SID '98 SHOW ISSUE

Information DISPLAY

April/May 1998
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SID

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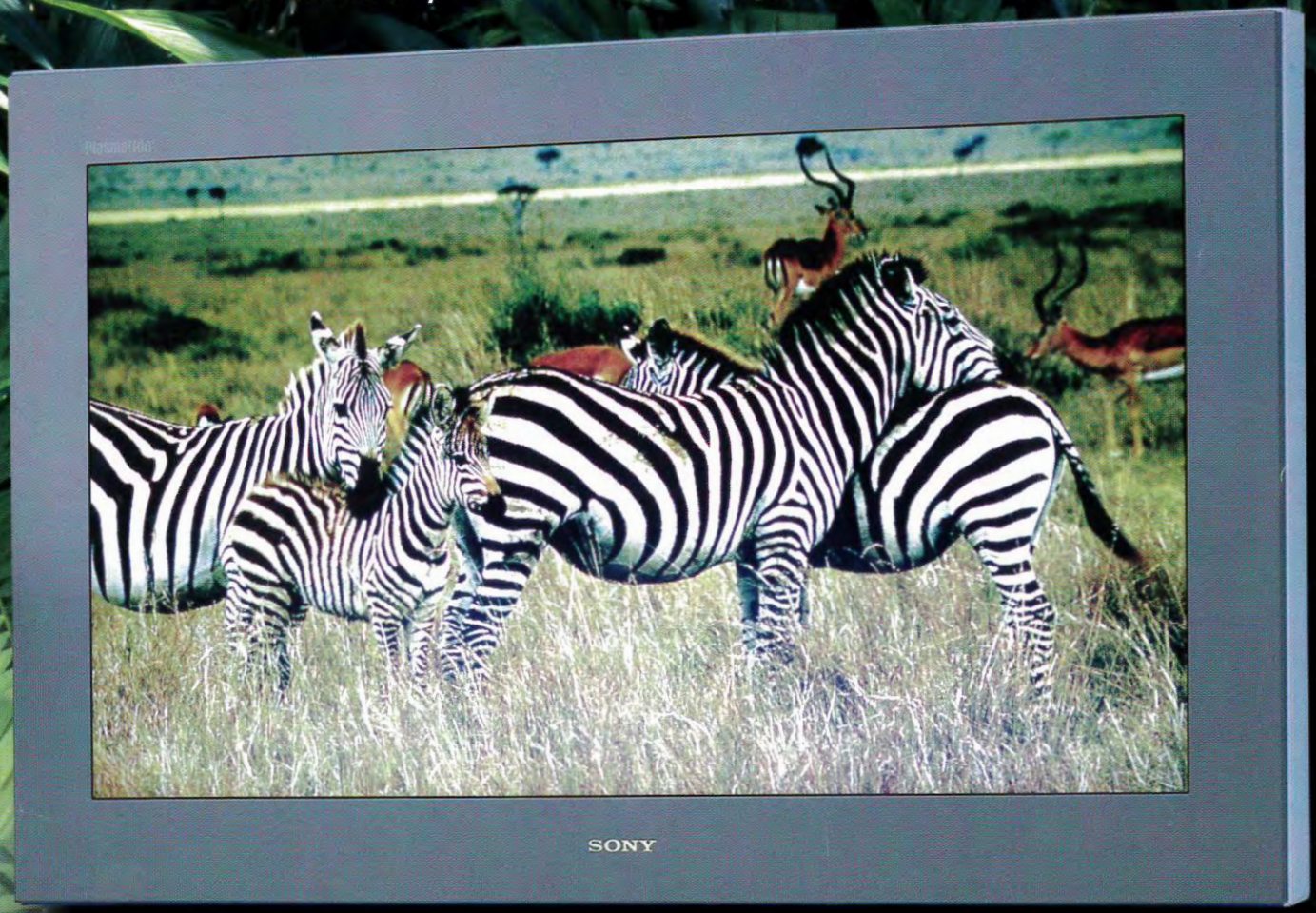

Large PALC TV Arrives

- Products on Display
- FPD Interfacing
- Display Works Review
- Special Section: PALC Displays
  - How They Work
  - Future Prospects

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INFORMATION DISPLAY
APRIL/MAY 1998
SID '98 SHOW ISSUE

BPA INTERNATIONAL

COVER: Philips, Sony, and Sharp are working together as equal partners in a facility in Mizunami, Japan, to bring plasma-addressed liquid-crystal (PALC) technology to maturity. In two articles in this issue, the companies – along with Tom Buzak, the technology's inventor – explain why they believe PALC technology poses a serious threat to plasma-display panels (PDPs) in many large-screen direct-view applications.

CREDIT: Sony Display Company

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

Next Month in *Information Display*

CRT Issue
- Improving Soft-Copy Medical Images
- Opinion: End of the Shadow Mask
- Video-Wall Cube Systems
- FPD Strategic Forum Report
- IDW Review

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Information DISPLAY

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editorial

But It Sure Is Nifty …

Here's a true new-technology story for you. We've just leased a new small-office postage meter from Pitney Bowes. Nothing wrong with the old one, but the U.S. Postal Service is mandating that all of the old electro-mechanical meters be taken out of service in about a year, and Pitney Bowes is offering lease deals to those who make the change now.

The deal is that the lease is cheaper than it will be in a few months, but it's still more expensive than our current one. Also, we can't just lease a meter. We have to lease a postage-scale-and-meter package.

Still, the new technology is neat. We no longer have to trek to the local post office to fill the meter. That is now done electronically, but not by plugging a phone line into the meter as you might expect. You call Pitney Bowes, tell them how much postage you want and give them some code numbers, and they give you a number to key into the meter, which increments the value in the meter. Not elegant, but it beats a trip to the post office lugging the meter.

Neater is the fact that the scale is connected by cable to the meter – and that each device has an electronic display. You put your letter on the scale, which automatically calculates the postage and sends it to the meter, so you never have to key in the postage. (This sort of thing has been around for quite a while in large mailing systems, but it is now migrating down to the bottom of the Pitney Bowes food chain.) You then take your letter, feed it into the slot, and the meter stamps it and ejects it into a tray. Unfortunately, it performs this electro-mechanical function considerably more slowly than a human being could hand feed and stamp with the old meter, but I guess you can't have everything. And, of course, the cleverness of the scale and the cable doesn't mean much to an operation like ours that is mostly mailing several hundred of the same thing, so the postage to be stamped doesn't change often.

In the end, what we're doing is paying more to do our most time-consuming postal task more slowly. But it sure is nifty. It's also idiot-proof. So the new system allows me to hire an idiot. Now that's something I'm looking forward to.

– Ken Werner

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

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Would You Like to Know What I Think? ...

by Aris Silzars

In the early 1970s, here in the U.S., there was both an energy crisis and a major and growing problem with air pollution. While the energy crisis was the outgrowth of politics and greed and was soon resolved, the growing problem with air pollution was of much deeper concern. There were predictions that by the millennium we would all be wearing air-purification masks whenever we had to go outdoors. When monitoring stations began measuring air quality in 1974 here in Washington State, which benefits from prevailing fresh breezes off the Pacific Ocean, there were over 1500 instances when air pollution exceeded healthy standards. Much has happened since then. Consider that in just the last 12 years the population in this area has grown by 20% and vehicle miles traveled have increased by 30%. Motor vehicles were and are the major contributors to air pollution. Therefore, should we conclude that in 1997 there must have been well over 2000 incidents of unhealthy air? Well, the actual number is 3. Yes, you read that right. The air in Washington State today is healthy, and there has been an improvement almost every year since 1974. What happened to the dire predictions?

After the energy crisis hit in the early 70s, among the solutions proposed were more public transportation, mandatory car pooling, and the push for really tiny energy-efficient automobiles. What actually happened? Here we are in 1998 and the most popular vehicles are pickup trucks and large sports utilities, with the humongous Ford Expedition the most desired of all. Energy efficiency? What a strange concept! And car pooling has dropped to below 10% – to the point where there is growing pressure to eliminate car-pool lanes on freeways.

How about a few other predictions from the last 50 years? What happened to the ultramodern high-tech houses we were all going to embrace? The most popular house style today in the U.S. is an imitation 1800s French chateau. It is built with mostly the same construction techniques that have been used for at least the last 50 or 60 years. The electrical wiring has benefited a bit from new plastic materials, and plumbing is no longer done with cast iron and copper pipes, but the rest of the construction techniques are virtually unchanged. What about all those high-tech gadgets that were going to control the light transmission of windows and the central computers that were going to monitor all the heating, entertainment, and security systems in these homes? I guess most of us had more common sense than the technologists promoting these concepts. Who wants to have a house with a useful life of over 100 years and make it dependent on technological gadgets that go obsolete in less than five?

But that doesn't mean that technology hasn't had some major impacts on our lifestyles. Instead of building plastic houses, what we have done is to dramatically increase the compute and communications power that we are able to put inside our traditionally constructed homes, and similarly in our cars and on our persons. Instead of just one phone line, we now need three or four – in addition to one or more cell-phones and a pager or two. And instead of using a big mainframe computer at work, we have compute capabilities in our homes and on our laps that would put the workstations of just a few years ago to shame. I don't

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French Flat-Panel Makers Don't Try to Do Everything – But What They Do Is Often World Class.

by François Maurice

The French FPD industry is active in the fields of active-matrix LCDs, plasma panels, and field-emission displays.

The first activity is led by ***Thomson-LCD,*** a 1989 joint venture between ***Sextant Avionique*** and ***Thomson Multimedia.*** Thomson-LCD manufactures direct-view cockpit displays for Sextant and high-resolution projection valves with a-Si integrated drivers for Thomson Multimedia.

Thomson-LCD allows Sextant, the first European cockpit-display supplier, to control the supply of the specific LCDs they need for their applications, which range from 3ATI – the standard 2 × 2-in. avionics instrument format – to 8 × 8 in. for the NH90 Helicopter.

These displays are used in all new fighters made by ***Dassault Aviation*** – which include the Mirage 2000-5 and the Rafale – as well as the new Canadian Dash 8Q-400 civil aircraft, whose first flight took place at the end of January.

EC Programs in France

Thomson-LCD has been participating in two research programs funded by the European Community (which spends a total of 12–15 million ECU annually in all of Europe for displays).

The first of these is "ECAM III," a program pursued by a 12-partner consortium led by ***Philips FPD*** (The Netherlands) that reached completion at the end of 1997. The program had four objectives:

- Improvement of manufacturing yield, manufacturing equipment, and methodologies of European AMLCD manufacturers.
- Development of European competitiveness in projection technologies with high-resolution a-SiH valves, low-temperature polysilicon, and microlenses.
- Development of reflective polarizers as part of an efficient backlight system for use in active-matrix TN displays.
- Creation of the know-how and infrastructure for the assembly of high-quality low-cost LCD modules.

The second program is "Mosarel," which involves a six-partner consortium led by ***BARCO*** (Belgium). The program started in September 1997 with three goals:

- Develop a European source for very-high-definition (2560 × 2048) reflective light valves based on European know-how in ASIC design and LC technology.
- Provide design flexibility to European display manufacturers.
- Develop a graphics workstation and HUD demonstrators around the developed LVs.

Sagem, one of the partners in the ECAM III project, is a French company whose main activities are in the fields of defense electronics, telecommunications, and automotive equipment. The company is providing French automobile manufacturer Renault with a new navigation system called the "Carminat," which uses a 5-in. AMLCD. Sagem has also released a portable traffic-information system with a 5-in. AMLCD and RDS tuner-decoder.

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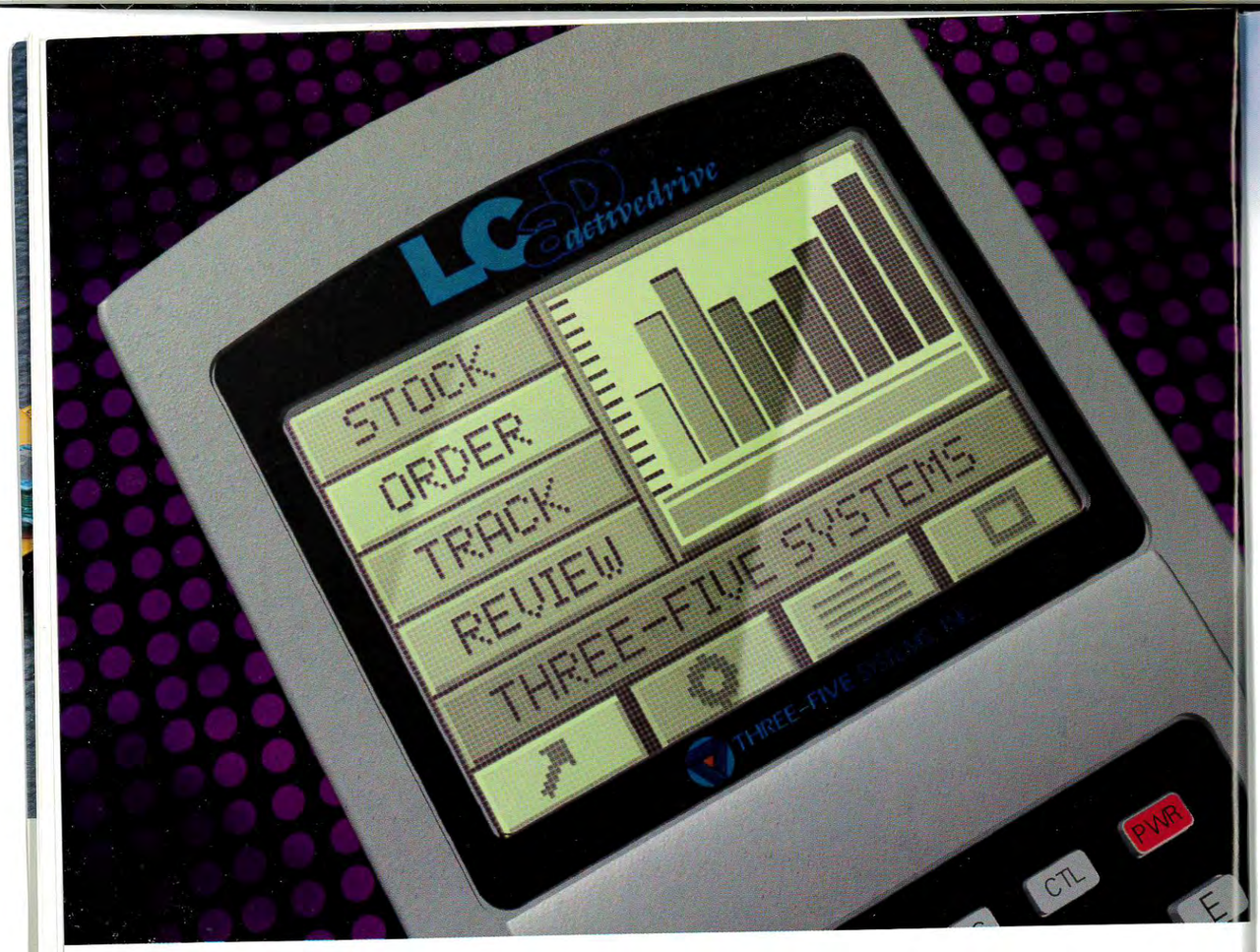

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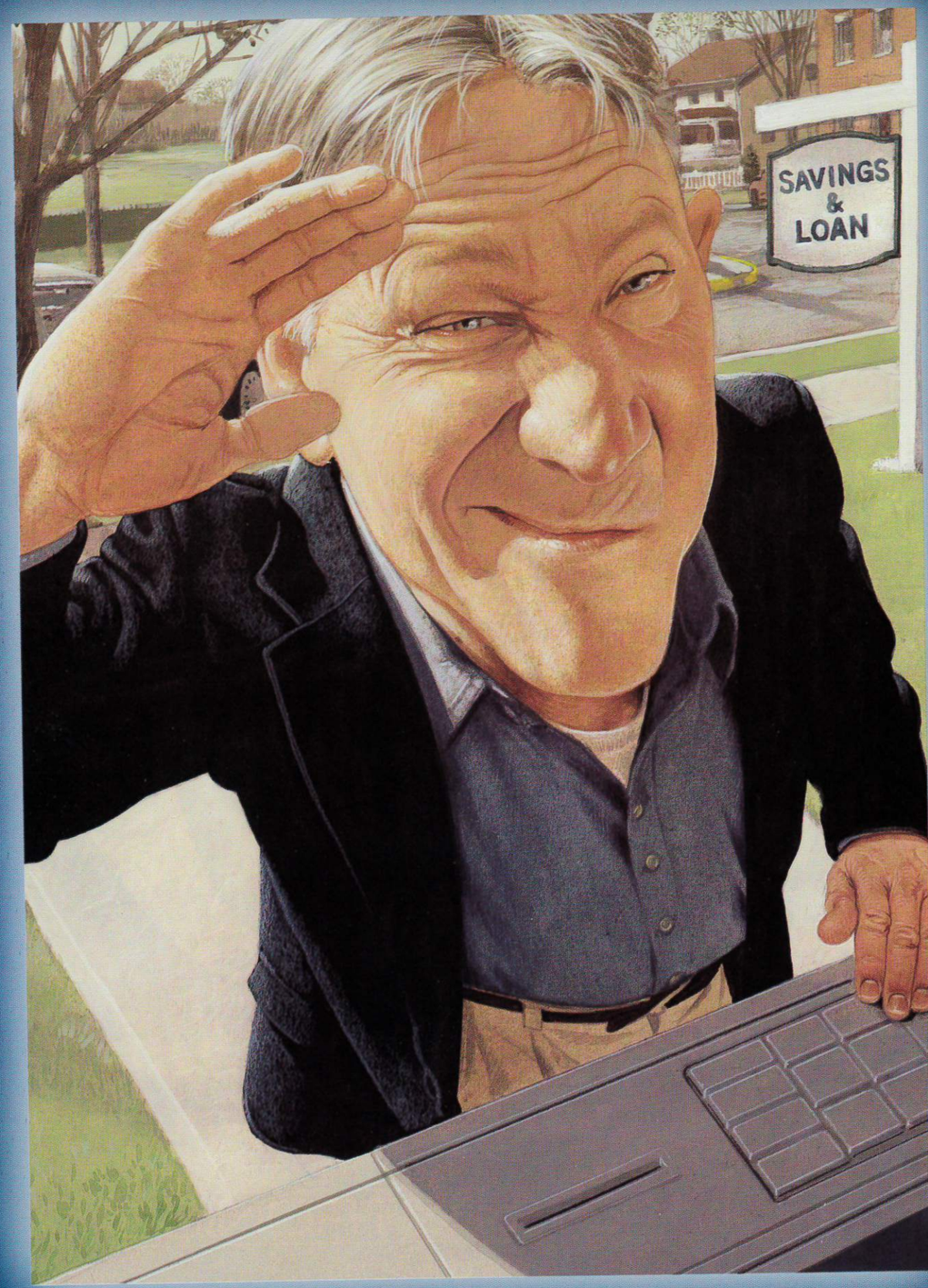

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Large, Wall-hanging PALC TV Arrives

Philips, Sony, and Sharp demonstrated prototypes of their jointly developed 42-in. TV based on plasma-addressed liquid-crystal technology at the Japan Electronics Show in October.

by Ad Burgmans, Takehiro Kakizaki, and Hisashi Uede

TELEVISION as a picture on the wall has been the dream of display designers and product planners for nearly half a century. This dream certainly cannot be realized by today's TV sets, which are based on heavy, bulky cathode-ray-tube (CRT) technology.

Many technologies are competing to replace the CRT with flat, thin matrix-addressable displays. Candidates include the field-emission display (FED), the active-matrix liquid-crystal display (AMLCD), the electroluminescent display (ELD), the plasma-display panel (PDP), and the plasma-addressed liquid-crystal (PALC) display. With all of these choices, why haven't we been enjoying wall-hanging TV receivers for years? The answer is that making large, flat displays with good performance is difficult; moreover, the cost of these matrix displays is high because they require lots of electronics to individually address each pixel. It is therefore difficult for large flat panels to compete with a mature CRT technology that offers good performance at a reasonable price.

The feasibility of many new display technologies has been demonstrated in recent years, and flat TV receivers based on plasma technologies – PDP and PALC – have recently been introduced to the market. Both technologies still have their problems, although rapid progress is being made. At the Japan Electronics Show (JES) last October, a large variety of PDPs and PALC displays were shown.

An accompanying article by Tom Buzak provides a detailed comparison between PDP and PALC technologies. In this article, we will elaborate on the recent progress in PALC technology, which now has an excellent chance to become *the* technology for large flat displays of the future.

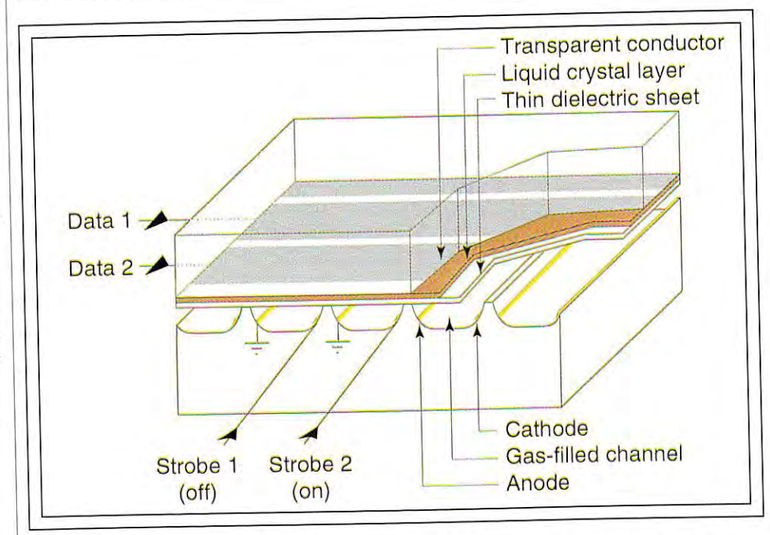

Fig. 1: *A PALC display is an AMLCD in which the TFT plate is replaced by a system for addressing the display with plasma switching.*

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Fig. 2: *Philips, Sony, and Sharp are working together as equal partners in this facility in Mizunami, Japan, to bring PALC technology to maturity.*

Principles

The PALC display is, in principle, a conventional active-matrix LCD (Fig. 1). However, in a PALC display the electrical properties of a plasma are used for the addressing instead of complicated semiconductor structures, such as the thin-film transistors (TFTs) that are currently used in most AMLCDs. The semiconductor structures limit display yield, particularly when screen sizes become large. Because of the simpler structure in the active plate of a PALC display, much higher yields can be achieved.

The active plate in a PALC display consists of channels in which a plasma can be ignited by applying an appropriate voltage between the anode and the cathode in each channel. Free charges (electrons and ions) are thereby produced in the channel, and they can be directed towards a thin dielectric sheet – the "microsheet" – by applying a voltage to the data lines. The microsheet is thus charged along the complete channel. When the plasma is switched off, the conductivity in the channel disappears and the data is captured a line at a time. The liquid crystal responds to the stored data values to form an image.

This is not a conventional plasma display because there is no image in the barely visible plasma glow. Each line is written sequentially and, after completion of a whole picture frame, the plasma in the first channel will be ignited again. As a consequence, the channel again becomes conductive, the previously stored information disappears, and new information can be stored. The decay time of the plasma must be fast enough to keep up with the frame rate, which can be accomplished by using the proper gas mixture.

Industrial Activities

PALC technology was invented by Thomas Buzak in 1987 while working for Tektronix in Beaverton, Oregon. Buzak now has his own company, Technical Visions, Inc., also in Beaverton, and is still involved in the development of PALC technology. Sony, who obtained a license from Tektronix some years ago, demonstrated their first 25-in. PALC display at the Internationale Funk Ausstellung in Berlin in 1995. In 1996, Sharp and Sony announced that they would join forces for the development of PALC displays.

In July 1997, a joint development agreement was signed by Philips, Sony, and Sharp to develop a high-resolution, high-brightness, high-contrast, and wide-viewing-angle PALC display. The three companies are now working together as equal partners in Mizunami, Japan, to bring this technology to maturity (Fig. 2).

Last year Sony introduced a 25-in. TV set based on PALC technology which is being produced in their Atsugi facility near Tokyo. Sony, Sharp, and Philips have recently shown prototypes of the 42-in. PALC display at the JES in Makuhari near Tokyo, the first major

Sony Display Company

Fig. 3: *Prototypes of the 42-in. PALC display were shown by Sony, Sharp, and Philips at the 1997 Japan Electronics Show.*

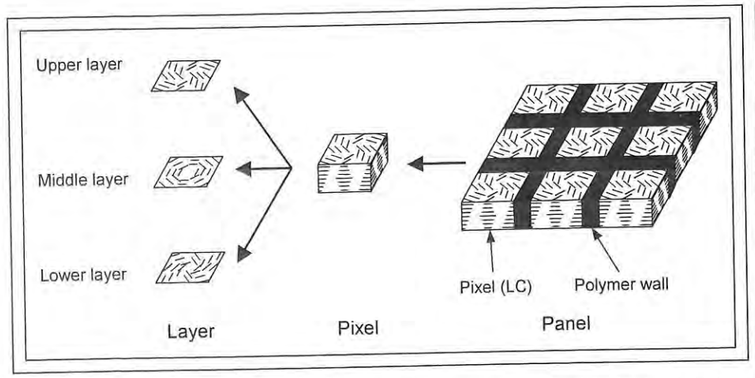
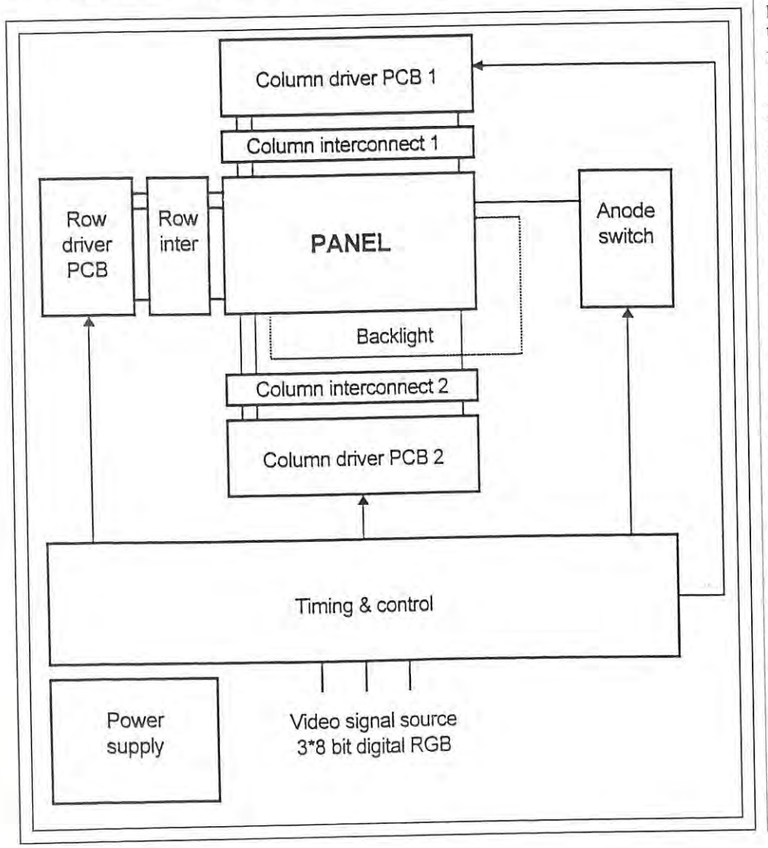


Fig. 4: Axially symmetrically aligned micro-cell (ASM) technology aligns the liquid-crystal molecules in each cell so that angular effects are largely self-compensating. With ASM, the viewing angle of the PALC display is 140° horizontally and vertically.



result of the cooperative agreement among the three companies (Fig. 3).

Both twisted-nematic (TN) panels and panels with axially symmetrically aligned micro-cell (ASM) mode technology were shown. The ASM technology is an in-cell solution for increasing the viewing angle of LCDs. With this technology, the viewing angle of the PALC display is 140° horizontally and vertically.

PALC products with 42-in. diagonals will soon become available in the marketplace. Specifications of the 42-in. PALC panels, as demonstrated at the JES, are given in Table 1. A small high-resolution black-and-white panel was also shown. With a pitch of 100 × 300 μm, it clearly demonstrated the high-resolution capabilities of PALC technology. Therefore, the PALC display seems to be a strong candidate for wall-hanging television, compact computer displays, and multimedia displays that will meet the challenge of the continuing convergence of audio/video and computer technologies.

ASM Technology

Narrow viewing angle and gray-scale inversion are serious problems in conventional LCD images. Many solutions to this problem have been proposed and implemented – with varying success. ASM technology, which was applied to 42-in. PALC displays shown at the last JES, is one of the first approaches to simultaneously realize wide viewing angle, high contrast ratio, and high brightness. In ASM, liquid-crystal material is aligned axially symmetrically in each pixel (Fig. 4).

This directional alignment results in excellent display characteristics. In addition to the characteristics listed in Table 1, ASM technology has the advantages of a highly efficient production process that does not require rubbing and a simpler fabrication process for large-sized panels that uses point-controllable resin spacers instead of conventional bead spacers.

Driving Electronics

The driving electronics for a PALC display are very similar to those of an AMLCD (Fig. 5). The two technologies have a central characteristic in common: light generation is separated from the addressing of the display because the display acts as a light valve and high-efficiency light sources such as fluorescent tubes are used. In this way, high display brightness can be achieved without compromising display life.

Fig. 5: The driving electronics for a PALC display, which are very similar to those for an AMLCD, address the PALC display a line at a time. The incoming data stream, corresponding to information in one display line (row), is stored in the column drivers.

The addressing electronics address a PALC display a line at a time. The incoming data stream, corresponding to information in one display line (row), is stored in the column drivers. After completion of each line, the data is put on the output of the column drivers and the row driver ignites the plasma in the corresponding row. Shortly after ignition, the row voltage is switched back to the level of the anode and the plasma is allowed to decay. While data is captured, the next row data is stored in the column drivers. Thus the column drivers are required to store two rows of data.

Table 1: Characteristics of a PALC Display

Display category	Plasma-addressed liquid crystal (PALC)
Liquid-crystal mode	Axially symmetrically aligned micro-cell mode
Scanning	Progressive
Color filter	RGB vertical stripe
Aspect ratio	16:9
Display area	524.2 (H) × 932.6 mm (V) (42 in.)
Number of pixels	854 RGB trios × 480 lines (wide VGA)
Dot size	0.364 × 1.092 mm
Daylight contrast	100:1 (at 300 lux)
Luminance	400 cd/m^2
Viewing angle	>140° (horizontal, vertical)
Number of colors	16.7 million

Conclusions

Although several technologies can, in principle, be used for large flat displays, both PDP and PALC technologies are the most developed and already have commercial products for TV applications. From our observation of recent prototypes shown at the JES, PALC displays are superior in terms of brightness and daylight contrast. However, improvements in both technologies are expected to occur in the coming years.

An important issue is the cost of large flat displays. The cost for all flat technologies is still too high to compete with the CRT, which has an attractive price/performance ratio. But with time, the cost of the large flat displays, *i.e.,* the cost of materials, processing, and driver electronics, will come down. Eventually, flat panels will become real competitors to the CRT.

It is expected that large flat displays will first find their way into professional markets. The consumer market will become important as soon as the price of these displays starts to approach that of CRTs. Nonetheless, large flat displays will certainly become *the* displays of the 21st century, and it will not be long before people are enjoying TV entertainment on large direct-view screens in their homes. ■

letters

To the Editor:

I read with keen interest the article "Making a Projector Lighter," in your December 1997 issue, and I would like to clarify some of the article's omissions. Contrary to the article's inference, Lightware, not CTX Opto, should be credited with the design and engineering of the Viewpoint line of ultra-portable LCD projectors, also marketed as the CTX EZ Pro line.

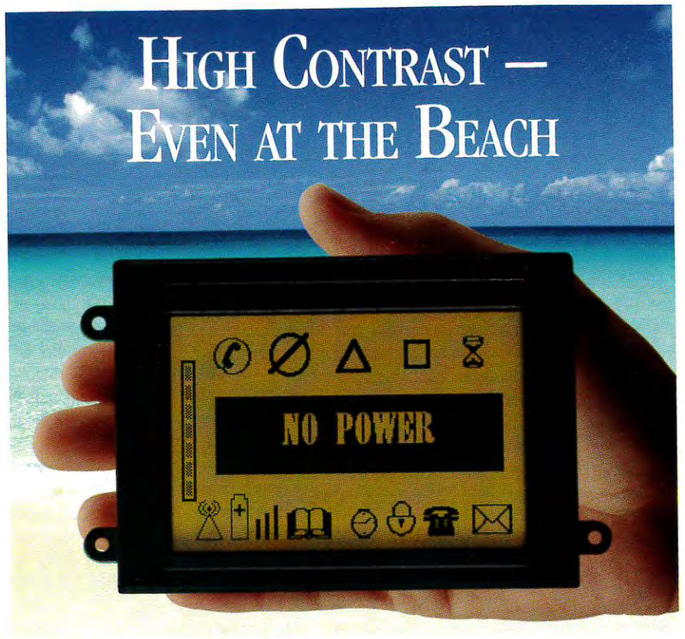
Several of Lightware's engineers, including myself, developed some of the industry's first data video projectors prior to our work with Lightware. We used our depth of experience to redefine the market in 1996 by introducing this first ever sub-10-pound LCD projector, the VP100. This product set the benchmark for the industry's move toward a new category of smaller, lighter-weight, yet higher-performance projectors.

The optical and mechanical layout of the VP line of ultra-portable projectors was designed and engineered by the Lightware engineering team. Lightware has five patents issued on its VP projectors, including patents for the unique keystone correction; for the system which cools the LCD, the illumination optics, and the power supplies; for the trademark "pop-up" projection-lens assembly; and for the modular design of the product.

In order to bring this unique product to market quickly, economically, and reliably, Lightware chose CTX to manufacture its VP products. Under a licensing and manufacturing agreement with Lightware, CTX assembles the VP units, and is allowed to market a like product under its own label. CTX's manufacturing abilities in tooling plastics and sheet-metal parts, and in contributing interface electronics, have been a real benefit to Lightware and the success of the VP line of products, which have consistently been awarded top ratings for reliability and overall ease of use. But it is Lightware's design and technology that make the VP line unique and powerful.

All of us on the Lightware engineering team are proud of the success the VP products continue to have, exceeding even our own expectations. Thank you for the opportunity to highlight Lightware's engineering and design accomplishments.

– Arlie Conner (D.S.)
Vice President of Technology
Lightware
Beaverton, OR



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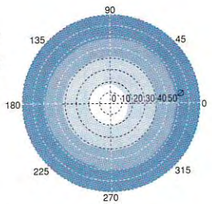

This contrast ratio polar representation illustrates KENT's 360 degree viewing cone.

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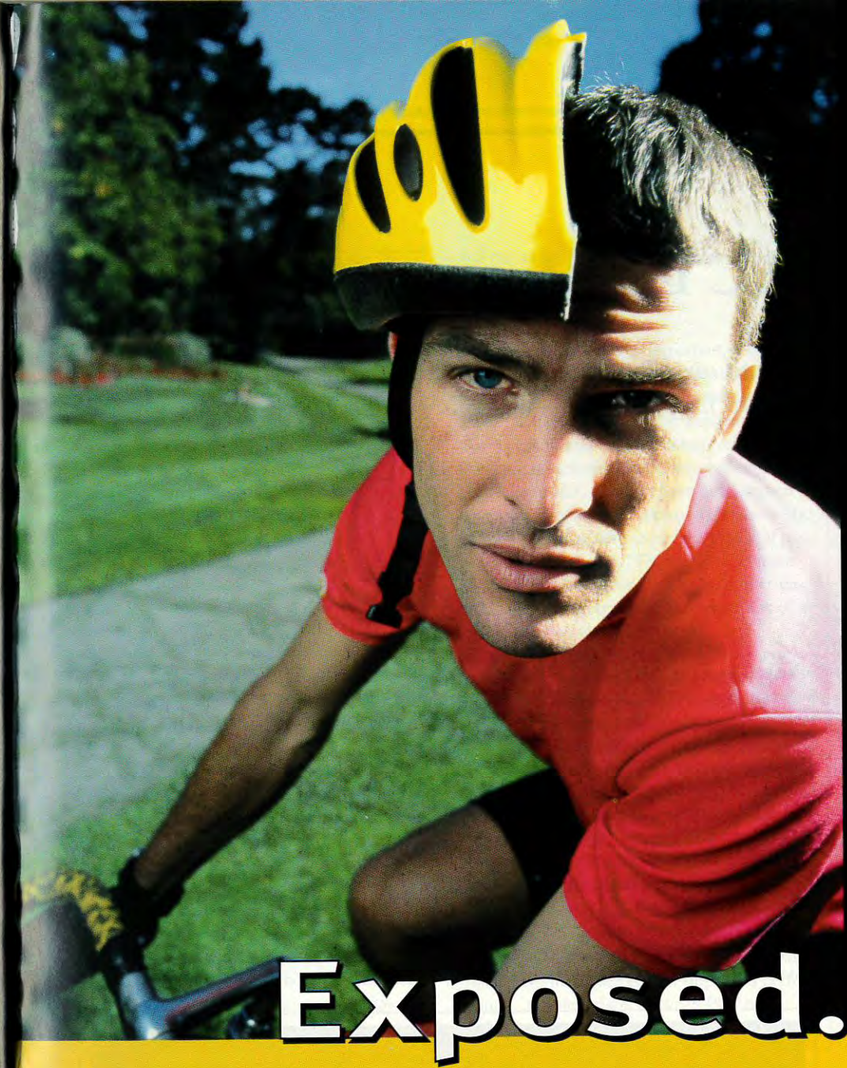

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The Future of PALC Displays and PDPs

PDPs have a $2 billion investment lead over PALC technology, so why do we believe that PALC displays will be the standard large direct-view display of the 21st century?

by Thomas Buzak

At recent technology expositions, large, bright direct-view displays have been visually stunning. At the Japan Electronics Show (JES) in October of 1997, more than 100 plasma-based displays were exhibited. Most were larger than 40 in. on the diagonal; some were as large as 50 in. Although the majority of the displays employed the conventional ac plasma-display-panel (ACPDP) approach pioneered by Fujitsu and others, Sony, Sharp, and Philips utilized the newer plasma-addressed liquid-crystal (PALC) approach.

The recent demonstrations of PDP and PALC-display prototypes are dramatic proof that these displays are no longer just heroic laboratory demonstrations, but are serious products moving toward mass availability. Just as CRT technology dominated display markets in the 20th century, plasma-based displays are poised to be the 21st-century display of choice for mainstream applications such as television and multimedia (Fig. 1).

One question that is frequently asked and eagerly debated is whether either of the two plasma technologies will dominate the 21st-century display marketplace as the CRT has done in the past. It's too early to know the answer with any certainty, but the determining factors will include the strengths of the individual technologies and changes in the marketplace. Specifically, the evolution of the marketplace towards "convergence" – where the distinct market segments of television and computers merge – will require multimedia displays that have large size and high resolution. Reviewing the intrinsic capabilities of the PDP and PALC technologies with this marketplace trend in mind should give us some indications about the likely performance of each technology at maturity.

Both technologies rely on gas plasmas. The key difference is that PDPs use the light generated by a plasma/phosphor combination and are emissive displays, whereas PALC displays use the electrical properties of the plasma and are transmissive AMLCDs requiring backlights.

The current status of PDP and PALC technologies reflects, in part, where each technology is in its overall development cycle. PDPs, as an older technology, have enjoyed considerably more cumulative investment and thus hold a lead in the large-area television market. PALC technology, on the basis of several recent innovations, promises performance advantages that could place it in the lead for multimedia and computer desktop markets – and also position it as a strong contender for television and HDTV.

Fig. 1: The 42-in. Sony PALC display is an example of the wall-mounted flat-panel display that will become increasingly common in the 21st century.

***Thomas S. Buzak** is the President of Technical Visions, Inc., 14000 S.W. Karl Braun Dr., M/S 46-944, Beaverton, OR 97077, and led the team that invented the plasma-addressed liquid-crystal (PALC) display; telephone 503/627-1411, fax 503/627-2225, e-mail: thomas.buzak@tek.com.*

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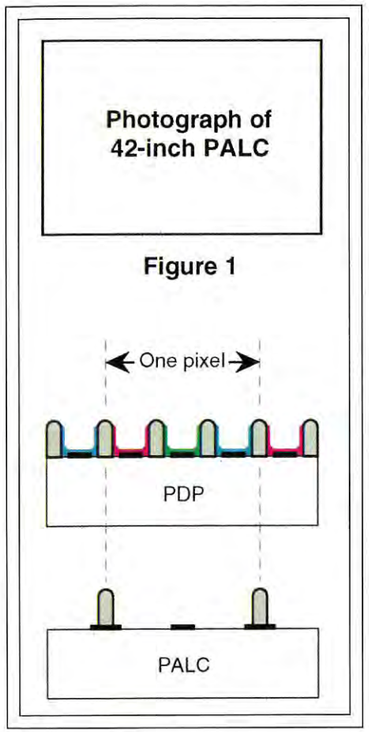

Figure 1

Fig. 2: Three times as many barrier ribs are required for a PDP having the same resolution as a PALC panel.

Big Is Beautiful

PDP prototypes range in size from 20 to 50 in., with the most common size being 42 in. PALC prototypes have been built in 16-, 25-, and 42-in. sizes. The sizes attainable by both technologies are limited by the size of available process equipment and display glass. There are no device-physics issues that limit size, although power requirements grow proportionally with display area.

Many of the displays demonstrated at JES '97 broke size records, and there is still no reason to suspect that either technology has approached its ultimate size. The 50-in. PDPs are the largest direct-view full-color video displays of any kind. The 25-in. PALC Plasmatron product is the largest AMLCD ever sold, and the 42-in. PALC display is the largest AMLCD ever demonstrated.

Screen Resolution

Although display size is important, resolution is more likely to be the parameter that differentiates the multimedia and television markets. In general, multimedia displays require two to three times the resolution required by the standard television market segment. Both PDPs and PALC displays have been demonstrated at screen resolutions of approximately 85 lpi – referring here to physical lines of pixels on the screen, not "TV lines." The most common resolution for both technologies has been approximately 25 lpi, the resolution of a 40-in. 480-line video display.

In the PDP architecture, barrier ribs separate each of the three color subpixels that together form one full-color pixel. In the standard PALC architecture, barrier ribs are needed only to separate each full-color pixel; color separation is achieved in the liquid-crystal color-filter plate. Consequently, a PDP requires three times as many barrier ribs as a PALC display of similar size and addressability (Fig. 2).

Conversely, for an equal barrier-rib pitch, PALC technology can achieve three times the screen resolution. Therefore, the resolution advantage enjoyed by PALC technology can translate to improved cost or improved performance. A comparison between PDP and PALC structures having barrier ribs with the same spacing is presented in Fig. 3.

Luminance and Power

Maximum reported luminances are approximately 500 cd/m^2 for PALC displays and 400 cd/m^2 for PDPs. Typical reported luminances for most of these displays are in the 200–300-cd/m^2 range. As with many types of displays, luminance values are sometimes difficult to compare. In phosphor-based displays such as PDPs, reported values often represent peak values that are valid for small image areas or limited times.

Peak brightness can be a good metric for video images that typically require only 30% of full-white brightness on average. However, for typical images found in desktop or multimedia displays that contain large areas of white, PDPs have difficulty maintaining adequate brightness. Moreover, the power consumption in these display modes is high and typically unsustainable in commercial applications. On the other hand, the peak luminance for all AMLCDs, including PALC displays, is determined by the choice of backlight. So for PALC displays, peak luminance is constant, independent of the image, and often greater than for PDPs.

In PALC displays and PDPs, the primary source of power consumption is related to the generation of light. PALC displays have an efficiency similar to that of other AMLCDs. For a modest aperture ratio of 50%, a light-conversion efficiency of 3–4 lm/W is typical. In AMLCDs, power consumption is largely independent of image; the backlight is fully on for dark as well as bright images. For

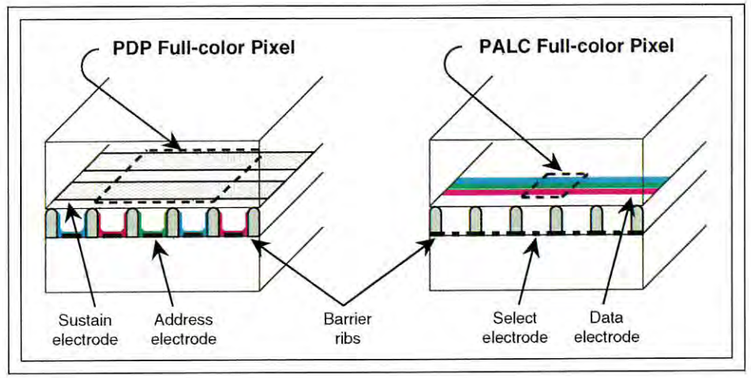

Fig. 3: For PDPs and PALC displays with the same barrier-rib pitch, the full-color pixel size of the PALC display can be one-third the size. This gives PALC displays a resolution advantage when compared with PDPs having comparable manufacturing tolerances.

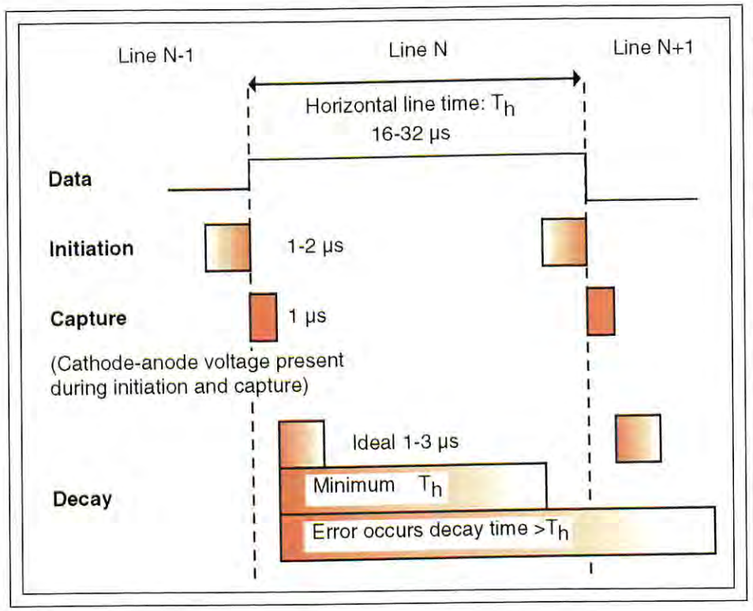

Fig. 4: Three processes must occur during the addressing of a single horizontal line in a PALC display: plasma initiation, data capture, and plasma decay. Only the last two of these need to occur during the horizontal line time, so the sum of their durations determines the maximum addressability of the PALC display – up to 3000 lines.

PDPs, the highest reported efficiencies are between 1 and 2 lm/W.

Contrast

Maintaining good contrast in well-lighted environments is always a challenge for emissive displays. There are two sources of light that contribute to the reduction of contrast in a PDP. One is light emitted by the PDP that is not related to image generation – erase pulses, for example. This light sets a baseline or "dark room" contrast. The other source is ambient light reflected back to the observer by the phosphor and other structures in the display.

There are several ways to reduce the reflected light. The simplest, although least desirable from an applications point of view, is to restrict viewing to controlled environments. A neutral-density filter in front of the display can increase contrast by absorbing reflected light twice (once for each pass through the filter) and emitted light only once. This technique is used in most color CRTs, but has the disadvantage of further reducing overall display luminance. The use of pixelated color filters is a more efficient and sophisticated approach to increasing contrast, but brings with it additional complexity and cost.

PALC displays enjoy the same contrast performance as other AMLCDs. The dark-room contrast of an LCD is determined by the integrated performance of the entire optical path, including backlight, polarizers, color filters, and liquid-crystal cell design. LCD dark-room contrast ratios in excess of 100:1 are common. Since the LCD already uses a color filter as an intrinsic component, its contrast-preserving attributes in bright ambients are naturally present in the PALC display. Consequently, PALC displays can simultaneously achieve excellent contrast and brightness in bright office or home environments.

Addressing the Field

Addressability refers to the number of lines that can be addressed within the time allotted to a video field. For analog gray scale – as used with PALC technology in progressively scanned NTSC and VGA – each line must be addressed in 32 µsec. For HDTV and computer workstations, line times are about 16 µsec. That means that the three-step process of plasma initiation, data capture, and plasma decay must occur within 10–30 µsec.

Recent advances in PALC plasma-decay speeds have allowed addressing line times as short as 5 µsec.[1] This allows as many as 3000 lines to be progressively addressed in a PALC display – the highest addressability of any of the current direct-view display technologies (Fig. 4).

The situation for PDPs is somewhat more complicated because full-color ACPDPs are unable to utilize analog gray scale or pulse-width-modulated gray scale. In a PDP, gray levels are achieved by dividing each video field into eight subfields. The sustain time in each subfield is adjusted to correspond to eight values. In combination, these eight subfields can provide 8 bits of gray-level control. Since the entire display must be written and erased eight times for every field, line times for PDPs must be eight times faster than for PALC displays.

This increased speed requirement results in increased driver power and cost. Moreover, in high-addressability displays – such as computer workstations or HDTV receivers – the required addressing speeds may exceed that supportable by the response time of the plasma. In that case, PDPs must either reduce the number of gray levels or use costly dual-scan addressing.

Gray Levels and Colors

The number of addressable gray levels and colors for PALC displays and PDPs is enabled by the availability of row and column driver ICs. Both technologies require drivers that have challenging voltage, speed, current, and power requirements.

PDP drive schemes require additional signal processing to reduce the effects of motion contouring – an artifact of the subfield addressing method required for PDP gray scale. PDPs use fast, bi-level drivers, whereas PALC displays use more conventional multi-level (AMLCD-type) gray-scale drivers.

The drivers used for both PALC displays and PDPs typically have higher voltage requirements than those used for conventional AMLCDs. Reductions in driver voltage and cost are important goals of the plasma-based approaches.

Video Speed

It's apparent from the recent demonstrations of PALC displays and PDPs that both technologies exhibit excellent response to rapidly changing images. PDPs approach the fast response common in other phosphor-based displays such as CRTs. The PALC display's electro-optic response is the fastest of any AMLCD – a characteristic that is, in part, a consequence of its compatibility with very-low-viscosity liquid-crystal materials. The plasma-addressed liquid crystal has rise and fall times that are a speedy 8 and 10 msec, completely sufficient for fast-moving video imagery.

Life

In both PALC displays and PDPs, limitations on the useful life of the display are primarily due to the cumulative effects of the plasma. End of life is usually defined as the point where luminous intensity has dropped to some predefined value – typically one-half. End of life is then said to occur not because the display is unusable but because luminance has fallen substantially below the product specification.

In a PALC display, reductions in luminous intensity occur uniformly across the panel as it ages. This effect is a consequence of cathode sputtering, wherein sputtered cathode material redeposits on the inner surfaces of the panel and partially absorbs light. The darkening process is very slow because the time that the plasma is active during panel operation is only several microseconds during each video field. This means that for every 10,000 hours of panel operation, the plasma is active – the only time aging occurs – for a total of 1.25 hours.

Perhaps more important than the time during which aging occurs is the degree of uniformity of the aging process. In a PALC display, the plasma generated during the active plasma time is spatially uniform and independent of the displayed image. Consequently, the small amount of aging that does occur is uniform across the screen. Current lifetimes for PALC displays are in excess of 10,000 hours.

In PDPs, the glass-dielectric and MgO-overcoat layers protect the cathode from sputtering. Nevertheless, luminous intensity drops with operating time – a consequence of phosphor aging. During typical operation, the plasma is active many thousands of times longer than for an equivalent PALC display.

But again, the most important issue is one of uniformity of the aging process. In a PDP, aging is dependent on the displayed image: image areas that are brighter age faster than image areas that are relatively dark. This can result in the familiar "phosphor burn" that creates permanent latent images on CRTs as well as PDPs. Consequently, PDPs suffer not only from reduced luminance with use, but are also subject to differential aging that results in image burn-in. These differential aging effects are particularly troublesome with the display of semi-static images such as menu bars, windows, and other computer-based images.

Cost

Careful and repeated modeling of PDP and PALC-display manufacturing costs gives no advantage to either technology (assuming that PDPs will not require dual-scan addressing to achieve 1000-line addressabilities). Certainly, $50 per diagonal inch is initially achievable with high-volume production of either of the plasma-based technologies.

Investments

In the early 1990s, there was hope for a TFT-LCD solution for large-screen direct-view displays. But as investigators quickly learned that meter-sized TFT-LCDs were not practical, interest and investment in alternatives such as full-color PDPs intensified. To date, cumulative investments in PDPs have reached several billion dollars, with substantial recent investments devoted to preparations for high-volume production.

Meanwhile, the invention of PALC technology has provided an alternative route to achieving large AMLCDs that bypasses the manufacturing difficulties inherent in TFTs. And because it has been able to partially leverage the billions spent on smaller TFT-based AMLCDs, PALC technology has progressed more rapidly than PDP technology. But direct investments have been significantly lower than for PDP technology because PALC technology is at an earlier point in its development cycle. PALC-display developers have not yet reached the point of stepping up to the very large investments required for high-volume production. Now that Sharp and Philips have joined Sony in the development of PALC displays, investment will likely accelerate.

Outlook

Because of incremental improvements over a long development period and large cumulative investments, PDPs are considered the leading technology for the large-area direct-view television market. But the technical innovations needed to take PDP technology into the desktop and multimedia markets are not easily acquired through continuous improvement. Instead, they require significant innovation and invention, and progress toward the desktop and multimedia goals is difficult to predict.

Today, Sony, Sharp, and Philips are matching the size advantage of PDPs for large-area television use by extending plasma-addressed AMLCD technology to displays larger than 40 in. In addition, recent invention and innovation at Technical Visions, Inc., has eliminated most of the technical difficulties that have prevented the exploitation of plasma-based displays in the monitor and multimedia markets.

The Bottom Line

Whether in television receivers, computer monitors, or the multimedia displays of the "convergent" future, it is likely that a plasma-based technology will be an important factor in the replacement of CRTs in the 21st century. PDPs and PALC displays each hold a lead in a different applications area. An exciting future is in store for both technologies and the talented individuals working to bring them to the office and living room. Until the marketplace decides, we can all engage in the timeless art of predicting the future.

Note

[1]K. J. Ilcisin *et al.*, "Breakthrough Gas Mixtures for HDTV Performance in Plasma-Addressed Display," *Proceedings of the 16th International Display Research Conference, EuroDisplay '96*, p. 595. ■

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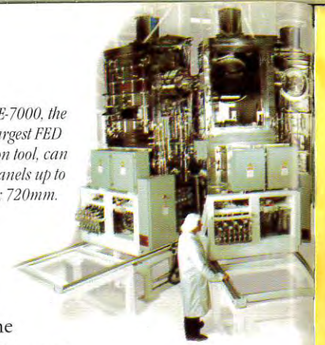

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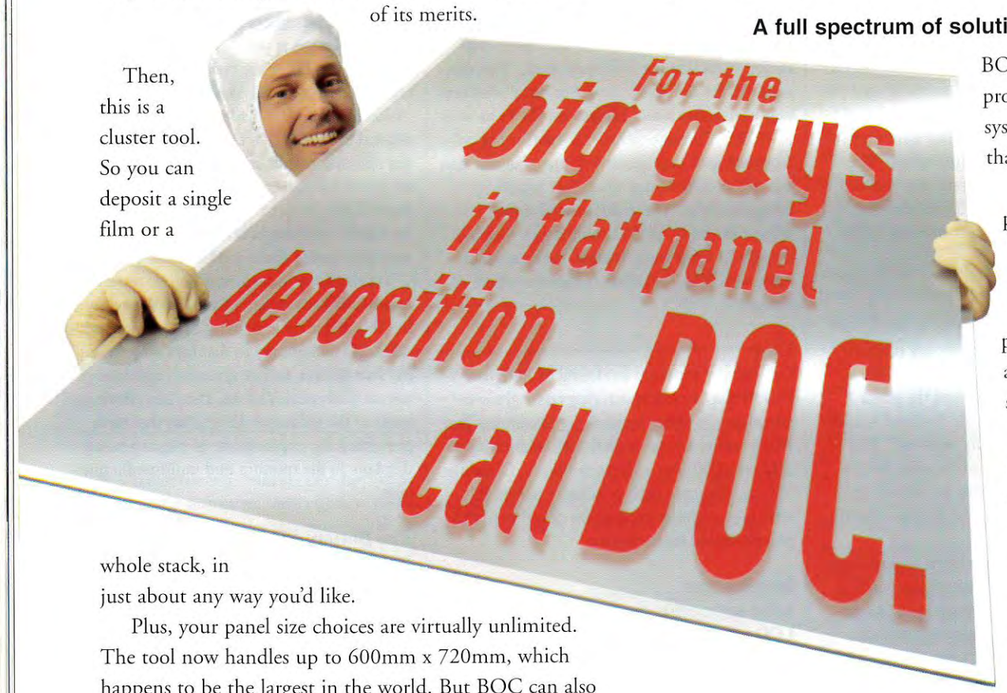

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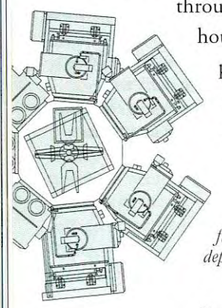

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The Technological Barriers of an Analog World

For FPDs to compete effectively with CRTs, display controllers that aren't biased toward the competition are needed.

by Albert Y. Lee

Until recently, CRTs have been the displays of choice. From a price and performance perspective, they are the benchmark by which all display technologies will be measured into the new millennium. Flat-panel displays (FPDs) have been a recent introduction in the display world. Their initial attractive feature was their "flatness." Taking up much less space and weighing less than a comparable CRT, FPDs have for the most part been lagging behind CRTs in two key areas: price and performance. But recent technology refinements by manufacturers in two critical display technologies – LCD and PDP – have brought FPDs into the performance realm of CRTs.

LCDs and PDPs Lead the Way

Improvements in viewing angle, contrast, and response time have brought LCDs to the forefront as possible desktop-monitor replacements. For example, Fujitsu Limited's recently introduced 15-in. XGA LCD using multi-domain vertically aligned (MVA) technology has equaled or exceeded desktop CRTs in most performance areas.

PDPs, on the other hand, offer great promise for large-area displays that would be ideal as TV replacements. Their overall performance, however, has until recently been far from a CRT's. But the recent introduction of higher-contrast and higher-resolution PDPs has brought their performance nearly on a par with the CRT's. Even with all the improvements attained by these FPD technologies, CRTs maintain a dominant role as the standard display device. As a result, analog interfaces will be around for years to come. Devices that make interfacing with FPDs transparent in any application will be critical to the success of these displays.

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It's an Analog World

A majority of the FPDs that are currently available are essentially digital in nature, *i.e.*, the interface signals to these devices are digital rather than analog-based signals. In portable computing devices (notebook PCs and PDAs) and electronic appliances (electronic organizers, pagers, and cellular phones), much of the information is digital in nature – which makes FPDs ideal and cost effective in these applications. LCDs have played a dominant role in these products, and, as a result of the tremendous growth in manufacturing capacity, the price of LCDs has declined sharply and quickly.

To realize even lower costs, display makers must establish even larger manufacturing capacities. Thus many manufacturers have targeted new applications such as desktop monitors and TV sets.

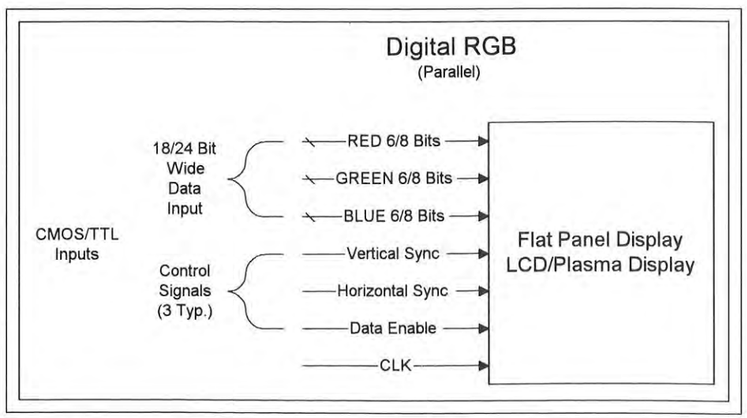

Fig. 1: *The most popular interface for color LCDs and PDPs is still the digital RGB interface.*

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Since CRTs are still the dominant display devices on desktops and in living rooms, all current display interfaces have been designed with analog-signal outputs – analog RGB or NTSC video. This has made it difficult to broaden the acceptance of FPDs. The problem has been especially acute in the arena of desktop monitors, as well as in the television world, where price is the name of the game.

In order to make their technologies more widely accepted, many manufacturers have resorted to making their products more transparent to the end user. Thus OEMs, FPD manufacturers, and graphics houses have developed specialized hardware that converts the analog input signal to a digital data stream better suited to FPDs. But there are drawbacks to this approach. Overall cost of the FPD monitor is increased, and image quality may be compromised because the input signal undergoes both a D/A and A/D conversion, which can produce data loss or the introduction of image artifacts. From an FPD-manufacturer's perspective, a straightforward digital-to-digital interface is the most desirable interface.

Current Digital Interfaces

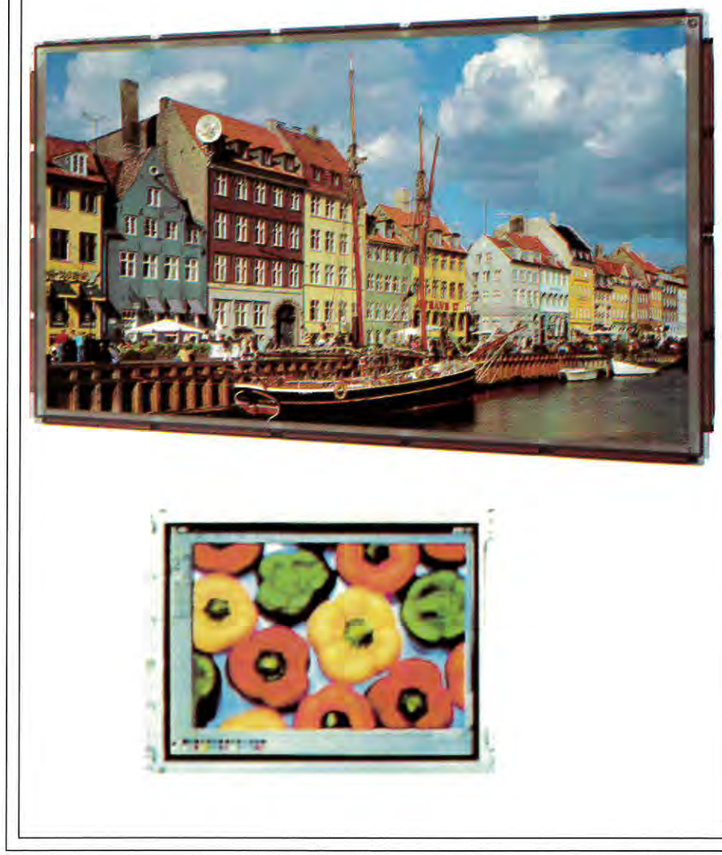
Generally, FPDs have a digital interface. There are some exceptions to this. For certain applications, LCD manufacturers have used analog column drivers in the display. This is done for the following reasons:

- It reduces overall interface cost by eliminating frame buffers (memory devices) and A/D conversions.
- It increases color depth (color levels) in the LCD – theoretically up to 16.7 million colors or more.

But these applications – which include viewfinders for camcorders and NEC's LCD monitors – are the exception, not the rule. Analog drivers for high-resolution LCDs increase the cost and power consumption of the overall LCD panel.

The most popular interface is still the digital RGB (Fig. 1). This interface contains 6–8 bits of information for each of the primary colors (R, G, and B). The digital data is usually at CMOS TTL levels of 5 or 3.3 Vdc. The 6–8 bits per primary – for a total of 18–24 bits of color – are transferred in parallel to the FPD on a rising or falling clock cycle.

This method has been effective and feasible for the first generation of FPDs having low to moderate resolutions from VGA (640 × 480, 60 Hz) to SVGA (800 × 600, 60 Hz). However, as FPDs make the transition to higher resolutions such as XGA (1024 × 768, 72 Hz), higher transfer rates (faster clock cycles) are required. The higher clock cycles required for higher resolutions, coupled with the high data densities, create the potential for EMI radiation problems, which were very apparent in the early development of high-resolution notebook-PC designs.



Fujitsu Microelectronics

Fig. 2: *The Advanced Television Systems Committee (ATSC) digital-TV specifications require a conforming receiver to support both the existing 4:3 aspect ratio (bottom) and the newer 16:9 wide-screen formats (top). The 4:3 display is Fujitsu's 15-in. XGA MVA; the 16:9 display is Fujitsu's 42-in. PDP.*

To counter the increase in EMI radiation, two types of serial differential-mode interfaces were developed: (1) LVDS (low-voltage differential signal, from TI and National Semiconductor) and (2) PanelLink™ (from Silicon Image, Inc.). A serial data stream emits much less radiation because the number of conductors (antennae) is reduced from 24 (8 bits/RGB) to three differential pairs of conductors with two additional pairs for clock and

control. In addition, the use of a differential voltage (as opposed to TTL) permitted a reduction in the overall emitted power. (The voltage is reduced from 5 Vdc/3.3 Vdc to 350 mVdc.)

PanelLink, which is similar to LVDS, uses a proprietary data-encoding method to reduce the actual amount of data sent, which amounts to a type of data compression. By reducing the amount of data that is transmitted, the number of differential data transitions is reduced, which should further reduce EMI emissions. In addition to reducing EMI, these serial interfaces allow the display device to be located at a substantial distance from the signal source. Both LVDS and PanelLink have been incorporated into industry standards endorsed by the Video Electronics Standards Association (VESA): FPDI-1.0 embodies LVDS and FPDI-2.0 embodies PanelLink.

Recently, a new differential-mode serial protocol known as Firewire (IEEE 1394) has attracted attention as a potential new interface standard for FPDs. Firewire is more than a serial-interface protocol because it defines both a bus and a networking architecture. Firewire provides communications and command-and-control functions for up to 64 networked devices. Continuous sustained transfer rates of up to 400 Mbits/sec have been achieved with the most current version of Firewire. In development at this time are 800-Mbits/sec devices. These transfer rates are acceptable for current and near-term FPD resolutions, but all of the interface technologies just discussed are far from adequate for meeting the challenge of the next generation of displays (Table 1).

Table 1: Estimated Bandwidth Requirements for Various Resolutions *vs.* Capabilities of Serial Interfaces

Computer Graphics		Digital TV		LVDS	Panel-Link	Firewire
PC (XGA)	WS (SXGA)	SD	HD	455	1.12	3.2
1 pixel/clock	1 pixel/clock	(704 × 480) Progressive	(1920 × 1080) Progressive	Mbits/sec	Mbits/sec	Gbits/sec
1.08 Gbits/sec	1.8 Gbits/sec	464 Mbits/sec	2.85 Gbits/sec			

Development of Graphics Solutions

There are currently two categories of graphics devices available for FPDs. Graphics accelerators, typically found in notebook PCs, are integrated into bus-type architectures such as PCI, VL, and ISA. In this configuration, the device usually relies on the bus for its data and control functions.

Another type is the stand-alone LSI device that can be a semi-custom or fully custom design. These stand-alone devices – which usually receive analog inputs such as RGB, composite video, or S-video – perform all the necessary processing on the inputs and deliver appropriate digital outputs to the FPD.

In addition to analog-signal conversions, FPDs and graphics devices have also been forced to deal with numerous resolutions and formats. FPDs, unlike CRTs, have a fixed spatial format (or screen resolution). In addition, they are progressively scanned. The recent introduction of digital TV has posed even more technical challenges to both FPD and graphics-device manufacturers. The current digital-TV specifications, as established by the Advanced Television Systems Committee (ATSC), requires a conforming receiver to support both the existing 4:3 aspect ratio and the newer 16:9 wide-screen formats (Fig. 2). Support of both interlaced and progressive field formats are required as well.

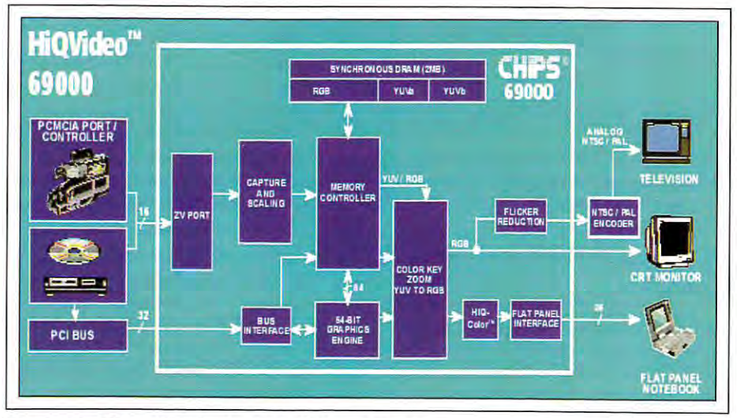


Fig. 3: The Chips & Technologies B69000 graphics accelerator can zoom an image to the full-screen resolution of an FPD, and can support both 16:9 and 4:3 aspect ratios.

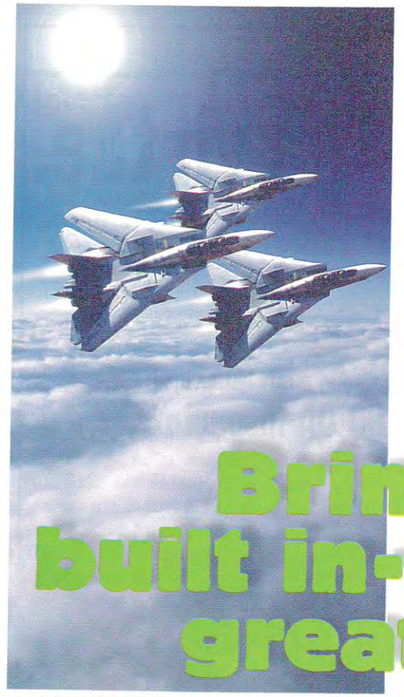
Portable Graphics Controllers

A majority of portable graphics controllers were originally designed to be used in PC applications (Windows 95). Recently, because of their extensive multimedia capabilities, these devices are now being considered for use in applications such as Internet appliances (set-top boxes) and PCTV applications. Digital-video (DV) and conventional-video sources can be inputted to these devices as a video overlay in a Windows 95 environment, or the video source can be scaled (zoomed) to the full-screen resolution of the FPD. Support for multiple FPD aspect ratios is also provided. Manufacturers such as Chips & Technologies, Inc., have developed graphics accelerators (Fig. 3) for use with traditional FPDs, *e.g.,* Fujitsu's 15-in. XGA LCD and the new 16:9-format displays such as Fujitsu's 42-in. plasma displays.

Stand-Alone Graphics Devices

In developing FPDs as monitor or TV replacements, many manufacturers have developed semi-custom (FPGA) controller solutions. These semi-custom (or full-custom) devices have been expensive and display-specific, which has limited their value to other FPDs. But recently, more generic and cost-effective off-the-shelf solutions, such as Genesis Microchip's, have become available. Genesis Microchip has several device offerings and reference designs that also address the issues of scaling, zooming, and de-interlacing video sources. Most of these devices have already established full compatibility with various LCDs and PDPs from many of the FPD manufacturers.

It is apparent that the FPD industry, in cooperation with its partners in other industries, will continue to develop a full range of solutions to the technological barriers that still remain to using flat panels in all appropriate applications. ■



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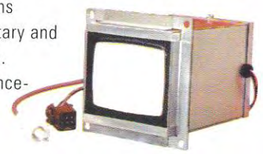

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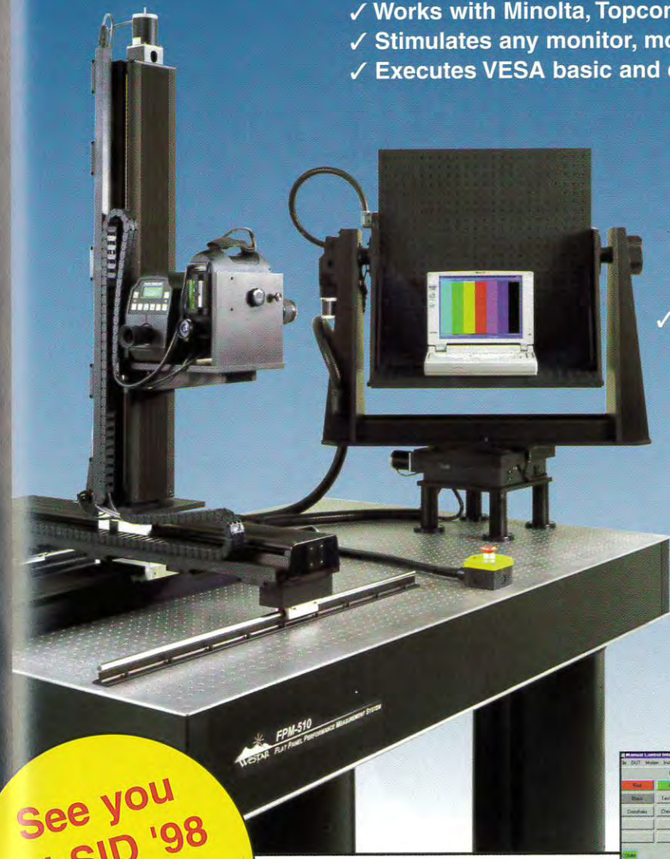

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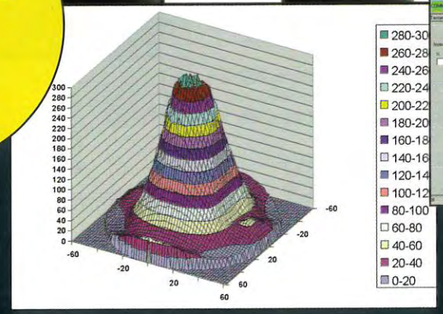

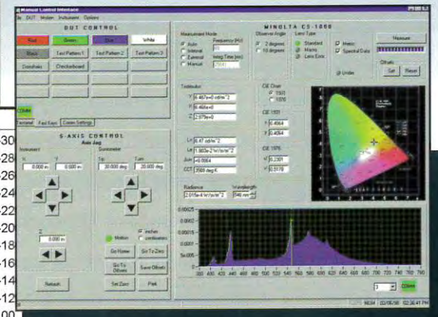

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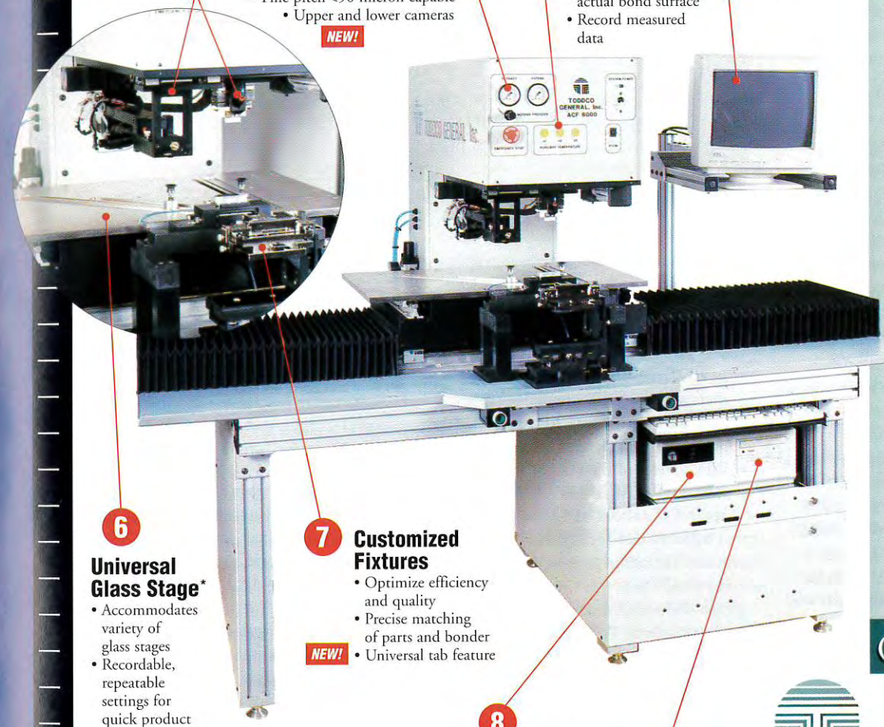

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Circle no. 102

The Business Conference at Display Works 98

Asian display makers and their equipment suppliers may be suffering today, but they are very bullish on the future.

by Stefanie Ann Lenway and Jeffrey A. Hart

Presenters at the 1998 United States Display Consortium (USDC) Business Conference, entitled "Enabling New Markets," addressed topics ranging from wringing costs out of the manufacturing process to helping the desktop display market take off. In an after-lunch session jointly sponsored by USDC and SID, the conference brought the business and technical communities together to hear papers that addressed some of the technical and managerial challenges posed by the next generation of flat-panel-display (FPD) manufacturing. As one would expect, concern about the Asian economic crisis was pervasive during the day-long meeting.

The first speaker, Mr. Toru Shima, President of DTI (the IBM-Toshiba FPD-manufacturing joint venture), began by observing that the FPD industry had stopped growing during the latter half of 1997. Despite the current "curious economic times" stemming from the economic turmoil in Asia and the difficulty of making reliable market forecasts, Shima was optimistic enough to forecast a 15% growth rate in LCD demand through the next few years, fueled by an expanding monitor market. Based on this expectation, Shima said DTI will begin producing 17-in.-equivalent LCD monitors in quantity in 1998.

Shima provided some interesting data from DTI's LCD Market Outlook:

- The number of large thin-film-transistor (TFT) units produced in 1997 was about 10 million, up from 7 million in 1996. Unit volume was projected to grow to 23 million units in the year 2000 and 28 million in 2001.
- In 1997, more than half the large TFT units sold were 12.1-in. units, up from 30% the year before. About 20% of the large TFT units sold in 1997 were 13.3 in.
- DTI's share of the market for large TFTs was about 23% in 1997, Sharp's 21%, and NEC's about 11%.

Shima believes that DTI is ahead of NEC, Sharp, and Hitachi in gearing up for LCD-monitor production.

Shima showed that power-consumption reductions in large TFT modules between 1990 and 1996 were primarily due to the reduced power consumption by backlights, but that there had also been a continuous reduction in the power consumption of the TFT cells themselves – from 2 W in 1990 to about 0.5 W in 1996.

Shima emphasized the importance of reducing production costs – especially for TFT arrays – to expand the monitor market. Process costs are the main problem for TFT arrays, while materials costs are the main problem for assembled modules. Shima pointed out that DTI had increased its productivity sevenfold by ramping up its Phase I line in the first half of 1993 and its Phase III line in the second half of 1997. He attributed this gain to better tools for working with larger sizes of mother-glass and the introduction of computer-integrated manufacturing methods. His goal is for DTI to increase its productivity by another factor of 2 when it introduces Gen 4 equipment. To help achieve this target, he strongly encouraged FPD manufacturers and tool and materials suppliers to work together to discover new opportunities to reduce costs.

Displays for the "multimedia era" will have to have larger screens, lower power consumption, higher resolution, less thickness, and lower weight, and, together with their host systems, offer "system on" capabilities.

Ross Young, President of DisplaySearch, pointed out the difficulties faced by FPD manufacturers as a result of their dependence on the cyclical notebook-computer issue. Shipments of TFTs have been declining, he said, to the extent that supply exceeded demand in the second half of 1997 and some fabs were forced to cut production to 50% of capacity. The current excess capacity, combined with the Asian economic crisis, has led to several delays in planned investments in plant and equipment, especially in Korea. DisplaySearch forecasts that these delays may result in a display shortage sometime in 1999.

DisplaySearch estimated the sales of all FPDs at $12.3 billion in 1997, with LCDs accounting for over 80% and TFTs accounting for a bit less than half of the LCD total. TFTs will account for 70% of total FPD sales by 2002, Young said.

In 1997, Sharp had the highest worldwide sales of LCDs: around $2.3 billion; DTI was second with $1.125 billion; and NEC was third with $1.083 billion. Samsung had risen rapidly from zero LCD sales in 1994 to $700 million in 1997, but was still behind the top three, as well as fourth-place Hitachi. LG had also risen rapidly from zero sales in 1994 to about $400 million in 1997.

Young expects the cyclicality of the LCD business to decline as LCD markets become more diversified. Small LCDs for cameras and car navigation systems were selling quite nicely by September 1997 at around 1.6 million units per month. The demand for large LCDs was flat between January and September 1997 at about 600,000 units per month.

Young also found that large-TFT prices had dropped dramatically, and he expects this trend to continue for the next 7–8 quarters. The prices for 12.1-in. displays sank from $650 in 1995 to about $380 at the end of 1997, with Korean prices dropping to $280 as the Korean producers leveraged the won depreciation. DisplaySearch forecasts that by 1999 prices will be 50% below 1996 levels, and AMLCDs will begin to displace STN displays even in low-end ($1500–2000) notebooks.

Young indicated that the growth in notebook power consumption was being driven more by CPUs and other circuitry than by displays. This means, however, that customers will continue to look for ways to reduce the power consumption of displays and other components to compensate for the increased power demands of faster IC circuitry.

An approach for reducing array-processing costs has been invented by AKT which reduces processing steps by replacing the deposition of a passivation layer with the spin coating of a polymer passivation layer. The AKT approach reduces the number of masks from seven to five.

Young speculated that the best prospects for the development of an LCD-monitor market were for the 17-in.-equivalent displays, and that this would start in 1998 as the average price for LCD monitors came down to about 2 times the average price of 17-in. CRT monitors. He predicted that desktop-PC manufacturers would begin to integrate digital-output graphics controllers into the graphics circuitry of the computer, which would further lower the price differentials between LCD and CRT monitors.

DisplaySearch's optimistic projection for the size of the LCD-monitor market is for 19 million units by 2002; the pessimistic projection is for 7 million units by that year. In either case, the company predicts that shortages of monitor-sized TFTs will develop, especially in the 17-in. monitor sizes, by 2002 after several surplus years. DisplaySearch sees no short-term end to the quest for larger and higher-resolution displays, and therefore projects a bright future for low-temperature polysilicon technologies.

Young thinks that Taiwanese firms will take up some of the slack that results from the temporary hesitations of the Koreans so that they will have about 12% of total world TFT productive capacity by the end of 2002. Korea will have about 28%, while Japan will have 60%. He apparently sees no possibility of substantial U.S. participation in TFT markets (other than IBM through DTI) during this period.

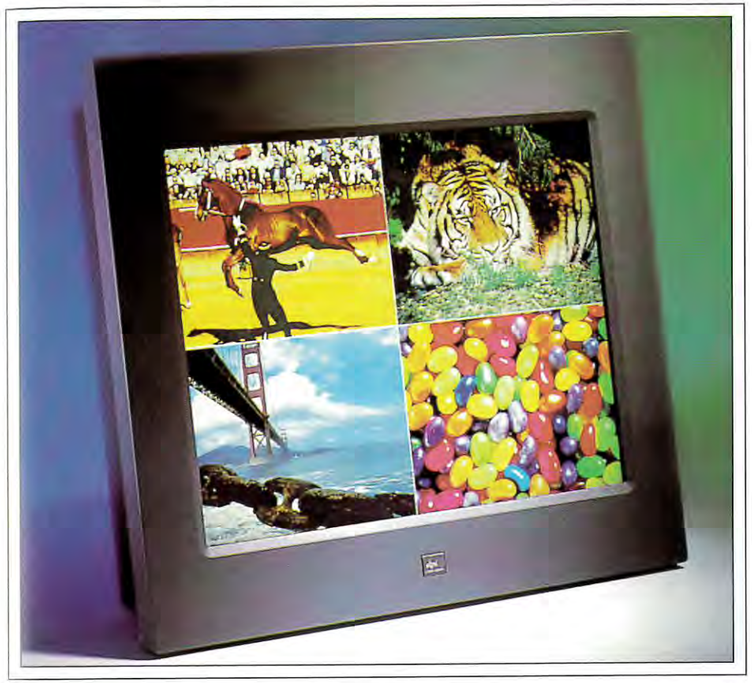
Young ended his presentation by suggesting that no one is making any money on LCDs. He suggested that agreements on equipment and substrate standards would help reduce costs, but other conference attendees were skeptical about this.

Following Young's presentation, the focus of the discussion shifted from TFTs to field-emission displays (FEDs). Harry Marshall, CEO of Candescent Technologies Corp., one of the best-funded Silicon Valley start-ups, presented CTC's strategy for developing a new market around Candescent's "thin CRT" technology.

Marshall focused his presentation on three questions that have interested the display and investment communities:

- How was Candescent able to raise the $280 million in venture capital?
- Why has Candescent's schedule slipped?
- How could Candescent compete with the Asian TFT juggernaut?

Marshall attributed CTC's ability to attract investment capital to the company's need to meet the display specifications set by Hewlett-Packard, their establishment of supplier partnerships, and their ability to show promising



dpiX

dpiX showed its beautiful Expression 100 19-in. 24-bit 150-nit 100:1-CR SXGA AMLCD with very wide viewing angle and a startlingly fast $t_{on} + t_{off}$ of 13 msec. The panel is also available in an Eagle 19 military version produced in partnership with Planar Advance.

***Stefanie Ann Lenway** is Professor of Strategic Management at the Carlson School of Management, University of Minnesota, Minneapolis, MN 55455; telephone 612/624-1343, fax 612/625-2873, e-mail: slenway@csom.umn.edu. **Jeffrey A. Hart** is Professor of Political Science at Indiana University, Bloomington, IN; telephone 812/855-9002, e-mail: hartj@indiana.edu. He has been performing research on the global display industry.*

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prototypes – although with a longer delay than is usual. He indicated that the manufacturing schedule slipped because of the company's commitment to finding appropriate manufacturing partnerships and to the strategy of putting quality assurance before time to market.

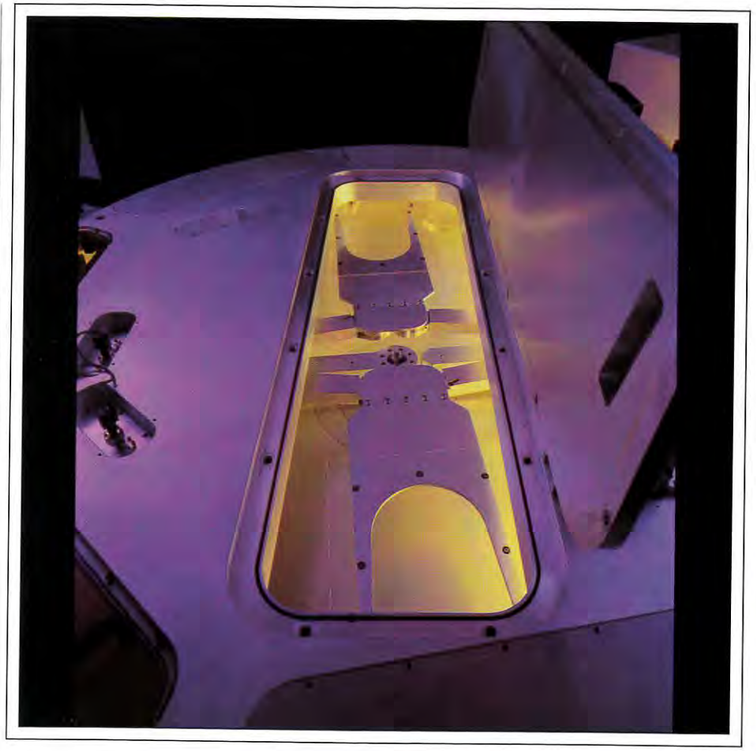
Marshall expressed considerable confidence that thin CRTs will compete with TFTs by offering higher performance at lower cost. He hinted that thin CRTs would be most competitive at XGA or higher resolutions and in applications where good heat dissipation, lower power consumption, and thinness of the display module were particularly important to system designers.

The Panelists Speak

Marshall's discussion of Candescent's strategy was clearly intended to generate optimism about the future of FEDs. Moderated by Malcolm Thompson, the panel that followed Marshall's talk addressed the question of how display manufacturers exploiting a variety of technologies can leverage the current price reductions in TFT-LCDs to create markets around new applications. Joseph A. Castellano, President and CEO of Stanford Resources, began the discussion by observing that sales of FPDs of all sorts were $13.9 billion in 1997. He forecast that, by 2003, 85% of the $31.6 billion FPD market will be LCDs and that 85% of the $25.2 billion LCD market will consist of active-matrix (primarily TFT) displays.

Computer applications, continued Castellano, would continue to generate the greatest share of total demand for FPDs; that share would increase from 54.7% in 1997 to 67.4% in 2003. The share of plasma-display panels (PDPs) is predicted to grow gradually from roughly $230 million in 1996 to approximately $4 billion in 2003. He suggested that by 2003 FPDs will begin to make substantial inroads as CRT replacements in the desktop-monitor market. For FPDs to make major inroads into consumer TV markets, they must be available in screen sizes of 30 in. or more and eventually have 16:9 aspect ratios. Luminance will have to be 200 nits or higher, viewing angles will have to be at least 160°, and prices will have to be low. These factors imply that consumer TV sales will be quite limited until the prices of PDPs come down considerably.

Joe Garcia, executive director of business development at Kaiser Electronics, posed some of the dilemmas faced by FPD producers whose primary customers are military. He described his customers as "financially challenged" but still demanding performance unachievable for the price they are willing to pay. Fighter pilots, for instance, take their need for an "unfair" advantage over their adversaries very seriously and tend to make extraordinary demands on the FPDs used in cockpits. But economies of scale do not exist, and once a display is designed into an airplane a manufacturer may need to provide replacement displays for as long as 30 years.

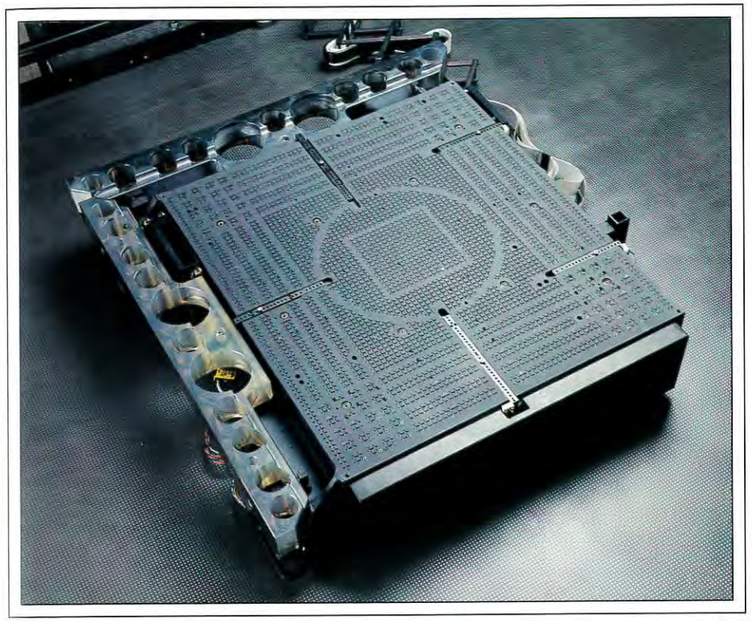


Lam Research

This high-throughput 600 × 720-mm transport module is for Lam Research's Continuum™ advanced FPD etch system.

Jerry Vieira, director of strategic marketing and business development at Planar Systems, was somewhat more optimistic. He emphasized the importance of creativity in understanding how a particular display would add value and meet the needs of potential customers. Eugene Munteanu, marketing manager for the Electronic Device Group at Epson, emphasized the importance of cross-functional communications between marketing, manufacturing, and the systems integrator to successfully develop new display applications.

After lunch, Davis Lee from LG discussed the impact of the won devaluation on Korean manufacturing. He commented that in Korea "IMF" could mean "I am fired" or "I am fine." LG's FPD division seemed to be doing "fine." Lee explained that before the economic crisis Korean manufacturers had built up a 30% global market share, and speculated that the explosive growth in FPD capacity would slow down in 1998. Instead, Korean producers will continue to work on refining Gen 4 manufacturing concepts and making minor investments to augment current operations. The deferred investment may lead to a shortage around Q2 '99. Notwithstanding the Asian financial crisis, Lee does not expect any major changes in the strategic commitment of Korean companies to the FPD industry, although Hyundai's decision to close down Image Quest Technology was associated with rumors that Hyundai may exit the industry.



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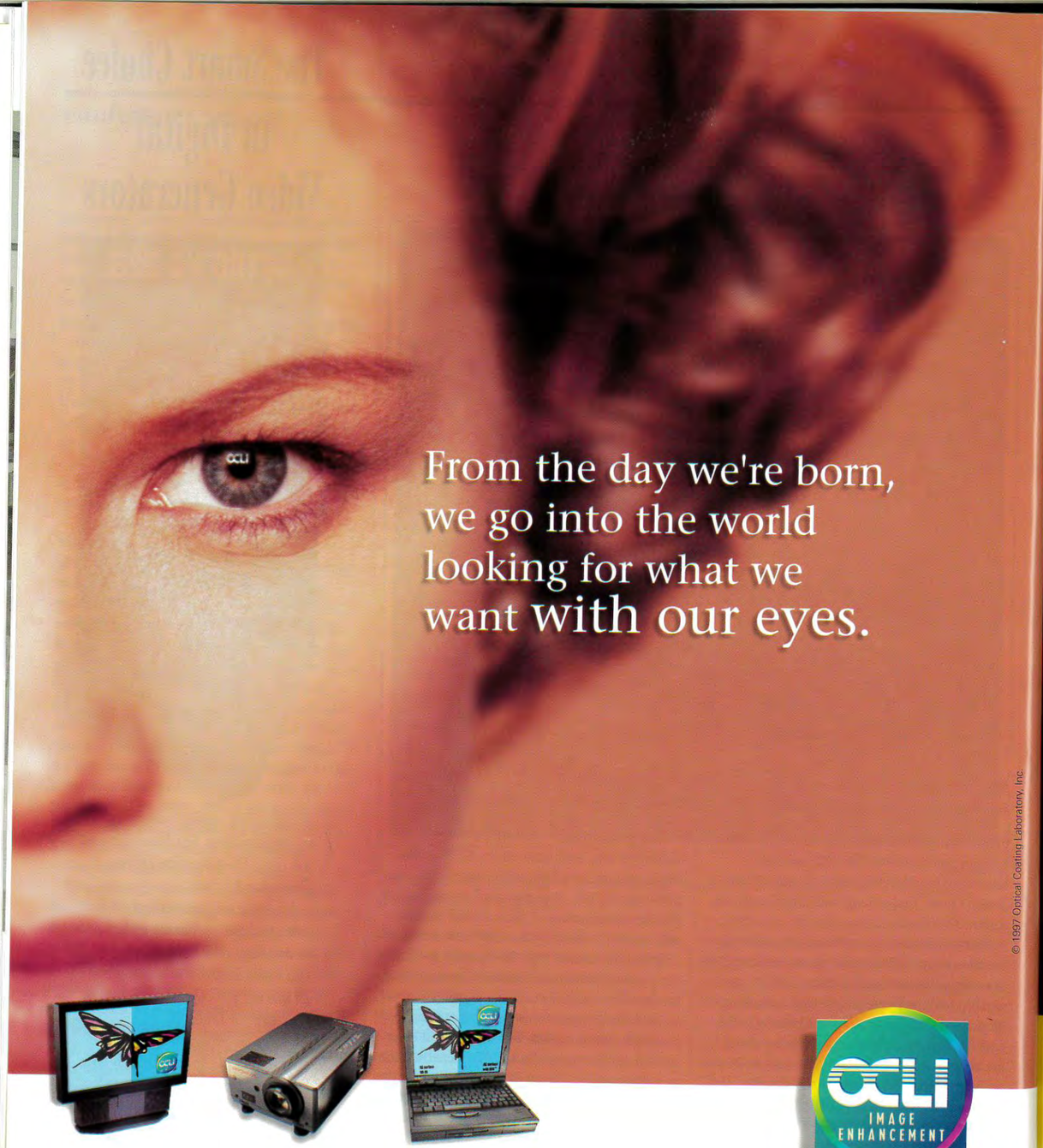
MRS's AccuStep™ X-Y stage motions incorporate a keyless flat linear motor technology which enables high-performance frictionless and scalable substrate-positioning capability.

Martin Aguilera from Planar provided useful advice for FPD manufacturers interested in developing a successful silicon-foundry partnership with companies involved in making displays on silicon-wafer substrates: (1) Educate foundry engineers and operators about the optical characteristics of displays and the problems created by particle defects; (2) leverage the IC business cycle to make a relatively low-volume display contract look attractive; and (3) form a strong partnership with the foundry and emphasize the benefits to both entities.

Norman Bardsley followed with a comprehensive discussion of global planning for Gen 4 manufacturing, based on work done by the SEMI/Japan PCD Phase II Organization. He focused on the gap between what equipment manufacturers can supply and panel maker requests for Gen 4 equipment, which includes motherglass of 800 × 900 mm, average cycle time of 60 sec, footprints about 125% of the status quo, prices 125% of the status quo, and 500-hour MTBF. Supplier predictions suggest that the manufacturers' goals would be difficult to meet, especially as costs varied from 139% of the current cost for a prober to 180% for a coater/developer. Bardsley stressed that the growth of the FPD market depends on better and cheaper processing equipment and materials because price will be a crucial determinant of the rate at which FPDs penetrate the monitor market. The shift in emphasis from creating new FPD markets to competing with a mature technology such as the CRT will put enormous downward price pressures on manufacturers, which could be addressed, at least in part, by increased cooperation among users, manufacturers, and tool and materials suppliers – and by the increased use of standards.

An afternoon discussion concluded with some philosophical comments on the importance of a long-term commitment to profit from participation in what remains a very exciting, perhaps too exciting, industry. ■



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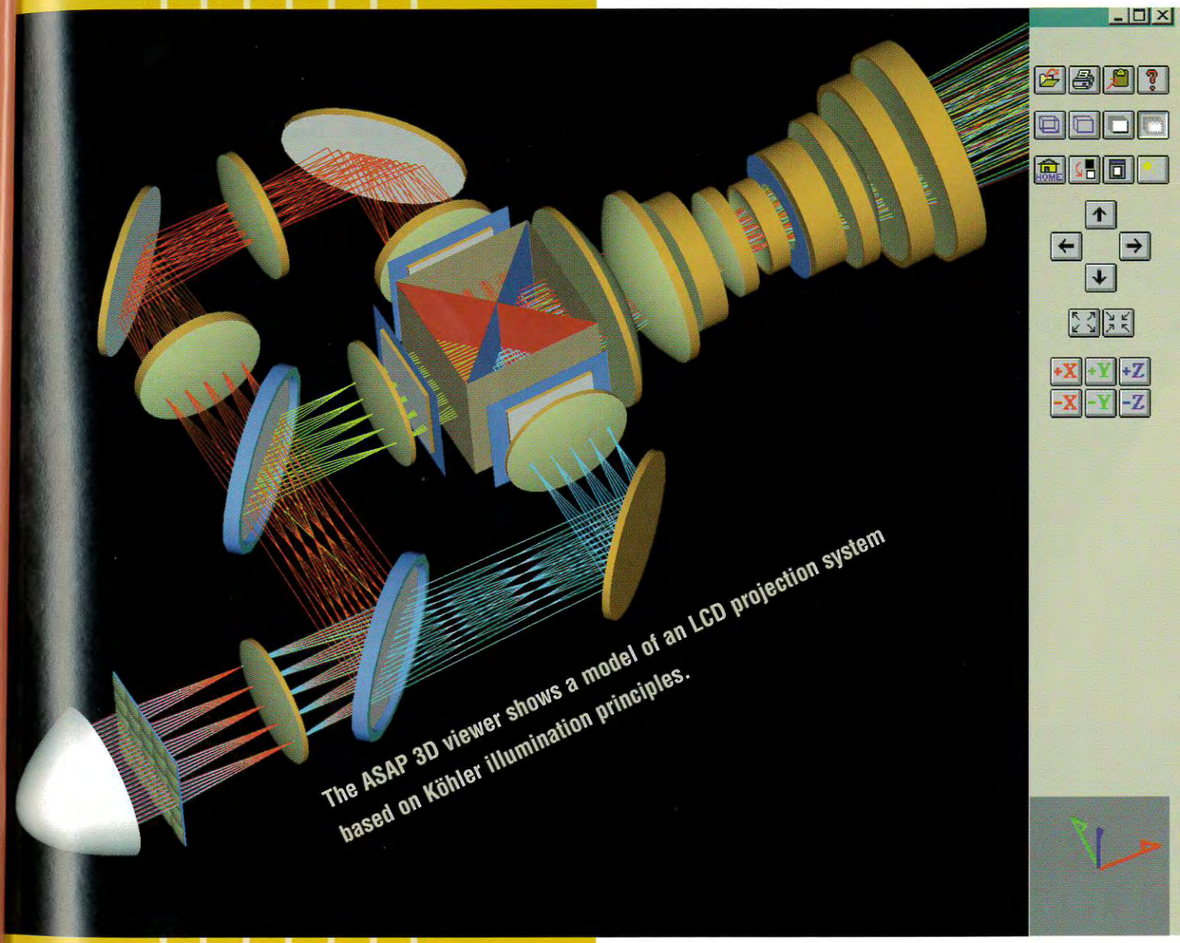

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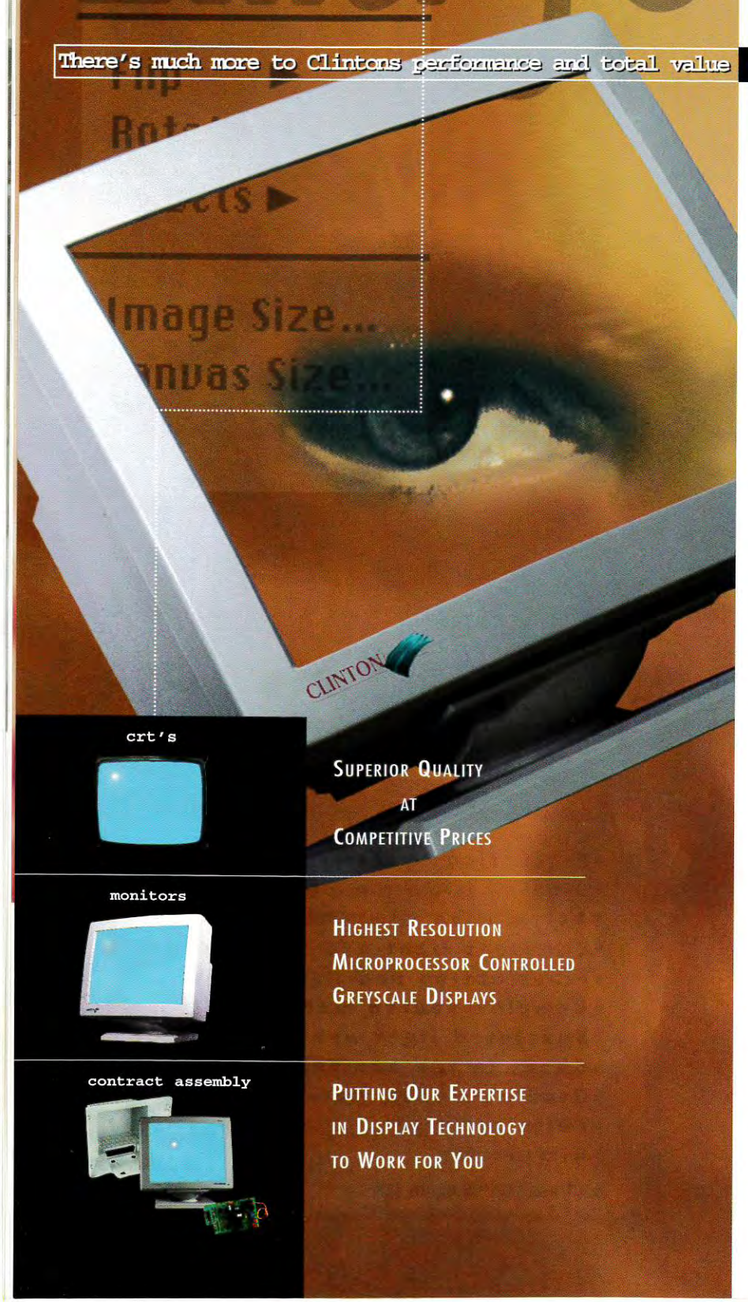

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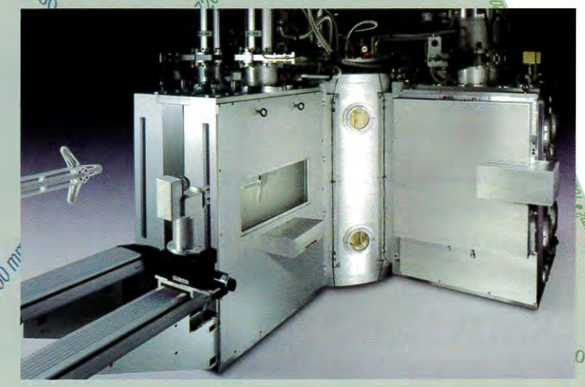

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Display Works Bounces Back

The "Asian Flu" was a constant topic, but the Koreans were determined, the Taiwanese optimistic, and, with nearly 4000 participants, DW '98 was full of energy.

by Ken Werner

THE THREE MOST VISIBLE COMPONENTS of Display Works 98 – the business conference sponsored by the United States Display Consortium (USDC), the technical conference sponsored by the Society for Information Display (SID), and the trade show sponsored by Semiconductor Equipment and Materials International (SEMI) – are primarily about display manufacturing and materials.

One of several motivations for the event, held this year January 20–23 in San Jose, California, was to provide a central arena for the activities of USDC. The original concept behind USDC was that a partially government-supported industry consortium could help develop an infrastructure of manufacturing equipment and materials that would enable a fledgling flat-panel-display (FPD) manufacturing industry to grow in North America. That growth has been much slower than originally anticipated, but another benefit has been that the enhanced equipment and materials have, in some cases, turned out to be attractive to Asian manufacturers.

Although USDC's initial focus was on the needs of U.S. FPD manufacturers, there was a natural inclination to adopt a more international agenda. "The global nature of the display industry makes it desirable – even necessary – for us to enter into international relationships, a development that is welcomed by our main government sponsor, the U.S. Department of Defense, as well as by USDC's partners in DW '98: SID, an international society devoted to the development of display technology and manufacturing, and SEMI, an international trade association of manufacturing equipment and materials companies," said Gary Jones, a member of the USDC Board of Directors and President and CEO of FED Corp., Hopewell Junction, New York.

One fruit of this increasingly international agenda is USDC's recent agreement with the Electronic Display Industrial Research Association of South Korea (EDIRAK) to work on joint development projects. According to Jack Robertson of *Electronic Buyers News*, EDIRAK will invest $2 million and USDC will invest $2.6 million to develop a laser glass cutter for FPDs; and the two organizations will invest $2 million and $6 million, respectively, to develop a lithographic stepper for FPDs.

Hornell Automation

At DW '98, Hornell Automation displayed its combined LCD rub and ultrasonic dry-clean module for LCD production. The innovative machine is part of the company's MELP™ series of modular LCD-manufacturing equipment.

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Ergotron

Ergotron workstands mount various combinations of displays, system units, and keyboards on rugged arms that tilt, extend, and rotate.

The inherently global nature of the display industry was evident in many aspects of DW '98, including conversations held with exhibitors on the show floor. If an equipment maker or material supplier at DW '98 was both sizeable and happy, they almost certainly had Asian firms on their client list. The kicker, of course, was the "Asian Flu" – the economic crisis that had turned several of the Asian tigers into pussycats in the weeks preceding DW '98. And the flu was a major topic of conversation on the show floor, in the corridors, and at the business conference that led off the event's major activities on Tuesday, January 20th (see the accompanying article in this issue).

The Koreans were coming out of their shock by the time of DW '98 and were gracefully carrying off both gallows humor ("I found out what IMF stands for: I M fired") and rueful determination. Sungkyoo Lim, a professor of electronics engineering at Dankook University who is well connected to the Korean display industry, told *Information Display* that the semiconductor and display industries were too important to Korea's future for the country to stint on investments. He predicted that all investment money committed to display development and manufacturing would be spent, although there might well be slowdowns in the pace of spending. Subsequent presentations and conversations at DW '98 made it clear that the pace would be very slow indeed through much of 1998, particularly because manufacturing equipment valued in dollars or yen had suddenly become prohibitively expensive.

Keynote Session Spans East and West

In the technical conference's keynote session on Wednesday morning, Hsing C. Tuan, President of Unipac Optoelectronics Corp., made it clear that what is a problem for Japan and a crisis for Korea is considered to be an opportunity for Taiwan. Since mid-1997, the Taiwanese display industry has announced investment plans of at least US$2.5 billion for expanding its STN- and TFT-LCD industry. The industry currently produces TFT displays up to 6.1-in. VGA, with laptop product on the horizon. Equipment manufacturers are hoping Taiwan will pick up some of the 1998 sales slack left by Japan and Korea. "Taiwan will become a major player in the TFT-LCD market," Tuan said.

In the opening keynote address – which was one of five – Takahisa Hashimoto, Director of Display Technology for IBM Japan, noted that in 1997 14 manufacturers shipped 10 million 10-in. or larger LCDs, and starting in 1999 several more companies will enter the fray. "Last year was the best I've seen, but

this year may be tough," said Hashimoto, who predicted a price erosion of about 30% for notebook-class displays. "But this is good for consumers," he said, "like 1995."

Hashimoto noted that today the curves for price *vs.* size for CRT- and LCD-based monitors cross at slightly less than 23 in. Although prices for both technologies will continue to decrease, we can expect the price of LCD monitors to decrease more rapidly, thus moving the price-parity point to smaller sizes. He predicted that the price of 13–14-in. LCDs will drop to less than $300 in the not-too-distant future. "The fourth generation is the generation that brings us the LCD that competes directly with CRTs. If we can't do that yet, we should wait."

Hashimoto had some challenging predictions for the year 2000:

- Twenty companies will be producing high-information-content LCDs.
- Between 23 and 25 million panels will be produced.
- Large high-resolution displays will be produced for PC/NC/digital TV.
- Reflective LCDs for PDAs and subnotebooks will be large-volume products.
- Non-IT applications – such as digital cameras, navigation systems, and medical applications – will increase substantially.

Kyung Y. Park, Managing Director of Samsung Display Devices, startled some members of the keynote-session audience with the openness of the cost breakdowns in his talk, "Manufacturing Costs for a PDP Business." Among his predictions were that 5 million large PDPs would be sold in 2002 and 8 million in 2005, and that 40-in.-class displays will still be the dominant size in 2005. Also, luminous efficiency would increase from 1.5 lm/W today to between 3 and 5 lm/W in 2002; luminance would increase from 350 to between 500 and 600 cd/m^2; and price would decrease from $300 per diagonal inch to $100.

Critical to the success of PDPs is pushing down panel cost through volume manufacturing and materials costs. Machinery costs are high for PDPs, being more than double construction investment, so, said Park, "we need to reduce machinery costs through collaboration or our own efforts."

Bob Duboc of Candescent Technologies took over the keynote slot assigned to his boss, Harry Marshall, who had given a highly polished refutation of Candescent's critics at the business conference the day before – a refutation that some in the audience felt fell into "the lady doth protest too much" category. Duboc's talk covered the potential of field-emission displays (FEDs) in general and Candescent's progress in particular.

More impressive than either presentation, though, were the three Candescent 4.4-in. prototypes being exhibited in a nearby hotel suite. The QVGA units were producing 90 nits (prior to the 50% neutral-density filter worn by at least one of the displays), had a less than 5-msec video response, and consumed 1.1 W (total for panel and electronics) with 15-V switching. Production units will switch at 8–10 V, produce 100 nits, and consume only 400–500 mW, said Candescent marketing manager Stewart Hough. Although equipped with only 3-bit drivers (which were standard 18-V LCD drivers), these displays looked remarkably good showing video, and the most recent example often showed no evidence of its internal spacers.

At other times, what Hough identified as wall charge made the five wall-like spacers visible, but not horribly so. Six-bit drivers are in house, Hough said, and will be used in the 5.3-in. prototypes scheduled to come off the line beginning in February. Technologically, Candescent has clearly come a long way, and they're not done yet. Hough said the company will make a 14.1-in. FED demonstrator by the end of '98.

Rick Knox, Director of Advanced Technology for Compaq Computer Corp., finished off the keynote session with a system-makers perspective in "Integration of Display and System." Last year, Knox said, 60% of TFT-equipped notebooks were 12.1-in. SVGA; this year, the majority are 13-in. XGA, with 5–7% using 14-in. displays. Because of price decreases, 75% of notebooks are using TFT displays.

Notebooks with 14-in. SXGA displays should start to appear in Q4 '98, and 15-in. SXGA displays in the second half of '99 – although these computers may be some kind of a luggable rather than an oversized notebook.

Up to 13 in., systems don't suffer much of a power penalty for enhanced display performance, with current 13.3-in. XGA displays producing 100 nits while consuming only about 3 W. But a 14-in.-class XGA display consumes about 4 W. The system-maker's goal, said Knox, is to make the screen act like a piece of paper. That would imply 8.5 × 11 in. (with an aspect ratio of 51:66 instead of 3:4) and a diagonal size of 13.9 in. But parts of the market seem to be pushing beyond that size. How big is too big?

Some segments of the market want larger displays, but still in a notebook configuration, which has fueled packaging advances that make the non-active periphery of the display smaller and smaller. Integrating the panel and the enclosure, rather than installing a pre-built module with redundant structure, could narrow the bezel, cut a few millimeters off the thickness, and reduce weight.

Polysilicon looks attractive for the future because it offers less weight, high aperture ratio, and can integrate circuitry. Good reflectives are still at a contrast ratio of 10:1. They need to get better, but the idea of doing away with the backlight is very attractive.

Some important developments for system makers are not high tech. There are now bolt holes in the sides of the display, which eliminates the tabs that required wider bezels. This is what allows a 13.3-in. display to be put in an A4-sized laptop.

LVDS has become the dominant interface for new notebook panels, and has helped solve the EMI problem that was very troubling last year with the inclusion of bigger panels and faster processors.

What should we look for in the near future? Polysilicon drivers should start to appear in the last quarter of this year, said Knox, and people are wanting luminances higher than 70 or 100 nits. He would like to see panels that tell the system what they are and controllers that automatically adapt. This would allow notebook system makers to swap displays from different suppliers almost as easily as users of desktop systems now swap monitors. A wireless data link would also be nice, so the system maker would only have to hook up the power to the display.

Farther down the road, Knox would like to see the display double as a scanner, so road warriors could simply hold a page up to their notebook's screen to be read by the system.

Knox concluded his paper with his informal "Knox Awards to Industry" for display advances that have substantially improved notebook computers:

- DSTN and FSTN displays (Epson and Sharp). For the first time, displays looked more-or-less black and white instead of green and yellow.
- Fluorescent tubes 2–3 mm in diameter, which permitted portable computers to make the transition from "laptop" to "notebook."
- The Sharp 8.4-in. color TFT-LCD, which launched the TFT laptop computer.
- 3M brightness-enhancement film (BEF), which made laptops much more usable.
- The transition from 0.7- to 0.5-mm glass, which was important in making lighter notebook configurations.
- Multi-domain, in-plane switching, and other wide-angle electro-optic technologies.
- LVDS/PaneLink interfaces.
- 3M double-brightness-enhancement film (DBEF).

Motorola Flat Panel Display Division

Motorola showed several of these 5.1-in. high-voltage 6-bit-color QVGA prototypes, two of which were mounted in real airliner seatbacks. Unlike the display in this photo, those at DW '98 were showing bright and attractive video images.

Off Line

A spectacular display-manufacturing development of the last year was apparently not mentioned in the technical sessions at DW '98, although it has been clear to anyone who has shopped for a 15- or 17-in. monitor: prices have dropped precipitously. This was only possible because of sharp price reductions in CRTs, the result of a year of very hard work at CRT-manufacturing plants, as *ID* was told by Hsing-Yao (Jimmy) Chen, Senior Consultant at Chunghwa Picture Tubes of Taiwan. To calculate the price of a CRT, said Chen, subtract the dealer's mark-up on a CRT monitor; half of what's left is generally the price of the CRT. So, if the dealer mark-up on a $400 monitor is $50, the CRT cost is about $175. Chen also seconded Hsing Tuan's view that Taiwan will be a major LCD player.

Evening Panel Discussions

Two strong evening panels unfortunately competed with each other. In "Challenging a Dominant Product," moderator Chuck McLaughlin of the McLaughlin Consulting Group and his panel of experts discussed whether it is really possible for "a leapfrog technology" to leap over an entrenched technology with a dominant market share. The panelists included Tom Credelle (Director of Marketing, Motorola Flat Panel Display Division), Bob Duboc (COO, Candescent Technology), Charles Hoke (VP, Planar Standish), and Mark Willner (President of the recent start-up, Colorado Microdisplay).

Chuck began the session on a typically provocative note by asking when each of the panelists' companies would have a billion dollars in annual revenues. Credelle quipped that he was already part of a billion-dollar company, but went on to say that Motorola believed there was serious market potential for their FEDs and that they were developing displays for products that had not yet been envisioned.

Duboc reiterated that it was CTC's strategy to target high-volume applications that had drawn venture-capital money to the company. Hoke said Planar-Standish's goal was to grow their revenues 20% every year. (At that rate, they would make money in the FPD business, but it would take a while for them to get from their 1997 revenues of $120 million to $1 billion.)

Willner commented that if someone does not plan for a new business to reach at least $100 million in revenues, it's not worth the effort to build it. His company's strategy is to continuously develop innovative technologies to leverage the U.S. semiconductor-manufacturing infrastructure and to work closely with customers to develop new applications for microdisplays.

The audience did not hesitate to follow up the opening discussion with hard questions. Elliott Schlam asked how the FED manufacturers thought that they would make any progress competing against well-entrenched TFT displays. The predictable answer was that outside of laptop computers, TFTs are often a compromise technology and that the FED's superior performance and lower costs would create opportunities for the technology to thrive. Credelle commented that the auto industry is especially interested in FEDs because of their ability to perform over a very wide temperature range.

The evening ended with a question from Tom Striegler, formerly a marketing executive at Samsung and now an industry consultant. He asked whether FED manufacturers could learn any lessons from Apple's decision not to

license its technology, and whether a more open licensing strategy among FED companies would help build the FED industry. Beyond the comment that hardware is different from software, Striegler's question remained unresolved: a point to reflect on until Display Works 99.

The second evening panel was the second annual "Rugged Displays Roundtable," which drew about 70 people, virtually none of whom left early. The panelists were J. Norman Bardsley of USDC, Ken Mahdi of Computing Devices Canada, Richard Van Atta of the Institute for Defense Analyses, and Roger Ellis of Korry Electronics. One focus of the meeting was to address and expand upon Van Atta's DoD-sponsored study of whether commercial off-the-shelf (COTS) or custom displays are better for military applications.

In his introductory comments, Bardsley commented that the military display business will amount to about a billion dollars over the next 10 years, which is attractive. The difficulty is that it will take perhaps $300 million of investment to get to the point of manufacturing for it.

What are the technical issues involved in meeting military needs? As far as custom and COTS displays are concerned, Van Atta put the question this way: "What 'requirements' require custom FPDs?" Dealing with shock and vibration provides an example of the contrasting approaches. The ruggedizer of a COTS display will use a mounting that cushions the LC cells and will install vibration-resistant connectors. The custom display maker, who is designing and assembling the display from scratch, also has the freedom to use high-strength seals, optimized spacers, and special metal and glass treatments. A member of the audience noted that when large LCDs are used in helicopters or turboprop aircraft they can wash out if the mechanical resonance of the panel is in the operational frequency range. (The "washing out" takes the form of white, cloudlike features in the case of a normally white display.) The solution rests in moving the resonant frequency by stiffening the panel, *etc.*

To extend the operating range of an LCD down to lower temperatures, a ruggedizer might add an ITO layer to serve as a heater, but when applied to the front plate such a heater reduces transparency and increases reflectance. A custom display maker has the option of using special LC materials to extend the operating-temperature range both down and up.

For more luminance, ruggedizers can always add a brighter backlight (but too hot a backlight can damage other components and reduce MTBF), or they can add a brightness-enhancement film. A custom maker can optimize the pixel structure (go to a quad structure, for instance) or push the aperture ratio (but commercial display makers are becoming very good at this).

Ellis observed that the most important issue for military buyers is often not whether the display is ruggedized COTS or custom, but whether long-term support is available from the vendor.

Van Atta added that it may be too late for thoughtful consideration of where COTS or custom is the preferred solution. Many service budgets have been so sharply limited that program managers are being told, "Buy COTS and do the best you can with it." Buying a unique system often just isn't possible, Van Atta said, but obtaining replacements down the line or re-engineering the system for a newer display are non-recurring engineering costs that are usually not budgeted.

From the audience: "One solution is for us to provide the system with an electrical/mechanical interface so that we can provide new commercial displays having this interface and it will look the same to the system. But this will require budgeting for the refit and the periodic interface development."

Van Atta: "COTS isn't free."

The Rugged Displays Roundtable engaged a wide range of stakeholders in military display systems and the platforms that use them. The event is now regarded by the organizers as a valuable and regular component of Display Works and will be repeated next year.

Walking the Show Floor

Although the Display Works trade show focuses on materials and manufacturing and test equipment, there was a decent scattering of display makers exhibiting their wares. We'll provide a fairly complete survey of the display makers who exhibited at DW '98 and a suggestive but very incomplete sampling of the equipment and materials makers.

Most of the display makers were at least reasonably happy with the attention they received at the show. Perhaps the happiest was ***Motorola's Flat Panel Display Division*** (Tempe, Arizona), which was making the first public showing of its FEDs. The 5.1-in. high-voltage 6-bit-color QVGA prototypes are capable of an area white luminance of 250 nits, said marketing manager Barry Moehring.

Two of the prototypes were mounted in the backs of real airliner seats, and looked very good showing full-motion full-color video. (Local TV station Channel 36 seemed to find this intriguing, since its camera and crew spent more time in Motorola's booth than anywhere else.) Several observers commented that the images – Motorola's, not Channel 36's – provided a sensation of depth. The spacers were visible, and Moehring said the company was working on invisible spacers.

Motorola's Tom Credelle said engineering samples of these prototypes would be available in the second quarter of this year. Samples of the first product – a 5.6-in. display – will be available in Q3, with ramp-up in Q1 '99. Although Motorola's exhibit was perhaps the largest at DW '98, and seemed to have the heaviest traffic, company representatives declared it a modest effort and promised something more substantial at SID '98 in Anaheim.

dpiX also attracted a lot of attention with its beautiful Expression 100 19-in. 24-bit 150-nit 100:1-CR SXGA AMLCD. Samples are available now at slightly less than $10,000, said Connie Des Autels. The display had a startlingly wide viewing angle, with images still visible when the bezel started blocking the viewing angle – nearly 180°! Several dpiX representatives refused to discuss the wide-angle technology.

The display also has a fast optical response of $t_{on} + t_{off}$ equal to 13 msec, said Alan Lewis, following the show. Lewis is Manager of Display Engineering and Development at dpiX. The display is intended for "visual-computing professionals" and (in the Eagle 19 version) military users.

At Display Works, dpiX and Planar Advance announced a $1.35 million contract from Kaiser Electronics to develop an alternate source for the 6.25-in.-square AMLCD sub-assembly multipurpose control display (MPCD) used in the U.S. Navy's F/A-18 E/F aircraft.

OIS

OIS exhibited this full-custom 3ATI (2.4 × 2.4 in.) AMLCD module for avionics applications.

Plasmaco/Matsushita (Highland, New York) showed a 42-in. PDP with a 4:3 aspect ratio running a digital source with 525-line progressive scan and a 16:9 (852 × 480) PDP running a MUSE analog source. Swimming artifacts were more noticeable on the 16:9 display, which was attributed to the analog source and subsequent A/D conversion. The 4:3 had a "dark-room" CR of 200:1 and produced 300 nits before the 50% neutral-density filter absorbed half of it. Plasmaco has made prototypes that produce 450 nits, said Jane Birk. The handsome high-contrast displays drew crowds throughout most of the show.

Thomson Tubes Electroniques (Moirans, France) and ***Thomson Components and Tubes*** (Totowa, New Jersey) showed the latest iterations of their high-resolution (SXGA) rugged 19- and 24-in. PDP prototypes, which looked good and had only a few pixel defects. Production versions of both units will be available by the time you read this. Either unit costs $25,000 if you buy one, $18,200 if you buy 50. The 19-in. produces 80 nits with a power consumption of 180 W; the 24-in. produces 100 nits at 220 W. Thomson representative Leon Neisius said that potential air-traffic-control customers are expressing interest in the 24-in. but that most potential military customers are more interested in the 19-in. Thomson will sell both monitors and PDP modules to other monitor makers.

Mitsui Comtek Corp., acting as the sales channel for ***Sanyo*** LCDs, was showing STN displays from 3.9 to 15.0 in. Looking very nice, at viewing angles not too far from the perpendicular for the static spreadsheet displays being shown, was a 15-in. XGA monitor with 220-msec response time, 30:1 contrast ratio, and 150-nits luminance. The price for a module is about $700, and the price for a complete monitor is $1300–1500 in volume.

United Technologies Automotive (Dearborn, Michigan) teamed up with ***Planar Systems*** (Beaverton, Oregon) on a slick automotive instrument-cluster demonstrator using a Planar electroluminescent (EL) display that produced a contrast ratio of 2:1 in direct sunlight. The demonstrator consisted of a cluster in the dashboard and a small display in the steering-wheel hub used in conjunction with programmable control buttons. Auto companies, said a UT Automotive representative, are most interested in the smaller of the two displays (which is 4 × 1 in., the "1 DIN" size). Also shown was a Planar yellow EL with clear phosphors and ITO structure for "see-through" capability.

PixTech (Santa Clara, California) was showing its familiar green monochrome production FED and low-voltage color prototype. The medical market likes the monochrome unit, said marketing VP Tom Holzel, and sales are currently production-limited. Holzel said the company, which has championed the low-voltage approach to FEDs, is working on a 15-in. high-voltage color display "and hopes to show it shortly." He added that low voltage is the lowest-cost approach for FEDs, but it doesn't scale well above 10 in. Also coming is a 5.7-in. production color display with transparent cathode and greater than 200-nits luminance; engineering samples are expected in Q3.

OIS (Northville, Michigan) showed its 2.4 × 2.4-in. 3ATI avionics module, which produces over 100 fL, a non-operating 4 × 4-in. 5ATI module, a 5 × 5-in. module, a 10.4-in.-diagonal VGA with 6-bit color and over 100 fL, and its very nice new 6.25 × 6.25-in. module in Apache configuration.

Visual Environments (Fremont, California) was showing a clever autostereoscopic viewer that uses conjugate optics. The company is looking for hardware and software partners, said president Bob Simpson.

Manufacturing and Test Equipment, and Miscellaneous

Maureen McCracken of ***Ion Systems*** was delighting in telling electrostatic-discharge (ESD) horror stories, particularly because Ion produces a variety of air ionizers that neutralize static charges. Included were the AirForce™ Ionizing Blow-off Gun, the 5184 ceiling emitter that relies for its effectiveness on the gas flow of a laminar flow system, and ionizers designed for use inside processing

tools. Ion Systems ionizers are used by several manufacturers, including OIS, and they are used in processing tools made by KLA Tencor and Photon Dynamics.

Team Systems (Santa Clara, California) was happily showing the Astro VG823 250-MHz digital video generator: "More capable than the old 819 at half the price," said George Stoeppel (that brings the price to $7950). The VG827 is the only commercially available scope with dual analog and digital outputs, as well as LVDS, said Stoeppel, and the digital output can be switched between 3.3 and 5.0 V for CMOS and TTL; output goes up to 150-MHz analog and 75-MHz digital. Cost: $6950; $7500 with a control box. Also on display were two new ***Unigraf*** boards for turning a PC into a high-performance signal generator. The 530, the more capable of the two, works at up to 300 MHz and provides single-pixel resolution.

ELDIM (Caen, France) introduced its new tool called "Optiscope," which provides a direct computation of response time and flicker using normalization standards. A stand-alone version uses a photodiode. A version built in to ELDIM's EZContrast display-measurement system uses a photomultiplier tube and can quickly map flicker as a function of viewing angle. The only other way to do this, said ELDIM's Jean-Noel Curt, is with a goniometer, "which is a nightmare." By measuring the appropriate delay, it is also possible to use the Optiscope to check driver performance.

Ergotron (St. Paul, Minnesota) was showing one of its portable workstands for the medical, manufacturing, and – the company hopes – financial markets. The workstands mount various combinations of display, system unit, and keyboard on rugged arms that tilt, extend, and rotate. The whole assembly can be part of a wheeled stand or mounted to a wall or piece of large machinery. In addition to stands and arms, the company is now making brackets – which provide just tilt and rotation when the extension ability of an arm is not needed.

Gamma Scientific (San Diego, California), which bought Graseby Optronics last August, was showing Graseby's popular SLS 9400 colorimeter, as well as Gamma's own GS-1280 RadOMAcam spot spectroradiometer system.

LAM Research (Fremont, California) was featuring its new high-density low-pressure plasma-etch system with electrostatic clamping, which allows control of the substrate surface. Introduced about a year ago, the system is now taking market share, said Lam's Karl Heimer. The company had 11% of the total etch market for FPDs in 1997, said Heimer, is selling units in the U.S., Korea, and Taiwan, and is about to ship a unit to Japan. Units are being used to etch LCDs, PDPs, and FEDs.

Sopra (Acton, Massachusetts) was showing glass substrate on which 4 × 5-in. rectangles of polysilicon had been laser annealed in one shot. General Manager Jean-Claude Fouéré said that single-shot laser annealing appears to supply greater uniformity than row-scan laser annealing, and that the uniformity of the 4 × 5-in. areas on the sample substrate was 2–3% edge to edge. Because the single-shot method uses a smaller number of shots per substrate, there is less stress on the material and the laser has a longer life, he said. Installation is relatively quick. It is possible to run the first tests two weeks after the tool is delivered to a customer, Fouéré said.

Photo Research (Chatsworth, California) was showing its newest spectroradiometer, the PR705, which can be used either as a stand-alone system (it has its own 80486 microprocessor, floppy-disk drive, and printer) or hooked to a PC and used with the company's new and powerful SpectraWin software, which runs under Windows 95. There are six selectable circular apertures, from ⅛° to 2°, and optional custom slit apertures. At the smallest apertures, the system measures to a 2.5-nm bandwidth. The PR705 is far more sensitive than its predecessor, the PR704, being able to measure down to 0.001 fL.

The company was also showing its PR-9000 FPD tester, which is motorized and programmable. Product Manager Manjit Daniel was enthusiastic about the new VESA display-measurement standards, and said Photo Research would soon have VESA-compatible procedures embedded in software for the PR-9000.

Outgoing president Griff Resor and marketing manager Debbie Durgin were talking about interesting new technology at ***MRS*** (Chelmsford, Massachusetts). The Model 6700 PanelPrinter uses a new high-speed stage and accommodates substrates up to 650 × 830 mm. The company will beta test a machine for meter-sized glass in Q1 '99, and is currently in discussion with Asian manufacturers. The new machine is part of the joint USDC-EDIRAK project.

Hornell Automation (Twinsburg, Ohio) showed its combination LCD rubbing and dry-cleaning tool, the first in a series of processing modules that combine two functions. The dry-cleaning is done with an ultrasonic head with de-ionization. Particles that are dislodged by the ultrasonics are sucked up with high vacuum. Cleaning efficiency is 99.7% down to 1 μm. The chucks for the substrate and the roller are both rotatable for even rub-wheel wear as well as even rubbing.

The second combination tool in the series, a brand-new bake-and-fill module, was introduced at the show. It is the first machine that allows one set of cells to bake and another to fill at the same time, said Hornell President Dale Pfriem. The new module generated very favorable comment at the show, said Pfriem. ■

17 NOVEMBER 98

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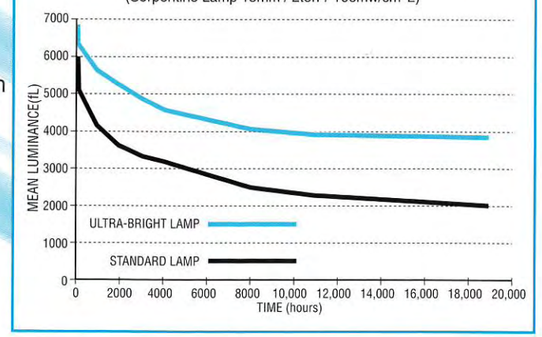

ULTRA-BRIGHT™ vs. STANDARD LAMP MAINTENANCE

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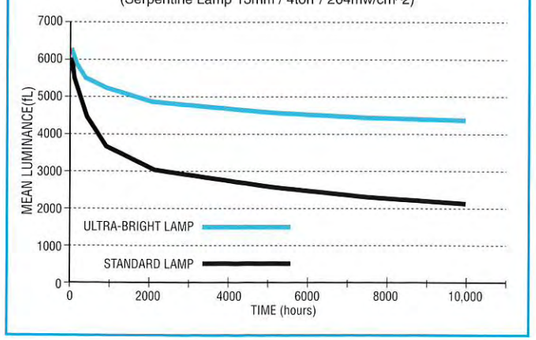

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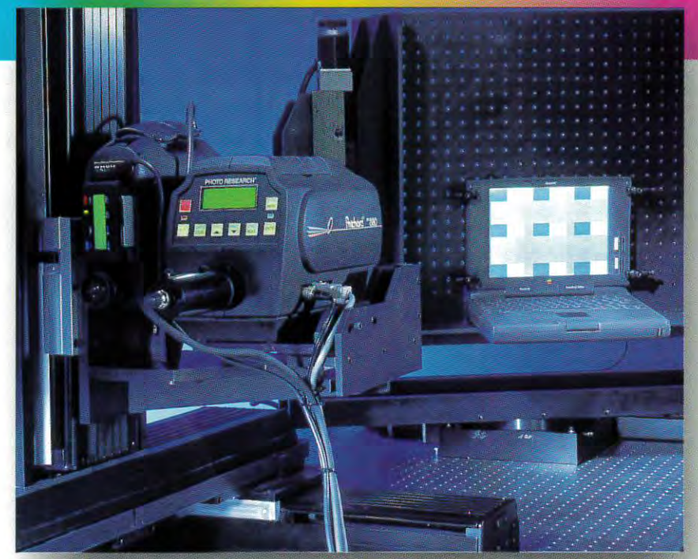
Any way you look at it...



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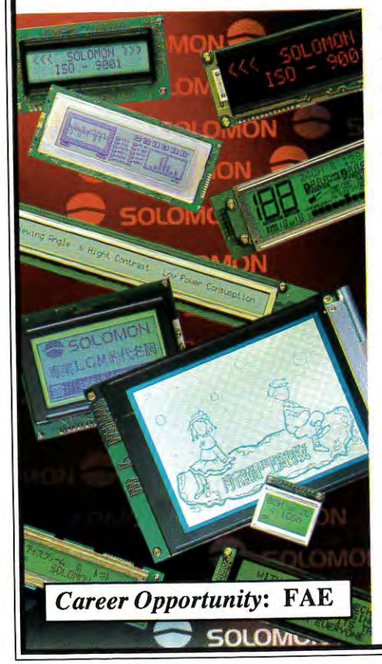

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Circle no. 113

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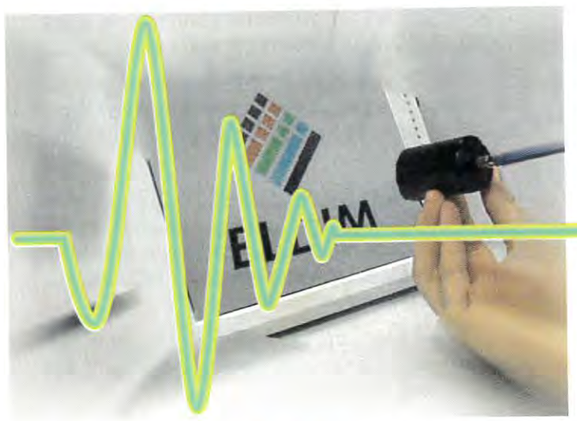

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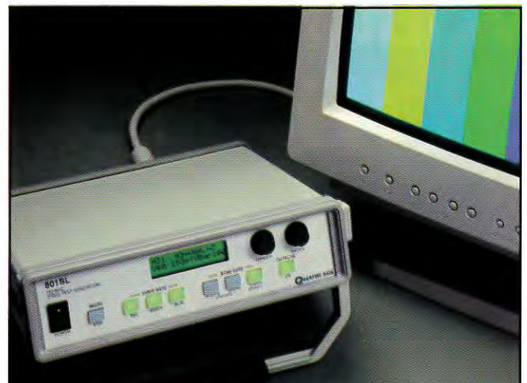

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See Us at SID '98 Booth 300

Circle no. 116

Products on Display at SID '98

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

by The Editorial Staff

The SID '98 International Symposium, Seminar & Exhibition *will be held at the Anaheim Convention Center in Anaheim, California, the week of May 17. For 3 days, May 19–21, 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.*

AKZO NOBEL
Arnhem, The Netherlands +31-26-366-3024
Booth 819

Retarders

Akzo Nobel will introduce Twistar™, a retarder that provides temperature-matched compensation for STN-LCDs. The retarder is based on a side-chain liquid-crystalline polymer, coated on a plastic substrate and subsequently laminated with a commercially available polarizer. Twistar is especially suitable for outdoor applications, such as automotive and cellular phones, and for PDAs and notebook computers. Retarder values up to 2000 nm are possible, making Twistar retarders ideal for ECB displays.
Circle no. 1

AMERICAN HIGH VOLTAGE
El Cajon, CA 619/258-5804
Booth 156

High-voltage power supplies

American High Voltage will introduce the Millenium™ 2000 Series of high-voltage power supplies, featuring a thickness of only 5 mm, the thickness of a floppy disc. The power supply operates up to 7500 V at a rated output power of 10 W. The standard input voltage is 3.3 Vdc, with other voltages available. There are five standard power levels, five standard output voltages, and six standard input voltage options, all in five standard case sizes.

Circle no. 2

APPLIED DATA SYSTEMS
Columbia, MD 301/490-4007
Booth 754

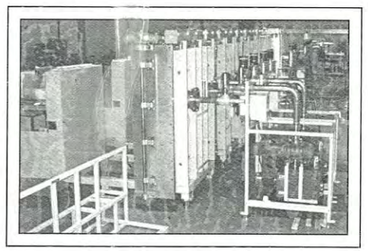
Dual-scan FPD driver

Applied Data Systems will feature the FlatPanel-Direct™ Passive Palette, an external analog converter card that drives passive (dual-scan) flat panels. A passive LCD coupled with the Passive Palette results in a product competitive with active LCDs and CRTs. The Passive Palette will maintain the price advantage that passive displays have over active panels. Features include a passive color depth of 8 bits, positioning, automatic resolution detection, and automatic bordering for lower resolutions. The Passive Palette is priced as low as $230.
Circle no. 3

APPLIED FILMS CORP.
Boulder, CO 303/581-5444
Booth 452

Sputtering equipment and thin-film coatings

Applied Films offers in-line sputtering equipment and thin-film coatings to the flat-panel industry, and supplies SiO_2 and ITO-coated glass substrates to the LCD industry worldwide. The company's conductive coatings and sputtering systems are used in other markets, including the plasma, electroluminescent, field-emission, organic-LED, and electrochromic industries.



Circle no. 4

ARITHMOS
Santa Clara, CA 408/982-4490
Booth 834

Flat-panel-monitor semiconductor products

Arithmos will feature the ADE100 and ADE200, highly integrated Display Engine™ semiconductor products that enable OEMs to deliver low-cost LCD monitors. The Display Engine products incorporate the graphics subsystem, signal processing, and interface functions that are required to drive high-performance passive-matrix STN-LCD panels in

desktop-monitor applications. The PerfectColor™ Algorithm, providing true color performance while eliminating traditional passive-matrix artifacts, is incorporated into the ADE100/200.

Circle no. 5

ASTRA PRODUCTS
Baldwin, NY 516/223-7500
Booth 144

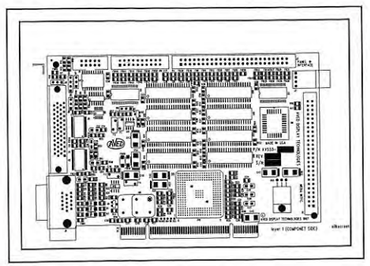
Edge-lighting panels

Astra Products will feature Clarex HSOT panels for edge-lighting applications. HSOT panels convert the incident beam into a very homogeneous illumination, yielding a 50% increase in luminance while eliminating the need for conventional diffuser film or printed dots.
Circle no. 6

AVED DISPLAY TECHNOLOGIES
Tustin, CA 714/573-5035
Booth 354

Subsystem controller

AVED Display Technologies will introduce the AV555-PCI-LVDS, a high-performance PCI flat-panel subsystem controller for industrial-control and LCD-monitor applications. The controller supports local digital and remote LVDS flat-panel interfaces, as well as CRT interfaces, simultaneously.



Circle no. 7

BOC COATING TECHNOLOGY
Fairfield, CA 707/423-2608
Booth 141

Cluster tool

BOC Coating Technology will feature the TEMESCAL Model FCE-7000 modular cluster tool that uses sequential-layer electron-beam evaporation for high-volume FED flat-panel deposition. The system processes panels up to 600 × 720 mm and can be configured for sizes up to 1 × 1 m. The throughput ranges from 10 to 65 panels per hour, depending upon the process, providing the lowest cost of ownership available.

Circle no. 8

BOC EDWARDS VACUUM TECHNOLOGY
Wilmington, MA 978/658-5410
Booth 641

Gas reactor column

BOC Edwards Vacuum Technology will demonstrate its gas reactor column, an active dry scrubber that removes and renders harmless toxic gas exhaust from all metal, oxide, and poly etch processes without generating hazardous waste. The Thermal Processing Unit (TPU) has demonstrated a greater than 95% DRE for C_2F_6 and CF_4 without adding other hazardous gases such as NO_x to the exhaust stream. The TPU is the only third-party verified device for abating PFCs.

Circle no. 9

BREAULT RESEARCH ORGANIZATION
Tucson, AZ 1-800-882-5085
Booth 358

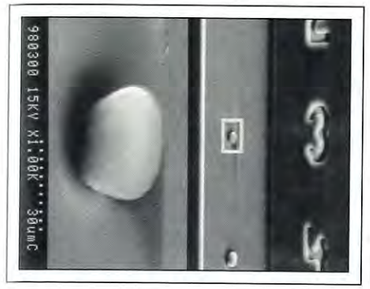
Illumination software

Breault Research Organization will feature the Advanced Systems Analysis Program (ASAP), an illumination software program with a comprehensive source modeling capability for serpentine fluorescents, LEDs, polychromatic volumetric emission from arc lamps, etc. ASAP handles micro-optics for backlit displays, complex dichromics for projectors, as well as polarization and scattering effects. Its non-sequential ray-tracing algorithm is one of the fastest on the market.
Circle no. 10

BREWER SCIENCE
Rolla, MO 573/364-0300
Booth 441

RGB color filter

Brewer Science will demonstrate a new directly photoimageable color-filter resin system. The colors currently available are high-saturation red, green, and blue. These color resins are capable of high resolution with nearly vertical sidewalls and offer a wide process latitude.

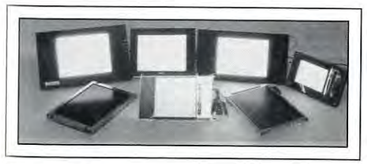


Circle no. 11

BRITEVIEW TECHNOLOGIES
Holland, OH 419/868-7290
Booth 627

Backlighting systems

Briteview Technologies will feature flat-collimator-based backlighting systems, including a highly collimated backlighting system, an extremely high-brightness backlighting system using stacked-light-pipe technology, a dual-mode (day/night vision) backlighting system, and a backlighting system with wide viewing angle in the horizontal direction. Also featured will be an efficient and uniform backlighting system and a frontlighting system using LEDs as the light source.

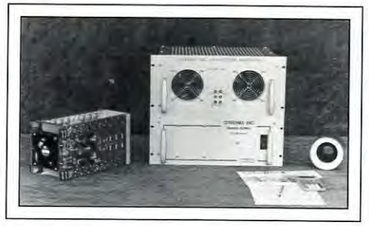


Circle no. 12

CITRONIX
Carmichael, CA 916/489-9858
Booth 417

Power FET deflection amplifier

Citronix will introduce the CD-100-6FT POWER FET deflection amplifier that magnetically deflects the electron beam in a CRT. The amplifier provides the CRT projection industry with a low-cost deflection amplifier capable of calligraphic and raster operation. The design exploits the greater power dissipation of proven N- and P-channel power FETs. This new design is superior in performance to the CD-100-6 deflection amplifier, and at a greatly reduced price.



Circle no. 13

CLARITY VISUAL SYSTEMS
Wilsonville, OR 503/570-0700
Booth 733

LCD projection displays

Clarity Video Systems will feature the VideoBanner® and VideoWall LCD projection-display systems that provide brilliant flicker-free images on screen sizes of 40 and 52 in., with resolutions as high as 800 × 600 pixels. Extremely wide viewing angles, optimum contrast, stability, and high reliability are hallmarks of these displays, which emit brightness in excess of 200 fL in the most demanding high-ambient-light environments.

Circle no. 14

CLINTON ELECTRONICS
Rockford, IL 61111
Booth 400

Medical displays

Clinton Electronics, with its Orwin Associates Division, will exhibit a full line of medical displays with microprocessor controls, from 1.5 to 5 million pixels in landscape and portrait format to meet the performance needs of clinical to diagnostic imaging. Featured will be the high-brightness 17- and 21-in. color units with contrast-enhancing filters that achieve 2× the light output of commercial units.

Circle no. 15

COLORADO MICRODISPLAY
Boulder, CO 303/546-9700
Booth 336

Miniature-display evaluation kit

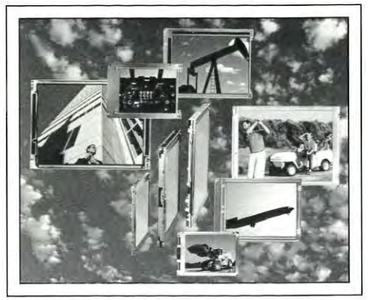
Colorado Microdisplay will provide OEM evaluation kits for a new miniature information display (0.47-in./1.2-cm diagonal) that delivers low-power full-color high-resolution SVGA output. The kit contains the system interface unit, headset, software, and documentation. The kit is available to develop products for industrial applications, personal computing systems, and portable entertainment products.

Circle no. 16

COMPUTER DYNAMICS
Greenville, SC 864/627-8800
Booth 238

Sunlight-readable color TFT-LCDs

Computer Dynamics will feature a line of fully integrated, tested, and warranted color flat-panel assemblies, incorporating high-efficiency backlights to 1600 nits and dimming inverters. Ultra-HiBrite panels are available in six sizes ranging from 6.4 to 15.1 in. and are virtually no thicker than standard LCDs.

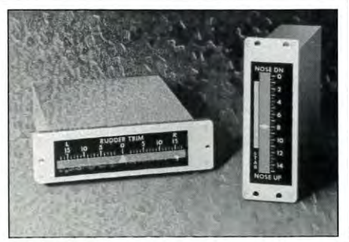


Circle no. 17

CRYSTALOID ELECTRONICS CO.
Hudson, OH 216/655-2429
Booth 554

Custom-designed displays and modules

Crystaloid produces thousands of high-quality, reliable display designs for even the most demanding applications, from prototyping to production runs as large as 100,000+ units. Display-technology types include twisted-nematic, supertwisted-nematic, dichroic, and Reverse Contrast Twisted Nematic™ white-on-black displays known for their low cost and rugged durability. Crystaloid recently became the first domestic LCD company to receive ISO-9001 certification.



Circle no. 18

CRYSTAL VISIONS TECHNOLOGY
Costa Mesa, CA 714/642-4800
Booth 556

High performance at a reasonable price

Crystal Visions Technology, Costa Mesa, California, will feature the Sapphire SA-10 10.4-in. VGA resolution (640 × 480) active-matrix LCD, a high-performance LCD at a reasonable price. The Sapphire offers a high contrast ratio of 300:1 and a high bright, 270 nits, LCD for better performance than typical LCDs and CRTs. The sturdy aluminum case and sealed glass face provide protection against dirt and moisture making the Sapphire the ideal choice for a wide variety of applications. A five-wire resistive touch-screen option with a standard RS-232 serial connection is available as well. Prices begin at $1595.00 for the SA-10 available in May 1998.

Circle no. 19

CTX OPTO
Sunnyvale, CA 408/541-6060
Booth 832

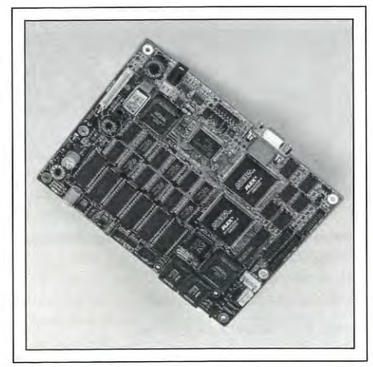
TFT resistive touch screen

CTX Opto will feature the PanoView 630T, a 12.1-in. flat-panel monitor with touch-screen capability. The resistive touch screen allows for high touch resolution and high clarity, and it works with any stylus. The monitor provides true SVGA 800 × 600 resolution, direct analog RGB input, a tilt steel base, and a replaceable backlight. The PanoView 630T delivers 200-nit brightness for viewing ease, flicker-free images to avoid eyestrain, and generates virtually no emissions.

Circle no. 20

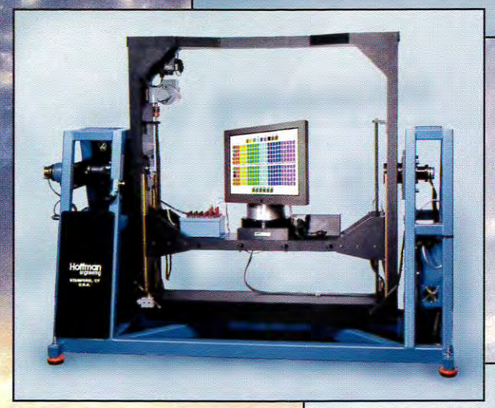
DIGITAL VIEW
Morgan Hill, CA 408/782-7773
Booth 409

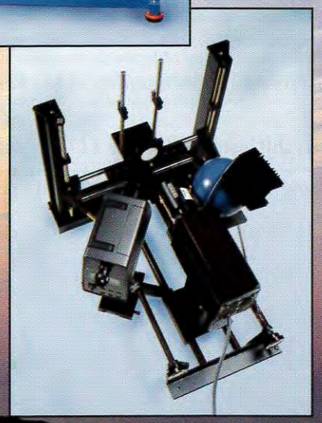
Digital View will be exhibit the AC-1024, a new member of its broad line of FPD controllers. The controller, with NTSC and PAL video-input options, is offered as a complete kit. Specifications include TFT or DSTN panel types; VGA, SVGA, and XGA resolution; PC, Sun, or MAC compatibility; ARGB, composite-sync, or sync-on-green signal compatibility; NTSC or PAL video input; a maximum refresh rate of 85 Hz; a color level of 3 × 8 bits (16.7 m); on-screen display; and image expansion. Availability is from stock.



Circle no. 21

Hoffman engineering





AT HOFFMAN ENGINEERING, we know light. We simulate it and detect it. We filter it and focus it; bend, project and analyze it. We design, build, test and calibrate equipment to measure it.

Accurate light and energy data is critical to the success of any lighting project. We combine mechanical and electro-optical skills to provide flat panel display manufacturers the gonio-photometric resources to completely analyze today's advanced displays with confidence. Hoffman's photometric test and contrast measurement systems support automotive, aerospace and display equipment manufacturers – industries where precision lighting measurement is essential.

As a recognized leader in lighting standards, integrating spheres and test equipment, Hoffman's extensive experience and philosophy of personal service has given us a well deserved reputation for electro-optical engineering excellence.

Our mission is to design and produce the next generation of test and measurement equipment. ***With over 40 years of experience in photometric and radiometric technology, we accept that challenge with confidence.***

Where innovation comes to light

See Us at SID '98 Booth 653

8 Riverbend Drive · P.O. Box 4430 · Stamford, CT 06907-0430
TEL: (203) 425-8900 · FAX: (203) 425-8910
EMAIL: sales@hoffmanengineering.com · www.hoffmanengineering.com

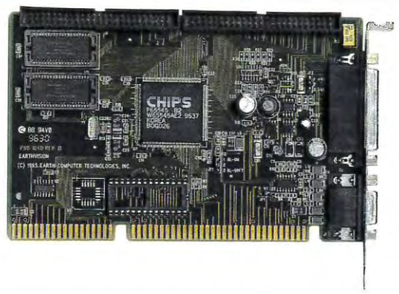
Circle no. 119

Making Yesterday's Flat Panel Today's Solution

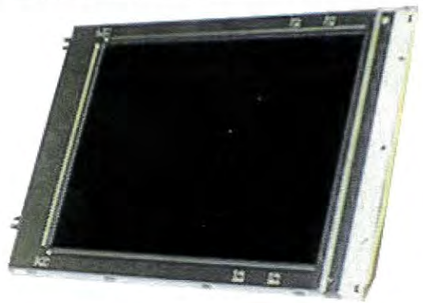
From the World Leader in Flat Panel Recycling

Three years ago Earth set out with a vision to recycle the left over displays from the world's largest producers of notebook computers. Today Earth Computer Technologies has the largest flat panel LCD inventory in the world (150,000 LCD's spanning 340 models). Whether you're looking for prototype, concept or small production of low cost LCD solutions we are the one stop shop. We give surplus LCD's new life with our ISA, P.C.I., PC-104, VGA Input & NTSC LCD controllers. Our new NTSC & VGA monitors provide solutions for embedded or mobile PC applications. Earth's recycling has seen Epson notebook displays end up in medical imaging machines and Apple's displays from California made by Toshiba in Japan on drive testers in Singapore at Western Digital. Earth's price points have spawned new applications that are ready to go when the display industry prices catch up. Major display users have been able to continue to support their product because Earth had the hard to find display they required. When OEM's use Earth to buy their left over displays they know they are being put to good use. Earth customers and vendors alike have all benefitted because of our success in recycling the surplus of the flat panel industry. Give us a chance to demonstrate to you our commitment to value and service.

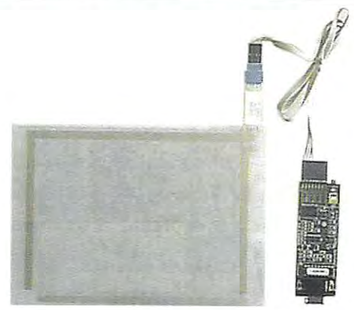
LCD Controllers



LCD Displays



LCD Touch Screens



LCD Monitors

Get our current catalog on the web at ***http://www.flat-panel.com***

EARTH Computer Technologies

1110 Calle Cordillera
San Clemente, CA 92673
Ph: (949) 361-2333
Fax: (949) 361-2121
Email: lcd_king@ix.netcom.com

$$ CASH FOR YOUR EXCESS DISPLAYS $$

See Us at SID '98 Booth 618

Circle no. 120

dpiX
Palo Alto, CA 650/842-9890
Booth 717

Two-page multimedia FPD

dpiX will feature the Expression 100, a 19-in.-diagonal AMLCD that delivers crisp, photorealistic images and full-motion video. With workstation-class SXGA resolution (1280 × 1024 color groups) and an extended color gamut, the display offers unparalleled color performance for bright high-contrast 24-bit photorealistic imagery. The Expression 100 incorporates proprietary technologies to achieve a very wide viewing angle without compromising video rates, as well as a digital data path for optimum signal fidelity.

Circle no. 22

DUPONT COMPANY
Wilmington, DE 302/992-2338
Booth 727

New FPD materials

DuPont will exhibit new materials for the FPD industry, including two new photopolymer-based materials. Fodel® photoprintable Silver and Black Electrode materials are used for the front and back panels of plasma display panels (PDPs) and other emissive displays. Fodel electrodes are compatible with SnO_2 or ITO-coated glass substrates, employing low-temperature firing (540–580°C). The materials are capable of 30-µm line resolution, have high conductivity (less than 10 mΩ/❑), and use environmentally friendly aqueous processing. When used on the front panels of emissive displays, Fodel® black electrodes improve display contrast.

Circle no. 23

EARTH COMPUTER TECHNOLOGIES
San Clemente, CA 714/361-2333
Booth 618

Industrial TFT monitors

Earth Computer Technologies will exhibit its Earth Vue/Mobile series of industrial VGA LCD monitors for the growing global positioning system (GPS) market and on-board computers for airplanes and automobiles. The VGA monitors run on 12 V and accept standard VGA input from a notebook or industry-standard PC. Featuring a 500-nit sunlight-readable backlight, the Earth Vue/Mobile is ideal for automotive applications. The compact unit features a Sharp 8.4-in. TFT-AMLCD and a backlight from Landmark with extended dimming control. Various mounting options are available. For only $1295, it is the lowest cost monitor in its class.
Circle no. 24

ELDEC CORP.
Lynnwood, WA 425/483-7719
Booth 260

Dimmable backlight drivers

ELDEC Corp. will feature backlight drivers designed for AMLCD applications requiring high-dimming capabilities. With a dimming capability of greater than 20,000:1, these backlight drivers enable readability in almost any ambient lighting condition from sunlight to NVIS. The drivers are compatible with both tubular and flat lamps and cold- and hot-cathode technologies. Unique features include low component count for miniature size and high reliability, low power consumption for improved thermal management, and low filament stress for long lamp life. The drivers can also be integrated with ELDEC low-voltage power supplies to provide a total display-system power solution.
Circle no. 25

ELDIM
Caen, France +33-2-31-94-76-00
Booth 536

Fully integrated LCD test system

ELDIM will introduce a fully integrated EZContrast System for the rapid automated testing of TFT-LCDs, STN-LCDs, and any other LCD panel up to 22 in. on the diagonal. The system performs luminance, contrast, and color-coordinates measurements as a function of viewing direction and temperature. Additional analysis for crosstalk, gray-level analysis, *etc.*, can be performed. The system includes XYZ tables, a climatic chamber, various illuminations, and suitable pattern-generator drivers.
Circle no. 26

EMCO ELECTRONICS
Charlotte, NC 704/571-3880
Booth 207

Sunlight-readable display

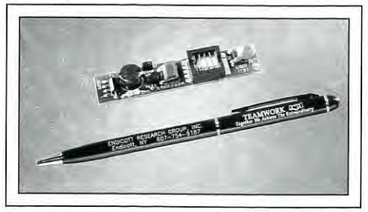
Emco Electronics will introduce their MITRA™ sunlight-readable displays designed for high-ambient-light environments. With a power consumption of only 26 W and a contrast ratio of 10:1, MITRA displays feature a uniform brightness of 1500 ft./nits, screen sizes from 6.5 to 12.1 in., and 16.8 million colors. MITRA displays are priced within 30% of standard panel prices and samples are available immediately.
Circle no. 27

ENDICOTT RESEARCH GROUP
Endicott, NY 1-800-215-5866 ext. 3011
Booth 342

Miniature inverter

Endicott Research Group will feature the S Series of dc to ac inverters. At less than 8 mm high, 16 mm wide, and 72 mm long, these new lightweight

miniature inverters can be specifically designed for any single-tube backlit LCD. Three dimming options are available: pulse-width-modulated controlled, resistive controlled, and voltage controlled. The S Series is application specific, featuring efficiencies as high as 90%, and offers a flexible system interface. The inverters are ideal for applications requiring the inverter to be mounted near the display, such as in gas-station pumps, video/internet telephone systems, and hand-held equipment. Pricing is $10 each in quantities of 1000, and they are available for immediate delivery.



Circle no. 28

FAS TECHNOLOGIES
Dallas, TX 214/553-9991 ext. 305
Booth 736

Coat, bake, and develop tool

Jointly developed by FAS Technologies and Tokyo Ohka Kogyo, the TOK TR Series Coat, Bake, and Develop System combines direct extrusion and conventional spin coating to precisely apply thin-film coatings of color filters, photoresists, polyimides, and other polymers onto the surface of large-area substrates, such as third-generation display glass. Moving over the substrate, the extrusion head applies the material before a brief spin cycle provides final uniformity. Material consumption is decreased by 75%, resulting in a significant decrease in production cost, and the decrease in required spin time provides higher throughput.

Circle no. 29

FRONTLINE SYSTEMS
Phoenix, AZ 1-800-767-9903
Booth 356

Restaurant drive-thru color LCD

Frontline Systems will demonstrate Order Perfect™, a Color Graphics Advantage restaurant drive-through or lobby-presentation color LCD with computer-downloadable graphics capability. The display features wide-viewing-angle flat-panel (3-in.-thick) technology and an ultrabright backlight (1000 nits) for optimum daylight readability. The Order Perfect™ operates on low dc voltage and offers NSTC and PAL video compatibility. Its ruggedized construction is engineered to withstand a 100% condensing-humidity environment. The display is a stand-alone unit or can be mounted into an existing menu board, walls, pedestals, counters, or lobby presentations. Order Perfect™ can be customized to meet specific graphics and promotional requirements.

Circle no. 30

FUJIPOLY AMERICA CORP.
Kenilworth, NJ 908/298-3850 ext. 208
Booth 845

Elastomeric connector

Fujipoly America will feature Silver Zebra high-performance elastomeric connectors, which demonstrate an extremely high-current-carrying capability of 700 mA. The silicone connectors are of rugged low-compression-force construction, consisting of alternating conductive and non-conductive layers with a 0.125-mm pitch. A wide range of sizes is available for most applications.

Circle no. 31

FUJITSU GENERAL AMERICA
Fairfield, NJ 973/575-0380
Booth 456

42-in. plasma display

Fujitsu General America will exhibit the Plasmavision 42EP 42-in. plasma display, featuring major improvements over the original. There is a higher contrast ratio (400:1 *vs.* 70:1); quieter, lower-speed fan operation (50 *vs.* 44 dB/m); new component video input capability; SVGA compatibility; and white balance adjustment. A monitor with a PC card slot can be ordered at additional cost, eliminating the need for the extra PC. Up to 85 MB of information can now be displayed. This stand-alone feature is suitable for models used as electronic posters, information displays, and in the presentation market.

Circle no. 32

IMT MASKEN UND TEILUNGEN AG
Greifensee, Switzerland
+41-1-944-2776
Booth 732

Large-format hard masks and mask substrates

IMT will feature large-format precision hard masks and mask substrates in chromium or iron oxide, designed for substrate sizes up to 600 × 800 mm (24 × 32 in.). The masks offer high dimensional accuracy, micron-precision resolution and positioning, excellent contour definition, low-reflection, scratch-resistant coating on the glass substrate, and lifetime in excess of 100,000 copies per mask.
Circle no. 33

INSTRUMENT SYSTEMS
Ottawa, Ontario, Canada, K2A 2E9
613/729-0614
Booth 630

Display test system

Instrument Systems will demonstrate the DTS140, a display test system featuring an array-based back-illuminated CCD spectroradiometer (the CAS140B). Configurable for many applications, the DTS140 will dramatically increase productivity due to its unrivaled sensitivity and versatility. Test accessories interface with the spectroradiometer via a calibration-retaining fiber-optic connection, resulting in easier switching between applications. The feature-packed software provides a built-in spreadsheet that can dynamically link with successive measurements, a built-in editor for creating custom report templates, on-line help files, and an easy menu-driven calibration procedure.

Circle no. 34

IPS AUTOMATION
Markham, Ontario, Canada 905/946-9831
Booth 206

Portable display inspection system

IPS Automation will feature the ADI 5200 QA, a hand-held portable display inspection system which combines multiple inspection tests in a single device: convergence, purity, beam profile, color and white balance, brightness, RGB intensity, and more. Multiple measurements at a single point take less than a second. Users are guided through the series of tests by the system's easy-to-use graphical interface, and all results are logged for reporting purposes. The system is perfectly suited for quality assurance and evaluation, compliance testing, factory servicing, and research and development of new products.

Circle no. 35

JACO ELECTRONICS
Hauppauge, NY 516/273-5500 ext. 3060
Booth 751

LCD-selling partnership

JACO Electronics acts as a master distributor for all LCD products, supplying the necessary components to VARs and systems integrators so that they can deliver complete solutions to the end customer. In an effort to build stronger relationships with VARs, resellers, and systems integrators, JACO Electronics has launched a new LCD-Selling Partnership VAR program offering deep discounts, a pass-through co-op, floor planning/leasing services, value-added services, a new LCD-technology sales and technical-support service with toll-free hotline, an exclusive registration program for VAR protection, and a program to demonstrate the application-specific advantages of LCD monitors.
Circle no. 36

KOPIN CORP.
Taunton, MA 508/824-6696
Booth 726

Ultra-portable information displays

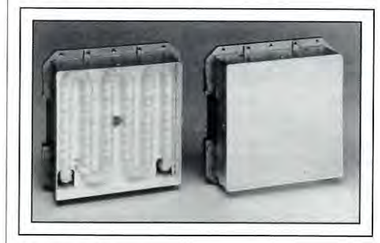
Kopin Corp. will feature their CyberDisplay line of small 0.24-in.-diagonal 320 × 240 monochrome and color AMLCDs that are the first such displays to meet all of the requirements of ultra-portable devices, such as the next generation of smart cellular telephones, pagers, PDAs, GPS systems, digital cameras, smart-card readers, toys, games, HMDs, and a host of other consumer devices. These low-power low-cost displays are currently available to OEMs. Also shown will be the new CyberDisplay 480, a half-VGA small-format display targeted at many of the same markets, but with twice the resolution.

Circle no. 37

KORRY ELECTRONICS CO.
Seattle, WA 1-800-257-8921
Booth 118

Night-vision-compatible backlights

Korry Electronics will feature night-vision-compatible backlights for AMLCDs. Designed for avionics cockpit applications, the backlights offer a wide dimming range and full sunlight readability. Korry's expertise in light-management optics means exceptional uniformity in luminance and color. Optional Nightshield® NVIS filtering provides high performance at reduced cost and is MIL-L-85762-compliant. Off-the-shelf military and commercial backlights are available in a variety of sizes.



Circle no. 38

LAMBDA PHYSIK
Ft. Lauderdale, FL 954/677-3665
Booth 822

Laser products

LAMBDA PHYSIK offers excimer lasers, UV optics, and complete systems for annealing TFT-

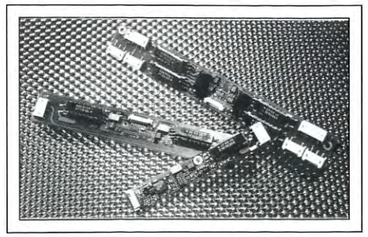
AMLCDs, laser microprocessing (as ITO structuring and repair), and for UV laser surface treatment, including laser cleaning. Laser products include excimer lasers up to 200-W stabilized output power, diode-pumped solid-state lasers, and tunable lasers. The system spectrum ranges from R&D systems to high-duty-cycle industrial tools with AMLCD load/unload stations and preheating systems in the vacuum chamber.

Circle no. 39

LINFINITY MICROELECTRONICS
Garden Grove, CA 714/372-8335
Booth 511

Backlight inverter

LinFinity Microelectronics will feature its new RangeMAX™ backlight inverter line offered in modules for single-, dual-, and quad-lamp LCD applications. The new inverters introduce direct-drive circuitry with a 2000:1 dimming range that saves power, extends lamp life, and provides reliability advantages over analog inverters for lighting LCDs.



Circle no. 40

LMT
Berlin, Germany +49-30-393-4028
Booth 212

Tristimulus colorimeters

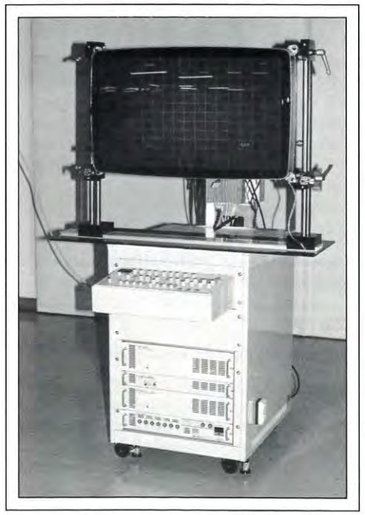
LMT will demonstrate their C 1210 and C 2210 tristimulus colorimeters that measure light sources and self-luminant objects such as flares, lamps, luminaires, VDUs, and CRTs. Because of their accuracy, fast measurement times, reliability, simplicity of operation, and minimum maintenance, LMT tristimulus colorimeters are unmatched in the industry.

Circle no. 41

MECC
Des Plaines, IL 847/827-4874
Booth 242

Universal drivers

MECC will exhibit the YAM-20 Series of universal drivers for CRTs, deflection yokes, TV sets, and computer monitors. Their high performance, reliability, and durability will meet the needs of any CRT, including super-high-resolution displays, digital TV, and HDTV.

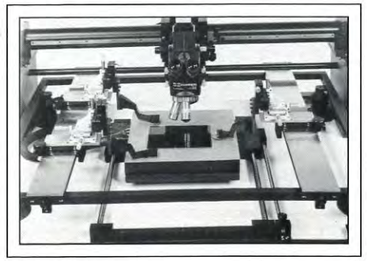


Circle no. 42

THE MICROMANIPULATOR CO.
Carson City, NV 702/882-2400
Booth 723

Probe station

The Micromanipulator Co. will feature the Model 2250 probe station, a large-area flat-panel tester for diagnostic probing on substrates or board-mounted delidded packaged devices. The system features two independent X-motion track-driven platens which permit faster probing because of the extra axis of control. The vibration-isolation air table and the massive microscope mount and boom assembly provide maximum stability. A full line of accessories includes thermal chucks, manipulators, probes, and measurement equipment for low-current and high-frequency testing.



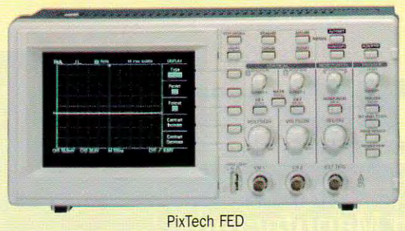
Circle no. 43

MICRONIC LASER SYSTEMS AB
Täby, Sweden +46-8-638-5200
Booth 655

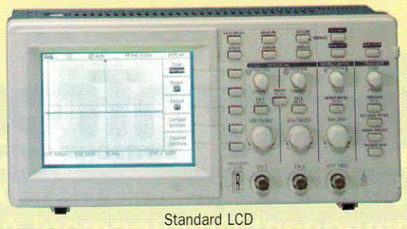
Next-generation laser writer

Micronic Laser Systems will feature Enterprise4, a next-generation laser writer with an advanced pattern-preparation unit based on a powerful Sun Solaris platform and highly advanced fracturing software. The system also includes enhanced tools for pattern inspection and analysis. The Enterprise4 increases productivity by speeding up sorting as much as 100 times.

Circle no. 44



PixTech FED

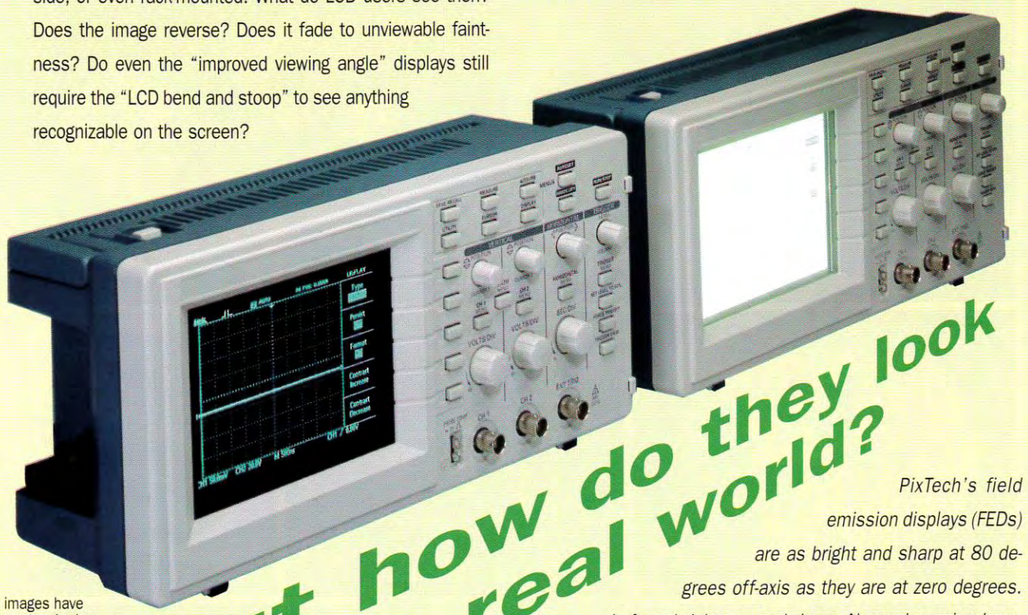


Standard LCD

Well sure, most LCDs look swell when viewed head on.

Ideally, users of your LCD-display equipment will have a head-on view, like a TV or lap-top computer. But, in the real world, they must often work with the instrument's display off to the side, or even rack-mounted. What do LCD users see then? Does the image reverse? Does it fade to unviewable faintness? Do even the "improved viewing angle" displays still require the "LCD bend and stoop" to see anything recognizable on the screen?

Consider the display user's visual task ... in real world applications. How easy (or difficult) is it for your customer to see what is on the screen of the instrument with *your* name on it?



Screen images have not been retouched or enhanced in any way.

But how do they look in the real world?

PixTech's field emission displays (FEDs) are as bright and sharp at 80 degrees off-axis as they are at zero degrees. Left and right; up and down. No neck-craning here. This clear, undiminished viewing angle makes working with PixTech FED displays much more user friendly and workplace-efficient. And lets you, the equipment manufacturer, get a real leg-up on the competition. So specify PixTech FEDs. Everyone (except chiropractors) will thank you for it.

PixTech

Flat panel displays for the real world.

3350 Scott Boulevard, Bldg. 37 ■ Santa Clara, CA 95054
(408) 986 8868 ■ Fax: (408) 986 9896
1 888 PIXTECH ■ www.pixtech.com

See Us at SID '98 Booth 831

Circle no. 123

What's New at Polaroid

- **"Durable KE" Polarizers –** The ideal product for displays requiring durability and reliability
- **Polatechno (of Japan) Polarizers –** Polaroid is now distributing Polatechno's complete line of polarizers
- **"LIFT" Holographic Reflectors –** Light Intensifying Film Technology "The brightest idea in the world for LCDs"
- **Anti-reflection Film –** Polaroid introduces a high-performing, low-cost, anti-reflection film
- **Circular & Linear Polarizers and Retarders –** Complete spectrum of polarizers available in a wide variety of colors, transmittances and formats

Visit us at Booth 601/603

Society for Information Display
Anaheim, California
May 19 – 21, 1998

www.polaroid.com
1-800-225-2770

Polaroid

Circle no. 124

MINOLTA
Ramsey, NJ 201/934-4642
Booth 408

CRT image analyzer

Minolta will introduce the CRT Image Analyzer IA-1000 which provides various adjustments items and inspection standards and requires only a single measurement to measure both misconvergence and geometry of the entire CRT screen using a single camera. Also on display will be the CB-150 focus meter, the CS-1000 radiometer, a complete line of CRT convergence meters

Circle no. 45

MITSUI COMTEK CORP.
Saratoga, CA 408/446-7818
Booth 137

TFT-LCDs

Mitsui Comtek Corp. will offer a range of Tottori Sanyo TFT-LCDs from 1/4-VGA modules up to 17-in. monitors. The TFT-LCDs are currently being used in a variety of products, such as PDAs, notebook computers, POS applications, kiosks, and stand-alone monitors, incorporating Tottori Sanyo's unique ASIC and analog or digital interfaces.

Circle no. 46

MOTOROLA FPD DIVISION
Tempe, AZ 602/755-5511
Booth 542

FEDs

Motorola's Flat Panel Display Division is committed to bringing field-emission-display (FED) technology to the electronics marketplace. Motorola FEDs offer bright and colorful pictures, wide viewing angles, high contrast, and extremely fast video refresh rates. In addition, they have low power requirements and maintain their excellent performance over a wide temperature range.

Circle no. 47

NANOMETRICS
Sunnyvale, CA 408/746-1600
Booth 157

Thin-film metrology tool

Nanometrics will feature the NanoSpec® 6500, a new thin-film metrology tool for FPD-production applications that accommodates glass panels up to 950 × 950 nm. The system allows film measurements to be made at pre-programmed locations and the generation of film-uniformity maps. Options include interfaces to automated factory substrate-transport systems and a robot for panel load and unload. The Model 6500 is the latest in a series of FPD metrology tools which have been developed in cooperation with leading FPD manufacturers in Japan and Korea.

Circle no. 48

NEOVAC
Santa Rose, CA 707/576-7496
Booth 142

ITO coatings

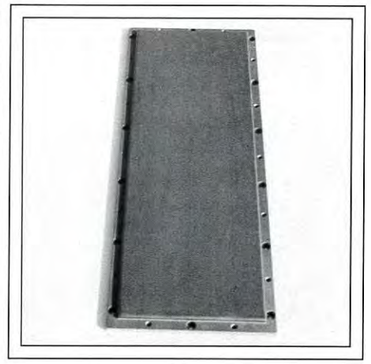
NeoVac offers a complete line of indium tin oxide (ITO) coatings deposited on polyester (PET) and a variety of other flexible webs. Standard ITO coatings are available on optical-grade, hard-coated, and heat-stabilized PET. Standard film thicknesses as well as other gauges are available. Coatings are available up to 660-mm-wide on 700-mm-wide substrates. Full service slitting is done in a Class 10,000 clean room.

Circle no. 49

NIMTEC
Chandler, AZ 602/732-9857
Booth 103

ITO targets

NIMTEC will feature Japan Energy ITO targets made of raw materials such as high-purity indium that are produced and supplied by other divisions of the company, resulting in consistent quality and stable supply. The ultra- and super-high-density targets are manufactured by a unique oxygen-sintering method. The targets feature excellent film properties and very low particle generation.



Circle no. 50

P.T.G. PRECISION TECHNOLOGY CENTER
Lake Mary, FL 407/804-1000
Booth 702

Glass cutting tools

PTG offers innovative low-debris glass-cutting tools using PTG's proprietary zero-width cutting technology (0WCT™). Existing test data shows that 0WCT™ produces enahnced product yield, radically

reduced debris, and provides increased efficiency when compared to traditional scribe and break technologies. The PTG Laser Line Series of thin-glass cutting machines provide a low-risk high-reward approach to improving any company's glass cutting capability.
Circle no. 51

PHOTO RESEARCH
Chatsworth, CA 818/341-5151 ext. 130
Booth 304

FPD inspection system

Photo Research will introduce the PR-9000, an inspection system that completely automates photometric and colorimetric testing of FPDs using ISO- and VESA-recommended procedures. The PR-9000 is a turnkey system with industry-standard instruments, five-axis goniometric motion, and display-under-test (DUT) control. The base system includes a PR-880 Pritchard® photometer to measure luminance, contrast, and chromaticity. A PR-650 or PR-705 can be added for color measurements if spectroradiometric accuracy is required. Custom DUT fixturing can be provided for testing both CRT and flat-panel displays of different sizes.
Circle no. 52

PIXELWORKS
Tualatin, OR 503/612-6700 ext. 240
Booth 801

Single-chip display controller

Pixelworks will introduce the PW364 ImageProcessor IC, the first complete flat-panel-display controller integrated on a single chip, which includes on-board frame-rate conversion, automatic image optimization, high-quality image scaling, and an on-board microprocessor. Applications include LCD monitors, plasma displays, rear-projection systems, and CRT-based displays.
Circle no. 53

PLASMACO
Highland, NY 914/883-6800
Booth 405

Large-area ac plasma displays

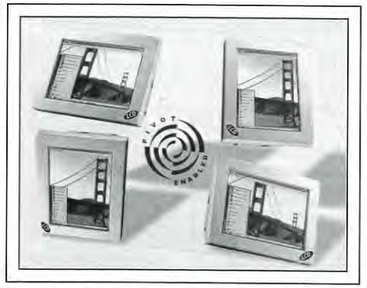
Plasmaco will exhibit 42-in.-diagonal color ac plasma displays with 4:3 and 6:9 aspect ratios. These panels can display 16.7 million colors with a bright, high-contrast image and a 160% viewing angle, the widest of any flat-panel technology.

Circle no. 54

PORTRAIT DISPLAYS
Pleasanton, CA 510/227-2700 ext. 222
Booth 100

Pivot displays

Portrait Displays will demonstrate Pivot® software, engineered to be compatible with the most popular graphics cards and operating systems and to allow users to rotate an LCD, CRT monitor, or tablet computer 90°, 180°, or 270° without restarting the active application or the computer. Pivot® Software, currently available for licensing, is comprised of WinPortrait™, for Windows 95® and Windows NT Workstation® 4.0, and MacPortrait™, for Mac/OS® System 7.1X to 8.X. With Pivot Enabled™ LCDs, documents in English, Japanese, French, German, and Spanish can be edited in both portrait and landscape mode.



Circle no. 55

PROTELEVISION TECHNOLOGIES
Mahwah, NJ 1-800-421-0888
Booth 708

CRT color analyzer

ProTeleVision Technologies will demonstrate the PM5639/00, a CRT color analyzer consisting of a color sensor, which can be placed directly on the CRT, and a display unit, which can be operated by one hand, leaving the other hand free to adjust the monitor. A rechargeable battery pack is built-in, allowing portability of the instrument.

Circle no. 56

RAYTHEON COMPANY
Quincy, MA 617/984-8227
Booth 404

Prototype 4-in. FED

Raytheon Quincy Operations will feature a prototype full-color 4-in.-square field-emission display (FED) designed for use in avionics and vehicular applications. Both 4- and 6-in.-square high-brightness FEDs in color and monochrome versions are being developed.

Circle no. 57

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

RORZE AUTOMATION, INC.
Milpitas, CA 408/935-9100
Booth 853

Dual-arm robot

Rorze Automation will exhibit a high-throughput dual-arm robot for handling large-scale glass. Ferrofluidic seals at all robot arm joints result in ultra-clean robot performance (zero particles at 0.1 μm). Rorze manufactures single- and dual-arm robots for atmospheric applications and single-arm and "Boomerang" robots for vacuum applications.

Circle no. 58

SAMSUNG ELECTRONICS
San Jose, CA 408/544-4122
Booth 200

30-in. UXGA TFT-LCD

Samsung Electronics will feature a 30-in. TFT-LCD that has an effective screen size of a regular 33-in. CRT. The LCD is just 4.5 cm thick, weighs only 7.5 kg, and operates on 45 W of power, one-fifth the power needed by a conventional CRT of equivalent size. The product offers UXGA picture quality, which amounts to 5.76 million pixels (1600 × 1200 pixels). The response time has been brought down to 40 msec or lower for excellent motion-picture reproduction and clarity.
Circle no. 59

SCHOTT FIBER OPTICS
Southbridge, MA 508/765-3250
Booth 600

FED spacer components

Schott Fiber Optics will exhibit novel glass spacer components for use in FED products. Several high-precision micro-configurations (posts, rails, and arrays) have been produced using high-volume fiber-optic manufacturing processes.
Circle no. 60

SILVER CLOUD MANUFACTURING
Millville, NJ 609/825-8900 ext. 201
Booth 857

Display filters and lenses

Silver Cloud Manufacturing will feature Durlan II™ display filters and lenses, designed to provide contrast enhancement, EMI/RFI shielding, and protection against scratches for most flat-panel and CRT displays. Durlan filters are available with hard-coated anti-glare surfaces and can include specialty materials such as polarizers and light-directional films. A/R coatings can be used for optimum light transmission. In addition, graphics can be integrated into the filter. Silver Cloud's CNC milling equipment is utilized to fabricate filters to custom shapes and configurations.

Circle no. 61

SOUTHWALL TECHNOLOGIES
Palo Alto, CA 650/962-9115 ext. 10340
Booth 255

Anti-reflection film

Southwall Technologies has introduced the ARA-50, a new absorbing type of anti-reflection film designed specifically for electronic display and television applications requiring reduced visible light transmission for contrast enhancement. The film features a reflection of 0.6%, a transmission of 50%, and an electrical conductivity of 200 Ω/❑. ARA-50 incorporates a PET substrate with a hard-coat for scratch resistance and a low-surface-energy coating on the AR film for low friction and ease of cleaning. The conductive coating meets TUV and TCO requirements. The film is available in roll and sheet form and can be provided with or without adhesive for lamination to a display surface.

Circle no. 62

TAMARACK SCIENTIFIC CO.
Anaheim, CA 714/632-5030
Booth 337

New lithography tools

Tamarack Scientific will exhibit its new Model 302 scanning projection system, one of a series of tools to expose panel sizes up to 840 × 1025 mm. System specifications include a resolution under 4 μm with large depth of focus, automated focusing, alignment and loading, and variable Hg-line selection for process flexibility. Tours to the local factory to view the larger Model 340 will be conducted at SID '98.

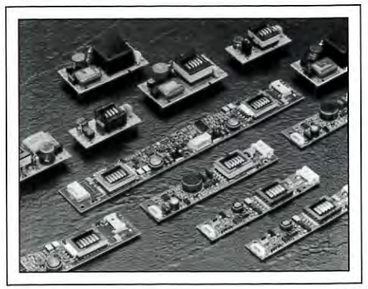
Circle no. 63

TDK CORPORATION OF AMERICA
Mt. Prospect, IL 847/390-4371
Booth 221

dc/ac inverters

TDK Corp. of America will feature the CXA series of inverters specifically developed for driving cold-

cathode fluorescent lamps (CCFLs). The series features high-frequency sine-wave oscillation with dimming functions for three methods of brightness control: resistive, voltage, and PWM. The CXA series is available in low-profile narrow-width compact packages for virtually every display application.

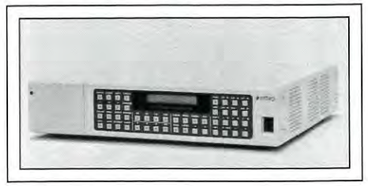


Circle no. 64

TEAM SYSTEMS
Santa Clara, CA 408/720-8877
Booth 327

Programmable video generator

TEAM Systems will introduce the ASTRO VG-851, a state-of-the-art programmable video generator that offers pixel frequencies up to 400 MHz and horizontal scanning up to 300 kHz with full 1-dot resolution. The VG-851 features memory cards for entering program data and storing many special patterns for specific applications, while accepting the EEPROM of all the earlier VG-800 Series of video generators. Up to 150 timing setups can be combined on the fly with 150 patterns at any time.



Circle no. 65

TELEDYNE LIGHTING & DISPLAY PRODUCTS
Hawthorne, CA 213/242-1900
Booth 211

Diffuse illuminators

Teledyne Lighting & Display Products will feature ALPHALIGHT™ diffuse illuminators for back, edge, and front lighting of non-emissive flat-panel displays. Also on display will be large-screen emissive display products, ranging from single pixels to complete display systems, and high-intensity lighting systems for a myriad of high-performance and rugged applications. All products employ advanced non-imaging optics that utilize total internal reflection (TIR) in their design.

Circle no. 66

THOMAS ELECTRONICS
Wayne, NJ 973/696-5200 ext. 310
Booth 317

Miniature monitors

Thomas Electronics will feature two high-resolution high-brightness miniature monitors. The 1-in. monitor provides 800 TV lines at a brightness of 1000 cd/m^2, and the 1.5-in. monitor provides 1000 TV lines at a brightness of 130 fL. Both monitors operate at 12 V with a power consumption of less than 3 W. The units weigh 4.00 and 5.20 oz., respectively. The typical input signal is 1.0-V peak-to-peak NTSC, with PAL available at no additional charge. These monitors are designed for miniature view finders and portable display applications.
Circle no. 67

THREE-FIVE SYSTEMS
Tempe, AZ 602/389-8815
Booth 150

Liquid-crystal–on–silicon microdisplay

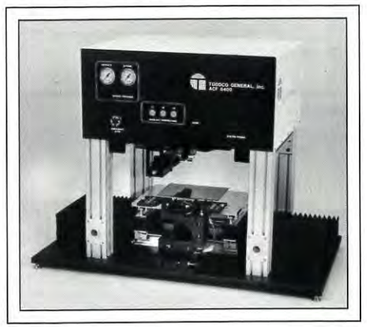
Three-Five Systems will introduce the LCoS™ (liquid-crystal–on–silicon) microdisplay, a tiny high-information-content display that delivers crystal clear resolution and high brightness in an area much smaller than a postage stamp. This reflective silicon-on-glass display, which operates in both projection or virtual modes, currently provides SVGA or SXGA resolution, a contrast ratio greater than 200:1, and the lowest cost per pixel of any display technology.

Circle no. 68

TODDCO GENERAL
Poway, CA 619/877-2100
Booth 507

FPD workstations

Toddco General will introduce the model 6800, the next generation in TAB bonders for flat-panel display rework and repair operations. The all-new bonder combines the best features of previous bonders (model 6400 shown in photo) into a single unit that can migrate from a low-volume manual rework station to a fully automated high-volume repair workstation. Industry-proven features include all-ceramic thermode, universal glass stage, and universal TAB fixtures that are combined with motion and software tools to enhance both quality and throughput.



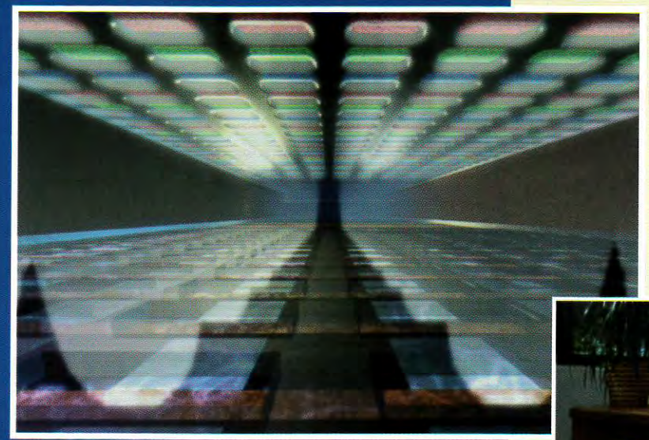
Circle no. 69

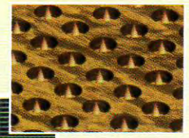
ULVAC TECHNOLOGIES
Methuen, MA 978/686-7550
Booth 737

OELD manufacturing equipment

ULVAC will feature SATELLA, the first manufacturing equipment used in the production of organic electroluminescent displays. SATELLA can handle

A Career Making Opportunity.





We are Candescent Technologies, a five-year old company with over 250 skilled employee-shareholders developing a revolutionary new flat panel display called the "Thin CRT." Thin CRTs embody what display engineers have envisioned for over 40 years: a 7mm thin, lightweight, ultra-low power CRT with an image quality that sets new industry standards. In addition to our breakthrough technology, we have gathered an exceptionally experienced management team, a set of powerful corporate allies such as Hewlett-Packard and broad financing (more than $230 million in committed capital so far) from blue chip investors and corporate partners. We are now preparing to become a major manufacturer of Thin CRTs for notebook computers, desktop monitors and handheld products. We offer a chance to help shape the future of our company and make an indelible mark on our industry. We're looking for world-class professionals in the following areas:

Screening Engineer
Lacquer Engineer
Test Process Engineer
Cathode Process Engineer
Test Equipment Engineer
AMHS Equipment Engineer
Vacuum Equipment Engineer

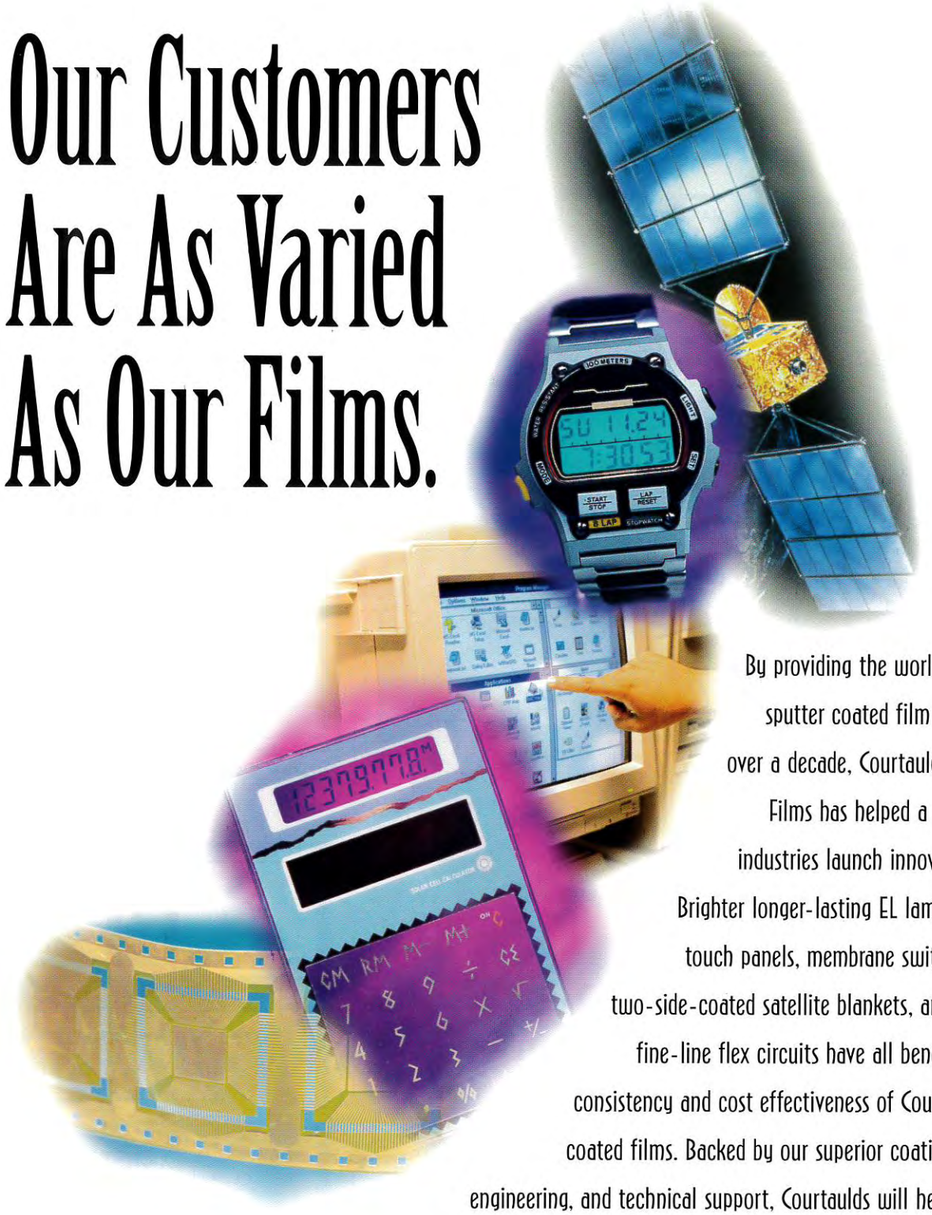
See a complete listing of these and other openings at the Anaheim Convention Center, Room B2, or anytime at: **www.candescent.com**

CANDESCENT

6320 San Ignacio Avenue, San Jose, CA 95119
e-mail: recruit@candescent.com
Fax 408.229.0664

Circle no. 129

Our Customers Are As Varied As Our Films.



By providing the world with the best sputter coated film technology for over a decade, Courtaulds Performance Films has helped a wide variety of industries launch innovative products. Brighter longer-lasting EL lamps, transparent touch panels, membrane switches, specialty two-side-coated satellite blankets, and miniaturized fine-line flex circuits have all benefited from the consistency and cost effectiveness of Courtaulds' sputter coated films. Backed by our superior coating technology, engineering, and technical support, Courtaulds will help you convert ideas into realities. So, no matter what the application, bring your ideas to Courtaulds. We have your film needs covered.

COURTAULDS PERFORMANCE FILMS

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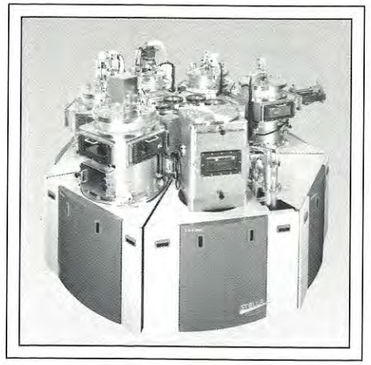
See Us at SID '98 Booth 841

Circle no. 130

glass substrates from 200 × 200 mm to a maximum of 400 × 400 mm and can integrate seven process modules around a core transfer chamber. Substrates are continually processed in vacuum chambers where cleaning, multilayer coating, and encapsulation are performed in order to prevent deterioration of the films due to oxidation or exposure to moisture.

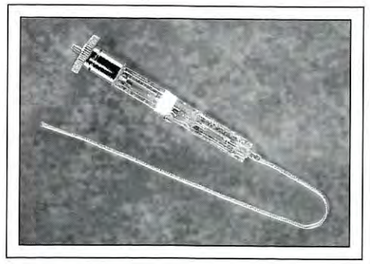


Circle no. 70

USHIO AMERICA
Cypress, CA 714/229-3147
Booth 108

dc metal-halide lamps

Ushio America will introduce the 125W dc metal-halide lamp, featuring a 1.0-mm arc gap and an average life of 5000 hours. The lamp is available mounted in a parabolic reflector or as a stand-alone burner and is designed for all etondu applications. Two other new dc metal-halide lamps, the 270W with a 1.5-mm arc gap and the 350W with a 2.0-mm arc gap, will also be on display. Both lamps are also available mounted in parabolic reflectors or as stand-alone burners and are ideal for use in all etondu applications.

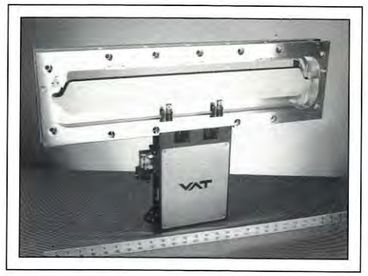


Circle no. 71

VAT, INC.
Woburn, MA 781/935-1446
Booth 241

Vacuum valves

VAT will exhibit a rectangular slit valve incorporating Monovat sealing technology and featuring shock-free and particle-free performance for up to 1 million cycles or better between maintenance, depending upon size and application. The valves are ideally suited for use on cluster tools for transfer between chambers and for load-lock applications during the manufacture of flat-panel displays.



Circle no. 72

VIRATEC THIN FILMS
Faribault, MN 507/334-0051
Booth 501

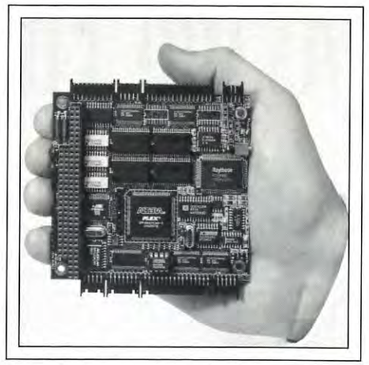
PDP filter

Viratec Thin Films will introduce Plasmar™, a plasma-display-panel filter for hang-on-the-wall TV. The lightweight, safety-laminated glass filter (3.8 mm thick) is comprised of multilayer, vacuum-deposited, conductive, anti-reflection coatings, and provides sharp imaging, contrast enhancement, EMI/RFI shielding, and IR transmission of less than 5% for uninterrupted remote-sensor operation. Plasmar™ filters are currently being produced in 21- and 42-in.-diagonal sizes. Custom sizes and silk-screening options are available.
Circle no. 73

WESTAR CORP.
Bridgeton, MO 314/298-8748 ext. 234
Booth 520

Modular electronics for FPDs

Westar will feature the new LCDcube™ modular electronics modules that can integrate AMLCDs into display systems. The palm-sized modules are PC/104 format cards that stack together to form a "cube" that is less than 4 in. on all sides. LCDcube modules perform all the video processing and control functions needed to drive AMLCDs. Westar VP1 and VP2 modules digitize signals from standard analog sources, providing output that is configurable and can directly drive commercial AMLCDs. Modules DD1 and RS1 control the timing and transport of all pixel information to the display head assembly.



Circle no. 74 ■

14 SEPTEMBER 98

Fourth International Conference on the Science and Technology of Display Phosphors

BEND, OREGON
SEPTEMBER 14–17, 1998

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

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continued from page 4

remember anyone mentioning in 1970 that a UNIVAC 1108 or an IBM 370 wasn't powerful enough or fast enough to be considered for implementation into a decent laptop computer.

On the other hand, television sets today look just about how we would have predicted, especially if we include the new plasma panels. Actually, in 1960 or 1970 we might have predicted even more – such as full-color 3-D.

All in all, the track record of technology predictions is pretty dismal. Well then, what makes me think I can do better? Certainly, I haven't been doing it for 50 years yet so I can't tell you how good a half-century prognosticator I'm going to be. But I have tried my hand at it for the last 20 years, and in reviewing my track record for looking ahead 10 years or thereabouts, my projections have turned out to be better than most – in other words, only a few embarrassing misses.

Would you still like to know what I think? OK then, I will first give you my conclusions regarding some of the more important display-related market segments, and then I will briefly explain how I arrived at my predictions. The topics that follow were written down as they came to mind with no particular intent to order or prioritize.

Electronic Photography

Just yesterday, I read an article in *Popular Photography* magazine comparing a typical 35mm-film-based camera with a new digital camera from the same manufacturer – Olympus. The conclusion was that the 35mm-film camera was still ahead in image quality but not by much. It was also gratifying to, at last, see a realistic resolution number of 800 lines being quoted for the 35mm-film camera, compared to the digital camera's 600 lines. As many of you know, for some time I have been on a campaign to undo the widespread misconception that 35mm photographs have 3000-line resolution. They don't and never did. And because of that, digital cameras are already good enough to compete with 35mm-film images in most popular picture sizes; and the added benefits of digital imaging are significant – instant editing, image manipulation, and image transmission, to name the more important ones.

There is only one remaining but surmountable obstacle holding back the avalanche of digital photography. And that is photo-quality printer technology. Photo-quality printers are about 2 years behind digital cameras but are catching up rapidly. Some already have the image quality but are too expensive for home or casual office use. The ones targeted for home use are not yet quite good enough. In the next two years, we should begin to see affordable photo-quality printers, and then the shift from film to digital will occur rather quickly. My prediction is that we will see the crossover in about 5 years, when over 50% of all photos taken will be with digital cameras.

For those of us in the display industry, this presents opportunities in small high-resolution displays for cameras, photo-quality printer technology in all shapes and sizes, and displays for showing the electronic photos in various home and business environments.

Wearable Electronics

In this category I include all such portable appliances as laptop computers, cell-phones, pagers, audio disk/tape players, new video digital tape and disk players, and global positioning equipment. I don't think any of you will be surprised with my prediction that this will be a major growth area over the next decade, especially if you read last September's column. The fundamental driving force is that we want our communications and entertainment to be location-independent: "I don't want to talk to your telephone, I want to talk to you." And of course this applies to visual information as well. The small- and medium-sized high-resolution displays already available, as well as those yet to be invented, will greatly facilitate all of these portable information appliances. It will be a great business opportunity for display makers.

Drive-Around (Automotive) Electronics

Is it really necessary to already be making phone calls with the car barely out of the driveway and with the garage door still closing? Having a cell-phone attached to one's ear while driving seems to be the "in thing" these days. We can expect that electronics and displays will make their biggest impact in cars over the next decade by facilitating the introduction of new features. These will be for such functions as position-location (mapping) systems, communications devices, and entertainment systems. Don't expect the traditional instrument cluster to undergo an electronic revolution anytime soon. The way an automobile, or pickup truck, looks hasn't changed all that much in the last 40 years, and there is no compelling reason to make a change now. This is a cost-driven business, and the traditional instrument cluster provides the right combination of attractive styling, functionality, and low cost. What would an electronic instrument-cluster display offer that is significantly better?

For airplanes, on the other hand, there was a major problem that could only be solved with electronic displays – we ran out of cockpit panel space for adding more gauges. Not only that, trying to add more was increasing maintenance costs and reducing reliability.

The Internet

It's amazing how quickly we have adapted to this new mode of communications and information retrieval. Last month, my column dealt with the four-step human-interaction process of: (1) acquiring information, (2) thinking about and processing it, (3) sending it on, and then (4) waiting for feedback so we can do it all over again. The Internet has dramatically speeded up steps one and three, for certain types of information, but has done nothing to improve the vitally important step two. The information velocity has gone way up, but how we think and behave has not changed one bit. Thus, the Internet becomes just another convenient appliance to be used – like the telephone. For some transactions, such as stock trading, it's of great benefit. For other activities, like browsing through a bookstore or a magazine rack, it's pretty useless. Personally, I'm just as comfortable making a phone call as I am sending an e-mail, and it takes about the same time to do each. I alternate between the two to vary my activities, but will lean toward e-mail for group communications and for communicating with those who I know are hard to reach by phone.

In the next decade, expect that more people will become comfortable with the Internet for information searches, communications, shopping, and entertainment. But don't expect too many existing businesses to disappear because of the Internet. The real challenge will be for the information providers to figure out how to make money with the Internet. We all want to

have instant access to information, but we don't want to pay for it. I know my own behavior. As soon as I hit a site that wants billing information, I hit the exit button and move on to a free provider.

One great benefit of the Internet has been to bring the world closer together – essentially for free. Why is it that I can send and receive an unlimited number of e-mails to/from someone in France, Germany, Russia, or anywhere else in the world for my basic fee of $19.95 per month, but if I make a phone call, I have to pay maybe as much as several dollars per minute? Is the phone too expensive or is the Internet too cheap? If it's my tax dollars at work, I'm very happy, but no one has given me a really good explanation. I'm sure some of you know. Send me an e-mail and enlighten me, please. However, I like this current situation, and I wouldn't want it to come to an untimely end because someone finally figures out that we have all been getting away with something for which we should pay, at least a little.

Teleconferencing

Ten years ago, this was all the rage and was promoted as the great new technology that would cut back on corporate travel. In these last 10 years, however, I have used it exactly twice. In my case, teleconferencing served the limited purpose of allowing two groups, on opposite coasts, to have a rather stilted meeting. We accomplished most of what we intended, but it was not nearly as pleasant as a real get-together.

My prediction is that, although technically feasible, teleconferencing will not make the slightest dent in business travel in the foreseeable future. A teleconference can never accomplish what can be done in seemingly accidental meetings, such as the ones that take place in hallways during technical conferences or over meals.

On the other hand, there are a couple of Internet-related developments that have many of the attributes of a teleconference. These are the "chat rooms" and the interactive sites offering sex-related activities. Apparently, the attraction here is that the level of interactivity and anonymity can be controlled by the user. Interestingly, this resolves the problem that has kept video-phones from gaining wider acceptance – I don't have to let you see me unless I want to. In this new environment, that is considered quite acceptable.

Digital TV and HDTV

As we said 12 years ago, "this one is going to take a while." Why? Well for one, the U.S. Government had to get involved and they haven't yet figured out how to make decisions at the speed of the digital age. Nevertheless, after many years of wrangling, we finally have the approval and encouragement of the U.S. Government to do digital TV – in 18 formats, and by the year 2006! OK, you're a TV-station owner. Which format should you choose? You're a TV-set maker. Which set do you make? Ah, but you're an enterprising IC designer. You decide to design a converter chip that can take *any* of the 18 formats for input and output *any* of the other 17 formats you may wish to have. Aha, now we have something we can all work with. For my direct-view set, since I can't see more than about 500 lines anyway, I can still buy a conventional TV for less than $350; or if I want I can now get a beautiful noise-free 500-line digital picture that looks about three times better than my existing NTSC set, and I can decide if I want 4:3 or 16:9 aspect ratio – all still for about $500. If I'm a projection-TV fan, I can take my output at about 700 or 800 lines and get all the quality I'm able to appreciate on my 50-in. home projector. At that resolution, it is still something that I am likely to be able to afford. And the full-blown HDTV resolution of 1080 × 1960? Well, I can sell that to the folks implementing electronic cinemas in commercial movie theaters. After all, this is significantly *better* resolution and quality than 35mm film and can only be appreciated on a very large screen with a very-high-quality (expensive) projector.

For the display community, all this is great stuff. There will be plenty of choices. The CRT will live on because it will continue to be cost effective, especially as resolution goes up. Flat-panel technologies will continue to be challenged for consumer applications because the cost of driver circuitry is proportional to the sum of the rows and columns that need to be addressed. The next decade will be a busy one as the next generation of television (finally) begins to be implemented.

Web TV

I admit it. I can't figure this one out. Here I sit at my laptop computer with the screen less than 2 ft. away. And there across the room, about 12 ft. away, sits my TV. And I'm supposed to combine these into one marvelous entertainment/Internet appliance? Right… If I want to see text on my television, I think at best I can manage about ten words across the screen and about that many total lines. Maybe movies or sports events on demand? But I can get those now. Sports scores on demand? What else? Perhaps Web TV is intended to

appeal to the majority of homes, which today have cable TV but don't have a PC. Bill Gates has put a few billion dollars into several cable companies to get himself into set-top boxes. I saw him interviewed on TV the other day. He was demonstrating the Web-TV concept. He was sitting 2 *ft.* in front of the demonstration set! Needless to say, this didn't help my understanding.

Now maybe this is all a smoke screen for something else. What do the cable providers really have? Bandwidth – into more than 60% of the homes in the U.S. One channel of cable signal can carry many times the information of a phone line, even though the new xDSL technology will improve some phone lines significantly – for an extra charge of course. The cable network is already in place, and it needs no dial-up access. It's there and it's always "on." If I were a rich man like Mr. Gates, I would go after that bandwidth. And not only is it already in place, it's cheap and just waiting for someone to put some useful information on it. The only additional equipment needed are the servers to receive as well as send the data and multiplex it by neighborhood. That's a lot easier than wiring up the whole country all over again. Of course, satellite TV is also growing, but may not become popular enough to have the same penetration into homes as cable has already achieved. So maybe what we really are after is not Web TV but the ability to connect our computers into the cable network and send information at much higher speeds with full video capability. And by the way, how do you feel about not only having to buy your computer's operating system but also having to rent your information pipeline from Mr. Gates?

The Electronic Office

I have an electronic office. I have two computers, a fax machine, a copier, two printers, two telephones, and four phone lines into the house. And I have stacks of paper everywhere. The two computer screens are apparently inadequate substitutes for a desktop covered with piles of carefully arranged and prioritized paper-based information. I would have to spend hours on my computer to accomplish what I can do in a few minutes of scanning this random-looking stuff on my desk, and sometimes on the floor. Fortunately, we're not hearing too many predictions anymore promoting the paperless office. Of course, there are some nice, but very specific, paperless applications, such as electronic tickets for airplanes. However, most of us still print out everything we think is important enough to retain or work with.

The next decade, I think, will bring more displays and more compute power into the office, home, or business. Some of the larger companies will migrate back to mainframe-based computing with networks of less-expensive satellite computers, but I think there will be resistance to that from employees who like to have as much control over their workspace as they can get away with.

The one disturbing trend is the frustration that I am hearing from many of you using Windows-based computers. Our computers seem to be getting more human-like and mistake-prone everyday. Then, when you finally concede defeat and call a help line, the typical answer seems to be, "Try it again and see if it still does it," or, "We don't know why it does that, you'll have to delete the entire program and re-install it." There's a story circulating about a mechanical engineer and a software engineer on a drive in the mountains. They're going down a steep hill when the brakes fail and they go careening into a dirt bank. The mechanical engineer gets out and crawls under the car to see if he can find a broken brake line. The software engineer looks around for a while and finally suggests, "Why don't we push it back up the hill and see if it does it again?"

Software will be a bigger problem during the next decade than hardware. The basic configuration of the desktop computer is set and will not change all that much. There will be more compute power aimed specifically at real-time or near-real-time image processing. The displays for desktop computers are really quite good already. Flat panels will increase their penetration but will not dominate, and some new display concepts will evolve but the user will not see them as dramatic changes in the visual experience. The software arena will be much more turbulent. Microsoft worked very hard to achieve their monopoly operating-systems position. They will come to regret their success. Without a competitive choice, they will be blamed for every fault and imperfection, no matter how insignificant. The complexity of the operating system will cause great frustration and lead to new approaches. I wouldn't exclude the possibility of a hardwired operating system or at least a portion thereof supplied by an Intel or an IBM.

Electronic Billboards

The world is full of advertising and information signs. But most of them today are painted or printed and just sit there and do nothing. Well, we display engineers should and will do something about that. Already, as I stand in front of my favorite convenience-store gas pump, it tells me that I should go inside and buy some special candy-bar or

display continuum

other goody. For those few minutes I am a captive audience.

A new electronic billboard between Seattle and Tacoma created quite a stir recently but now seems to have become a popular and effective advertising fixture. At airports, electronic-display kiosks using plasma panels are on the way. I believe that this is just the beginning of what we will see during the next decade. This may be the biggest new market opportunity for the introduction of new display technologies. Large flat panels, configurable tiles, video walls, and, especially, sunlight-readable displays in all sizes are needed. For display engineers, this could become a fertile ground for innovations which will go hand in hand with new applications.

There are a few other topics I would like to mention, but my esteemed chief editor tells me that I am wearing out my welcome for this month. Therefore, I will bring this month's column to a close with the offer that some of these other topics will be included in columns yet to be written.

But before I go, I promised that I would briefly describe how I approach my technology prognostications.

The biggest mistake I think most technology forecasters make is to assume that once a new technology is developed its acceptance is a given. Thus, they base their futuristic projections on when they think a technology will become available. Unfortunately, the situation is much more complex than that and, in fact, technology often plays a relatively minor role. The other and more important considerations are *societal, political, economic,* and *ecological.* For example, for the DTV analysis, I have been watching the political and economic scenarios far more than technology developments. Until the Government and the station owners could come to some agreement, the technology was going to go nowhere. Sometimes the issues are not nearly so global, such as, for example, the concept of a computer-controlled house, or the minor but practical problem of where to hang or stand a plasma panel in many of today's homes or apartments.

When I hear about a new technology, the easiest task, I think, is to sort out the credibility of the performance features and claimed benefits. It's also relatively easy to come up with innovative products. The much more challenging task is to understand what will be required from the technology for it to be accepted by society, how it must be configured, and for what cost it must be produced to maximize its chances of success. I'm a technologist at heart, but when I am trying to see into the future, I give technology the same harsh and skeptical look that the non-technologist buyers in this world are going to give it.

Finally, I look very hard for what I have learned to call "those little tiny fatal flaws." Most of the time these are people-related rather than technology-related and, as I well know, are sometimes darn hard to spot – until it's too late.

Should you wish to add some of your own prognostications or comment on the ones I have made, I would enjoy hearing from you by new media or old. My e-mail is silzars@ibm.net, my telephone is 425/557-8850, my fax is 425/557-8983, and the real-paper address is 22513 S.E. 47th Place, Issaquah, WA 98029. ■

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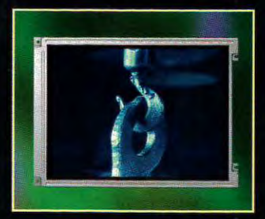

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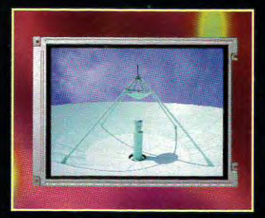

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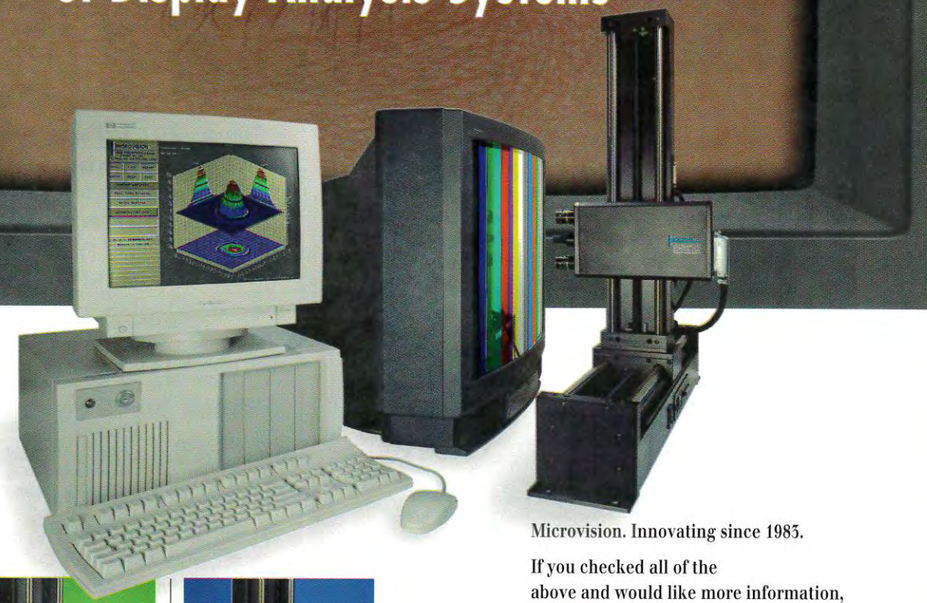

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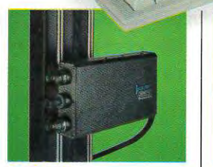

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european view

continued from page 6

Plasma technology is being developed by ***Thomson Plasma***, a 1997 joint venture between ***Thomson CSF*** and Thomson Multimedia. The objectives of the 60-person company are to assess Thomson's plasma technology for consumer TV and to serve the industrial and military markets with high-resolution products. A seven-partner consortium named "Lampady," led by Thomson Plasma and Thomson Multimedia, is to demonstrate by the end of June 1998 a European-made 42-in. 16:9 (560 × 768) plasma TV set. The participating European firms have extensive experience in collaborating on all aspects of plasma-panel technology, including glass substrates, dedicated electronics, and signal-processing circuits.

The June 1998 milestone will conclude the first step of this EC-supported R&D effort, which amounts to ECU 9.9 million – about US$1.1 million – for the first year. Through this program, the EC is demonstrating its commitment to supporting the FPD industry, as well as its belief in the strategic importance of plasma technology.

FEDs

Field-emission displays (FEDs) are actively promoted by ***PixTech.*** The company, based in the south of France, has set up an "FED alliance" that enables its members (PixTech, ***Motorola***, ***Futaba***, and ***Raytheon***) to share an FED portfolio of about 350 patents. The original patents came from ***LETI*** – the research center of the French Atomic Energy Agency – located 10 miles from Thomson-LCD and Thomson Plasma in the so-called "French Flat Panel Valley" near Grenoble.

PixTech and Futaba have started production of monochrome panels, while Motorola gave the first public demonstration of its color FEDs at Display Works in San Jose, California, in January.

PixTech has reached an agreement with Taiwan's ***Unipac*** for high-volume manufacture of its products. By January, ten million dollars' worth of equipment had been installed in Unipac's facility in preparation for the start of this FED production. ■

François Maurice *is R&D Manager at Thomson-LCD, ZI Centr' Alp, Moirans, F-38430 France; telephone +33-4-76-86-10-11, fax +33-4-76-86-10-10, e-mail: francois.Maurice@utopia.eunet.fr. He is also Director of SID France.*

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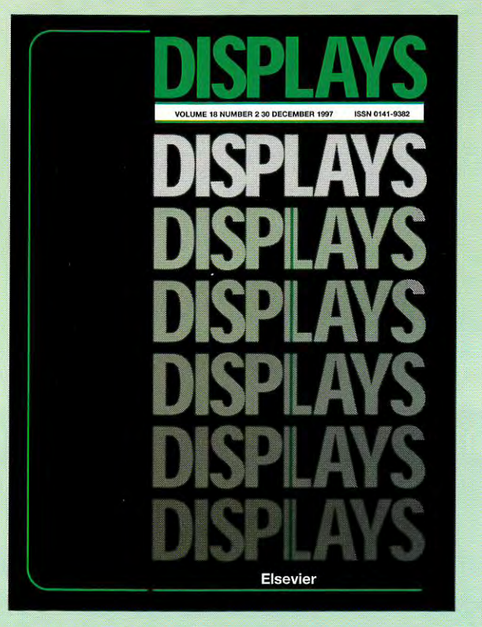

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CELCO leads the industry into the 21st century. Our recent acquisition of DISCOM Inc.'s CRT deflection yoke and related component line, enables us to provide continuing supply to DISCOM customers enhanced by CELCO's unparalleled customer service and well-known CELCO YOKES and components design/manufacturing capabilities.

CELCO designs and manufactures high resolution CRT Deflection Yokes & Focus Coils, CRT Deflection Amplifiers, CRT Spot Measurement Analyzers & CRT Test Equipment, X-Y Traveling Microscopes, Correction Coils, Circuitry, and The CELCO eXtreme Digital Motion Picture Film Recorder for animation and special effects for Film Producers worldwide.

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