houston, TX 713/690-9909
Booth 443

Industrial color monitors

Innova Electronics will feature the STS-4000 series of rack- and panel-mounted LCD color monitors designed for use in a wide range of applications requiring large touch-screen-based displays. The monitors are available in sizes up to 18.1 in. with auto-dimming sunlight-viewable display options. Visible regardless of ambient light conditions, the new monitors feature resolutions up to SXGA (1280 × 1024) and standard analog VGA interfaces, making special drivers or interfaces unnecessary. Operating temperatures range from 0° to +50°C; storage temperature range from -20° to +70°C.



Circle no. 22

INTERFACE DISPLAYS & CONTROLS
Oceanside, CA 760/945-0230
Booth 630

Multi-purpose control and display unit

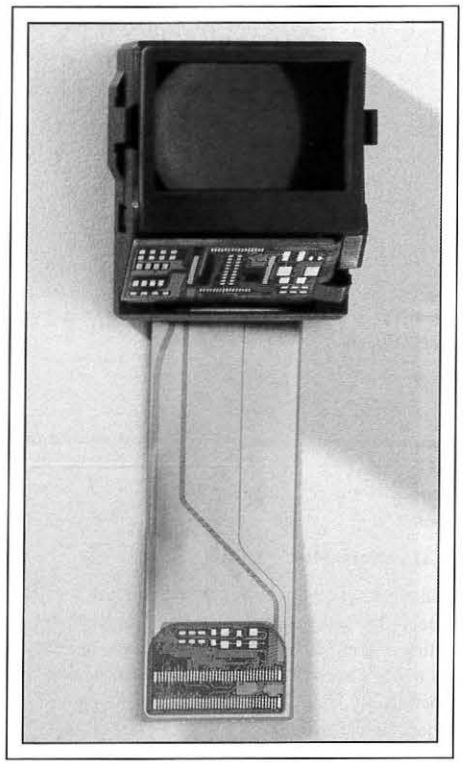
Interface Displays & Controls will feature their Multi-Purpose Control & Display Unit (MCDU) designed to accommodate a variety of avionics applications. The MCDU can communicate with multiple systems through standard protocols or message formats and display a variety of messages, including system control parameters, navigation, communication, annunciation, or verification of data inputs. The unit is flexible in design, providing ease of use, low cost, light weight, and low power. The form factor is a standard Dzus mounted control panel, and is 9 in. high by 5.75 in. wide. Connectors can be customer specified and accommodate navigation or display control functions.

Circle no. 23

INVISO
Sunnyvale, CA 408/734-9200
Booth 751

Display module

Inviso will show their OptiScape II display module that combines a digital backplane with advanced liquid-crystal technology with patented viewing optics to create a low-power highly integrated color display for mobile appliances. Typically viewed at about 30 mm from the eye, OptiScape II creates a virtual image equivalent to a 19-in. SVGA desktop monitor viewed at 2.5 ft.



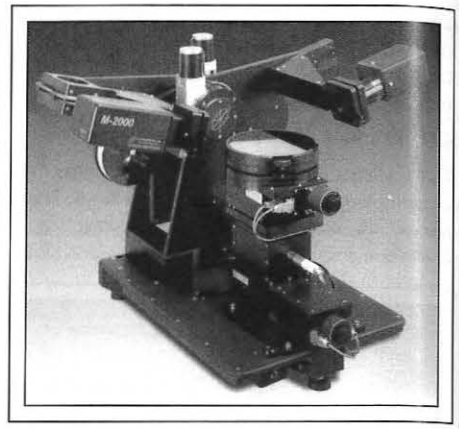
Circle no. 24

SID '01
San Jose, California
San Jose Convention Center
June 3–8, 2001

J. A. WOOLLAM CO.
Lincoln, NE 402/477-8214
Booth 210

Spectroscopic ellipsometer

J. A. Woollam Co. will introduce the M-2000X, a spectroscopic ellipsometer designed for thin-film characterization for the display industry. The M-2000X simultaneously measures 300 wavelengths from 370 to 1700 nm. The high speed and large spectral range make it ideal for either *ex-situ* large-area mapping or *in-situ* deposition monitoring and control. Display applications include conductive oxides; transparent films on transparent substrates; poly-Si; liquid crystals; SiNx, SiOx, and SiON; color filters; metals; and polymers.



Circle no. 25

KORRY ELECTRONICS CO.
Seattle, WA 1-800-257-8921
Booth 430

NVIS-compatible AMLCDs

Korry Electronics will feature night-vision-compatible AMLCD products designed for avionics cockpit applications, offering a wide dimming range and full-sunlight readability. Optional Nightshield® NVIS filtering provides high-performance at reduced cost and is compliant with MIL-L-85762.

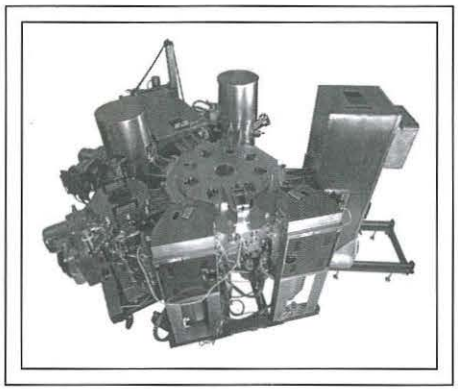
Circle no. 26

KURT J. LESKER CO.
Clairton, PA 412/233-4200
Booth 937

Organic OLED/PLED cluster tool

The Kurt J. Lesker Co. will be offering flexible cluster tool systems for OLED/PLED film R&D

nd pilot-production applications. The cluster tools eature substrate entry and exit locks, plasma clean- ng chambers, small-molecule organic material eposition chambers, metal evaporation chambers, magnetron sputtering chambers, and mask storage and changing capability. Systems are fully computer controlled including extensive recipe creation and data logging capabilities.



Circle no. 27

LAMBDA RESEARCH CORP.
Littleton, MA 978/486-0766
Booth 325

Virtual prototyping software

Lambda Research will introduce Tracepro 2.1, a 3-D virtual prototyping software that designs and analyzes display systems. Tracepro reduces the time to bring products to market and typically reduces standard trial-and-error prototyping by 30%. Tracepro is the only software product based on the ACIS kernel, allowing import and export from almost any CAD product using SAT, IGES, or STEP formats.
Circle no. 28

LCD LIGHTING
Orange, CT 203/795-1520
Booth 538

Single-lamp backlighting system

LCD Lighting has announced the development of RoBo-Bend, a new manufacturing process technology that now enables serpentine hot-cathode lamps to be manufactured with automatic bending processes. Now, a single 8- or 9-mm lamp can cost-effectively replace multiple lamp systems. By reducing the number of cathodes in a backlight, the power loss is greatly reduced. A typical 2:1 power savings is possible by replacing the six cold-cathode lamps with a single hot-cathode lamp, and the complexity, assembly time, and cost and risk elements of the electronics and wiring are reduced while wider dimming ratios are permitted compared with cold-cathode lamps.

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Mr. Han Zhihai, Mr. Wang Wei

DDTX

DDRX

EXTRON DDTX/DDRX

Break the Distance Barrier for Direct Digital Signal Distribution

What is Direct Digital Technology?
Direct Digital technology is a new form of video for computers which uses a direct digital video link between the computer's video output and the local monitor. With Direct Digital the video signal stays in digital form from the computer to the monitor; this maintains the original signal and image quality perfectly. Two Direct Digital connectivity standards have been created that use the same digital signal but vary in terms of the pin configuration and connector type. The Digital Flat Panel (DFP) connector/pin configuration was developed by VESA. The Digital Visual Interface (DVI) connector/pin configuration was developed by a group of companies called the Digital Display Working Group (DDWG). Both of these connectors carry the same digital signal format referred to as transition minimized differential signaling (TMDS). This signal format was developed by Silicon Image, and is a component of Silicon Image's PanelLink® technology.

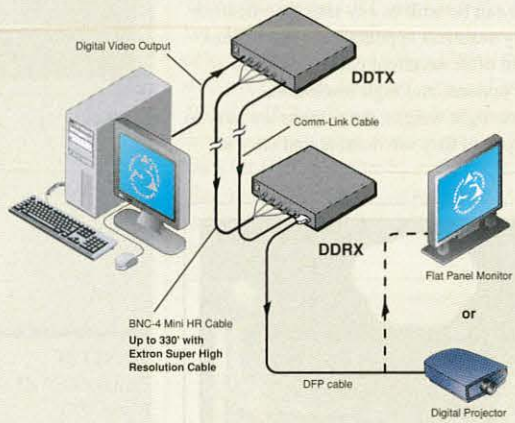
Distance Limitation
Normally, DFP/DVI—TMDS/PanelLink®—signals are designed to travel a maximum distance of 15 feet; however, with use of the DDTX/DDRX, DFP/DVI signals are able to travel up to 330 feet (100 meters), depending on the type and quality of cable used. The DDTX/DDRX uses proprietary digital technology to compensate for signal loss and ringing. And ensure high quality results.

Direct Digital Long Distance Line Driver
Extron's DDTX/DDRX is a direct digital video transmitter-receiver set designed for long-distance transmission of DFP or DVI signals between a source and direct digital display. The DDTX/DDRX set is comprised of a direct digital transmitter (DDTX) and direct digital receiver (DDRX).

Direct Digital Distribution Amplifier
Extron's D/2 DA4 is a one input, four output, direct digital distribution amplifier that distributes DFP or DVI signals to up to four comparable displays. The D/2 DA4 is ideal for applications requiring identical images on multiple direct digital monitors or projectors with identical resolutions and refresh rates. The D/2 DA4 accepts DFP/DVI—Panel Link/TMDS—signals and distributes them up to four identical, independently buffered outputs for cable runs up to 15 feet.

Extron's DDTX/DDRX and D/2 DA4 provide the following advantages:

- Compatible with direct digital sources and direct digital displays
- DFP connectors for DFP signals; DDTX uses attached DFP input cable
- Accept single-link DVI signals via optional DVI-to-DFP adapter
- Housed in 1U high, 1/2 rack width enclosures
- 100-240VAC, 50/60 Hz, auto-switchable internal power supplies



The DDTX/DDRX part number is 60-316-01.
The D/2 DA4 part number is 60-315-01.

For complete details, visit Extron's website at
www.extron.com/m/ddtx
www.extron.com/m/d2da4

Extron Electronics

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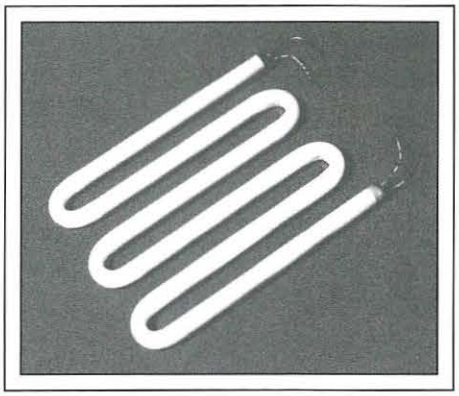
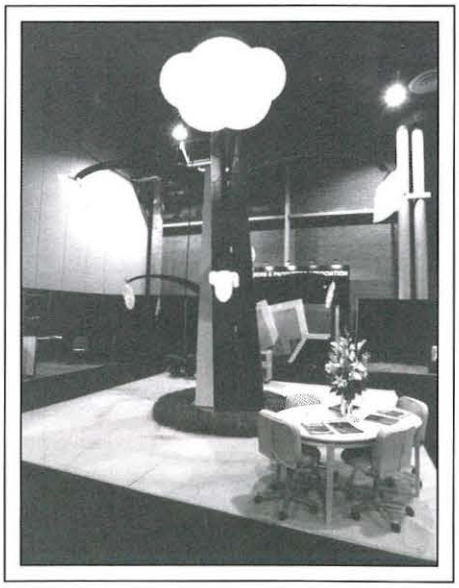


Circle no. 29

LUMIN-OZ
Culver City, CA 310/838-1199
Booth 533

Polymer video screens

Lumin-oZ will feature Revolution optical polymer video screens that can be vacuum formed into any 3-D shape and can be built to any size specification with a virtually seamless appearance. The screens are flexible and offer excellent color rendition, image control options, and high resolution. Because of their light weight, the screens are easy to install and ship, and they are durable and easy to maintain.

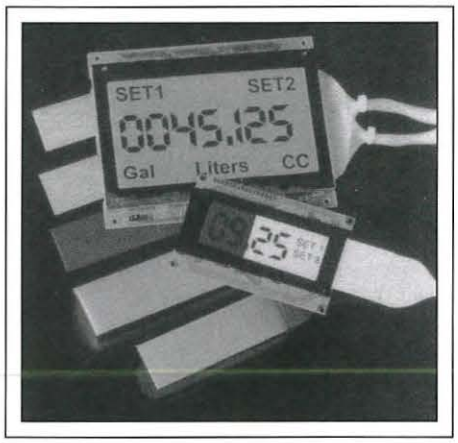


Circle no. 30

LUMITEX
Strongsville, OH 1-800-969-5483
Booth 130

Fiber-optic backlights

Lumitex will feature fiber-optic backlighting panels that offer the performance of EL without degradation in brightness. Ideal for LCDs, membrane switching, and a variety of special backlighting applications, these thin light-emitting panels are woven from plastic optical fibers and provide long life, operate at very low power, emit no heat or EMI, and require no inverter to power them up. A standard 2 × 16 LCD (assuming a viewing area of 16.0 × 200 mm) can be backlit using just one LED, with an output of about 30 fL at just 30 mA. Larger panels may require additional LEDs.



Circle no. 31

MERITEC
Painesville, OH 1-888-637-4832
Booth 920

High-speed cabling system

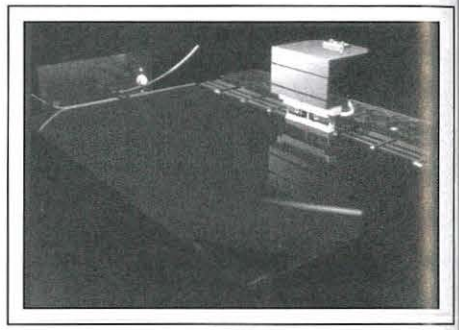
Meritec will introduce the HPM-5 2mm high-speed cabling system featuring a strain relief without overmolding, a slightly inductive contact, and the most reliable form of wire termination. The HPM-5 is available in 1 × 5 and 1 × 5+2 configurations. The 1 × 5+2 unit provides ground tabs to mate with the optional side grounding pins in the mating header. Both configurations are stackable to 25 × 5 and are available with shielded backshells. With each 1 × 5 wafer having its own shield that comes within 0.010 in. of the pin header floor, crosstalk and reflections are minimized.

Circle no. 32

MICROJOIN
Poway, CA 858/877-2100
Booth 431

FPD manufacturing and rework equipment

MicroJoin's new Model 3200 Tracker and Model 6300 Laminator systems combined with the Model 6800 Bonding system provides a comprehensive integrated solution for the manufacture of flat-panel LCDs. The Model 3200 tracker system automates the precision application of anisotropic conductive film material to the substrate. The Model 6800 bonding system is a full-function bonding workstation which combines an advanced positioning and handling system with Ceramic Hotbar Technology™. The Model 6300 laminator system further enhances LCD manufacturing productivity by providing an automated method for applying overlays to the screen, such as polarizing film.

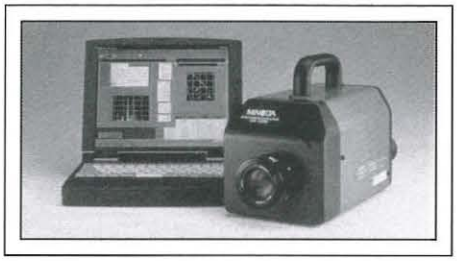


Circle no. 33

MINOLTA
Ramsey, NJ 201/825-4000
Booth 220

Spectroradiometer

Minolta will feature the CS-1000, a spectroradiometer that measures spectral power distribution, luminance, color, and the correlated color temperature of CRTs, LCDs, and lamps/LEDs. The CS-1000 is used in R&D centers of monitor and LCD manufacturers. Models that can measure areas as small as 0.45 mm and angles as small as 0.14° are available. Its Windows® data-processing software allows for easy calculation, statistical analysis, data storage, and printout. The CS-1000 can be operated as a standalone or can be connected to a PC through a standard RS-232C interface.



Circle no. 34

MITSUBISHI ELECTRONICS AMERICA
Sunnyvale, CA 408/730-5900
Booth 139

ANGLEVIEW™ TFT-LCDs

Mitsubishi Electronics America will demonstrate the AA150QA02, a 15-in. QVGA ANGLEVIEW® TFT-LCD for the CRT monitor replacement market. Because the display demonstrates 24-bit true-color performance and offers 1280 × 960 pixels with a 0.238-mm dot pitch, a typical brightness of 250 nits, 16.7 million colors from true 8-bit RGB drivers, and a typical contrast ratio of 350:1, it is ideal for DVD multimedia applications. The display also features wide viewing angles of 130° (H) and 105° (V), as well as a low-power 3.3-V CMOS interface.

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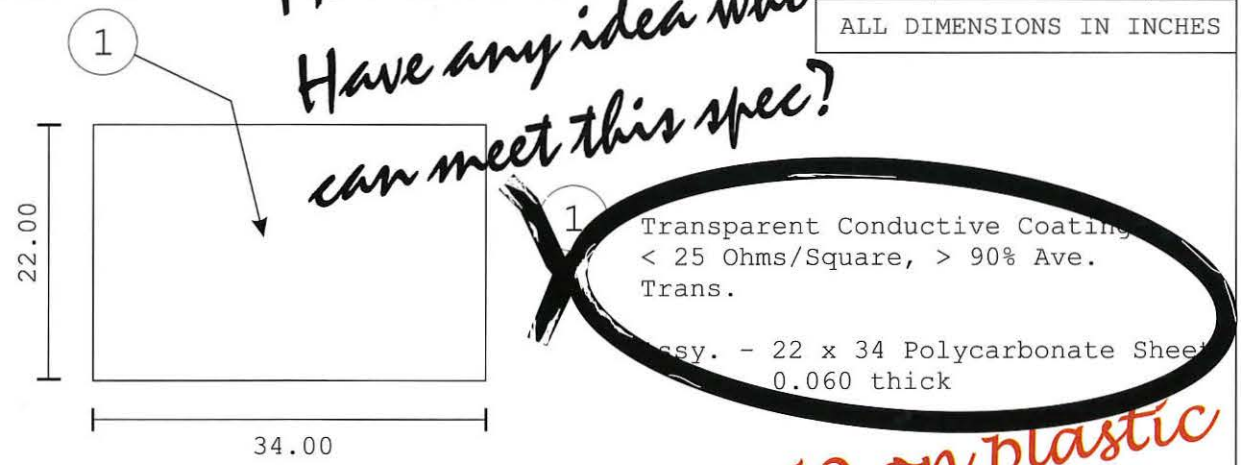

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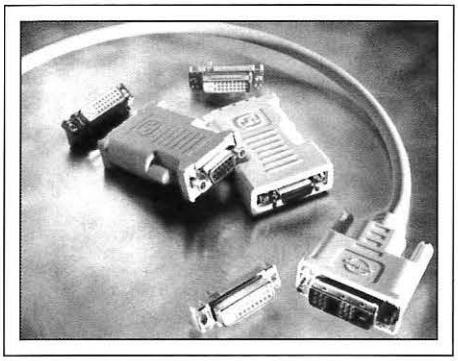
Circle no. 120

MOLEX
Lisle, IL 1-800-78MOLEX
Booth 849

DVI connector system

Molex will feature the MicroCross™ DVI connector system, chosen by the Digital Display Working Group (DDWG) as the standard digital video I/O interface design for connecting a host and a display device to support high-resolution video applications. The MicroCross DVI interconnect system provides up to two digital TMDS links (9.9 Gpps) and 2.5 GHz for the analog coax interface. The MicroCross family offers a complete system solution for adapting to existing video standards, including VGA, DFP, and P&D. It can accommodate analog only, digital only, and digital/analog integrated video functions.

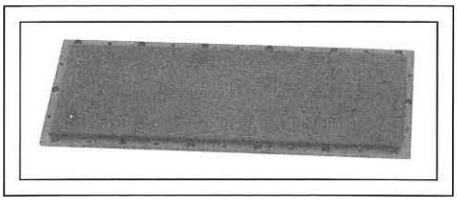


Circle no. 36

NIMTEC
Chandler, AZ 602/732-9857
Booth 663

Ultra- and super-high-density targets

NIMTEC will feature ultra- and super-high density targets manufactured by a unique oxygen sintering method. The raw materials used, such as high-purity indium, are produced and supplied internally, resulting in consistent quality and a stable supply.

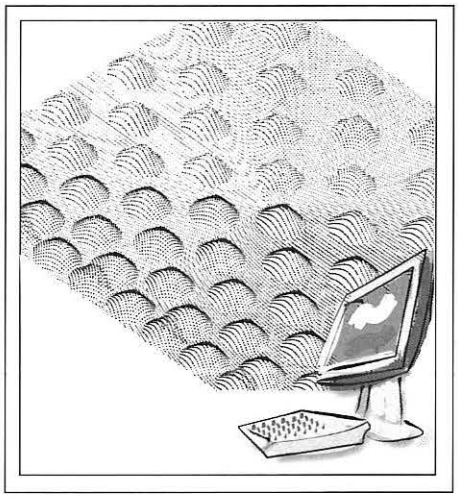


Circle no. 37

OPTIS
Toulon, France +33-494-086-690
Booth 1404

Modeling tool

OPTIS will feature SPEOS, a modeling tool that allows for the easy application of textures on surfaces with complex shapes. By using 3-D textures, thousands of shapeless patterns for microstructure-based applications (LCD backlighting systems, micro-lens matrix, *etc.*) can be created. The type of shape (cone, cylinder, box, or sinusoidal deformation) and its distribution on a surface can be defined. This tool is very useful when the surface deformation is small compared to the size of the geometry or when it is difficult to perform modeling with traditional CAD software.

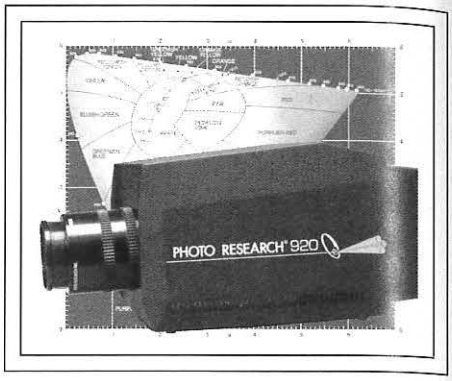


Circle no. 38

PHOTO RESEARCH
Chatsworth, CA 818/341-5151
Booth 201

Video photometer/colorimeter

Photo Research will feature the PR-920 Video Photometer/Colorimeter, the latest addition to a family of industry-standard instruments designed to deliver the utmost accuracy. The PR-920 is the result of 15 years' experience in imaging photometry and colorimetry, and the mating of a cooled 1024 × 1024-pixel digital CCD, CIE tristimulus filtering, high precision, and high dynamic range.

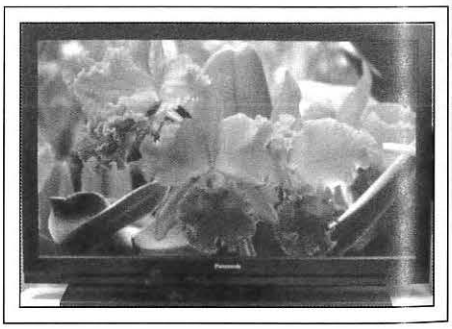


Circle no. 39

PLASMACO
Highland, NY 914/883-6800
Booth 300

Plasma displays

Plasmaco will feature their 60-in.-diagonal full-color ac plasma display designed for the growing HDTV market. The wide-screen 16:9 aspect ratio display has a striking image due to its high luminance of 450 cd/m^2 and a contrast ratio of greater than 500:1. The panel is capable of displaying both 720p and 1080i HDTV signals. These displays can show 16.7 million colors with a 160° viewing angle, the widest of any flat-panel technology.



Circle no. 40

PORTRAIT DISPLAYS
Pleasanton, CA 925/227-2700
Booth 1502

Wide-screen software tool

Portrait Displays will feature Pivot® Plasma, a software program that allows the image on a wide-screen display operating on Windows™ platforms to be rotated 90°. The software "plug-in" supports wide-screen resolutions on the most popular graphics cards that support wide-screen resolutions.

Circle no. 41

ROMAG GLASS PRODUCTS LTD.
Tyne & Wear, U.K. +44-191-414-5511
Booth 1102

Filters

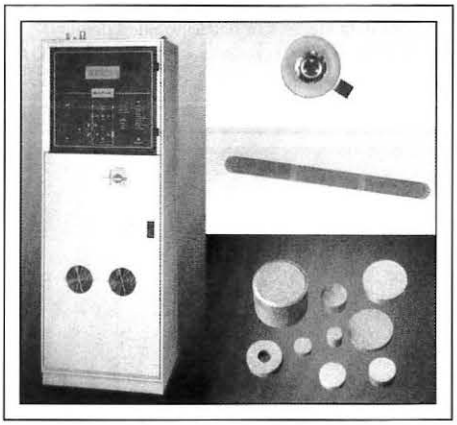
Romag Glass Products specializes in the manufacture of flat and curved laminated glass and acrylic or polycarbonate filters for use on all types of displays. Their range of filters include Sunvue, to improve readability under adverse lighting conditions; Ultrashield, Clearshield, and Surfshield for EMI/RFI shielding; Hitrans heater panels for de-misting and de-icing; and Zytouch projected capacitive touch sensors.

Circle no. 42

SAES GETTERS
Colorado Springs, CO 719/576-3200
Booth 922

Gettering materials and configurations

The SAES Getters Group has announced an extensive new range of products and solutions for any type of information display, from getters that serve as internal pumps inside CRTs, FEDs, PDPs, OLEDs, and VFDs to purifiers and analyzers used during LCD manufacturing. Various types of getter materials and configurations are being developed.

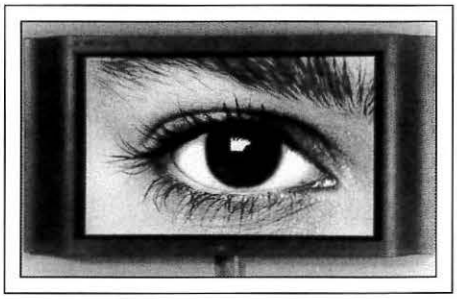


Circle no. 43

SAMSUNG SEMICONDUCTOR
San Jose, CA 408/544-4000
Booth 731

AMLCDs

Samsung will offer a complete line of AMLCDs including a 21.3-in. UXGA TFT-LCD as well as a 24.0-in. wide-viewing angle UXGA PVA TFT-LCD with a 500:1 contrast ratio. Other products to be featured include a 17-in. PVA and a 15.0-in. small-form-factor wide-viewing-angle TFT-LCD for monitor-type applications. In addition, ultrathin 12.1- and 14.1-in. TFT-LCDs as well as 14.1-in. SXGA+, 15.0-in. XGA, 15.0-in. SXGA+, 15.4-in. SXGA, and 16.5-in. SXGA+ TFT-LCDs for the mobile desktop market will be demonstrated.



Circle no. 44

SOLOMON LCM
Walnut, CA 909/468-3733
Booth 457

Graphic modules

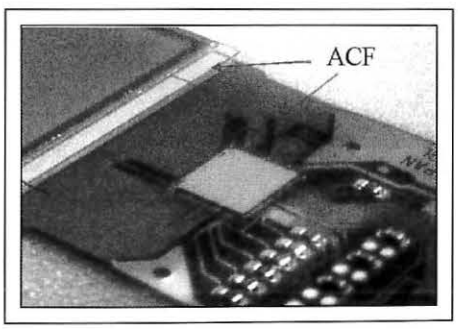
Solomon LCD will demonstrate the LM6530 and the LM6520, two new standard graphic modules for the industrial market. All modules feature low voltage and COB technology that uses high-volume telecom ICs, meeting the demands of low voltage and ultra-low power consumption. The module offers all the advantages that small-sized telecom modules have had for the last 5 years: maximum utilization of a new driver/controller chip, a 2.4–6.0 Vdc power supply, high-speed microprocessor interface, 8-bit serial or parallel interface, and inverse display mode.

Circle no. 45

SONY CHEMICALS CORP. OF AMERICA
Mt. Pleasant, PA 724/696-8931
Booth 158

Anisotropic conductive film

Sony Chemicals Corp. of America will feature the latest anisotropic conductive film (ACF) for LCDs and PDPs. Chip-on-glass flex board and the new concept of multilayer flex circuits will be demonstrated.



Circle no. 46

TEAM SYSTEMS
Santa Clara, CA 408/720-8877
Booth 221

High-performance video generator

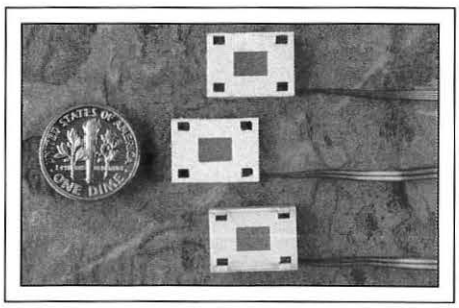
TEAM Systems will introduce the ASTRO VG-844, a high-performance video generator with 400 MHz of pixel frequency. This flexible unit can be fully programmed with a PC or controlled/operated with a remote box. It has a surprisingly small footprint and offers full HDTV/Y-PB-PR compatibility. This is an ideal low-cost unit for manufacturing and servicing high-resolution and HDTV monitors. The 850 programmable and 150 fixed timing/pattern combos combined with "Flash Card" storage make it very easy and fast to operate.

Circle no. 47

TELEDYNE LIGHTING & DISPLAY PRODUCTS
Hawthorne, CA 323/242-1900
Booth 121

LED illuminators

Teledyne will feature ALPHALIGHT™ 0.25-in.-diagonal (QVGA) and 0.50-in.-diagonal (VGA) aperture-sized LED illuminators, available in white and full-color RGB standard formats. High optical efficiencies significantly optimize LCD and spatial light modulator (SLM) display performance. The QVGA and VGA illuminators provide users with a variety of design implementation advantages compared to other technologies.



Circle no. 48

THREE-FIVE SYSTEMS
Tempe, AZ 602/389-8800
Booth 901

Microdisplays

Three-Five Systems will feature the MD1280, a microdisplay developed for front projection, rear projection, monitor, and TV applications. The 1280 × 1024 microdisplay has a 0.78-in. array diagonal (12-μm pixel pitch), is supported by custom digital and analog ASICs, and has a color resolution of 24 bits. Similar microdisplays will be offered for viewfinder-type ("near to eye") applications such as wireless data viewers or head-mounted displays. Microdisplays with resolutions greater than SXGA, such as those needed for HDTV, are also being readied.

Circle no. 49

TRICOR SYSTEMS
Elgin, IL 847/742-5542
Booth 159

Video photometer

TRICOR Systems will feature the Model 822 video photometer that measures the absolute brightness of any size sample or scene and provides quantitative data in foot-lamberts (fL) or candela per square meter (cd/m^2). The 822 is used to measure the performance of displays, lamps, LEDs, backlit panels, control switches, *etc.* It also quantifies reflectance, luminance, contrast, viewing-angle performance, flatness, haze, residue, and other appearance characteristics. The 822 generates 1024 × 1024-pixel images digitized to 4096 gray levels.

Circle no. 50

U.S. ELECTRONICS
Minneapolis, MN 612/591-2605
Booth 916

Medical-grade digital LCD monitors

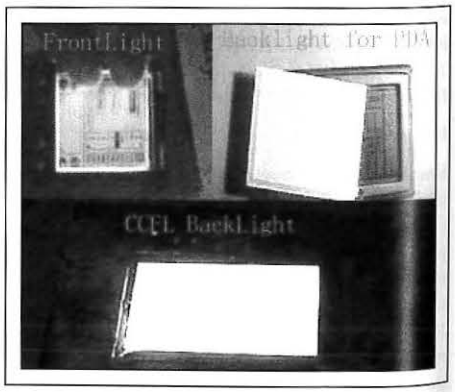
U.S. Electronics will feature the CDL1521A, a 15.1-in. digital AMLCD monitor with a 1024 × 768 maximum resolution and a viewing angle of 160° in all directions. The monitor, designed exclusively for medical applications, meets the fast response times, excellent gray scales, and true color required by state-of-the-art medical imaging. The unit comes with universal VESA mounting for wall mount and other robotic fixtures and is available with various touch panels integrated with USEI controller boards. The product meets worldwide safety approvals in addition to medical safety approvals.

Circle no. 51

U.S. MICRO PRODUCTS
Los Angeles, CA 310/215-1800
Booth 134

Backlights

U.S. Micro Products will feature a full line of backlights.



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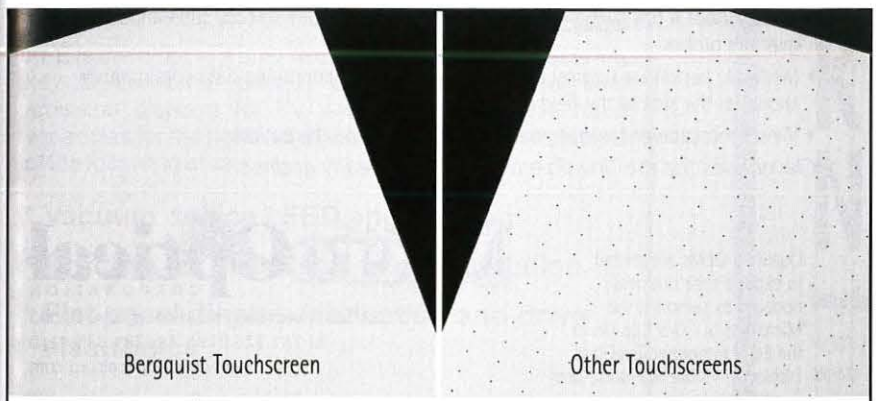

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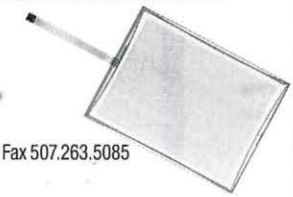

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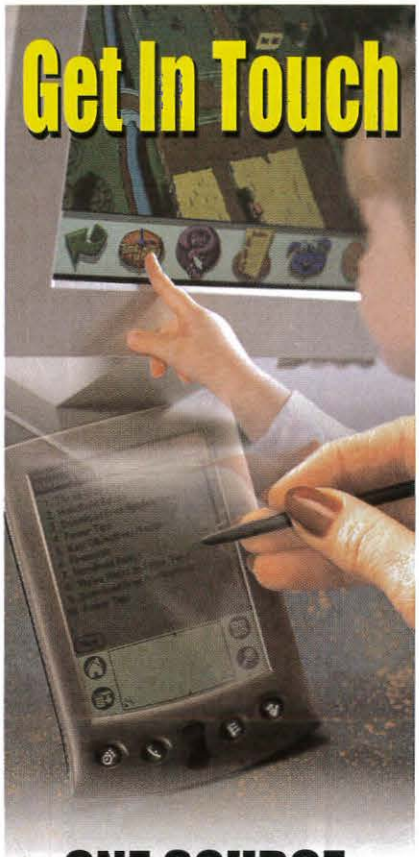

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calendar

FPD Expo Taiwan 2000. Sponsored by SEMI Taiwan. Contact: Sue Chung, SEMI Mountain View; 650/940-7961, fax-7953, e-mail: schung@semi-org.
June 12–13, 2000 Hsinchu, Taiwan

Microdisplay 2000. Sponsored by Displaytech, Inc., and the SID Southwest Chapter. Contact: United Engineering Foundation Conferences; 212/591-7836, fax -7441, e-mail: engfind@aol.com.
Aug. 7–9, 2000 Boulder, CO

The First International Display Manufacturing Conference (IDMC 2000) and Vendor Exhibition (FPD Expo 2000). Sponsored by the SID Korea Chapter and Korea Information Display Society. Contact: Prof. S. Lim, Secretary General; telephone +82-417-550-3542, fax -3592, e-mail: limsk@ns.dankook.ac.ker.
Sept. 5–7, 2000 Seoul, Korea

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

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

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

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

Eighth Color Imaging Conference: Color Science, Engineering Systems & Applications. Sponsored by IS&T and SID. Contact: Dee Dumont, SID HQ, 408/977-1013, fax -1531, e-mail: office@sid.org.
Nov. 14-17, 2000 Scottsdale, AZ

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

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

continued from page 4

Wide Web, and cellular phones. As these communications methods proliferated and as the cost of communicating began to decrease, we all, almost imperceptibly, broadened our circle of daily contacts. Not so many years ago, receiving a telegram or making a long-distance telephone call was an event of some importance. Today many of us make more long-distance calls each day than local ones and we have the ability to send e-mail messages at costs so low that almost everyone can do it without having to consider budgetary limitations. In the first two decades of the 21st century, worldwide voice and e-mail messaging will continue to expand and costs will decrease further – eventually approaching zero.

Therefore, as we enter the third millennium, fewer and fewer countries will be able to function effectively while attempting to exert arbitrary control over these communications channels. Electronic communications is creating a new world order that is becoming independent of geographic or political boundaries. As the traditional political alignments based on territorial boundaries become less and less meaningful, people will begin to realize that the most beneficial groupings are by common interests and not by geography. No longer will we need to organize as our cave-dwelling ancestors did to control certain pieces of land. Instead, we will organize based on personal or business relationships with others in the global community. The ones who do that most effectively will be the winners in what will continue to be a highly competitive environment. The traditional government structures will hang on, most likely longer than they should, and serve as arbitrators to keep any one group from gaining too great a competitive advantage.

Therefore, organizations such as our Society for Information Display will play a vital and pre-eminent role in this new world order that will be driven by the ability to exchange information freely and instantaneously with colleagues anywhere on planet Earth – and someday beyond. The electronic information exchanges will be supplemented by frequent "real-life" meetings, so that we can solidify these personal relationships, as we human beings have done throughout history.

Over the last seven-and-a-half years of "The Display Continuum" columns, we have contemplated a future in which we will have an overabundance of opportunities for new and existing display technologies – a future where we can expect to have reliable and simple-to-use Internet appliances, desktop knowledge-space displays, digital photography and DVDs, high-resolution 2-D electronic imaging displays, hardware-based knowledge cubes, sunlight-readable displays in all sizes from micro- to billboard-size, and location-

independent data and voice communications devices. And we have also thought about some ways in which our lives will change – hardly at all.

The Society for Information Display has an important role to play in the personal and technical interactions that will be the catalysts for many of the new developments that will facilitate rapid progress in the Information Age. Therefore, we can and must look for ways to take a few well-measured steps toward creating an even stronger and more vibrant technical society that grows and broadens its influence in all regions of the world. This conviction, that we can and should be an important and fundamental contributor to the 21st-century Information Society, is a guiding principle on which we can base how we build SID, how we decide which new directions to take, and which new ideas to implement.

I am anxious to hear from you. Please send me your suggestions. Offers of participation and help will be most graciously accepted. I look forward with enthusiasm to serving as your President. You may contact me by e-mail at silzars@attglobal.net, by phone at 425/557-8850, by fax at 425/557-8983, or by regular mail to the hilltop at 22513 S.E. 47th Place, Issaquah, WA 98029.

Aris Silzars is President of the Society for Information Display. He lives on a hilltop in Issaquah, Washington. ■

continued from page 2

depressions on the outside of the LCD's back plate. There are also other schemes afloat for repartitioning the elements in a familiar AMLCD using different technologies and architectures. In each case the goal is to reduce cost or improve performance (or both) by modifying the partitioning of the system in such a way that materials and processes are better matched to the structures and devices being fabricated.

Materials, processes, partitioning, packaging — anything else? Is there any new way of creating an image that has not yet reached the display mainstream? The only one I can think of is direct optical writing with laser beams (or other highly collimated light sources). Done on a screen with high power, this approach becomes an alternative to projection displays. Done directly on the retina with very low power, it substitutes for a variety of virtual and head-mounted displays. But interesting as they may turn out to be in the long run, laser-based displays appear to be years away from the mainstream.

So we're back to materials, processes, partitioning, and packaging as the sources of the "next big thing," whatever it may be. I would be surprised to find any new electro-optic effects raising themselves from the primordial ooze in the foreseeable future. So I come to the conclusion that the "next big thing" will arise from the application of the "three p's and m" to one of the current electro-optical effects that we know and love. It will be an LCD, OLED, PDP, EL, or FED that is cheaper, brighter, lighter, has higher pixel density, or is more energy-efficient through the creative application of repartitioning, repackaging, new processes, or new materials — or perhaps some combination of the four.

That doesn't exclude too much, of course. Except the snake-oil salesman who says, "We've discovered a unique electro-optic effect and we'll be in volume production in 18 months." That's not a bad thing to exclude, come to think of it.

— KIW

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

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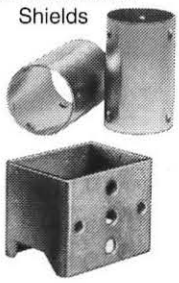
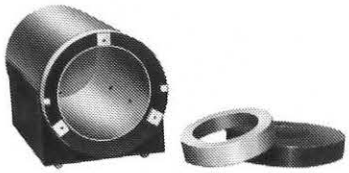
CRT Shield

CRT Deflection Yoke & Neck Shield ("L" locking)

Small Transformer Shields





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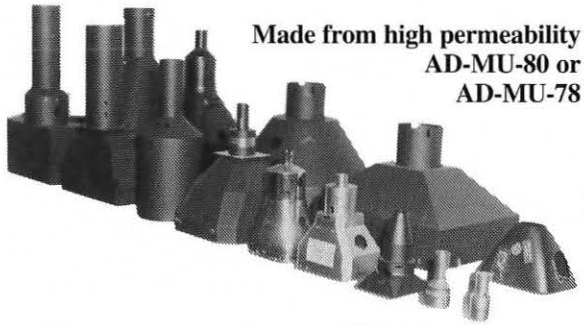

Electrical Characteristics

Typical DC Magnetic Properties for AD-MU Shielding Alloys

	Material	Initial Permeability at 40 gauss	Permeability at 100-200 gauss	Maximum Permeability	Saturation Induction gauss	Coercive Force oersteds
High Permeability	AD-MU-80	75,000	100,000	300,000	8,000	0.015
	AD-MU-78	60,000	43,000	250,000	7,600	0.01
Med. Permeability	AD-MU-48	11,500	20,000	130,000	15,500	0.05
Low Permeability	AD-MU-00	*300	1,300	3,000	22,000	1.00

*Unannealed State

Typical Physical Properties of AD-MU Alloys

(Forming Temper – Not Annealed)

	AD-MU-80	AD-MU-78	AD-MU-48	AD-MU-00
Density (lb/in³)	0.316	0.305	0.294	0.283
Thermal Expansion Coefficient/°F(68°-212°F)	$7.0x10^{-6}$	$7.5x10^{-6}$	$4.6x10^{-6}$	$7.6x10^{-6}$
Thermal Conductivity (BTU/in/ft²/hr/°F)	136	115	90	–
Electrical Resistivity (ohm-cir mil/ft)	349	331	290	–
Curie Temperature (F)	845	761	932	–

Typical Mechanical Properties of AD-MU Alloys

(Forming Temper – Not Annealed)

	AD-MU-80	AD-MU-78	AD-MU-48	AD-MU-00
Tensile Strength ($lbs/in^2 \times 10^3$)	90	85	85	45
Yield Strength ($lbs/in^2 \times 10^3$)	35	30	40	30
Modulus of Elasticity ($lbs/in^2 \times 10^3$)	32.0	30.0	24.0	29.5
Elongation in 2" (%)	40	30	25	30
Hardness (rockwell B)	62/75	64/74	59/68	65

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