Official Monthly Publication of the Society for Information Display

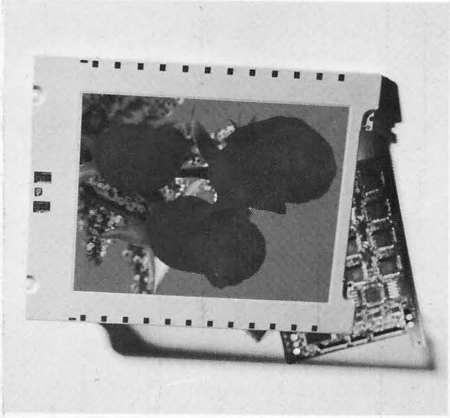
INFORMATION DISPLAY

October 1994
Vol. 10, No. 10

FLAT-PANEL ISSUE

Active addressing
Computex Taipei '94
Color plasma displays

Cover: The long-awaited engineering evaluation units of Motif's Active Addressing™ liquid-crystal display (AALCD) are now available. This photographer's composite shows an actual AALCD image and some AA application-specific ICs.



Kent Derek Photography for Motif, Inc.

Next Month in Information Display

Display Manufacturing Issue
- FPD manufacturing
- Large precision masks
- Lasers in FPD manufacturing

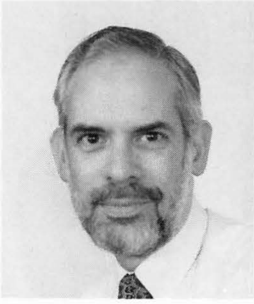
INFORMATION DISPLAY (ISSN 0362-0972) is published ten times a year for the Society for Information Display by Palisades Institute for Research Services, Inc., 201 Varick Street, New York, NY 10014; David Slater, Chief Executive Officer; Leonard H. Klein, President; Laura Manganiello, Secretary/Treasurer. EDITORIAL AND BUSINESS OFFICES: Palisades Institute for Research Services, Inc., 201 Varick Street, New York, NY 10014; telephone 212/620-3371. Send manuscripts to the attention of the Editor, ID. DISTRICT SALES OFFICES: WEST/MID-WEST – Ted Lucas, 5428 N.W. Pinery, Newport, OR 97365; telephone 503/265-9140. EAST – Jay Morreale, Palisades Institute for Research Services, Inc., 201 Varick Street, Suite 1006, New York, NY 10014; 212/620-3371. SID HEADQUARTERS, for correspondence on subscriptions and membership: Society for Information Display, 1526 Brookhollow Drive, Suite 82, Santa Ana, CA 92705-5421; telephone 714/545-1526; fax 714/545-1547. SUBSCRIPTIONS: Information Display is distributed without charge to those qualified and to SID members as a benefit of membership (annual dues $55.00). Subscriptions to others: U.S. & Canada: $36.00 one year, $5.00 single copy; elsewhere: $72.00 one year, $6.50 single copy. PRINTED by Sheridan Printing Company, Alpha, NJ 08865. Third-class postage paid at Phillipsburg, NJ. POSTMASTER: Send address changes to Society for Information Display, 1526 Brookhollow Drive, Suite 82, Santa Ana, CA 92705-5421.

Official Monthly Publication of the Society for Information Display

INFORMATION DISPLAY

OCTOBER 1994
VOL. 10, NO. 10

editorial



The Invisible Display Company

You would think that the one company in the world (to the best of my knowledge) that is still working on high-information-content (HIC) electrophoretic (EP) displays would have at least a moderately high profile in the display community. It doesn't.

When you consider that this company has been developing EP technology since 1982 – and that the last major efforts from Philips, Xerox, and Exxon were discontinued in the mid-to-late 80s – you would think that each technical advance would be the subject of a SID conference paper or an article in the *Journal of the SID*. It isn't.

When this company recently demonstrated a low-power 200-dpi display that could arguably cost the same as a VGA-format STN-LCD, you'd think its staff would aggressively distribute news releases to the trade press and attempt to place articles in magazines such as *Information Display*. They didn't.

In fact, this company – CopyTele, Inc. of Huntington Station, New York – has until recently made secrecy part of its corporate policy and largely isolated itself from the larger display community. This secrecy and isolation have arguably contributed to CopyTele's periodic bombardment by investment-community rumors that have bounced the company's NASDAQ stock up and down like the corn in a popping machine. Charges of fraud and deceit have been leveled against the company by certain financial columnists; and charges of deceit and collusion have been leveled against the columnists, as well as against certain analysts and brokers, by some shareholders.

Company management has maintained that one reason for secrecy was a long-term agreement with the French telecommunications giant Alcatel (perhaps to develop a flat-panel derivative of the French MiniTel terminal). CopyTele's latest drama (as I write this in late August) was its August 11th announcement that Alcatel Business Systems "has decided not to pursue the projects which could have incorporated CopyTele's flat panel display."

What has been lost in all this furor is that CopyTele – in its own idiosyncratic way – has actually developed an electrophoretic-display prototype that is worth looking at. For those of you who may have forgotten, electrophoresis is "the movement of electrically charged particles through a gas or liquid as a result of an electric field formed between electrodes immersed in the medium," according to the 1994 edition of the *Microsoft Encarta Multimedia Encyclopedia*. If the liquid contains a dark dye and the particles have a light color, attracting the particles to a front transparent electrode will create a lightly colored pixel against a dark background. This phenomenon can obviously form the basis of a flat-panel display. Since at least the 1980s, the particles have usually been yellowish and the dyed organic liquid a very dark purple.

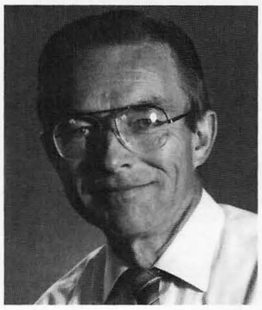
Once an image is formed on a well-made EP display, it remains there even if the power is turned off. For applications in which quasi-static images are important – such as maps on a GPS terminal or screens of text – this characteristic offers substantial power-saving opportunities.

Mechanically, CopyTele's display consists of two patterned glass substrates, one of which has "particle wells" formed by ribs on the substrate. A third "grid"

continued on page 31

Official Monthly Publication of the Society for Information Display
INFORMATION DISPLAY

the display continuum



Jump, Jump! Your Team Is Cheering You On

by Aris Silzars

Standing on the small platform, with my toes hanging over the edge, I'm approximately 45 ft. aboveground. There is no railing. The instructor behind me is hooking up my harness to the two thin wires extending several yards above me and strung in a loose arc for over a hundred yards to another tower even less substantial than this one. The tower we are on shakes with every movement we make. I can neither see nor feel the wires connecting the back of my harness to the overhead "zip-lines." My team of colleagues is standing in a group far below me yelling a variety of encouragements such as, "We know you can do it!"

Now, one's mind is a marvelous thing. Through several million years of genetic imprinting, it has learned that falling off anything more than about 6 ft. high is likely to cause one significant bodily harm. In fact, for anything much above 8 ft. – your mind very quickly tells you that – you are ***within epsilon of infinity***. So 45 ft. up could be 200 ft. or a mile – the results are likely to be the same – somewhere between disastrous and highly fatal.

So while my team is providing all this great encouragement, and I have been assured by the instructor, at least 10 times, that the harness is perfectly safe, my mind has decided (with no special help from me) that even a very small probability of harness failure, multiplied by an infinite probability of making an embarrassing spot on the ground, is a bad risk. (You weren't under the ridiculous assumption that it was simple panic instead of careful calculation that was making me behave this way, were you?) Now, figuring that direct intervention will produce a better result than just expressing an opinion, my mind has proceeded to send a top-priority message to my legs to do some serious shaking and to refuse to cooperate when the rest of me gives the command to launch off the platform.

I look out at the river in the distance and at the fall colors of the surrounding trees. It's a beautiful view. I look down at the sparse grass and gravel far below me. Another look at the horizon. The Chesapeake sure is spectacular. I take a few more deep breaths. My knees continue their involuntary shaking. For a split second I close my eyes. Time to quit thinking. JUST DO IT! I am airborne – in free fall. In a few hours (does it really take that long to free-fall roughly 15 ft.?) the harness takes hold. I slide down the long arc of the zip-line and then back and forth several times. Wow, I have done it! The adrenaline is pumping. The rest of the team helps me down and everyone gathers round for hugs and congratulations. I have triumphed over fear and risk. I feel great!

I am surviving my first day at management boot camp, officially designated as "The Playing to Win Seminar."

During the next 2 days, other team-building experiences take place, such as climbing a 30-ft. wall with rock-like handholds while tied to two other teammates with 3-ft. lengths of rope. For this challenge, all have to succeed for anyone to succeed. Then, for even more excitement, we climb a 25-ft. telephone pole capped by a 10-in. rotating disk, the object being to figure out how to stand on top of said rotating and very wobbly disk – on a telephone pole that insists on

continued on page 27

Society for Information Display
1526 Brookhollow Drive
Suite 82
Santa Ana, CA 92705-5421
714/545-1526
Fax: 714/545-1547

Edited by JOAN GORMAN

Trade show at DMTC '95

The Society for Information Display's second annual Display Manufacturing Technology Conference (DMTC), to be held at the Santa Clara Convention Center, Santa Clara, California, January 31–February 2, 1995, will incorporate a display-manufacturing trade show. DMTC is North America's only trade show and conference devoted exclusively to display manufacturing. "The show and accompanying technical conference are expected to fan an already-hot fire," said Conference Chair Sal Lalama, Manager of Camera and Display Applications at AT&T High Resolution Technologies in Berkeley Heights, New Jersey. "With the recognition that electronic information and graphic displays are a strategic economic and military technology, a lot of private and public dollars are flowing into the technology and business of display manufacturing." Efforts to create a North American display-manufacturing infrastructure are getting hotter, with active support from the U.S. Advanced Research Projects Agency (ARPA), the U.S. Department of Defense, and the United States Display Consortium (USDC), and other industry and university consortia. Interestingly, this is not creating an "us-versus-them" environment. "Many of the efforts to built the infrastructure and establish new display-manufacturing ventures involve alliances or joint ventures between North American and Asian or European companies," said Renee Mello-Robinett, Marketing Manager for Milpitas, California, equipment maker Photon Dynamics. Last year's DMTC, the first ever, did not include exhibits. The outpouring of objections from companies wanting to exhibit at DMTC, combined with the exuberant growth of the manufacturing section of SID '94 – SID's general exhibition and conference – confirmed the organizers in their plan to incorporate an extensive trade show this year. Early exhibitors include Accudyne, Advanced Display Systems, Electron Vision Corp., MRS Technology, Plasma-Therm, Semiconductor Systems, Tamarack Scientific, TEAM Systems, VEECO, and XMR. The technical conference accompanying the trade show will include presentations on flat-panel and CRT manufacturing, display materials, manufacturing equipment, cost reduction, yield improvement, and manufacturing economics.

Information: Mark Goldfarb, Palisades Institute for Research Services, 1745 Jefferson Davis Highway, Suite 500, Arlington, VA 22202. 1-800-787-7477, 703/413-3891, fax 703/413-1315.

Second Color Imaging Conference

The Second Color Imaging Conference will be held November 15–18, 1994 at The Radisson Resort (formerly The Registry), Scottsdale, Arizona. The conference will take an interdisciplinary and interactive look at the creation, transmission, and reproduction of color images – a growing multibillion-dollar industry being challenged and transformed by electronic technology. The conference is jointly sponsored by the Society for Information Display (SID) and the Society for Image Science & Technology (IS&T). "For four days in November, the Color Imaging Conference will bring together people who are concerned with color imaging, uniquely uniting professionals with different skills instead of dividing them as specialized conferences do," said Andy Lakatos, President of SID and SID Co-Chair of the conference's advisory board. "Psychologists and printers, photographers and computer-monitor designers, color scientists, software developers, and electronic hardware designers will all be sharing their perspectives and hammering out solutions to problems that are too complex for any one discipline to solve by itself." "The Color Imaging Conference is aimed at becoming the premier conference in its field," said Robert Buckley of Xerox Corp., the IS&T Conference Co-Chair. "It is the only conference that brings all pieces of the electronic color imaging puzzle together, and brings those pieces to bear on the practical matters of building color imaging systems and creating applications." The conference will begin with half-day tutorials that introduce essential topics: fundamentals of color science, perception, and measurement; digital color reproduction and halftoning; image processing and compression; and color in electronic displays and hardcopy. These tutorials will be followed by 3 days of presentations – in a single track to encourage all speakers and attendees to come together and bring their widely different perspectives to bear on all significant issues. A panel discussion on "Color Imaging on the Information Superhighway" will highlight opportunities and applications, the technical barriers to providing high-quality imagery, and the means for overcoming those barriers. A poster session will feature electronic presentations – "an appropriate medium," says Xerox's Buckley, "for sharing the latest advances in color science, imaging systems, and applications."

Information: Pam Forness, Society for Imaging Science & Technology, 7003 Kilworth Lane, Springfield, VA 22151. 703/642-9090, fax 703/642-9094.

Announcement: Getting the Best from State-of-the-Art Display Systems

The British Computer Society and the Society for Information Display are pleased to announce a joint two-day meeting to be held at the National gallery in central London 22–23 February, 1995. A 1-day tutorial will be held on the preceding day. A book based on papers presented at the event will be published subsequently. The motivation for joint organization of the conference is to bring together the complementary disciplines of display technology and display usage, by providing a forum in which experts from both fields can participate. The focus will be on the assessment and optimum utilization of new display technologies, especially flat-panel, projection, virtual-reality, and augmented-reality displays. The level of presentations should be aimed at the professional engineer engaged in the development of applications that depend on displays. The intention should be to give attendees at the conference practical guidance on standards and procedures that can be applied directly, as well as an overview of the current state of the art and guidance as to the major trends that will shape future applications of displays and display systems. The expectations and needs of the display-user community should also be considered in

continued on page 38

Active Addressing™ of Passive-Matrix Displays

Taking the transistors off the glass and putting them in plastic-encapsulated ICs cuts the cost of video-rate LCDs.

by Paul Gulick and Thomas Mills

OVER THE YEARS flat-panel displays (FPDs) have become an enabling technology for a wide variety of portable electronic products. Constraints on power, size, and cost have pushed the leading display technologies to evolve rapidly, but designers must still compromise when selecting leading FPD technologies for most applications. Engineering evaluation units of a new FPD – the Active Addressing™ liquid-crystal display (AALCD) – are now available and promise to ease the compromises designers have had to make between performance and cost.

The several types of FPD technology on the market today address different applications, but LCD technology has emerged as the most common and best accepted FPD technology among the designers of portable systems. The basic function of an LCD is to control the light that passes through it. The liquid crystal (LC) material responds to voltage signals, which allows discrete picture elements – pixels – to be selectively turned on or off, creating patterns on the display.

Two primary types of LCD have evolved: passive-matrix LCDs (PMLCDs) and active-matrix LCDs (AMLCDs). A PMLCD consists of two pieces of glass, each with parallel transparent electrodes patterned on its surface. The two pieces, called substrates, are put together like the slices of bread in a sandwich. A small gap between them is filled with LC material.

Paul Gulick is Chief Executive Officer and Chief Technology Officer, and Thomas Mills is Marketing Manager at Motif, Inc., 27700A S.W. Parkway Ave., Wilsonville, OR 97070; telephone 503/682-7700, fax 503/682-7036.

One substrate's electrodes are at right angles to the other's, forming columns and rows. The many addressable intersections are called pixels. If a color display is desired, color filters are deposited on adjacent columns to produce red, green, and blue (RGB) subpixels, which permit the control of color. Integrated circuits (ICs) called drivers, often mounted on the periphery of the display, are connected to both the columns and the rows so pulses of voltage can be sent to the pixels. Displays with good contrast and high information content (HIC) can be fabricated in this way. In fact, performance of passive-matrix displays has steadily improved over the last few years, and this type of display still has the highest production volume of any FPD technology. But one major performance characteristic has been lacking in passive-matrix displays for many years: the ability to show fast-moving or video-rate images.

It is easy to make low-viscosity LC materials that can respond at video rates, but if this fast-moving LC material is used in traditional passive-matrix displays, the addressing system produces unacceptably low contrast, very low transmission, and other undesirable display artifacts such as flicker and excessive crosstalk. The root cause of this deficiency is the method by which the electrical signals are sent to the pixels.

Traditional PMLCDs are addressed by sequentially selecting one row at a time. Initially, a large pulse of voltage is applied to the first row while zero voltage is applied to all the other rows. Then, an additional voltage is applied to each column corresponding to each pixel in that row which is to be turned on.

The first row's voltage is then turned off and the next row is selected. In this way, the entire display is scanned one row at a time before sending voltage signals back to the first row. This straightforward system has been very effective in conjunction with *slow-response* LC material because the LC material itself tends to average the voltage's effect across many frames. The material's response is simply too slow to react to the instantaneous pulse applied during a single row-select time. However, if we attempt to make a video-rate passive-matrix display by simply substituting a faster LC material, the material *can* respond to a single row pulse and the optical transmission of each pixel begins to decay from the time its row is selected in one frame until it can be selected again during the next frame. This phenomenon is commonly called "frame response" – the response of the LC material to signals within a frame time. It causes low contrast, low transmission, flicker, and other undesirable artifacts. The first solution to this problem was the active-matrix display, which successfully eliminates frame response from video-rate displays.

The Active-Matrix Solution

An active-matrix display is fabricated similarly to a passive-matrix display. The primary difference is that an active-matrix display has thin-film transistors (TFTs) patterned directly on the surface of the glass – one transistor for each pixel – in addition to the transparent conductor electrodes. The TFTs are fabricated on the substrate by depositing and patterning a

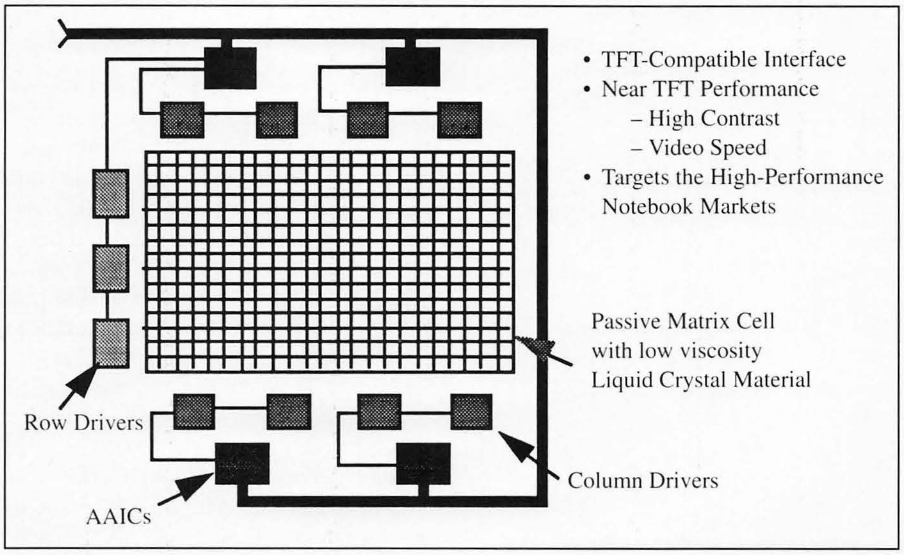


***Fig. 1:** The Active Addressing™ system adds AAICs to what is otherwise very similar to a conventional PMLCD.*

semiconductor material in a series of complex photolithography processes.

Color is obtained the same way as in a passive-matrix display. Color filters are deposited on adjacent columns, creating red, green, and blue sub-pixels. In a color VGA-resolution display – 640(×3) × 480 pixels – nearly one million transistors must be deposited successfully across a 10-in.-diagonal display area.

With the most common type of active-matrix display – in which the TFTs are made from amorphous silicon – driver electronics are again attached to all rows and columns just as in a passive-matrix display. The primary function of the transistors is to receive the control signals from the drivers and apply a constant voltage directly to each pixel or sub-pixel. In this way, fast-responding LC material can be used without producing the ill effects of frame response because the transistor holds the voltage constant at the pixel throughout the entire frame time.

Active-matrix displays provide uncompromising quality and performance, with high contrast ratios and the ability to show full-motion moving images. But active-matrix displays do offer a substantial challenge: fabricating the complex transistor patterns on the glass at low cost with high yield. This has proved to be a very difficult task. Several billion dollars have been spent on production facilities and R&D activities to improve upon the historically low yields and high fixed costs of active-matrix displays.

A New Solution

In May of 1992, Terry Scheffer and Benjamin Clifton of In Focus Systems reported on a new method for eliminating frame response in PMLCDs that does not require the costly transistors of an active-matrix display. Dubbed Active Addressing, this technology has successfully achieved high contrast ratios and fast response in displays that rival the quality of AMLCDs, but with a cost of manufacturing closer to that of passive-matrix devices.

Active Addressing relies upon the proven low-cost manufacturing techniques associated with PMLCDs and adds external electronics that change the standard addressing waveforms so that frame response can be avoided. Instead of the simple one-row-at-a-time selection method used in traditional passive-matrix displays, Scheffer and Clifton showed that a wide variety of orthonormal functions can be used to allow the selection of many rows simultaneously.

Such a system requires calculations to be made based upon the desired image data and the specific row functions to be presented to the display, which result in more complicated, multi-level column voltages. However, once these calculations are made and these column and row signals are presented to the display, each pixel receives many small pulses throughout the frame instead of the one large pulse and long dead time associated with standard passive-matrix addressing. In this way, a nearly constant voltage is applied to each pixel – a voltage similar to that of an active-matrix display. This eliminates frame response and allows the passive-matrix display to be constructed using very-fast-responding LC material.

The construction of an Active Addressing LCD is very similar to that of a passive-matrix display, with a few notable exceptions (see Fig. 1):

- Faster LC material is used and a slightly thinner cell gap is typically required so the fastest possible response times can be achieved.
- Different column drivers are attached to the columns so the multi-level column waveforms can be generated.
- An additional IC is required to perform the Active Addressing computations.

Thus, the cost of an active-addressed LCD is the cost of the basic passive-matrix cell plus the incremental cost of the increased electronics. The executives of Motif – the In Focus/Motorola joint venture that is manufacturing Active Addressing displays and ICs – anticipate that even as active-matrix manufacturing techniques and yields continue to improve, Active Addressing will maintain a significant cost advantage because all of its electronics can be processed in silicon using standard IC-processing techniques. This is in marked contrast to the active-matrix approach of processing TFTs directly on glass – and over a much larger area.

Most of the other cost parameters are very similar in all three of these LCD types because of the similar make-up of the materials in both passive- and active-matrix displays. Kevin Cornelius, VP Marketing and Sales at Motif, anticipates that Active Addressing LCDs will be able to maintain a cost that is 25–30% less than that of an active-matrix display – even as the yields of AMLCDs continue to improve (Fig. 2).

Bringing Technology to Market

In order to commercialize Active Addressing, In Focus Systems and Motorola, Inc. created

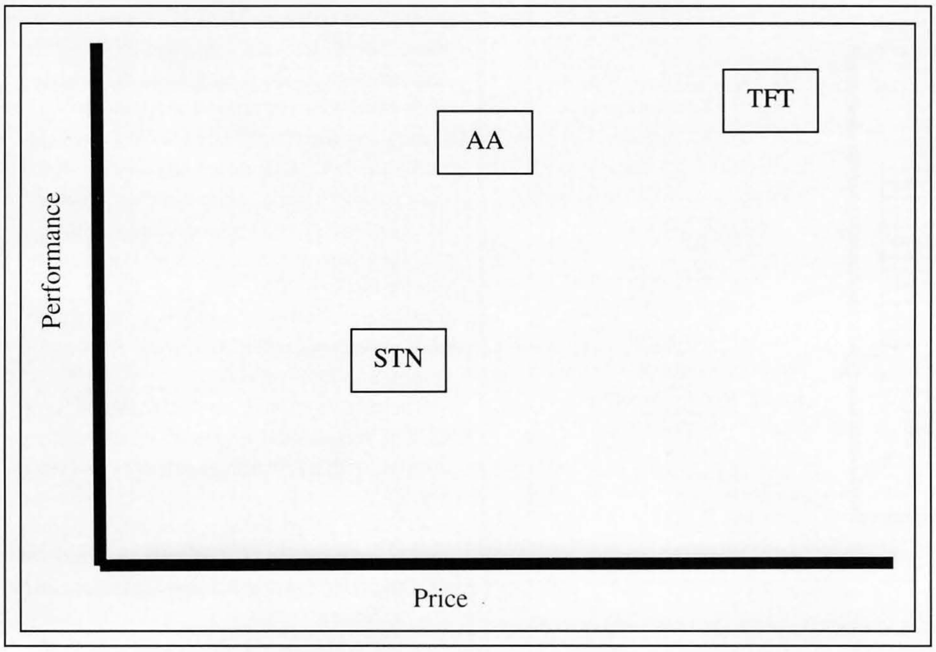


Fig. 2: AALCDs are intended to provide performance that is close to that of TFT-LCDs at a cost that is 25–30% less.

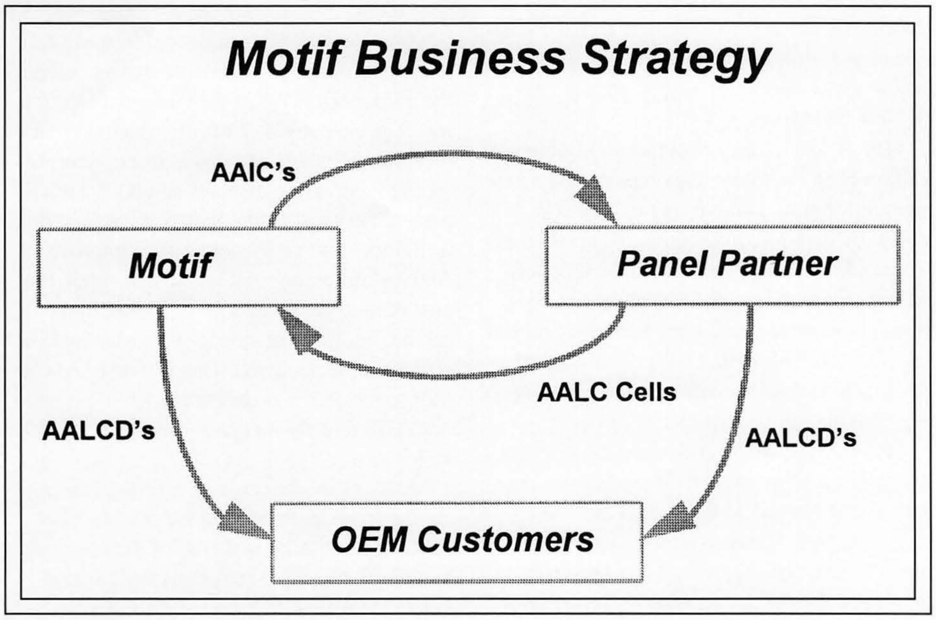


Fig. 3: Motif has consummated agreements with four "panel partners" to provide large-volume deliveries of AALCDs to OEM customers in 1995.

Motif, Inc. in October of 1992. Motif's charter is ambitious: to become a major supplier of LCDs to world markets.

Over the past year, Motif has constructed a PMLCD manufacturing facility near Portland, Oregon. This facility is capable of producing up to 300,000 LCDs per year, making it the highest-capacity HIC LCD plant in North America. Initially, the primary markets for Motif's LCDs will be in projection systems and hand-held instruments to serve the needs of its parent companies, as well as other OEMs.

But Motif executives believe that Active Addressing has much broader applications and anticipate that the demand for this new technology will far outstrip the current limited capacity that Motif is bringing on line at this stage of production. Therefore, Motif has consummated agreements with four major suppliers of PMLCDs that they become panel partners to help with the commercialization of AALCDs. The suppliers are Tottori Sanyo, Standish LCD, Kyocera, and Optrex (the Asahi Glass Company/Mitsubishi Electric joint venture).

Motif will utilize its custom ICs that embody the proprietary Active Addressing algorithms in its own displays, but will also sell those ICs to its panel partners for use in their broad offerings of products. This will allow OEM designers to have an immediate high-volume source for AALCDs even as Motif continues to ramp up its own supply (Fig. 3).

The first Active Addressing products are targeting the high-volume high-performance notebook computer market and are intended to compete directly with active-matrix technology. Active Addressing should permit more cost-effective notebook and sub-notebook computers, particularly as the push towards higher display performance drives manufacturers away from traditional passive-matrix display alternatives.

Motif second-generation Active Addressing integrated circuits (AAICs) will be tailored to fit the needs of the new personal digital assistant (PDA) marketplace, with 320 × 480-pixel capability, lower cost, and lower power consumption. Higher-resolution (SVGA and XGA) and larger-size (more than 10.5-in. on the diagonal) displays will be targets of third-generation IC development.

With Active Addressing, designers of portable electronic equipment now have a third technology option for filling their display needs. Active Addressing is capable of contrast ratios (CRs) of 50:1 or greater, compared with traditional passive-matrix CRs of approximately 15:1. Response times as fast as 50 ms have been measured, compared with 150–200 ms for traditional passive-matrix displays. Early prototypes displayed at SID '94 last June were already exhibiting CRs as high as 35:1 and response times as low as 65 ms.

Active Addressing displays can be built in either color or monochrome, and can be backlit or used in a reflective or transflective mode at the lowest possible power consumption.

To date, applications such as portable games, consumer-level virtual-reality products, and personal communications devices such as PDAs have not been able to offer the highest-quality displays because of the high cost of AMLCDs. Active Addressing™ should allow new products – such as PDAs with fast game-type graphics – to be offered at the price points required by consumer markets. Active Addressing™ therefore has the opportunity to serve a large portion of existing FPD markets, expand those markets, and move into new markets through its favorable price/performance characteristics. ■

SID '95

Walt Disney World Dolphin Hotel
Orlando, Florida
May 21–26, 1995
Mark Your Calendar Now!

DISPLAY MANUFACTURING TECHNOLOGY CONFERENCE

Santa Clara, California
January 31–February 2, 1995
Contact: Mark Goldfarb
703/486-7111 fax -8527

To participate as an exhibitor at DTMC '95 in Santa Clara, please call Erika Suresky, Exhibit Manager, Palisades Institute for Research Services, Inc., at 212/620-3375, fax -3379.

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

Circle no. 18

show report

Computex Taipei '94

The world capital of monitor manufacturing flexes its muscles.

by Bryan Norris

BILLED AS THE largest computer show in Asia, the 14th Computex Taipei ('94) Show opened its doors at the Taipei World Trade Center Exhibition Hall June 2–6, 1994. The 553 exhibitors – 482 of them Taiwanese export-oriented companies – played host to the expected 8500 international visitors and foreign buyers. With the "selling" idea uppermost, the first two-and-a-half exhibition days were for the trade only. Some of the companies, such as Mitac and Tystar, chose to provide comfortable and informal settings by having their presentations in one of the luxury suites on the top two floors of the nearby 25-story Grand Hyatt Hotel.

Foreign exhibitor participation at Computex this year consisted of 41 companies from the U.S., 17 from Singapore, three from Hong Kong and Germany (including miro), two from Japan, and one from the U.K.

In a concerted effort to make Computex more than just a trade show, the organizers – the China External Trade Development Council (CETRA) and the Taipei Computer Association – had arranged an impressive list of over 30 conferences and seminars, plus a "CEO Round Table Meeting," where 16 executives from some of the leading computer makers in Taiwan discussed "The Future Direction of Taiwan's IT Companies in Response to CPU Development Trends."

Bryan Norris is Monitor Program Manager at BIS Strategic Decisions, Ltd., 40-44 Rothesay Road, Luton, Bedfordshire, LU1 1QZ UK; telephone 44-582-405-678, fax 44-582-454-828. He is a Contributing Editor to Information Display.

Taiwan and IT Development

With output growing 15.5% to nearly US$12.5 billion in 1993, Taiwan became the world's fifth largest supplier of information technology (IT) products – behind the U.S., Japan, the U.K., and Singapore. Within the 1993 total, hardware production reached US$9.63 billion, "offshore" production reached nearly US$l.7 billion, and information services exceeded US$1.1 billion. Of the total 1993 IT production, monitors represented 33% (up from 29% in 1992), desktop PCs 12% (down from 15%), portable PCs 17% (up from 11%), and mainboards 9% (down from 12%). Production value is expected to grow a further 14% in 1994!

Since 1949, Taiwan has achieved an amazing annual economic growth of 8.7%, and now has a per capita GDP of US$14,200, the third largest in the Far East (after Japan and Hong Kong).

The impetus for the development of Taiwan's very successful IT industry is credited to the Government's having banned local manufacturers from making video gaming machines in 1982! Many manufacturers therefore shifted production to PCs – and rode on the back of IBM's entry into the PC market. The period between 1983 and 1987 was a boom time in Taiwan, with annual average growth rates of 60%. Companies such as Acer, Tatung, and Mitac moved into the international market and had difficulty keeping up with demand. But from 1988 onwards, the rising exchange rate of the New Taiwan (NT) dollar, spiraling local labor costs, and depressed international markets resulted in much more modest increases and the growth of "offshore" production.

Nevertheless, Taiwan's IT manufacturing status is still most impressive, especially when its export statistics are considered. According to the well-respected Market Intelligence Center (MIC) – part of the Institute of Information Industry (III), a company under the supervision of Taiwan's Ministry of Economic Affairs – exports of PCs, for example, increased from just over 2.5 million units in 1992 to nearly 3.3 million units in 1993. Of the latter, 34% went to Europe (compared to 38% in 1992), 46% to the U.S. (compared to 47% in 1992), and 20% to other areas (up from 15%).

Taiwan also claims an amazing 83% of the world's motherboard production, and this output is a first-rate indicator of PC trends. For example, in the first quarter of 1994, 91% of the 2.2 million pieces sold (worth US$200 million) were 486 boards. This represented a 25% growth over the same period in 1993 and clearly indicated the decline in the popularity of the 386 PC. Interestingly, while exports of motherboards to the U.S. dropped from just over 40% of the total in 1992 to less than 28% in 1993, sales to Europe increased by 51% – helped, no doubt, by rising sales to European PC makers, notably Vobis and Escom.

But the real success story for Taiwan must be monitor manufacturing.

17.5 Million Taiwanese Monitors in '93

MIC reports that in 1992 Taiwan's monitor manufacturers exported over 12.4 million monitors, of which just over 10.7 million units, worth about US$2.3 billion, were made in Taiwan. (The rest were made in Taiwanese offshore plants.) In 1993 exports were up to 17.1 million units, of which 12.9 million units, worth nearly US$3.2 billion, were made in Taiwan and 4.2 million units were made at offshore locations.

This continuing trend to move production offshore applies primarily to 14-in. models. Acer, Jean (Wen), Lite-on, Shamrock, TECO, and Viewsonic are producing monitors in Malaysia. ADI, Arche, CTX/Chuntex, Compal, EMC, and Tatung have plants in Thailand. Bridge, EMC, Regent, and TVM manufacture in Indonesia. CTX is also manufacturing in Hong Kong. AOC is moving production to China, where TW Casper, Tystar, and Vanda are already established. However, domestic production is still predicted to reach approximately 14 million units in 1994.

The destination of the exports may have changed a few percentage points from 1992 to 1993 – down from 36.2 to 32.1% to Europe and up from 42.1 to 46% to the U.S., for example. But in unit terms, quantities are always up – from about 4.5 to 5.5 million monitors to Europe, and from 5.2 to 7.9 million to the U.S. MIC suggests that one of the reasons for the market center shifting to the U.S. is that it was easier for Taiwanese companies to enter this market. MIC also noted that with the appreciation of the yen, Taiwanese vendors have been able to penetrate the Japanese market.

With such large quantities of monitors being exported, it is not surprising that some individual manufacturers produced significant numbers of units. MIC lists Philips (Taiwan) and Tatung as the leaders, making over 150,000 monitors a month; Acer, ADI, AOC, Capetronic, CTX, KFC, Lite-on, MAG, Sampo, TVM, and Viewsonic are selling between 50,000 and 150,000 a month; and Bridge, Cheer, Fair, Mitac, TECO, and Topfly are making (just) under 50,000 units. Acer, ADI, and AOC are all expected to increase production and begin producing more than 150,000 units a month this year.

Monitor Suppliers at Computex

Not surprisingly, monitor companies were very well represented at Computex Taipei '94. Although virtually all the 55 or so monitor exhibitors I saw had a number of 14-in. monitors to offer, there was a definite and striking orchestration to promote 15-in. models. Making the point even more strongly, some exhibitors talked about 17-in. models and a few even heralded 20/21-in. models. Some of the exhibitors had gone to the trouble of preparing glossy data sheets for monitors that were not intended for production until 1995.

Certain suppliers had good selections of models with "other" screen sizes. Action, ETC, and (Jean) Wen included 9/10-in. models in their portfolios. Chun had very-large-screen 29- and 33-in. models on display, with a 37-in. model promised.

It's Not Easy Being Green

In tune with the demand of the European and U.S. markets, many Computex exhibitors followed the lead of their colleagues at CeBIT '94 and climbed on the "green" promotional bandwagon. It seemed as though nearly every supplier was offering energy-saving, environmentally friendly, ergonomically acceptable monitors. The suppliers often reported that the monitor was both (1) built from recyclable materials and (2) built using "an environmentally friendly manufacturing process to reduce the amount of harmful pollutants." And this theme was taken up by the press. In a *China Post* "Focus on Computers" article, for example, two banner headlines were "High-resolution (Delta) monitors go green" and "Concern for the environment adding to the popularity of (Mitac's) green monitors."

Nevertheless, there did appear to be some confusion about low-radiation recommendations and TCO criteria, especially among smaller suppliers. MPR-II compliance was cited by most of the monitor suppliers, either as a standard feature or as an option. Phrases such as "MPR-II compliant" were often used, apparently without the makers realizing that the full MPR-II recommendations, backed with a certificate from an approved test house such as TÜV Rheinland, imply much more than meeting a few maximum radiation levels. There also appeared to be limited understanding of the fact that TCO '92 embraces the stringent TCO '91 environmental criteria as well as the (NUTEK) below-8-W power-down level. But then this can be forgiven, as few Europeans can understand the TCO requirements.

None of the factors cited detracted from the reality that Computex was a vibrant, colorful, bustling show with a multitude of completely up-to-date monitors being displayed by an almost unbelievably large number of suppliers. (Taipei also provided a wake-up call to all those visitors sleeping late on Sunday morning – a local earthquake.)

The Future for Taiwanese Monitors

Computex Taipei '94, arguably the most prestigious IT trade show in the Asia/Pacific Rim countries, provided a fascinating window on the Taiwanese IT industry – which in 1993 produced over half of the world's output of color monitors. This is not surprising because Taiwanese suppliers have an excellent range of modern *economically priced* monitors and are well aware of both the U.S. and the European market demands, particularly in terms of features such as power-down. Most of the exhibitors included 15-in.-screen models in their line-up, and many either had one or two 17-in. models or planned to have them very soon.

The Taiwanese monitor makers have long excelled in supplying basic and mid-range 14-in. models. Despite manufacturing costs in Taiwan giving cause for concern and South Korean makers proving to be formidable rivals, the Taiwanese offshore plants should ensure that even 14-in. monitors made by Taiwanese companies will remain competitive for a number of years to come.

Few stand-alone flat-panel monitors were to be seen at the show. Even Sun Up computers, whose FPD "SlimAGE" monitors have been seen at a number of the European exhibitions, promoted CRT monitors on its Computex stand along with the FPD products. But local companies, such as Chunghwa Picture Tube, Nan Ya, PICVUE, and UMC, are in the process of developing LCDs. ■

Color Plasma Displays: Where Are We Now?

Plasma fever has infected both the U.S. and Japan because plasma displays can be big – really big.

by Shigeo Mikoshiba

AT THE SID '94 SYMPOSIUM in San Jose last June, I saw standing-room-only audiences at the plasma display sessions for the first time in 20 years. Similar plasma fever can be found in Japan, where "plasma display technical meetings" are being held three times a year to informally discuss the technological issues of plasma display panels (PDPs) in detail. The last meeting in Tokyo attracted some 230 participants from 73 organizations. Support came from infrastructure industries dealing with a variety of components, including glasses, phosphors, thick-film print screens, pastes, and fabrication technologies.

Plasma fever is spreading, I presume, not because plasma developers have recently made magnificent technical breakthroughs, but rather because people have realized that TFT liquid-crystal techniques are not adequate for large displays – at least for the near future. Other technologies, such as electroluminescence (EL) and field-emission display (FED) technology, are demonstrating color and appear capable of producing small displays. In small sizes, these displays might have to compete directly with LCDs. If this were the case, they would have to compete under a handicap: the promoters of these technologies, although serious, do not have access to huge R&D budgets as LCD manufacturers do.

Dr. Shigeo Mikoshiba is Professor of Electronic Engineering at The University of Electro-Communications, Tokyo, Japan, and Associate Editor of Information Display.

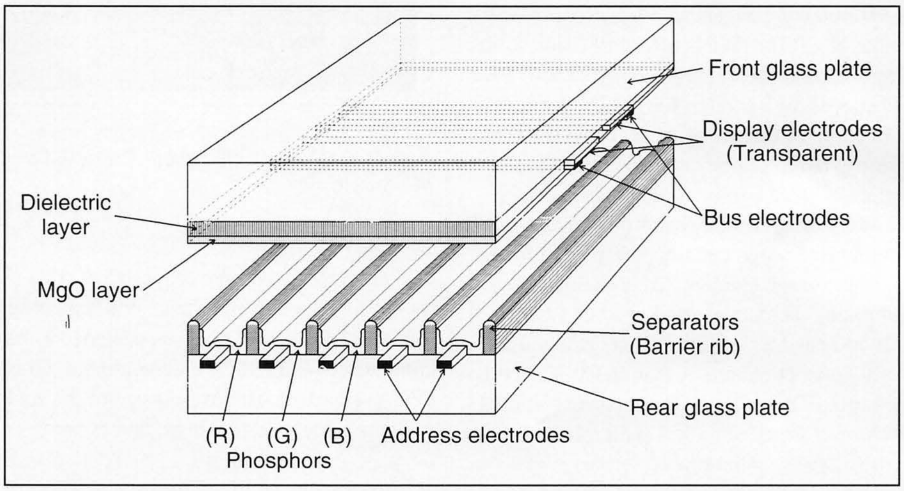


Fig. 1: *Fujitsu's epoch-making 21-in. plasma-display monitor uses a three-electrode surface-discharge structure. (Figure courtesy of Fujitsu, Ltd.)*

Another thing that impressed me at the SID meeting was that the statement "plasma is large and in full color" seemed to be commonly accepted, especially on the exhibition floor.

How They Operate

A PDP is a collection of miniature gas-discharge lamps working on the same principle as ordinary household fluorescent lamps. Images can be reproduced by controlling the intensity or duration of the discharge current at each lamp. The vacuum ultraviolet radiation emitted by the gas discharge excites the phosphor deposited on the inner wall of the lamp. The lamp's color can be determined by choosing an appropriate phosphor.

PDPs are categorized mainly by whether the voltages applied to their discharge electrodes are ac or dc, although there are also hybrid types such as ac-dc and dc-CRT. The electrodes of dc panels are exposed to the discharge gas; those of ac panels are insulated by thin-film dielectric layers.

A well-designed PDP has an extremely attractive set of features. First, it is thin, with a total panel thickness of 6 mm or less. The overall thickness of the final device is design-dependent. Electronic drivers are usually mounted at the back of the panel, but they can be attached to the panel's periphery to reduce thickness.

PDP is the only direct-view technology that can display an image having a diagonal measurement of 40 in. or more. Photonics of Northwood, Ohio, introduced a 60-in.-diagonal fully populated monochrome display in 1987. Dr. Peter Friedman of Photonics says he will be able to double the diagonal of the company's current 30-in. color plasma display without much difficulty.

PDP is rugged and safe. In the unlikely event that a blow or fall accidentally breaks a panel, there is no danger of glass-fragment implosion. No atoms are more stable than those of the rare gases that are commonly used in existing panels. The basic structure and materials are extremely durable, so system durability at ambient temperature is typically determined by the electronics. Users of early production units of ac monochrome PDPs report a lifetime of 100,000 hours.

PDP viewing angles are wide – comparable to that of CRTs. Panels offer full-color, 8-bit gray-scale capability, high contrast ratio (CR), and speeds high enough for HDTV displays.

Because of the strong current-voltage nonlinearity that produces a sharp "knee" in the current-voltage curve, plasma panels permit the addressing of many electrodes with a time-multiplexing technique. This eliminates the need for the complicated active-matrix addressing techniques used in some LCDs.

If you need a high-resolution display, LCD might be a better answer than PDP. The ability to put PDP pixels close together is limited because of the need to deal with relatively high voltages. What's more serious is that luminous efficiency is reduced as the discharge dimensions become smaller because more energy is wasted by the increased diffusion loss of charged particles to the cell walls.

Low luminance is another problem. Gas discharges do not produce ultraviolet radiation exclusively, and a lot of energy is wasted in simply heating the gas and cathodes. The luminous efficiency of the typical plasma display is 0.3 lm/W for white, which corresponds to an energy-conversion efficiency of only about 0.1%.

NHK Science and Technical Research Laboratories

Fig. 2: *NHK and Dai Nippon Printing Company have produced an impressive 40-in.-diagonal plasma display.*

Display Update

The epoch-making Fujitsu/Fujitsu General 21-in.-diagonal plasma TV and monitor are now on the market under the name "Plasma Vision." The initial price of the monitor – ¥1,150,000 – is now down to ¥780,000. Mr. Tsutae Shinoda, Project Manager, Display Division of Fujitsu, Ltd. Japan, said that he has received many more requests for price quotes than he had expected. The display resolution of 640 × 480 pixels is designed to be compatible with IBM's Video Graphic Array (VGA) standard. The overall size of the set is 490 mm wide, 440 mm high, and 60 mm deep.

The structure of the Fujitsu panel incorporates a pixel pitch of 0.66 mm, consisting of three (RGB) discharge cells (Fig. 1). The panel is an ac-type filled with a gas mixture of xenon and neon. Each single cell has three electrodes. Surface discharge takes place between the two transparent display electrodes, which are on the front glass plate. The electrical conductivity of these electrodes is enhanced by overlaid thin-film Cr-Cu-Cr bus electrodes.

The electrodes are coated with dielectric and magnesium oxide (MgO) layers. The MgO's low sputtering rate assures a longer panel life, and its high coefficient of secondary electron emission provides a lower operating voltage – but at the expense of a tedious thin-film process. The third electrode, which addresses the discharge cell, is on the rear glass plate. Separators – or barrier ribs – are 50 μm wide, 100 μm high, and are on a 0.22-mm pitch. They are made by a multiple printing technique of thick-film pastes. The separators prevent electrical and optical crosstalk between neighboring cells.

Phosphors are deposited on the address electrodes as well as on the side walls. This increases the phosphor-deposition area and improves the white peak luminance to 150 cd/m^2, the luminous efficiency to 0.7 lm/W, and the viewing angle to 140°. The CR is 50:1 in a dark room. The panel can display 64 gray shades and 260,000 colors. The highest voltage for the IC drivers is 180 Vp-p. The monitor, including the high-voltage drive electronics and their control circuits, consumes 100 W and weighs 4.8 kg. The panel life is in excess of 10,000 hours. Fujitsu's goal is to upgrade the size to 40 in. within 2 years.

At SID '94, NHK (Japan Broadcasting Corp.) Science and Technical Research Laboratories, in collaboration with Dai Nippon Printing Co., Ltd., reported on the development of an experimental 40-in.-diagonal full-color dc display (Fig. 2). Its active area is 874 mm horizontally and 520 mm vertically, with an aspect ratio of 16:9. A pixel is composed of four (RGBG) discharge cells. The number of discharge cells is 1344 × 800, with an average pitch of 0.65 mm. The peak white luminance is 93 cd/m^2 with 256 gray levels. The recent drive scheme developed jointly by NHK and Matsushita Electronics Corp. reduced the power consumption to 275 W, of which 200 W goes to the panel and the rest to the circuits. NHK's target date for the prototype of a 40-in. commercial TV with higher resolution than the current panel is 1998 – when the Winter Olympic Games will be held in Nagano, in the central mountains of Japan.

Thomson Tubes Electroniques of France recently announced a 22-in. TV prototype. It has a 330 × 440-mm display area with 512 × 480 pixels, which are on a 0.9-mm horizontal pitch and a 0.6-mm vertical pitch. An RGB triad forms each pixel, and the luminance is 150 cd/m^2. Each discharge cell has two electrodes, one on the front glass substrate and the other on the rear. This structure has a small intrinsic stray capacitance between electrodes, allowing fast addressing speeds. The discharge path is normal to the substrates, in contrast to the surface-discharge scheme in which the discharge is parallel to the substrate surfaces. Phosphor covers both of the substrates to provide a brighter image. Thomson's 19-in. color monitor for workstations has 1280 × 1024 pixels with a pixel pitch of 0.3 mm.

Photonics has an ac-type 30-in.-diagonal video monitor with 1024 × 768 full-color pixels whose pitch is 0.59 mm. White luminance is 100 cd/m^2, CR is 100:1, viewing angle is 160°, and the display exhibits 64 gray levels. The double-substrate two-electrode structure utilizes a high-resolution barrier technique that enables it to reproduce HDTV-quality images.

Plasmaco's 21.3-in.-diagonal monochrome displays for workstation monitors have 1280 × 1024 pixels with a discharge-cell pitch of 0.33 mm. The area luminance is 27 cd/m^2 and typical power consumption is 40 W. The display is notable for its L-C energy recovery circuit, which transfers the energy stored in the stray capacitance of the plasma panel to an external capacitance as the panel voltage drops, instead of dissipating it in resistors. The display also uses an "independent sustain and address" scheme, which can reduce the number of address drivers by a factor of two. Using the chip-on-glass (COG) technique allows the manufacturer to mount high-voltage drivers and their control electronics on the periphery of the glass panel, thus drastically reducing the number of connections between the panel and external circuits.

Both Photonics and Plasmaco are involved in the intensive program of the United States Display Consortium (USDC), whose mission is to develop the infrastructure required to support a U.S.-based manufacturing capability for high-definition displays.

R&D Trends

Brighter images, higher luminous efficiency, and lower operating voltages are the everlasting issues for PDPs. Short-term approaches to these issues involve improvements in discharge-cell configurations (such as the provision of wider phosphor areas with controlled thicknesses) or improvements in panel operating principles. Among the latter is the appropriate distribution of working voltages – assigning lower voltages to higher-frequency drive pulses and higher voltages to lower-frequency pulses, for example. In the future, development of lower-voltage cathode materials, higher-quantum-efficiency phosphor materials, more uniform cell fabrication over the entire active region, and a deeper understanding of discharge physics will all be essential.

A 40-in. HDTV needs a pixel pitch of about 0.5 mm. The required tolerance for such a panel is extremely high – 1/50,000. Thin-film and photolithography processes meet the requirements without too much difficulty, but thick-film screen printing needs substantial improvements in printers, masks, screens, and pastes. The greatest obstacle may well be the fabrication of large-aspect-ratio barrier ribs, for which thick-film, photolithography, sandblasting, and metal-etching techniques are being investigated. Sand-blasted ribs 50 μm wide and 200 μm high are currently being reported. Glass substrates are another issue when moving to large panel sizes. Glasses with a low thermal shrinkage and higher working temperatures are necessary. An alternative solution is the development of thick-film pastes with low firing temperatures.

Various companies are fabricating high-voltage driver ICs for color PDPs. A typical example is Texas Instruments Japan's 190-V 200-mA 32-output 8-MHz IC. High-voltage ICs no longer seem to pose a technical problem, but questions of price remain.

The Future of PDPs

"Multimedia display" is the key phrase for the future of PDPs, which should handle workstation information with Windows™-based GUIs as well as HDTV displays. Cost reduction is another key phrase, and always an important issue. Since the driver accounts for a significant portion of the total device cost, one of the most effective cost-reduction strategies is to lower the switching voltage and load current, thereby reducing the area of required silicon crystal.

An alternative strategy is to decrease the number of drivers. The PDP's sharp discharge threshold with respect to applied voltage plays an important role in successfully implementing this strategy. The threshold can be controlled by introducing charged particles into the gas-discharge vessel, a technique called "discharge priming." This allows the number of scan-pulse drivers (but not signal-pulse drivers) to be reduced by a factor of 10 or even more – a technique known as "gas logic." Although various methods of discharge priming are being investigated, there are certainly more possibilities for new ideas. ■

Please send new contributions or noteworthy news items to Aris Silzars, Contributing Editor, Information Display, c/o Palisades Institute for Research Services, Inc., 201 Varick Street, New York, NY 10014.

continued from page 4

swaying with each slight movement. I am convinced that I can't and won't do it, but somehow I do it anyway. In the process, I learn something about myself. The view is great from up there as well, and much more enjoyable, coming as it does after the most challenging part of the task instead of before. This event ends with a jump off the disk while trying to reach out to ring a bell hung in a nearby tree. Once again, the harness comes in handy for a more-or-less graceful descent to earth.

One morning, half of us are blindfolded and each led through the forest by an anonymous teammate with only tactile communications allowed. We learn to rely on our mystery guides to keep us safe. Then we trade places and now I am responsible for guiding one of my colleagues. Surprisingly, I find that being blindfolded and relying on someone else is not so bad after all. I am his problem. He had better keep me safe or risk the embarrassment of having me fall down while under his watch. I find that this is easier than having to be responsible for someone else. Gee, I think to myself, is this what goes on back at work with many of our employees? Do they find it more comfortable to just wait to be told what to do next?

The "experiential learning" activities are structured to challenge and test our limits by taking advantage of one or more of the following forms of stress: our normal, and I think well-founded, fear of heights; doing something unknown for the first time; doing silly things around ones colleagues; and the difficulty of adapting when one or more of our senses are inhibited.

The intensity of the activities creates great camaraderie. Even failures are cheered because trying hard is all that is required. There is a growing conviction among the group that support from other team members is of great value and that much more could be accomplished in our work environment if these principles were implemented. We learn, demonstrate, and enthusiastically embrace the key concepts of ***Trust, Accountability, Support, Truthfulness,*** and ***Empowerment.*** At the end of the 3 days we are not only ready to take on whatever challenges we might encounter when we return to work, we are ready to take on the Dallas Cowboys in the next Super Bowl.

The following day – back at work. The phone messages have piled up, customers are unhappy because their deliveries are behind schedule, and manufacturing is having problems with the latest run of parts. Haven't they heard? We're a new team here! We now know how to handle these trivialities. But, marketing once again blames manufacturing for gross incompetence. The engineering department can't seem to figure out what has gone wrong, and consequently manufacturing is upset with engineering. Wait a minute! Remember? – Trust, Accountability, Support! Didn't they get it? Why is it business as usual? What happened to the beautifully demonstrated and enthusiastically embraced concepts that were going to make this company a world-beater?

Is it really not possible to create a better work environment? Are these principles too idealistic? Or is something else going on here? Perhaps some sample events (that really happened) will help explain the discrepancy. How about the most recently announced "unexpected" layoffs. Did they perhaps have something to do with turning Trust into Suspicion? Or, when manufacturing worked extra hours to get a product out only to be told by marketing that they're a bunch of incompetents, did that do something to turn Support into Resentment? Or, when an employee suggested a process improvement to engineering only to be told that he simply didn't understand the technology, did that do something to turn Empowerment into Disenchantment? I think you get the idea.

The process of change and improvement is indeed a difficult one. Some of our basic behaviors are so deeply rooted that change occurs only when our personal survival is at stake. And even then, the change may not be sustained once the threat passes. Success seems to come to those organizations that are able to first select team members compatible with the temperament of the organization's leaders and then to provide enough strategic vision, predictability, support, and positive reinforcement to rise above the norm. And surprisingly, that is usually about all that it takes. For after all, **the difference between a successful company and a loser is only about 15%!**

This month there were a number of newsworthy events indicating that companies in the display business are hard at work making constructive changes, refining their strategies, and taking judicious risks in the never-ending quest to achieve greater business successes.

Planar Systems of Beaverton, Oregon, announced the signing of a letter of intent to acquire the Avionics Display business of **Tektronix, Inc.**, also of Beaverton. The Tektronix Avionics Display business unit is a leading supplier of high-performance CRTs for advanced avionics applications. The proprietary taut-shadow-mask high-brightness color CRTs developed by the Avionics group are used in many of the most demanding avionics applications. In addition, Planar will acquire a license to produce and sell liquid-crystal color shutter displays for certain military and commercial applications. **Jim Hurd**, Planar's President, explained that the interest in this business came about from a continuing desire to provide Planar's military customers with the best display solutions for their applications, especially where readability is required in full sunlight.

Tektronix is also continuing with the divestiture of all the other parts of its component operations. The former Hybrids Operation, which, along with other hybrid products, produces a line of excellent high-speed video drivers, has been divested as a jointly owned corporation with **Maxim**, with the new name **Maxtek Components Corporation. Scott Jansen** has been appointed as the Director of Engineering. The new company continues to be located in Building 13 of the Tektronix Beaverton campus.

The Tektronix-developed Plasma-Addressed Liquid-Crystal Display technology is being divested through the efforts of **Tom Buzak** and **Kevin Ilcisin** through their newly formed company **Technical Visions**. Tom is the President and Kevin is Vice-President. Most of the staff of the former group have found positions either within Tektronix or have moved on to other career opportunities. **Pat Green** has recently joined **Planar** as a Program Manager in the Advanced Technology Group. **Phil Bos** has moved to **Kent State.**

Motif, Inc. of Wilsonville, Oregon, has announced the signing of a strategic alliance with **Kyocera Corporation** of Kyoto, Japan. Motif is the developer and manufacturer of Active Addressing™ liquid-crystal display technology. Kyocera is a major manufacturer of passive-matrix LCDs, among other products. This alliance is another key milestone in the broad commercialization of Active Addressing™ by Motif. Through this alliance, Motif, a joint venture between **Motorola** and **In Focus Systems**, will sell Active Addressing™ integrated circuits to Kyocera, enabling Kyocera to supplement their current product offerings with the addition of Active Addressing™ LCDs. This is the fourth such alliance for Motif.

At its annual meeting of shareholders, **SI Diamond Technology, Inc**., developers of proprietary advanced diamond technology for flat-panel display, electronics, and industrial applications, elected **Howard K. Schmidt** to the position of President and Chief Executive Officer. Howard, who founded the company in 1987, replaces **Robert H. Gow**, who is retiring. Bob Gow explained the transition as the culmination of his efforts to get the company into a sufficiently strong business position so that he could accomplish this change.

Steve A. Mullane has been appointed to the position of National Sales Manager by **Semiconductor Systems Inc.** of Fremont, California. Prior to joining SSI, Mr. Mullane was national sales manager for Hoechst Celanese Corporation. Founded in 1982, SSI is a privately held manufacturer of customized high-performance processing equipment for flat-panel displays, silicon wafers, thin-film heads, and multi-chip modules. The company's systems perform a number of advanced processes, including cleaning, photoresist coating, developing, and polyimide processing.

Thomas L. Credelle has joined **Allied Signal Optical Polymers** as Director of Market

display continuum

Development. This group is part of the Engineered Materials Section of Allied Signal. At the present time, Tom has offices both in Santa Clara, California, and Morristown, New Jersey. The primary products of this group are backlight and film technology for LCDs. The objective is to provide materials with improved viewing angle and low reflectance for both color and gray-scale displays. Previously, Tom was with Apple Computer.

Your comments, information, and feedback are always welcome. You can reach me in person at 609/734-2949 or by fax at 609/734-2127. I have also finally succumbed to e-mail, so you may wish to try that method as well: aris_silzars@maca.sarnoff.com. Of course, the U.S. Mail is still there for you to use as well. Send me your information c/o Jay Morreale, Palisades Institute, 201 Varick Street, Suite 1006, New York, NY, 10014. ■

continued from page 2

electrode is deposited on the tops of the ribs. The space between the substrates is filled with the dyed organic liquid and suspended particles. The structure of the display is therefore only slightly more complicated than that of an STN-LCD and should not be much more expensive to fabricate. The glass fabrication is being done for CopyTele by Hoya Corporation. The suspension is produced by Sumitomo. Both companies are doing their work in Japan.

CopyTele demonstrated three prototypes of its 7.8-in. display at the annual general meeting of its shareholders on July 20th. Company CEO Denis Krusos said that the company was also producing 5.7- and 7.2-in. prototypes. The panels did not have any obvious flaws, and Krusos indicated that the glass was of production quality. The still-bulky electronics are to be embodied in ICs for the production version.

The CopyTele displays were shown in a restaurant banquet room under somewhat subdued lighting. They were illuminated by built-in edge-mounted front lights. "ON" pixels were a yellow-green against a background that appeared very dark gray under the lighting conditions in the room. (This is, obviously, a monochrome display.) Subjectively, the contrast ratio was reasonably good. With 200 pixels/in., resolution was very good. Maps and text were easily readable. Krusos commented that the display exhibits eight true gray levels. A horizontal band constituting the center three-quarters of the display seemed darker than the outer edges, which may have been an effect of the edge front-lighting.

EP displays have traditionally had a slow optical response. The response of CopyTele's display is reportedly about a third of a second – roughly comparable to many STN-LCDs. A fluttering mouse cursor (in the form of a bird) remains highly visible even when moved quickly. It appears as if this is done by having the electronics generate a sequence of quasi-static cursor images. In any case, it is a useful and effective trick that could probably be implemented on LCDs.

CopyTele's management has made some intemperate claims for the company's technology in the past. What the EP displays I saw seem able to offer in the foreseeable future is high resolution at low cost with low power consumption for applications that do not require color or a short response time. That could be enough to generate some curiosity among OEMs.

Of course, curiosity will turn to active interest only if Mr. Krusos and his colleagues can get over their penchant for secrecy. "The company is at the stage where we can now be more communicative," Krusos said at the annual general meeting. "We will be more open." If that commitment can be sustained, CopyTele will no longer be "the invisible display company."

Information Display Magazine invites other opinions on this and related subjects from members of the international display community. The opinions expressed do not necessarily reflect the opinions of the publisher of *Information Display Magazine*, nor do they necessarily reflect the position of the Society for Information Display.

– Ken Werner

continued from page 7

the context of technical and economic feasibility. For further information contact:

Tony Lowe
IBM T.J. Watson Research Center
Route 134 (10-106)
Yorktown Heights, NY 10598, USA
Tel: +1-914/945-3368
Fax: +1-914-945-4484
e-mail: tonylowe@vnet.ibm.com

Lindsay MacDonald
Crosfield Electronics Ltd.
Three Cherry Trees Lane
Hemel Hempstead, Herts HP2 7RH, England
Tel: +44-442-343-367
Fax: +44-442-232-301
e-mail: lm@crosfield.co.uk

Surface-inspection partnership

The U.S. Display Consortium (USDC), San Jose, California, has announced a $1.4-million program with Display Inspection Systems, Inc. (DIS), Wixom, Michigan, to develop a high-speed high-accuracy system that will perform on-line surface inspection of glass substrates used in the production of flat-panel displays (FPDs). The substrates can be bare glass, uniformly coated glass, or patterned glass. The goal of the program is to dramatically reduce the cost of FPDs by avoiding the expense of processing defective and unrepairable products. Presently, a significant amount of yield loss in the production of FPDs is due to surface defects on bare and coated glass, costing the industry millions of dollars every day. Automated inspection will permit 100% inspection of substrates in real time on the production line. Success will mean that defect-free high-quality substrates can be assured for the manufacturing process. This will have a significant impact on reducing manufacturing costs and improving product quality. "The large single-substrate manufacturing process used in FPD production simply does not leave us room for error, which makes inspection of the starting substrate absolutely crucial," said Bob Pinnel, Chief Technical Officer of USDC. "Where manufacturers of ICs have the flexibility to utilize most of the wafer even when a few of the chip sites fail, FPD producers often utilize the entire glass substrate for one operational display. Inspection plays a key role to improve process yields and leads to success and profitability." Dr. Andrei Brunfeld, Vice President of DIS, said, "Our technology is ideally suited to this purpose because it permits the detection of minute defects on the order of nanometers, and it can do this at the high inspection speeds required by the FPD industry. We believe this technology will be a significant factor in helping the U.S. flat-panel display industry achieve a world leadership position." DIS, founded in 1993, operates out of the Israeli-based Robomatix company plant in Wixom, Michigan. Robomatix makes laser-guided machine tools and is a minority investor in the firm. Brunfeld said his company hopes to work with OIS Optical Imaging Systems of Troy, Michigan, which makes liquid-crystal video displays for military and commercial aircraft.

AMLCD collaborative effort

Xerox Corp., Stamford, Connecticut; AT&T, Berkeley Heights, New Jersey; and Standish Industries, Lake Mills, Wisconsin, will use a $100-million DoD cost-sharing agreement to lay down the groundwork for domestic production of flat-panel displays. Total government funding will be $50 million, with a matching $50-million investment from Xerox, AT&T, and Standish. Initial DoD funding of the project is $20 million. The collaborative effort will blend the technical skills of the three companies to develop the manufacturing technology needed to produce the flat screens increasingly used in many applications, including aircraft cockpits, notebook computers, and military logistics systems. Over the next 2 years, the companies will develop manufacturing processes and procedures scalable to high-volume production of active-matrix LCDs (AMLCDs). In its announcement, the Defense Department said that U.S.-based AMLCD manufacturing capability is critical not only for America's strategic preparedness but also for the country's economic well-being. Principal Deputy Assistant Secretary of Defense Ken Flamm indicated, "This project should substantially reduce the major technical and manufacturing uncertainties which have been obstacles to the establishment of display manufacturing capabilities which meet national security needs. This project will be a key building block in the Department of Defense's efforts to secure early, assured, and affordable access to leading-edge display technologies." Dr. Lance Glasser, Director of ARPA's Electronic Systems Technology Office, said, "The collaboration of AT&T, Xerox, and Standish brings a unique combination of manufacturing expertise, technical skills, and leadership required to establish a competitive state-of-the-art AMLCD manufacturing capability in the United States. The program proposed by the three partners provides the first step in a clear success path to establishing viable on-shore AMLCD production." According to Peter Mills, Chief Executive Officer of the United States Display Consortium (USDC), "This program ensures that we will have a viable domestic customer base for the several hundred U.S. supplier companies making up the equipment and materials FPD infrastructure." Building on state-of-the-art a-Si TFT-array and color-filter capabilities at Xerox PARC, liquid-crystal assembly capability at Standish, and back-end packaging and module-assembly capability at AT&T, the program will address fundamental yield and manufacturing issues, including thorough evaluation of second- and third-generation manufacturing equipment and processes.

Machine vision superior to human inspection

Photon Dynamics, Milpitas, California, has announced the findings of an internal study utilizing its Flat Panel Inspection System (FIS) and human inspectors for final inspection of flat-panel displays (FPDs). The case study included 15 human inspectors with over 90 possible combinations of pixel defects relative to the background of the panel. The human inspectors viewed the panels at normal incidence as well as off-axis, at the optimum viewing distance. In only one of the test cases did human inspectors detect a defect where machine vision did not. In every other case, the FIS was equal to or outperformed human inspectors. In some cases, the FIS was able to detect defects two gray levels (more sensitive) below those detected by humans, further proving the necessity for quantitative inspection methods to verify the quality of completed FPDs. The average test time for the FIS was consistently 8 s. The test time for the human inspectors was typically greater than 20 s, and extended to 1 min for defects that had low contrast and were more difficult to detect. Currently, final inspection for FPDs is typically performed by humans. The test results indicate that machine vision is consistent, faster, and ensures more reliable data than the human inspectors.

PanelPrinter™ headed north of the border

MRS Technology, Inc., Chelmsford, Massachusetts, has reported the receipt of an order for their Model 5200G PanelPrinter™ system from Litton Systems Canada Ltd., Etobicoke, Ontario, Canada. Valued at approximately $2 million, the order is scheduled for delivery in the current fiscal year ending March 31, 1995. Litton Systems will be producing AMLCD displays using their unique cadmium selenide production process. Litton manufactures displays for both commercial and defense avionics applications. They have been active in research and development of advanced LCDs since the mid-1980s.

ORBITRAK system to HP

Semiconductor Systems, Inc., Fremont, California, has announced their first order from Hewlett-Packard Co. for the ORBITRACK™ photoresist wafer-processing system. Destined for HP's newest wafer fabrication facility in Corvallis, Oregon, the initial system will ship in the first quarter of 1995. "Having HP on board with the ORBITRACK™ system is yet another leap forward for our cluster-technology system applications," SSI President Michael Parodi commented. "The HP order serves to further validate the widespread praise we have received for the ORBITRACK™, as more and more fab managers have discovered the high productivity, flexibility, and low cost-of-ownership benefits our systems offer them." SSI National Sales Manager Steve Mullane adds, "Our ongoing drive for ever-higher standards across the board, for design, engineering, manufacturing, and cleanliness, has enabled us to meet or exceed the requirements of world-class organizations such as HP. We are very proud to have them involved." Praised by VLSI Research as "...a landmark in equipment design that sets new standards for excellence in all equipment markets," the ORBITRACK™ system supports sub-0.35-μm processing for wafers of up to 200 mm. Its advanced cluster-tool architecture and ergonomic design allows wafers to be processed in virtually any desired sequence for maximum multiple-product-cycle flexibility.

Photon Dynamics nominated for test product of the year

Photon Dynamics, Inc., Milpitas, California, has announced the nomination of its Flat Panel Inspection System (FIS-100) for the "Test Product of the Year" by *Test & Measurement World.* The nomination comes at a time when the flat-panel display (FPD) industry is exceeding its growth predictions and exploding worldwide. The editors of *Test & Measurement World* made their choices from the flood of exciting new products introduced in 1994, and have narrowed the voting down to 13 products, which were also voted the "Best in Test" for 1994. The nominations were given to companies who demonstrated technical innovation in the products they brought to the test and measurement market in 1994. As stated by Jon Titus, editor of *Test & Measurement World*, "I think these companies are smart and innovative. The companies listened to their customers talk and complain about the problems they face. Then the companies found ways to solve those problems and answer those complaints with innovative products." "This is a very exciting nomination for Photon Dynamics and for the Flat Panel Inspection System (FIS-100) product team," stated CEO Jim Ellick of Photon Dynamics, Inc. "We are very honored and pleased that this product has been so successful worldwide and that *Test & Measurement World* has nominated it for the "Test Product of the Year" award."

Penn-Tran becomes WinTron

Since 1989, Penn-Tran Corp. had been owned by a company in Oregon which sold it on June 1, 1994 to a local investor, who formed WinTron, Inc., operating out of the same facility. The highly experienced and knowledgeable staff was retained, with a new Executive Vice President, Terry Edwards, and a new Director of Marketing, Melissa Hein. WinTron will continue to design and manufacture custom deflection yokes, flyback transformers, and high-voltage power supplies for both military and commercial applications, and all past designs will still be available.

Smart highways

RGB Spectrum's RGB/View video windowing system is playing a key role in two major California cities' state-of-the-art traffic-management systems. Both Irvine and Pasadena have recently implemented a high-tech remote monitoring system called the Intelligent Vehicles Highway System (IVHS). In these "smart highway" systems, traffic engineers monitor key locations around the city from a control-room facility. A variety of electronic surveillance and detection systems, including video cameras, collect and transmit real-time data from the selected locations. The direction and angle of the cameras can be controlled from the traffic-control center, and the feeds from these video cameras are displayed directly on computer screens monitored by traffic engineers. Early detection of traffic congestion, traffic-signal timing adjustment, and dispatch of emergency crews are all facilitated by the RGB/View system. The City of Irvine's multi-modal network of freeways, streets, and transit systems has become a model for planners across the country. At the heart of the system is the ITRAC facility, which monitors and manages traffic circulation throughout the city. The ITRAC system is designed to be an active two-way communications link between drivers or transit riders and the entire transportation network. Regional and city traffic grids can be intermixed with live traffic video and, using the RGB/View system, can be viewed by traffic engineers on both their computer monitors and a large-screen projection display. ■

Please send new contributions or noteworthy news items to Aris Silzars, Contributing Editor, Information Display, c/o Palisades Institute for Research Services, Inc., 201 Varick Street, New York, NY 10014.

sustaining members

Ad-Vance Magnetics, Inc.
AEG Corp.
Arconium Specialty Alloys
Babcock Display Products
Brewer Science, Inc.
Canon, Inc.
Capetronic USA (HK), Inc.
Celco
Cherry Electrical Products
Chunghwa Picture Tubes, Ltd.
Clinton Electronics Corp.
Corning Inc.
Corning Japan K.K.
Dale Electronics, Inc.
David Sarnoff Research Center
Diagnostic/Retrieval Systems, Inc.
Dickey-John Corp.
DISCOM/Display Components, Inc.
EG&G Gamma Scientific
Electro-Plasma, Inc.
Endicott Research Group, Inc.
F-P Electronics
Futaba Corp.
Graseby Optronics
Grimes Aerospace Company
Hewlett-Packard Co.
F. Hoffmann-La Roche
Honeywell, Inc.
Hoya Corporation USA
Hughes Aircraft Co.
IBM Corp.
Imaging & Sensing Technology
Incom, Inc.
Industrial Electronic Engineers, Inc.
Industrial Technology Research Institute
Infodex, Inc.
Innotec Group, Inc.
Interface Products, Inc.
Interserv Corp.
Interstate Electronics Corp.
ISE Electronics Corp.
Kent Display Systems
Libbey-Owens-Ford Co.
Litton Systems Canada Ltd. (2)
Loral Librascope
Magnetic Radiation Labs., Inc.
Micron Display Technology
Microphase Laboratories
Microvision Corp.
Minolta Corp.
Motif, Inc.
MTL Systems
Nippon Seiki Co., Ltd.
Norden Systems Westinghouse
nView Corporation
OIS Optical Imaging Systems, Inc.
OKI Electric Industry Co., Ltd.
Optical Coating Lab., Inc.
Optrex America
Photon Dynamics
Photonics Systems, Inc.
Planar Systems, Inc.
Plasmaterials, Inc.
Polytronics
Quantum Data Inc.
Q.C. Optics, Inc.
Rank Brimar, Ltd.
Raytheon Co.
Regisbrook Group, Ltd.
Schott Corp.
Semiconductor Systems, Inc.
Sony Corp. of America
Sony Corp./Corporate Research Labs
Standish Industries, Inc.
Stanford Resources, Inc.
Supertex, Inc.
Syntronic Instruments, Inc.
Tamarack Scientific Co., Inc.
TEAM Systems
Techneglas, Inc.
Teledyne Electronic Technologies
Terapixel, Inc.
Thomas Electronics, Inc.
Thomson Components and Tubes Corp.
Toshiba America, Inc.
Viratec Thin Films Inc.
WinTron

index to advertisers

Business and Editorial Offices
Recruitment Advertising
Palisades Institute for Research Services, Inc.
201 Varick Street
New York, NY 10014
Jay Morreale, Advertising Manager
212/620-3371 Fax: 212/620-3379

District Sales Office – West/Mid-West
Ted Lucas
5428 N.W. Pinery
Newport, OR 97365
503/265-9140 Fax: 503/265-4225

District Sales Office – East
Palisades Institute for Research Services, Inc.
201 Varick Street
New York, NY 10014
Erika Suresky
212/620-3375 Fax: 212/620-3379

Circle no. 40