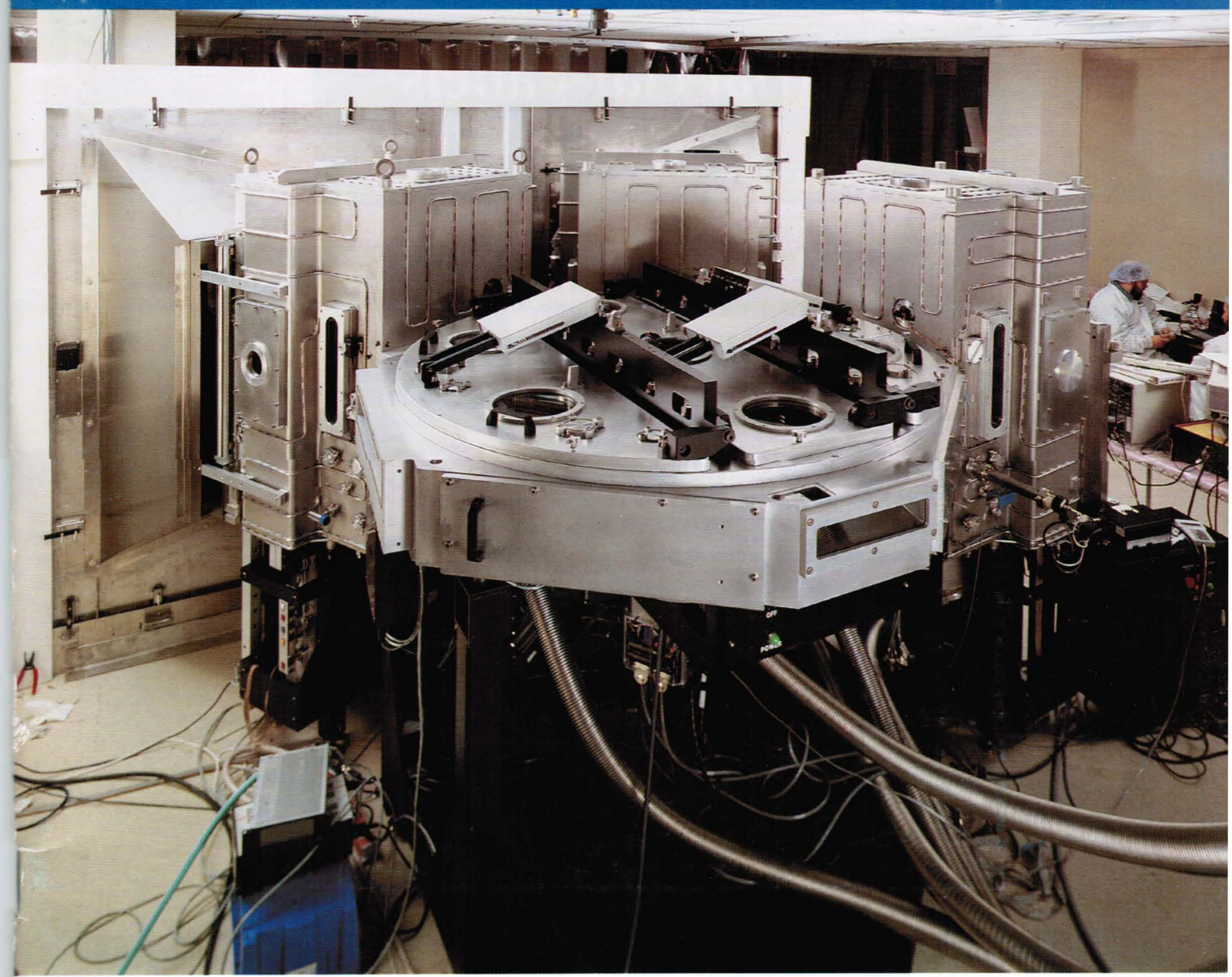
Official Monthly Publication of the Society for Information Display

INFORMATION DISPLAY

April/May 1995
Vol. 11, No. 4&5

SID '95 SHOW ISSUE



Products on display
FPDs in the former Soviet Union
Advanced FPD photolithography techniques
DMTC '95 review

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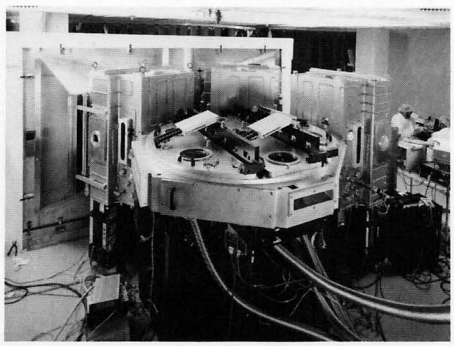
Cover: The first series of third-generation cluster tools for FPD manufacturing has been built by Brooks Automation of Lowell, Massachusetts, which provided information about the system at DMTC '95. A system based on this Hercules series is going into the world's first third-generation FP production facility in Japan.



Brooks Automation

Next Month in Information Display

Special CRT Issue
- Head-Mounted Tubes
- Medical Images
- Projection Display Shootout
- London Conference Review

INFORMATION DISPLAY (ISSN 0362-0972) is published ten times a year for the Society for Information Display by Palisades Institute for Research Services, Inc., 201 Varick Street, New York, NY 10014; David Slater, Chief Executive Officer; Leonard H. Klein, President; Laura Manganiello, Secretary/Treasurer. EDITORIAL AND BUSINESS OFFICES: Palisades Institute for Research Services, Inc., 201 Varick Street, New York, NY 10014; telephone 212/620-3371. Send manuscripts to the attention of the Editor, ID. DISTRICT SALES OFFICES: WEST/MID-WEST – Ted Lucas, 5428 N.W. Pinery, Newport, OR 97365; telephone 503/265-9140. EAST – Erika Suresky, Palisades Institute for Research Services, Inc., 201 Varick Street, Suite 1006, New York, NY 10014; 212/620-3375. SID HEADQUARTERS, for correspondence on subscriptions and membership: Society for Information Display, 1526 Brookhollow Drive, Suite 82, Santa Ana, CA 92705-5421; telephone 714/545-1526; fax 714/545-1547. SUBSCRIPTIONS: Information Display is distributed without charge to those qualified and to SID members as a benefit of membership (annual dues $55.00). Subscriptions to others: U.S. & Canada: $36.00 one year, $5.00 single copy; elsewhere: $72.00 one year, $6.50 single copy. PRINTED by Sheridan Printing Company, Alpha, NJ 08865. Third-class postage paid at Easton, PA.

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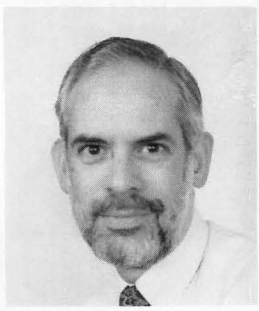


Et tu, Brute?

Those of you who studied Shakespeare may recall Act III, Scene I of *Julius Caesar*. A group of senators assassinate Caesar with daggers in the Roman Senate. Caesar struggles bravely despite multiple wounds. Then his comrade Brutus, who is one of the conspirators, emerges from the group of assassins to strike what is to be (in Shakespeare's version, at least) the final blow. Caesar, undone as much by his friend's betrayal as by his wounds, utters the famous dying words: "Et tu, Brute? (You, too, Brutus?) Then, fall, Caesar."

Brutus returned to the Senate – the U.S. Senate – on March 2, this time in the guise of the Senate Appropriations Committee. His victim was the U.S. Department of Defense's (DoD's) Technology Reinvestment Program (TRP). The TRP, already wounded by its removal from the House appropriations bill, is not likely to survive this attack.

It is perhaps understandable that a new House majority, drunk on a brew combining power and inexperience, is slashing at sophisticated programs it does not understand. But the more experienced Brutus should know better. The TRP's $202 million would have gone to encourage the development of dual-use technologies – those capable of supporting both government and commercial needs. DoD has correctly concluded that dual-use approaches are essential if the military is to have early and reliable access to cutting-edge technologies, including display technologies, at acceptable cost.

How could the committee, in the name of economy, assassinate a program whose whole design is to save money on system acquisitions and to stimulate a strategic industry? This is not theory. Related programs are already fertilizing an industry, creating technological know-how, and enlarging companies and adding workers – which are contributing to an enlarged tax base. Congress's action is anti-defense, anti-technology, and anti-business. It is bad for the U.S. economy, it is bad for the U.S. trade deficit, and it is bad for the U.S.'s technology partners, who value a colleague capable of keeping a steady hand on the tiller.

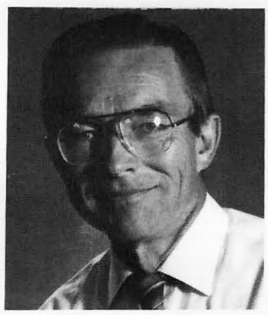
It is surprising that the actions of both the House and Senate committees are not seen as bad policy by all Republicans and Democrats inside the Beltway. Outside the Beltway, we shake our heads in wonder. "Oh judgment," Shakespeare has Mark Antony say, "thou art fled to brutish beasts, and men have lost their reason."

DoD spokesman Glenn Flood speculates that some Congressmen incorrectly see dual-use programs as defense-to-civilian conversion efforts. "We're still fighting for TRP and the other dual-use programs," says Flood. "We need to find ways of educating people about the dual-use concept and its importance to DoD and the country."

– Ken Werner

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

the display continuum



Does Your Computer Go Bump in the Night?...

by Aris Silzars

I mailed a letter the other day. Now, this was no ordinary letter – it was the genuine handwritten kind that in times past people used as a way of communicating with each other. It cost me ninety-five cents to send it by first-class mail. Now, I suppose that's not much for sending an ounce of anything nearly 6000 miles to a relative in a distant land. But it made me think. What do people send by first-class mail these days, anyway? So I asked my most expert advisor (my wife Sally) what she was sending by first-class mail and what she thought others were doing. It didn't take her long to give me a comprehensive answer – bills and greeting cards. Oh sure, there may be an occasional "real" letter, or maybe one from an aggressive realtor with a handwritten address, but we really don't communicate by mail anymore, do we?

A revolution happened and we hardly noticed. For a time, the telephone took care of most of our needs. But lately, we are sending more and more faxes and e-mail over those same telephone lines. And our telephones have gone cellular. We can now be found, no matter where we try to hide. We are definitely well along on our journey into the Information Age. But, as the vacation-bound kids in the back seat always ask, "Are we there yet?" Wherever "there" is, it may be too hard to define. Instead, how about looking for the next exciting attraction – that next stop on the Information Superhighway, where we can have "just hours of fun"?

The fax machine took 150 years to evolve, and it had a rocky start. As J. Coopersmith describes in the February 1993 *IEEE Spectrum*, the development of the fax machine was strongly motivated by the complexity of the Japanese alphabet and the difficulty of using it to send messages over telegraph and telex systems. Apparently, even Thomas Edison was motivated to work on a fax machine for just this reason. Professor Yasujiro Niwa built the first Japanese fax machine in 1928 for the Nippon Electric Co., but modern Japanese interest didn't build until the 1960s. Then, in the 1980s, the combination of mature and flexible standards, well-designed products, manufacturing technology, and societal forces launched the global fax boom. The U.S. market grew from 250,000 machines in 1980 to 500,000 in 1985. Starting in 1988, sales doubled annually. By the end of 1991, there were 6 million fax machines in use in the U.S., and 1.1 million computers had accessory boards providing fax capability. The number of transmitted pages increased from 1.5 billion in 1985 to 17 billion in 1991. Today, fax transmissions account for more than 40% of Japanese-U.S. telephone traffic.

Predictions in the 1970s and early 1980s about the impending automated office dismissed fax technology because it did not fit the model of an all-electronic paperless future. In retrospect, that's one of those "I told you so's" that I can personally feel good about.

After all those years of development, finally culminating in worldwide recognition and success, will the stand-alone fax machine be around for a while, or is it about to be absorbed amoeba-like into the domain of fax boards in desktop and laptop computers and laser printers? After all, isn't e-mail just a form of fax

continued on page 70

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Flat-Panel Display Technology in Russia, Ukraine, and Belarus

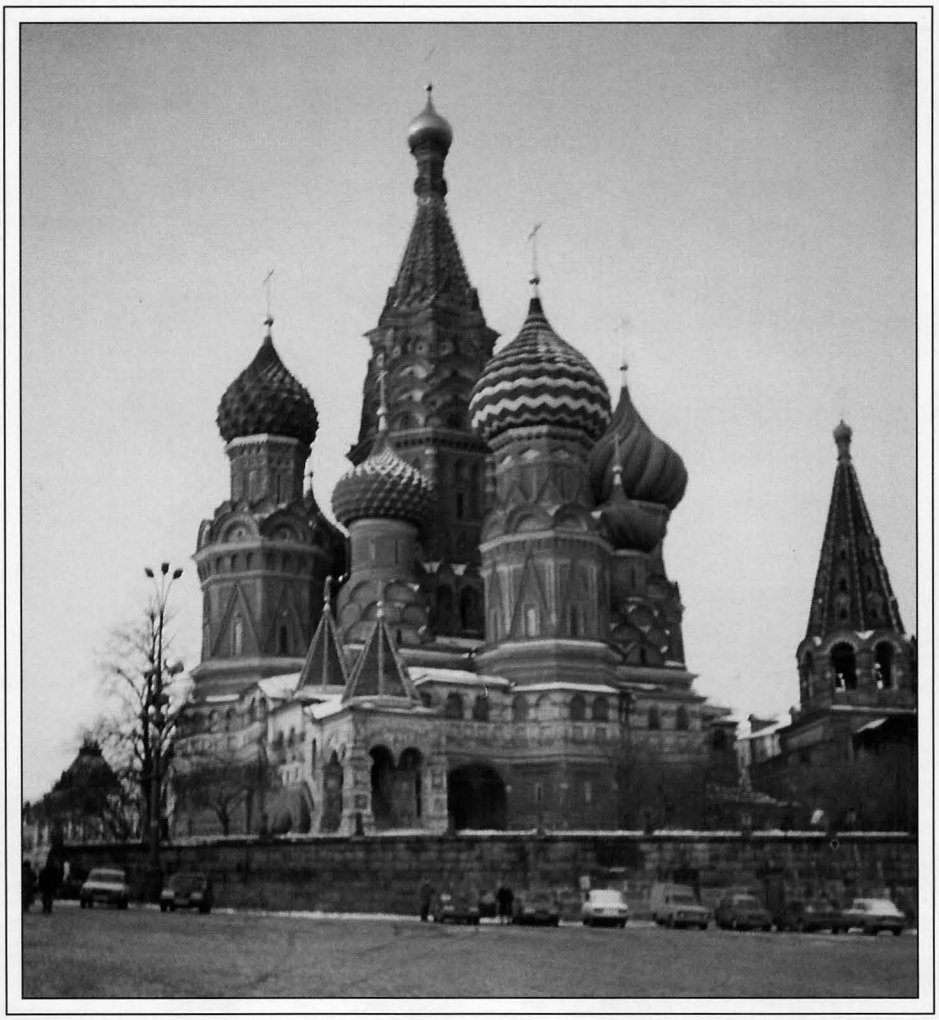
A tour of 36 sites uncovered innovative FPDs and energetic people anxious to bring their technology to the West.

by Bill Doane

THE DISSOLUTION of the Soviet Union opened research laboratories and development facilities previously inaccessible to Westerners. One example is Zelenograd, near Moscow – an entire city that had a military mission. The city did not even appear on Soviet-era maps, yet it is filled with state-of-the-art electronic technology.

There are many such sites in Russia, Ukraine, and Belarus, and many of them are homes for flat-panel display (FPD) technology (Fig. 1). As in the U.S., manufacturing is sparse, but there is display technology – some quite advanced, with innovative and different approaches. This should not be surprising in countries that led the world in space exploration, submersibles, undersea technologies, and other areas of science and science education. Some display technology is becoming available to the West as former Soviet Union (FSU) companies seek partners, investment, and manufacturing opportunities. Research directors, inventors, company officers, and government and university officials display great enthusiasm for entering the commercial world, finding markets, competing, and participating generally in the excitement of today's flat-panel technobusiness.

Bill Doane *chaired the WTEC panel on Display Technologies in Russia, Ukraine, and Belarus. Dr. Doane is Director of the Liquid Crystal Institute and the NSF Center for Advanced Liquid Crystalline Optical Materials (ALCOM) at Kent State University, P.O. Box 5190, Kent, OH 44242-0001; telephone 216/672-2654, fax -2796.*



Bill Doane

Fig. 1: *To many Westerners, St. Basil's Cathedral on Red Square symbolized the old Russia. But the display technology of Russia, Ukraine, and Belarus is also impressive.*

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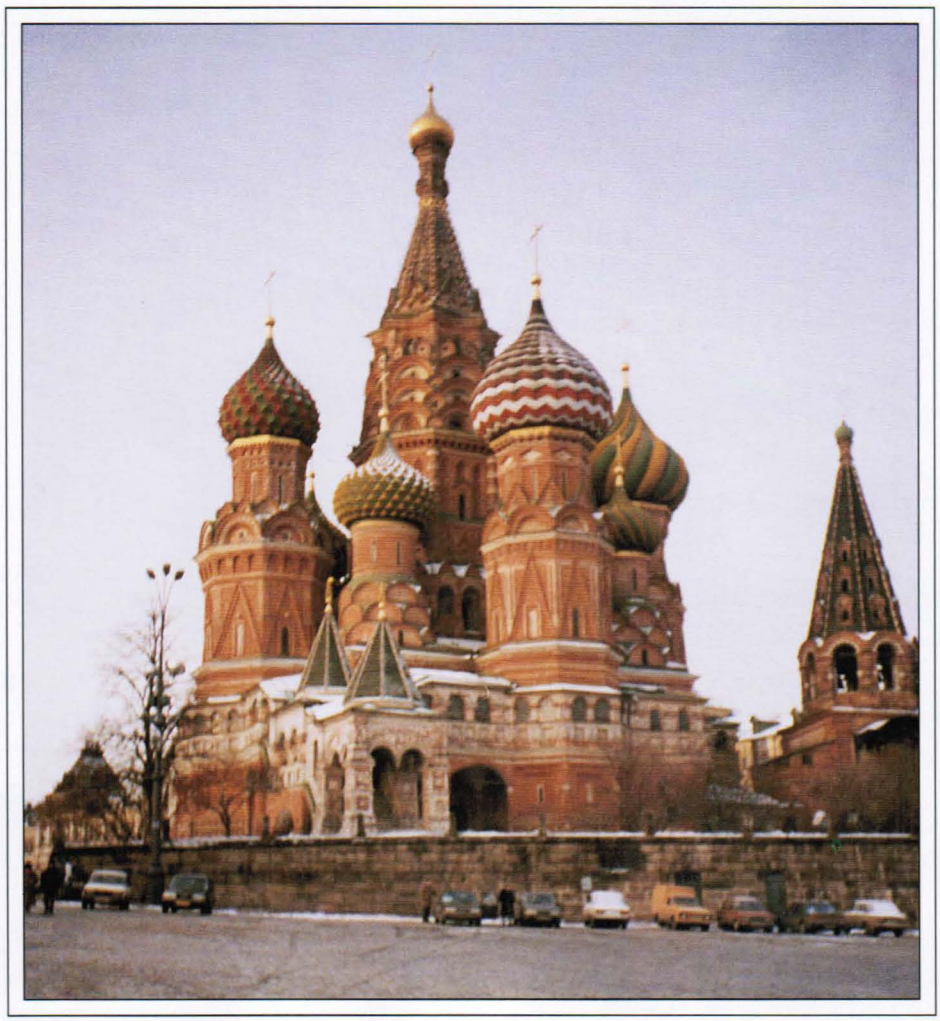


Bill Doane

Fig. 1: *To many Westerners, St. Basil's Cathedral on Red Square symbolized the old Russia. But the display technology of Russia, Ukraine, and Belarus is also impressive.*

The World Technology Evaluation Center (WTEC), supported by the Advanced Research Projects Agency (ARPA) and the National Science Foundation (NSF), formed a traveling team of 11 people to visit 36 sites in Russia, Ukraine, and Belarus (Fig. 2). In October, 1993, team members visited institutes, universities, companies, and former military establishments, interviewed key technology and industrial leaders, and, wherever possible, observed working displays. Site reports were prepared on each location visited by the traveling teams. Seven team members wrote chapters of a comprehensive report to be distributed by WTEC.[1]

Projection Systems

The most exciting developments were the projection systems we saw at several different locations. A key innovation is the quantoscope – an e-beam-pumped laser (Fig. 3). An e-beam pumps a semiconductor-resonant cavity that stimulates localized laser emission out the other side. Scanning the e-beam also scans the laser, making it an excellent candidate for laser projection. High-intensity red, green, and blue (RGB) colors made an impressive demonstration on a theater-sized screen.

The quantoscope was developed at three sites near Moscow: Rosich and Co., Ltd., Platan at Fryazino, and the Lebedev Institute of Physics. It has caused excitement because of its potential for use not only in projection systems but also in cancer therapy, visual-approach slope indicators (VASI) at airports, and photographing fast events such as interferometric visualization of shock fields around projectiles.

The quantoscope is of great interest to U.S. developers, but the question of intellectual-property rights surrounding the device is apparently confused. The technology also requires further work, such as developing blue emitters, finding an economical way to cool the cavity, and extending the lifetime of the emitter. The device infrastructure – such as crystal growth, material formulations, and e-beam technology – is for the most part being developed by the companies involved.

Bill Doane

Fig. 2: *The WTEC traveling team just before leaving for the former Soviet Union. Front row (left to right): Michael DeHaemer, Director of WTEC, Loyola College; Patricia Cladis, Bell Laboratories; Bill Doane, Kent State University; Jan Talbot, University of California, San Diego; and Elison C. (Dick) Urban, ARPA/ESTO. Back row (left to right): Oleg Lavrentovich, Kent State University; James Larimer, NASA Ames Research Center; Zvi Yaniv, Kent Display Systems; Marko Slusarczuk, Silicon Video Corp.; Chris Curtin, Silicon Video Corp.; Robert Rice, McDonnell Douglas Aerospace; David Slobodin, ARPA.*

Another innovation relates to CRT projection. Platan showed some unique multiple-beam CRTs for large-screen projection, including a 625-line projection system that produces a 6-m-diagonal image with a luminance of 30 cd/m^2. Platan researchers have also paid attention to home projection TV. These systems have compact packaging and special amplification screens.

The WTEC committee visited several sites where work focused on laser-addressed LCD projection systems. The Vavilov group at St. Petersburg reported activity on ferroelectric liquid-crystal (FLC) projection devices, and Rosich reported working on a light-valve system based on a laser-addressed LC photoconductor. Rosich claimed their system has a resolution of 1000 lines and an output of 1000 lm. Scientists at Rosich also have designed an innovative light concentrator that is used in their projectors.

Liquid-Crystal Displays

Zvi Yaniv evaluated the LCDs in the FSU, with emphasis on cell design and manufacturing issues. The WTEC team found several innovations in LCD technology, and in a few cases saw completed advanced displays nearly ready for manufacturing. The team saw a-Si and p-Si active-matrix displays at Platan in Russia and Integral in Minsk, Belarus, and was impressed that both a-Si and p-Si LCDs were being developed at Platan. It is Dr. Yaniv's opinion that with suitable investment, Platan could quickly rise to the level of a U.S. company such as OIS Optical Imaging Systems.

A well-integrated group dedicated to the metal-insulator-metal (MIM) active matrix is located in Minsk. Largely championed by workers at the Radioengineering Institute, this enterprise involves several different companies, institutes, and universities in the Minsk area:

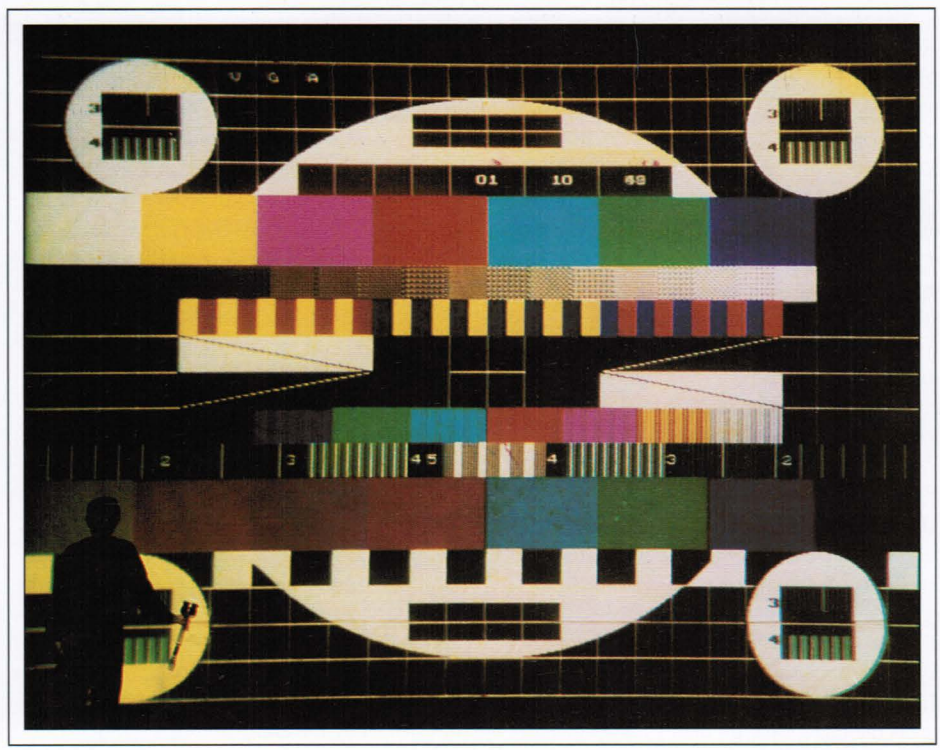
- Integral, a large electronics conglomerate that once served much of the Soviet Union;
- Planar, a leading FSU equipment producer for the microelectronics industry;
- The Sevtchenko Institute of Applied Physics Problems, a group that supplies LC material, color filters, and optical design technologies;
  and
- Many other small companies.

The group reported a previous demonstration of a 320 × 300-pixel color TV using MIM elements with a contrast ratio of 15:1. A 6-in.-diagonal 640 × 400 unit is under development. In support of this effort, professors and scientists at the Sevtchenko Institute have developed highly resistive LC materials with the large dielectric constants desirable for MIM AMLCDs. A color-filter program is in place. The well-qualified and highly motivated scientists working on this project could develop marketable display products for Belarus.

The team which visited Kyyiv – previously spelled "Kiev" by some Westerners – reported interest in MIM technology in Ukraine. A company called Helium in Vinnutsya is performing research and development on MIM displays, with LC materials and polarizers coming from other Ukrainian companies. Glass substrates will soon be supplied by Ukrainian firms. The Volga R&D Institute in Saratov, Russia, reports an interest in MIM for smectic-A and nematic displays. This group also reports a-Si TFT displays with 864 lines.

The activity in manufacturing supertwisted-nematic (STN) displays was surprising. Reflector, a company in Saratov that works closely with the Volga R&D Institute is a major supplier of STN-LCDs. Reflector produces STN displays of various sizes for a range of applications, including laptop computers. Platan, near Moscow, also manufactures a large number of STN displays, all with a chip-on-glass (COG) technology. Integral, located in Minsk, also claimed an STN line; however, all of the STN displays seen in the FSU were uncompensated.

In the WTEC report, Pat Cladis describes sources for other LCD supporting materials and technologies. Synthesis and formulation of advanced LC materials were seen in all three FSU countries. The Niopik Organic Intermediates and Dyes Institute near Moscow works cooperatively with groups in the Ukraine Academy of Sciences and F. Hoffmann-La Roche in Switzerland. Niopik produces LC materials and many other supportive materials, such as photosensitive monomers, that align under polarized light. This photoaligning material recently received worldwide attention. Applications include buff-free alignment layers and polarizing sheets. A variant of this work using polymer LCs is being pursued at Moscow State University (MSU). The advantage of the MSU material is that it can be written and erased with polarized laser light.



Platan, Fryazino, Russia

Fig. 3: *The quantoscope – an e-beam-pumped laser projection system – projects a high-intensity color image on a theater-sized screen. The shadowy figure at the lower left indicates the screen's size.*

Niopik also showed an array of electrochromic materials, with organic materials being among the most impressive. The company arranged with a U.S. manufacturer of automobile mirrors to use its electrochromics. Two major FSU materials developers have licensing agreements on LC materials with a Japanese LC-materials supplier. There was general interest in moving these materials into the world community, even as the company works closely with Russian display developers.

The Sevtchenko Institute showed a new color-filter technology using water-soluble negative photoresists. Western scientists should examine this process, which appears unique and easy to implement. Another water-soluble organic film technology for polarizing sheets was described at the Zelenograd Research Institute of Physical Problems. In this research, Langmuir-Blodgett films are being studied with the goal of layering the polarizing sheet inside the display cell. This technology is also being explored for color filters. In the area of innovations supporting LCD materials, a unique material for passivation of Na^+ in normal glass has been developed at the Sevtchenko Institute. This glass was used for STN-LCDs and AMLCDs in Belarus.

A cholesteric reflective-display technology was found at the Monocrystal Institute and at the Institute of Semiconductors of the Ukraine Academy of Sciences. The technology is similar to that being developed in the United States, but different materials are used to stabilize and modify the optical states of the material. Impressive low-resolution reflective displays without backlights have been prototyped in Ukraine. Their drive voltage, however, remains high, approaching 100 V.

The strongest components of the display infrastructure in FSU countries are research institutes and universities. The scientists and students in these locations have been among the best in the world and have made great

contributions to the science of LC materials. Unfortunately, many of them – 25% by one estimate – have left the country, and another large percentage now work in other fields. Nevertheless, strong basic-research programs on LC materials are being pursued in such places as the Institute of Physics of the Ukraine Academy of Sciences (Kyyiv); the Russian Academy of Sciences, Institute of Crystallography (Moscow); Moscow State University; and elsewhere.

Emissive Displays

In the WTEC report, Chris Curtin and Jan Talbot describe a number of emissive technologies found in the FSU. We've already mentioned the e-beam-pumped laser at Platan, where the visiting team also discovered a strong phosphor-materials group. The Platan group also featured unusual materials, such as phosphor-encapsulated polymers used for converting ultraviolet (UV) radiation to the 610–700-nm visible region that is useful for chlorophyll absorption and plant growth. The group visiting Saratov found a strong program in vacuum-fluorescent displays (VFDs) at the Volga R&D Institute, with manufacturing of large quantities being done at Reflector. VFDs developed at Volga range in size up to 640 columns × 480 lines. Phosphor development in Volga places emphasis on low-voltage phosphors in the range of 4–20 V. Volga develops the phosphors that are mass-produced in Stavropol. At the time of the WTEC team's visit, the VFD-manufacturing line at Reflector consisted primarily of Japanese production equipment. Reflector claims several technical advantages, including low-voltage structures that provide very high luminance and lifetimes of 100,000 hours with multicolor capability.

Research on electroluminescent (EL) display technology occurs at several sites in the Moscow region and Kyyiv. Interesting work at the Moscow State Institute of Electronics and Mathematics (MSI) deals with the ergonomics of EL displays. Some of these are old EL devices used in manned spacecraft, which the WTEC team had the opportunity to see. The team saw considerable work on aircraft displays at high brightness levels, and a novel description of a filter mask to control cockpit glare. A supplier of EL displays located in Kyyiv produces a number of different sizes based on ZnS:Mn materials (yellow).

The team saw work on field-emission displays (FEDs) at three sites in the Moscow region and at Saratov. Panel members observed small FED prototypes with silicon and carbon emitters. Work was being done on light-emitting diodes (LEDs) in two locations, Moscow and St. Petersburg. Sapphire Research and Production Amalgamation in Moscow manufactures a broad range of incoherent LED devices, including LEDs, arrays of LEDs, and dot-matrix and alphanumeric indicators. Sapphire is conducting research on blue- and UV-emitting diodes, and the company reported efforts to use UV emitters to stimulate emission from phosphors.

The St. Petersburg team visited Positron Research and Manufacturing Corporation. Discussion at this facility focused on III-V devices and a number of ultra-high-power IR-emitting devices.

Business and Infrastructure

In the former Soviet Union, a central planning bureau provided the components and resources required to attain manufacturing goals. Design or prototyping bureaus were coupled with simple industries to form a giant enterprise, but there was no market infrastructure to support these various functions.

In the emerging market economy, many managers are faced for the first time with elements of a market-based economy and a Western business process with which they have had no previous experience. In the WTEC report, Jim Larimer provides anecdotes that illustrate some of the problems encountered by U.S. and other foreign companies and individuals attempting to form business relationships in the FSU.

The report's overview of the FPD infrastructure covers education, R&D, supporting industries, transportation, and other components. Marko Slusarczuk reports on business perspectives. His chapter at the end of the report provides useful documentation on how to obtain information, get to the FSU, and get around once you're there. He reviews problems and intellectual-property issues, and leaves the reader with helpful hints for concluding a deal.

The FSU is undergoing an extensive industrial revolution from a military-commodities complex to a more balanced industrial–military-commodities complex – a process that shares similarities with the large-scale reorganization and downsizing of large corporations. The FSU is now restructured into competing countries, which is rather similar to the business-unit model. Since the region is now without most of its former prime manufacturing bases, it cannot support the large amount of research and development it once did. The FSU now has a large *educated* work force that is out of work and looking for new opportunities.

Japan reminded the United States of the importance of a strong manufacturing base. The disintegration of the Soviet Union teaches yet another lesson: the disaster that results when a strong national education and research program is not closely tied to manufacturing. Committee member Patricia Cladis recalled a comment by the Nobel prizewinning economist Friedrich August von Hayek:

> "We must build where we live. When a country loses the know-how and expertise to manufacture things, it loses its capacity to create wealth – its financial independence. When it loses its financial independence, it starts to lose political sovereignty."

Notes

[1]The World Technology Evaluation Center (WTEC) is administered by the International Technology Research Institute at Loyola College. A copy of the panel report can be obtained from the National Technical Information Service under call number PB95-144390. For pricing and ordering information, phone NTIS at 703/487-4650. ■

Solving the Problem of Differential Overlay

We can deal with imperfection if we sneak up on it gradually.

by John McCoy and Dave Kettering

WHEN THE SOURCE AND DRAIN of a thin-film transistor (TFT) overlap the gate by different amounts – a situation called differential overlay – the manufacturing yield of active-matrix liquid-crystal displays (AMLCDs) can be sharply reduced. Manufacturers sometimes find it difficult to control differential overlay, but there is a generic solution to the problem.

The Manufacturing Context

An AMLCD contains an array of light-transmission pixels, each of which contains a TFT. Each TFT consists of a gate, a source, and a drain (Fig. 1). The gap between the source and drain is created by exposing photoresist and then proceeding with other standard IC manufacturing techniques.

An AMLCD for a notebook computer typically measures 16 cm (6.3 in.) by 20 cm (7.9 in.), which is large by the standards of integrated circuits. One conventional way to fabricate such a large array of transistors is to expose six separate fields (Fig. 2) with a step-and-repeat exposure system such as our own Nikon FX401 or FX501.

The Problem

Not all the TFTs have the symmetry suggested in Fig. 1. The distance between the source and drain is reasonably consistent because it is set by photolithography, but manufacturers sometimes find it difficult to center the source and drain on the gate (Fig. 3).

When the source–gate overlap and the drain–gate overlap vary from their design values, the gain of the transistor changes. This change in gain is not intrinsically a problem. The transistor still works well by virtually all criteria, with one exception: the difference in the gain of the transistor translates into a slight difference in the luminance of the pixel. If the gain remains consistent across the display, or if it changes gradually across the dis-

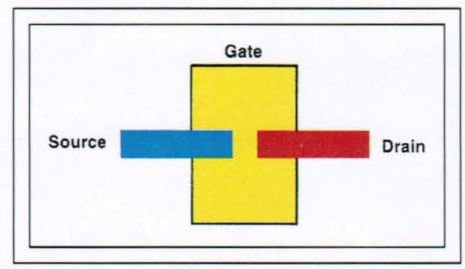


Fig. 1: A typical thin-film-transistor (TFT) configuration, consisting of a gate, source, and drain.

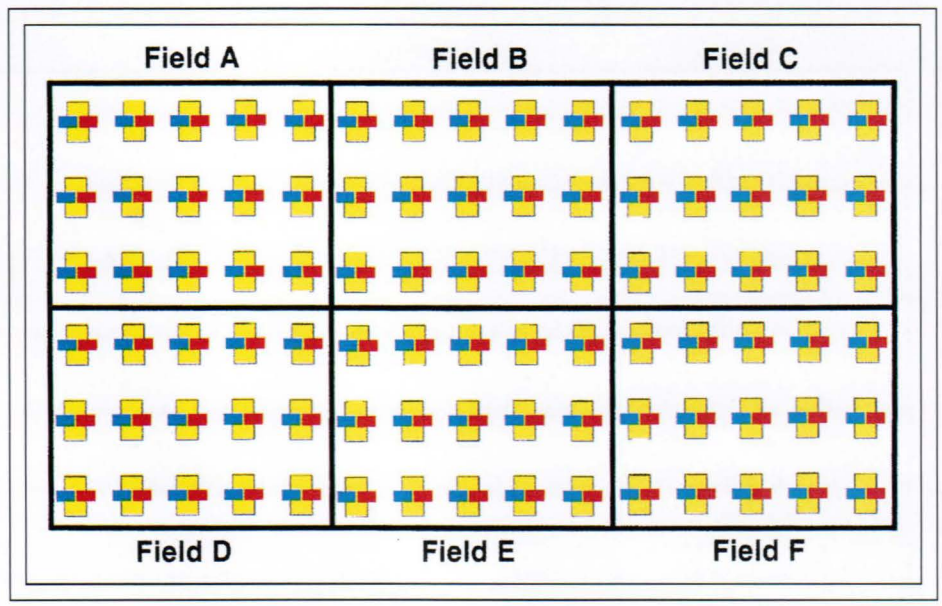


Fig. 2: A flat-panel display with six fields exposed independently by a step-and-repeat exposure system. Each field typically contains about 100,000 transistors.

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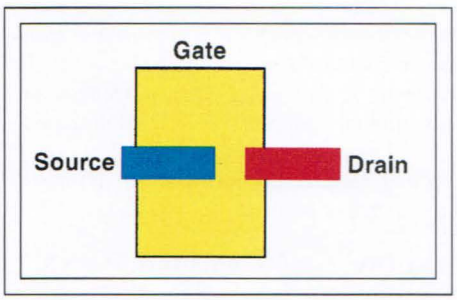


Fig. 3: This TFT suffers from differential overlay: the source and drain are misaligned, so they overlap the gate by different amounts.

play, the difference in luminance is imperceptible to the human eye. From a quality-control standpoint, the problem arises when the change in the gain of the transistors occurs abruptly across a field boundary.

But let's look at the desirable situation first (Fig. 4). The transistors on the immediate left of the field boundary have the same gain as the transistors on the immediate right of the field boundary. The field boundary is invisible to the eye, and the panel is good.

Misalignment

Let's now look at one of the situations that produces yield problems (Fig. 5). In Field A, the gates are correctly placed, and the sources and drains are precisely centered on them in a symmetrical fashion. However, in Field B, the sources and drains are misplaced relative to the gates, and the gain changes abruptly across the field boundary. If the gain of the transistors in Field A differs from the gain of the transistors in Field B by more than 1%, almost anyone who looks at the display will see the boundary. Quality-control inspectors typically discard panels with this type of problem.

If Field B were a separate display, its quality would probably be acceptable to the quality-control engineer and to the customer. A moderate change in gain is only a problem when it occurs abruptly across the boundary.

This misalignment problem is caused by the inherent difficulty in centering an exposure tool directly on the field with a precision of better than 50 nm – a distance sufficient to affect the gain of the transistors.

Lens Distortion

Although projection exposures are specified under the assumption of perfectly shaped lenses, the lenses are rarely – if ever – perfect.

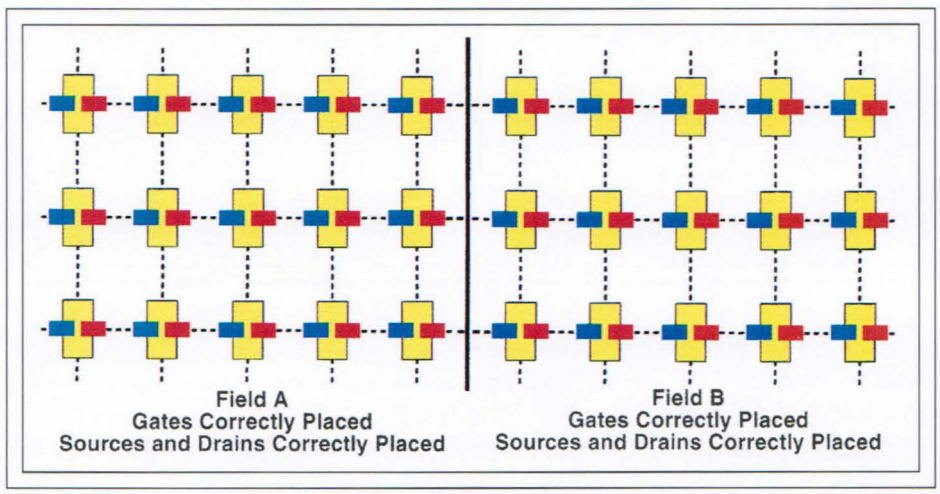


Fig. 4: Two fields from an ideally fabricated panel. All transistor elements on both sides of the field boundary are correctly placed. The transistor gain is therefore constant across the field boundary, and the boundary is invisible to the eye. The panel is good. (The dotted lines indicate the ideal design locations for the transistors.)

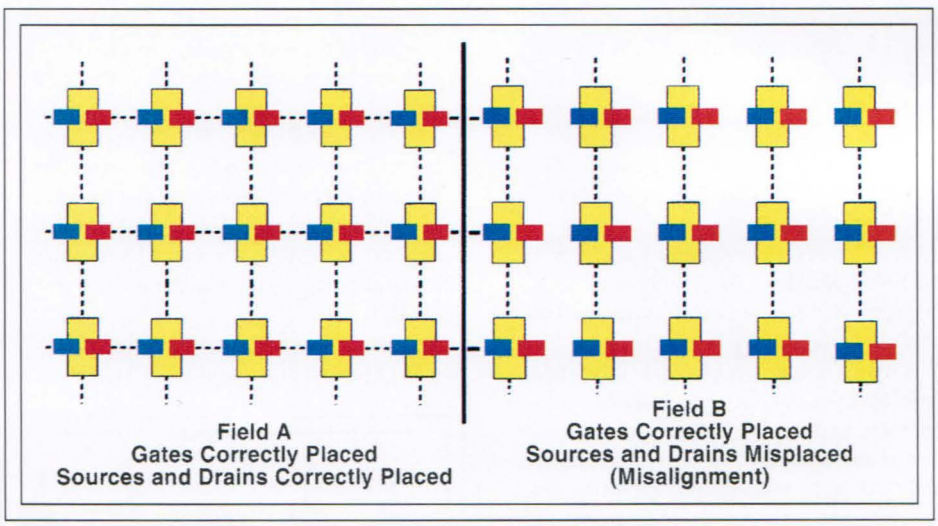


Fig. 5: In this panel, all transistor elements in Field A are correctly placed, but in Field B the sources and drains are misplaced relative to the gates. The transistor gain changes abruptly across the field boundary. If the gain difference is more than 1%, the boundary is visible to nearly all viewers. Quality-control inspectors would typically discard such a panel.

Their imperfections create a type of distortion in which, over a given region, the actual location of features gradually drifts farther and farther from the desired location (Fig. 6).

In the figure, all the features are perfectly placed in Field B. But in Field A, the gates move farther to the right of their target locations as they approach the field boundary. Fortunately, the sources and drains were deposited with the same lens (the same exposure tool), so they are displaced by an equal amount. The gain of the transistors is constant across the field boundary. The human eye can't perceive that the pixels in Field A are slightly displaced to the right. Practically speaking, this is a perfect panel!

It is critical that the gates, sources, and drains in Field A in the previous example

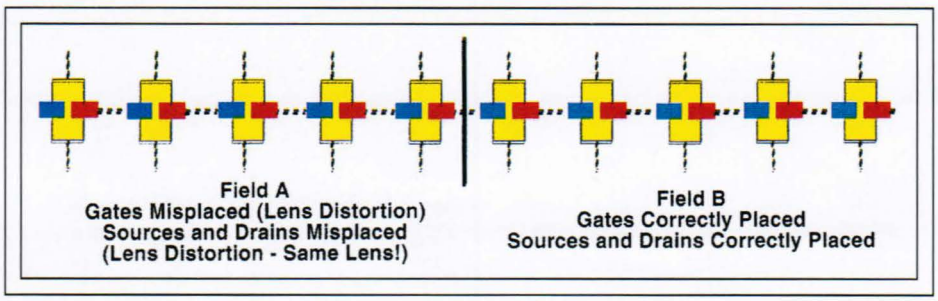


Fig. 6: *In this panel, all the features are perfectly placed in Field B, but in Field A all of the transistor elements move farther to the right of their target locations as they approach the field boundary. Fortunately, the sources, drains, and gates were deposited with the same lens, so they are all displaced by an equal amount. The gain of the transistors is constant across the field boundary, and the human eye can't perceive that the pixels in Field A are slightly displaced to the right. For all practical purposes, this is a perfect panel. (For simplicity, the figure shows only one row of transistors instead of an entire field of many rows.)*

have been fabricated with the same exposure tool. Let's see what happens when they aren't (Fig. 7). In Field B, as before, all the features are perfectly placed. In Field A, the gates show the effects of lens distortion – they increasingly move to the right of the target position as they approach the field boundary. But, in contrast to the previous situation, the sources and drains were not fabricated with the same exposure tool used for the gates. These elements are *correctly* placed in their target location and therefore asymmetrically placed on the gates. As a result, the gain of the transistors changes abruptly as we cross the field boundary. The quality-control inspector will see the boundary and will probably reject the display.[1]

A manufacturer can eliminate this type of problem by making sure each display goes to the same tool for the gate exposure as for the source and drain exposure. But this requirement can add considerable complexity, since the two steps are separated by a lengthy amorphous-silicon deposition process.

The Solution: Graded Exposure

In the conventional procedure we have been describing, the fields have "hard boundaries" – all the features in Field A are created during one step, all those in Field B are created during a separate step, etc. One possible class of solutions to the problem of differential overlay is to create fields with "soft boundaries." In this novel procedure, we "double-expose" features near the field boundary, with a partial exposure from the Field A step and a partial exposure from the Field B step. As a result, the gain of the transistors would change gradually across the graded double-exposed area, and the problem of abrupt changes across a "hard boundary" would disappear (Fig. 8.)

All of the features in Fig. 8(b) receive the same amount of radiant energy, but those in the region of the soft boundary receive it by a double exposure – some fraction of the total radiant energy from the Field A exposure and the complement from the Field B exposure. The row of transistors in Fig. 8(b) shows the effect of this graded exposure. The features move in a gradual transition from the characteristic position at the interior of Field A to the characteristic position at the interior of Field B.

Let's make this comparison more explicit. Figures 8(a) and 8(b) show 10 TFTs. In Fig. 8(a), the problem is the abrupt change in gain between transistors 5 and 6 in the row shown (and in identical rows above and below it). In Fig. 8(b), TFTs 1–2 and 6–10 are identical to those in Fig. 8(a). But transistors 3–5 show a gradual transition in degree of physical overlap, and therefore in gain, from that of transistor 2 to that of transistor 6.

Why Does Graded Exposure Work?

Since photolithography is an on-or-off process – there is no gray scale – the reader may wonder why the double exposure causes a gradual transition of the physical features across the soft boundary. Let's offer an intuitive explanation. Transistor 2 in Fig. 8(b) receives 100% of its exposure in Field A, and transistor 6 receives 100% of its exposure in Field B. In this schematic, the transition region spans only three transistors, but the transition region would span many more transistors in a real display.

It would be easy to imagine that some transistor near the left edge of the transition region might receive 98% of its radiant energy from Field A and only 2% from Field B, and that it would be very similar to transistor 2. It would also be easy to imagine that some transistor near the right of the transition region might receive only 2% of its radiant energy from Field A and the other 98% from Field B, and that it would be very similar to transistor 6.

A transistor in the center of the transition region would receive 50% of its radiant energy from Field A and 50% from Field B. This transistor would receive the maximum degree of "blurring" from the double exposure. Its position would be centered with

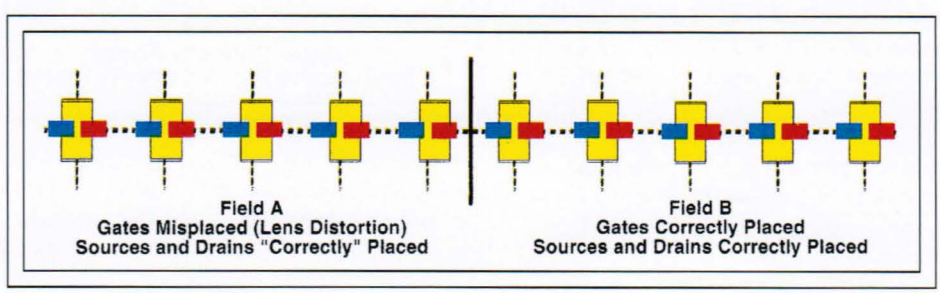
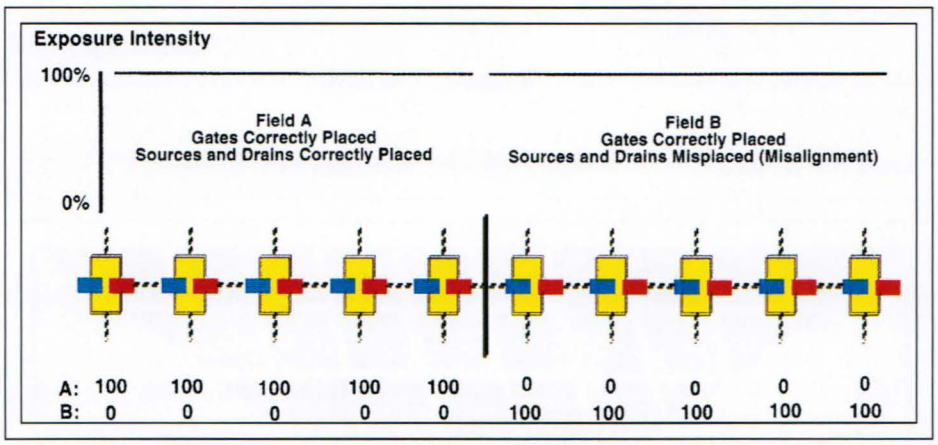
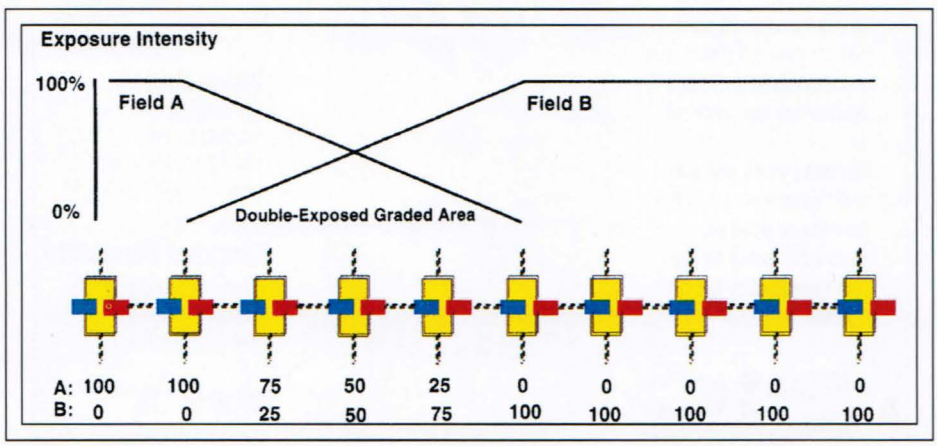


Fig. 7: *Problems can arise when all transistor elements are not placed with the same lens, i.e., with the same exposure tool. In Field B, just as in Fig. 6, all the features are perfectly placed. In Field A, the gates show the effects of lens distortion: they increasingly move to the right of the target position as they approach the field boundary. But, unlike Fig. 6, the sources and drains were not fabricated with the same exposure tool used for the gates and are* correctly *placed in their target location. They are therefore asymmetrically placed on the gates. As a result, the gain of the transistors changes abruptly as we cross the field boundary. The quality-control inspector will see the boundary and he will probably reject the display.*



(a)



(b)

Fig. 8: (a) The conventional procedure, which was also illustrated in Fig. 5. Above the transistors, one can see a plot of exposure intensity vs. position for each field. The exposure is nominally 100% everywhere, and the fields do not overlap. (b) The novel graded-exposure solution. The exposure intensity remains at 100% over the central portion of the field, but it diminishes linearly toward the periphery, reaching zero at the field edge. The exposure gradient at the edge of Field A overlaps the exposure gradient at the edge of Field B. As a result of this graded exposure, the features make a gradual transition from their characteristic position at the interior of Field A to their characteristic position at the interior of Field B. Because the gain changes gradually across the soft field boundary, the panel is good.

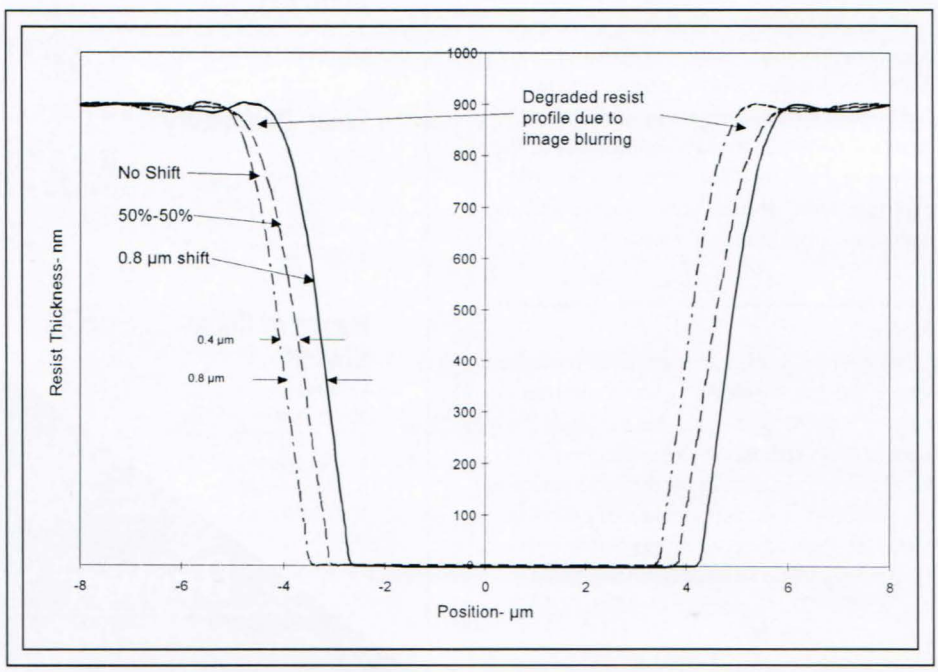


Fig. 9: Graded exposure slightly degrades the resist profile, but this would not affect the source–drain structures made by etching through the resist. The only effect is a gradual transition in the position of successive physical features.

respect to the features on both extremes of the transition region.

The blurring has only a minor effect on the resist shape (Fig. 9). The figure shows the resist profile arising from the different exposure conditions. Although the resist shape is degraded for the 50-50 exposure, the degradation would not affect the source–drain structures made by etching through the resist. The only effect is a gradual transition in the position of successive physical features.

Creating a Graded Exposure

There are several ways to take an intensity exposure linearly to zero at the edge of the field. One way is to introduce a graded filter. Another is to build a graded filter into the reticle by depositing a layer of chrome with graded thickness around its periphery. Yet another possibility would be to introduce "out-of-focus" blinds in the projection equipment.[2]

There is only one main disadvantage to using graded exposures: reduced throughput. In the conventional procedure, the six fields illustrated in Fig. 2 abut each other. In the graded-exposure procedure, the six fields overlap at their edges, so they cover a somewhat smaller area.

How severe is the reduction of the area caused by graded exposure? Another way to ask that question is this: How wide a transition region do we need to ensure that the entire display looks continuous to the human eye? To the best of our knowledge, the experiments that would answer that question have not yet been done. But we believe that manufacturers of step-and-repeat projection equipment for AMLCD displays will soon have the answer and that they will soon view graded exposure as an essential technique for remaining competitive in the marketplace.

Notes

[1]Misalignment and lens distortion can move the source and drain vertically as well as horizontally with respect to the gate, but we have ignored these vertical misalignments because they have no implications for the performance of the transistors or the appearance of the display.

[2]See J. P. Rominger, "Seamless Stitching for Large-Area Integrated-Circuit Manufacturing," *SPIE* **922,** *Optical/Laser Microlithography*, 188 (1988). ■

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

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

The Sun Shines on DMTC '95

An exciting industry plans its future in the face of waning U.S. Congressional support.

by Ken Werner

THE SECOND Display Manufacturing Technology Conference (DMTC '95), held in Santa Clara, California, from January 31 to February 2, 1995, began as watery sunshine ended a string of 27 rainy days, one day shy of a Silicon Valley record. That watery sunshine was symbolic because this conference was marked by growth, energy, and anxiety.

The growth was obvious. Registered attendees for the technical conference grew 26% from last year to 480. A total of 875 people attended the conference, the exhibits, and related activities, up from 500 last year. Fifty-two mostly happy exhibitors held forth on the show floor – the first time formal exhibits accompanied a DMTC.

The energy was obvious as well – in the technical sessions, in the hallways, in the deal-making, and in the press conferences. At one press conference, the Society for Information Display (SID), the United States Display Consortium (USDC), and Semiconductor Equipment and Materials International (SEMI) announced that next year DMTC would be incorporated within Display Works 96, a larger conference, jointly sponsored by the three organizations, that will be held February 6–8, 1996, at the San Jose Convention Center.

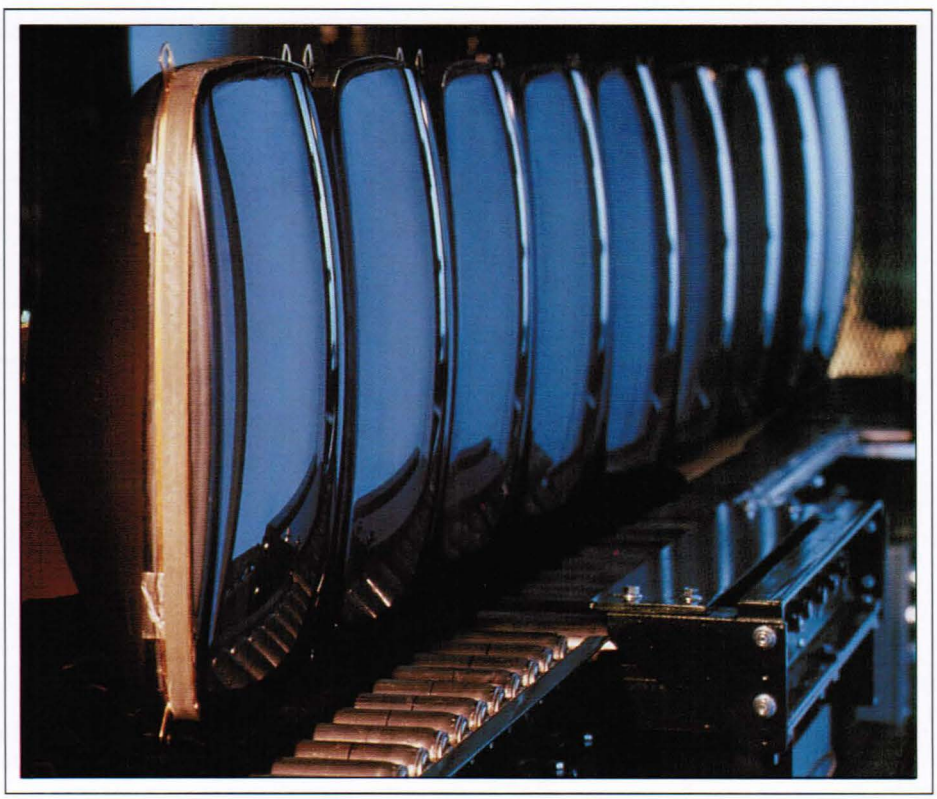
The anxiety was the result of cross-continental emanations from Washington, D.C., where Congressional budget-cutters were targeting some of the programs that had already begun to revitalize flat-panel-display (FPD) manufacturing in North America.

Ken Werner *is editor of* Information Display Magazine.

The Small Shall Inherit the Earth

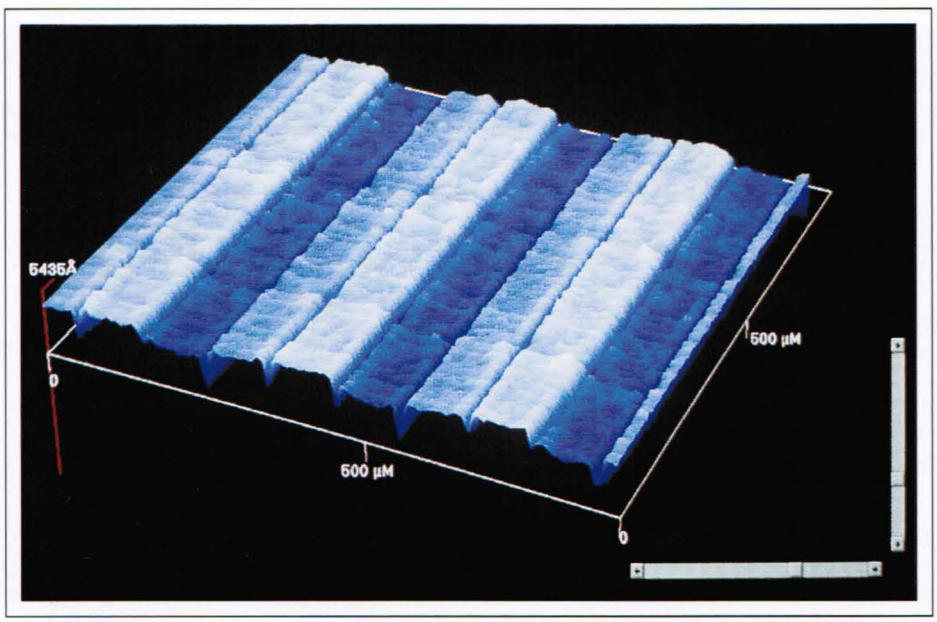
In a riveting keynote address, Wyckham D. Seelig (Global Manufacturing Planning Vice President, AT&T Global Manufacturing and Engineering, Berkeley Heights, New Jersey) told the occupants of a crowded ballroom at the Santa Clara Convention Center that most of what they believe about the future of display manufacturing is wrong – and the audience loved it.

Although state-of-the-art LCD factories now cost half a billion dollars, Seelig pre-



Viratec Thin Films

Viratec's new CaRT process for applying conductive anti-reflective coatings directly onto the CRT face is implemented with the only large-capacity in-line CRT coating machine of its kind in the world. It can accommodate tube sizes up to 35 in. on the diagonal.



Veeco Sloan Technology

Veeco Sloan Technology demonstrated its 3-D rendering package that allows most stylus-based surface profilers to produce, for the first time, full-color three-dimensional images of surface features. This is the surface of a color filter.

dicted that the size and cost of an economical LCD plant would become much smaller over the next 15 years – as they will for manufacturing plants generally. The reason, Seelig believes, is that information technology and high-speed multimedia communications will drastically reduce the two fixed-cost components associated with starting a manufacturing operation.

The two fixed-cost components, said Seelig, are knowledge costs and facility costs – with the cost of knowledge and expertise being greater than the cost of bricks and mortar. By the year 2010, it should be possible to clone the knowledge part of the fixed-cost structure, essentially for free. The remaining necessary investments will be relatively short-lived educational experiences – probably distance learning to educate and train the workforce. Human relations specialists, technology specialists, and accounting specialists "will be able to 'appear' at the newly cloned facility in a virtual-reality form which is nearly indistinguishable from the real thing."

Facility costs would be minimized by a growing ability to "plug together" individual capabilities. This would permit us to variabilize capital costs – right down to zero, if necessary. The idea is an extension of contract electronics manufacturing – an industry that has grown from virtually nothing to more than $20 billion over the last 10 years. "The notion," says Seelig, "is simple: rather than investing your assets in physical facilities, and then having to worry about keeping them productively employed, why not *share* these assets with lots of other companies and let someone else worry about utilization. The trend is to reduce economic break-evens to the point that it is no longer necessary to spend tens, hundreds, or even thousands of millions of dollars to get into manufacturing."

Seelig was speaking to an audience of people whose futures may depend on establishing flat-panel-manufacturing facilities inexpensively, so it should come as no surprise that his message brought down the house.

The Big Picture

DMTC's first technical session, "Retrospect and Vision of Display Manufacturing," opened with an invited address by the distinguished Shinji Morozumi of Hosiden, Kobe, Japan. Morozumi began by thanking the many well-wishers who had expressed their concern following the Kobe earthquake; Hosiden's suppliers, who had worked hard to help the company get back into production quickly; and the company's customers for their understanding. Hosiden's factory is located 10 miles from the fault line, and the damage was not catastrophic. The company expected to be back to 50% production during the first week of February and to full production a couple of weeks later.

In the main part of his talk, "The Present and Future of AMLCD Production," Morozumi focused on the evolution of AMLCD-manufacturing technology and its business consequences. Low-volume first-generation production of AMLCDs suitable for laptop computers began in 1988. About 1990, the plate size was enlarged, which allowed two 10-in. panels to be produced per substrate. But even when process and design improvements raised yields to between 50 and 70%, it was impossible to reach the price target of $500. Second-generation factories began production in 1994. A plate size of about 370 × 470 mm yields four 10-in.-class panels per plate, and cluster tools permit increased robotic handling while using 50–70% less floor space than the in-line tools of first-generation factories. Throughput is three to four times greater, and production yields in excess of 70% are expected. Morozumi expects the price of a 10-in. display in OEM quantities to be $500 by the end of 1996.

Third-generation production is expected to begin about 1997, probably with a plate size of 550 × 650 mm. This will permit the production of four 15-in., six 12-in., or nine 10-in. displays per plate, and should bring the price of a 10-in. display under $400. In spite of the advantages of polysilicon in reducing driver costs, amorphous silicon should dominate in these sizes through the third generation.

Dan McGill presented "Flat Panel Display Manufacturing at Sharp Microelectronics Technology, Inc." The 156,000-ft.^{2} facility in Camas, Washington, receives bare panels whose cells were formed at Sharp's plant in Nara and whose TFTs were fabricated at Tenri. Camas completes the assembly from that point. The facility's success, said McGill, depends on careful selection and training of employees, scrupulous process and quality management, and employee empowerment – which includes cross-training, multi-tasking, team problem-solving , and employee input to process design.

As an interesting historical note, Camas was originally a combined Sharp/RCA facil-

ity, joining the company that invented the LCD with the company that became its foremost developer. But when General Electric purchased and then liquidated RCA, Sharp bought out the GE interest.

In "Effects of Plant Scale on AMLCD Amortization Costs," Charles McClaughlin of O'Mara & Associates and Steven Jurichich and colleagues from Stanford University looked at the per-panel contribution of plant amortization for first-, second-, and third-generation plants. Looking at the capacity and investment data for AMLCD plants reported in Nikkei Microdevices' annual publication, *Flat Panel Display*, and figuring a 70% yield in each case, the authors concluded that a panel produced by a typical second-generation plant would have a selling price that is $100 less than that produced by a first-generation plant, all other factors being equal. Interestingly, the authors projected that a third-generation plant producing six displays per plate would be only marginally more economical, based on per-panel amortization, than a second-generation plant. To enjoy a benefit equivalent to that of the second-generation plant's benefit over a first-generation plant, the third-generation plant would have to produce nine displays per substrate.

The Technical Sessions

DMTC's technical papers covered CRT alignment, conductive adhesive bonding, standards, and the manufacturing economies of microenvironments. Here are a few examples.

In a standards overview session, SEMI's Christine Dannels described her organization's extensive manufacturing-industry standards program, which includes standards for sizes of FPD substrates and specifications for FPD glass substrate cassettes. Zenith's Bill Rowe discussed the different categories of the standards industry – national, military/governmental, and international – and the important role SID's standards committees could play as a coordinating body that prevents proliferation and confusion. But this can only happen if the companies that employ SID's members are willing "to apply their resources to address this challenge."

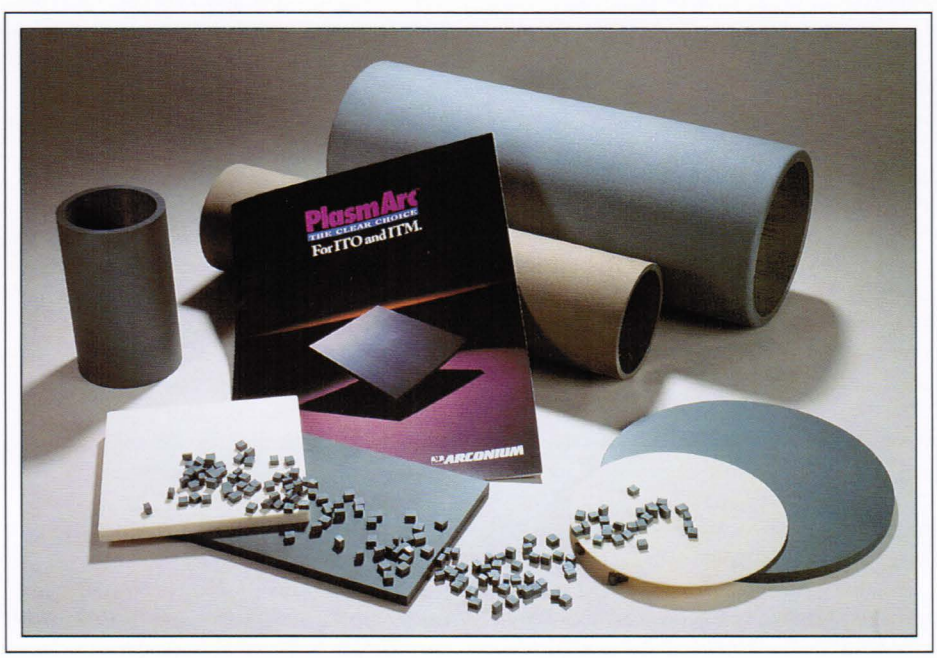
Scott Vouri, Chairman of the Video Electronics Standards Association (VESA), discussed the activities of VESA's Monitor Committee. The completed standard for the Display Data Channel (DDC) uses one of the ground lines in a standard VGA cable to provide two-way communication between the monitor and controller, and can implement Intel's plug-and-play protocol. VESA's Flat Panel Display Interface (FPDI) committee is developing a standard for the logical, electrical, and physical interface between graphics controllers and FPDs. The goal is to make FPDs as interchangeable as CRT monitors are today. In an interview with *Information Display* following his talk, Vouri expressed deep interest in working with SID on this and other programs, and noted that there was a substantial overlap in SID and VESA membership. Another VESA project is the development of the Enhanced Video Connector (EVC). With the growing popularity of multimedia, the back of a computer is often a rat's nest of cables for audio input and output and video input and output, and the monitor has become the natural location for speakers and a video camera. The EVC would replace all of these cables with an enlarged display cable. Laptop docking stations would be obvious beneficiaries of such a standard.

The team of Rudy Mui (Photon Dynamics), Renée Mello-Robinett (Wilson McHenry Company), and David Mentley (Stanford Resources) looked at the tradeoffs in factory-testing AMLCDs between capital cost and increased yield and quality. They concluded that at a yield level of 65% (without testing), fully automated testing is the most economical approach by a substantial margin. In response to a question from Peter Brody, Mui said he believed that automated testing would be viable up to about a 90% (untested) yield.

Dan Hawley and Jonathan Mayo (Brewer Science) discussed the challenges of producing color filters (CFs) in a low-volume non-captive production facility. Brewer has been operating a pilot facility for 2 years, has learned some lessons, and will have expanded to a 4000-sheet-per-month plant by the time you read this.

In a late-news paper, a team of authors from the Phosphor Technology Center of Excellence at Georgia Tech and SI Diamond discussed the development of low-voltage phosphors with longer lifetimes and lower voltage thresholds. These phosphors can be run at higher current densities, resulting in displays with higher luminance and efficiency.

Tom Swirbel described Motorola's prototyping facility that achieves 5-day turnaround, from design through electrical test, of new TN and STN displays. Developing the facility



Arconium

Arconium showed its PlasmArc line of indium tin oxide (ITO) materials, which are fabricated into products designed for physical vapor-deposition processes.

was difficult, but, "once implemented, in-house LCD prototyping has become a valuable tool to improve the product development cycle."

In "Manufacturing Economics: Optimizing the Layout of a Flat Panel Display Manufacturing Facility," Abbie Gregg (AGI) discussed the benefits of conceptual design, or "programming," as a first step in optimizing the layout and cost of a new or retrofitted facility. Along the way, she commented that the use of mini-environments within a Class 1000 room can reduce initial costs by 35% compared to constructing Class 10 clean rooms.

The Exhibits

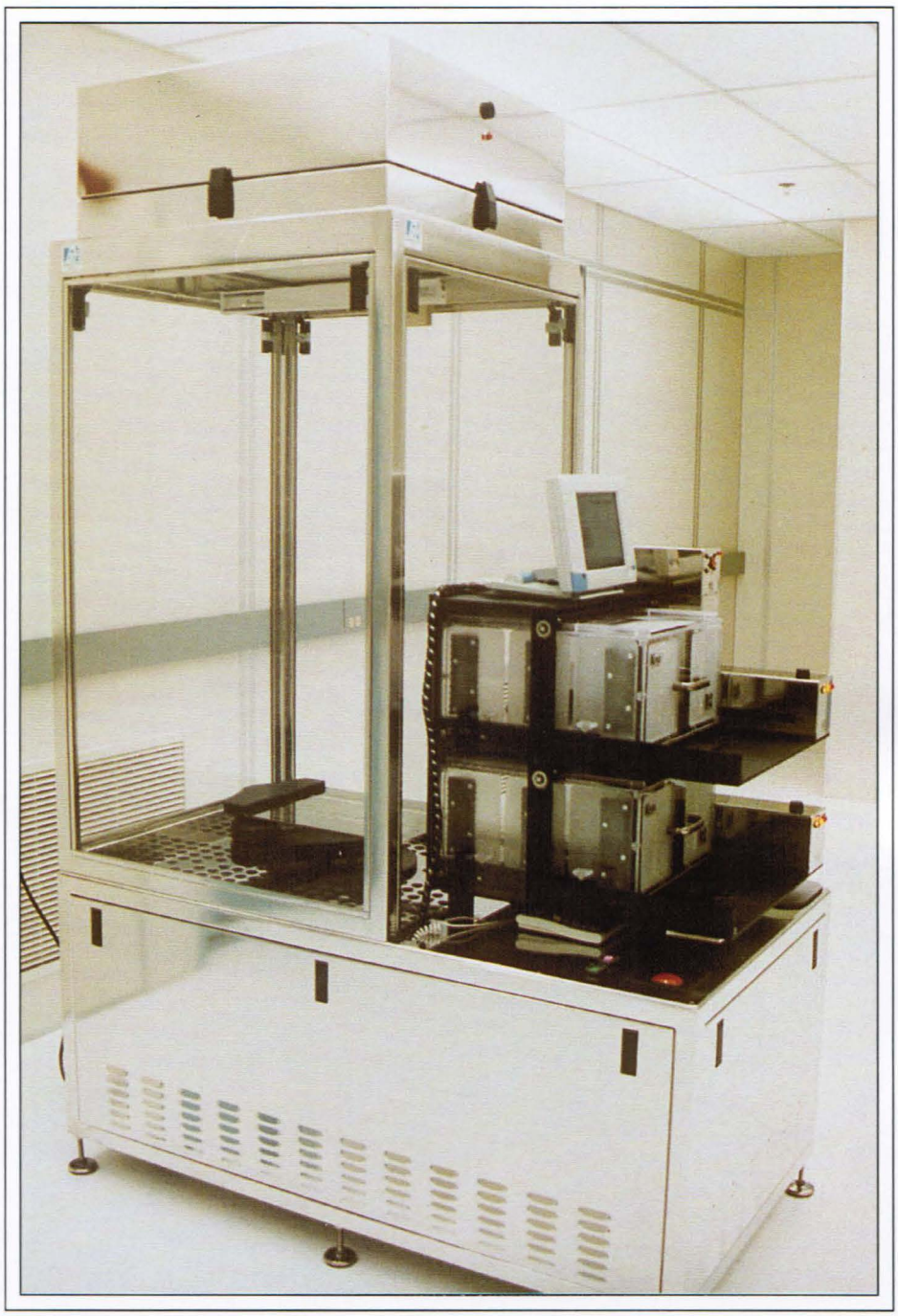
The 52 exhibitors occupying 63 booths at DMTC '95 included makers of manufacturing equipment, instruments and test equipment, materials, and consulting services. Most exhibitors reported traffic that was light to moderate, but with a high quality of contacts that made most of them happy. The few dissatisfied exhibitors were balanced by those who attracted a disproportionate amount of traffic and complained about being *too* busy. Here's a sampling of the exhibitors.

Tencor introduced its FP-20 Windows-based stylus profiler for substrates up to 650 × 650 mm. It uses an exceptionally low stylus force – as little as 0.05 mg – and will not damage even the softest surfaces. Tencor also introduced its FLX-2350FP thin-film stress-measurement system for samples up to 500 × 500 mm – unusually large, says Tencor.

EG&G Gamma Scientific showed their RadOMA anti-reflection-coating measurement system for QA and production environments, and their luminance and color-measurement system, which is suitable for FPDs. The system is the most accurate available, says the company, and it's NIST traceable.

Microchemistry, Ltd., and its U.S. rep **Advanced Thin Films** were introducing a new-generation machine for atomic-layer epitaxy (ALE) – its unique technology for large-area thin-film manufacturing. ALE reactors are now available for substrates as large as 14 × 16 in. **AIRCO** was showing its C-MAG® PLUS cylindrical sputtering system for thin-film coatings. The cylindrical system permits high target utilization and less down-time for target changes, says AIRCO.

Hörnell Automation of Sweden was showing production equipment for LCD cell assembly. The company touts its modular equipment that combines high quality and a reasonable price. Hörnell is optimistic about the U.S. market and will be establishing a U.S. organization. **Fairchild Convac** showed a modular minimum-footprint high-through-

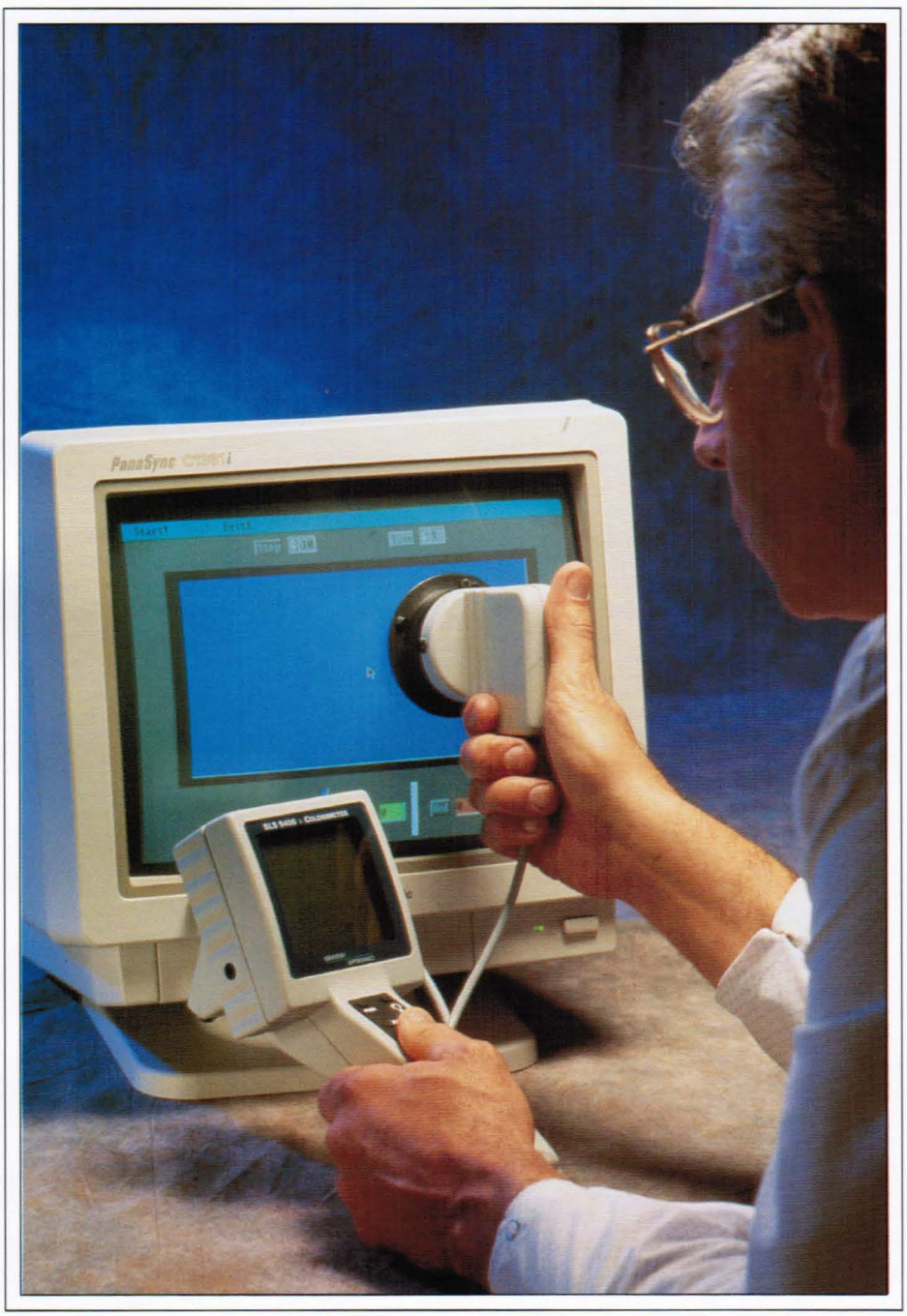


Progressive System Technologies

Progressive System Technologies exhibited a system in which FPDs are housed and transported between manufacturing tools in cassettes the company calls Kpods. It is more economical to maintain very clean conditions within the mini-environment of the Kpod than to maintain an entire room at Class 1 or Class 10 standards.

put system that coats, develops, etches, and/or cleans. The system can perform one or any combination of these steps.

Quantum Data introduced its 250-MHz PC-based 801GF-ISA video test generator with Windows™ interface, and the 150-MHz 801GC-ISA. **TEAM Systems** reported lots of interest in a digital generator well-suited to driving FPDs. TEAM's George Stoeppel said such a generator would provide 8 bits each for RGB, with each channel controlled independently, a dot clock that can run up to 120 MHz, and an adjustable delay of 4–32 ns between the clock and data. Not too surprisingly, TEAM has a new generator that fits this description: the Astro VG-825.



Graseby Optronics

Graseby Optronics introduced its SLS 9400 hand-held CRT colorimeter at DMTC '95. The company says the 9400 puts laboratory-grade precision in an affordable ($4995) hand-held unit.

Photo Research showed their PR-940G stereoscopic dual-camera imaging system for automatic geometry adjustments of CRT monitors. The monitor being adjusted does not require critical positioning: ±15° and ±15 cm (z-axis) will do just fine. Cycle test time is 0.2 s, and up to 32 controls can be adjusted simultaneously. Final values of the adjustments can be written back to the monitor's EEPROM to become the defaults for the unit. **Minolta** introduced its CC-200 on-line convergence instrument, which moves the simultaneous RGB measurements of the CC-100 to a production system.

ELDIM (France) introduced a non-mechanical system for measuring contrast and colorimetry of LCDs *vs.* viewing angle. The system, controlled with Windows™-based software, uses a CCD sensor, but "the optics are the most important part." A contrast map can be generated in less than 5 s, a capability that ELDIM's sales director took obvious delight in demonstrating. **n & k Technology** introduced a proprietary system that does complete optical characterization of thin films, such as ITO and amorphous silicon, on either transparent or opaque substrates, replacing three traditional instruments. The system won a 1994 R&D 100 award from *R&D Magazine.*

TNP showed its laser-repair system for color filters. It can trim the high spots by 1-µm thickness at a time, and can accommodate 20 × 20-in. substrates. (Why a 20 × 20 system was named the Model 2424-L was the topic of some good-natured conversation.) **Arconium** displayed their PVD materials for optical coating, including ITO sputter targets engineered for "highly stable, reproducible, long-life performance in FPD coaters."

Lucas Signatone demonstrated an 8-in. high-speed automatic short finder and laser-repair station for FPDs. At under $300,000, the system is said to fill the niche between manual systems and $500,000 fully automated non-contact systems.

Microphase was demonstrating its abilities to make 24-in.-sq. masks with 2-µm geometries for contact, proximity, and projection printing without stepping for FPD photo-

lithography. **Telic** was showing their chrome mask blanks, and introducing the ability to go to 24 × 24 in. (These are the blanks Microphase had used for their large masks.) Telic also introduced their fringeless resist coating with a uniformity of ±500 Å on a 10,000-Å coating.

XMR introduced their Model 5300 200-W 308-nm excimer laser and the ELA 9100 excimer-laser annealing tool for manufacturing polycrystalline-silicon layers for FPDs. **Delatech** was presenting information on its exhaust-gas scrubbing equipment for FPD manufacturers. The company claims the highest scrubbing efficiency and lowest overall cost of ownership. Customers include Intel and Motorola.

Brooks Automation was discussing its Hercules series of third-generation cluster tools for FPD manufacturing. The system – the only one of its kind currently available – is going into the world's first third-generation FP production facility in Japan. **Terapixel** (Finland), maker of large-area photomasks, was exhibiting for the first time in the U.S., and President Arto Salin was very happy with the results. Main applications for their masks are FPDs and CRT shadow masks.

Leybold introduced its new SSP600 static sputtering tool, and identified itself as the European and U.S. market leader for display sputtering applications. **SSI** was promoting its APEX FPD-500 large-substrate photoprocessing system. The company's second order was from Xerox.

MRS was presenting information on its 5200 series Panel Printers™ featuring the new high-resolution lens and second-generation graphical-interface program. The system can handle substrates up to 500 × 500 mm with a resolution of 2.5 µm. **Semitool** introduced its new Centurium, a fully automated batch-processing system used for wet etching, photoresist stripping, photoresist developing, and plate cleaning.

In its booth and in a technical session, **Display Inspection Systems** described its proprietary technology – black-beam interferometry – for rapid submicron testing of polished surfaces. The technology was developed with support from USDC. **Florod** introduced a laser frit-sealing system and its Random Access Multi-Probe (RAMP) testing system that simultaneously probes 96 points for electrical testing on ITO panels.

Graseby Optronics introduced its SLS9400 hand-held colorimeter with four proprietary detector/filter combinations. **Veeco Sloan Technology** introduced a 3-D modeling package that works with most FPD surface profilers.

SensArray showed its substrate embedded with an array of thermocouples for process control and improvement, along with data acquisition and analysis software. The software is available in a Windows™-compatible version written on a LabView base and in a Mac version. **Tamarack** introduced a scanning projection lithography system it described as a "totally new technological alternative to stepper and proximity printing. It is faster and lower in cost than steppers, with no stitching. The yields are much higher than proximity printing."

MRC presented information on production sputtering for ITO, metals, and SiN_x. The company has recently expanded its development-level system to full-scale production. **MDC** showed its wide range of mechanical vacuum components that attach to a vacuum chamber.

Steag presented information on its full lithography system – including a capillary coating system, spin developers, etchers, cleaners, and strippers – and its GenOS optical system for transparent thin-film thickness measurements.

Holtronic Technologies introduced its HMA400 large-field lithography exposure tools. The tools use a holographic technique that allows 0.5-µm features to be printed over a 21-in.-diagonal field in a single exposure. Technology development was supported by the European Community's Esprit program for supporting technology development. ■

Products on Display at SID '95

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

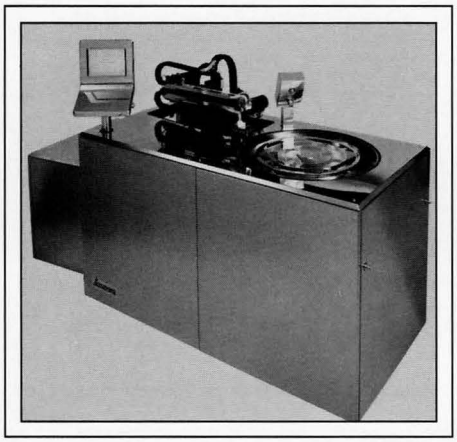
by THE EDITORIAL STAFF

THE SID '95 INTERNATIONAL SYMPOSIUM, SEMINAR, AND EXHIBITION will be held at the Walt Disney World Dolphin just outside Orlando, Florida, the week of May 21. For 3 days, May 23–25, 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.

ACCUDYNE CORP.
Palm Bay, FL 407/724-6500
Booths 209/308

Substrate cleaning machine

Accudyne will display their new substrate cleaning machine that was developed under the Spacer Applicator project sponsored by the United States Display Consortium (USDC). The cleaning machine can clean up to 500 × 600-mm substrates. This special machine features a megasonic cleaning head, plus surfactant and DI water dispense functions. The user-friendly PC touch-screen computer interface allows for complete flexibility as a modular stand-alone or fully automated system.

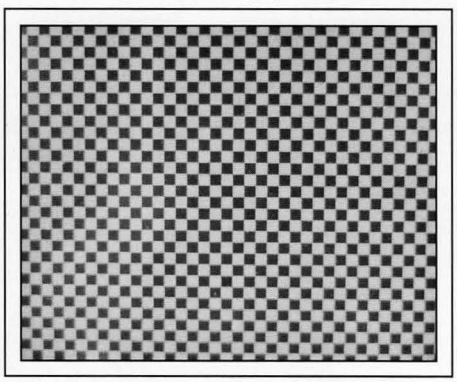


Circle no. 1

ADVANCED DISPLAY SYSTEMS, INC.
Richardson, TX 214/644-7796
Booth 507

High-speed reflective display

Advanced Display Systems (ADS) will introduce at SID '95 a revolutionary reflective display exhibiting high-speed zero-field multistability. The new multistable liquid-crystal display (MLCD) technology achieves these features for the first time without the use of polymer gels. With high speeds, this technology promises to capture a significant share of the notebook-display market. Recent developments include response times of less than 2 ms and contrast ratios over 40:1. In addition to long-term memory, no backlight or polarizers are required. Long-term memory enables high resolutions to be achieved that are unmatched by existing STN and TFT technologies. Color displays are planned.



Circle no. 2

ALLIEDSIGNAL, INC., MICROOPTIC DEVICES
Santa Clara, CA 408/565-0242
Booth 313

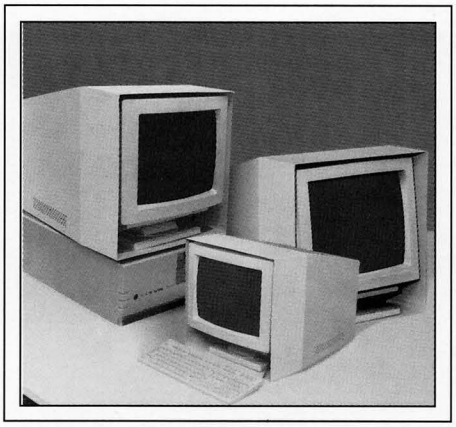
LCD viewing-angle enhancement system

MicroOptic Devices, a new venture of AlliedSignal, Inc., announces a new line of polymeric films which improve color and gray-scale performance of viewing angle for both active and passive LCDs. This breakthrough technology allows LCD devices to closely mimic, or even surpass, CRT performance. The system consists of an efficient, thin collimating backlight and a new diffusing screen incorporating a black matrix for high-ambient viewability. By taking advantage of the ability to control the output brightness distribution, system power consumption can be reduced. Also, modified STN- and TFT-LCD products in sizes up to 10.4 in. on the diagonal will be on display.
Circle no. 3

AMUNEAL MANUFACTURING CORP.
Philadelphia, PA 215/535-3000
Booth 631

VDT shielding enclosure

To protect against jitter, loss of color integrity, and distortion in video-display images due to magnetic interference, Amuneal is offering a new video-display-terminal (VDT) shielding enclosure fabricated in a sloped design to aesthetically conform to the shape of any monitor. The shield is guaranteed to restore color integrity and eliminate such problems as distortion, jitter, and waviness caused by strong magnetic fields generated by ac or dc sources. After fabrication and hydrogen annealing to maximize shielding effectiveness, the VDT is painted to match monitor or office decor, and will install in minutes over the existing terminal without tools.



Circle no. 4

BREWER SCIENCE, INC.
Rolla, MO 314/364-0300
Booths 132/134

Color-filter panels

Brewer Science has made substantial investments in clean-room expansion and equipment purchases for their color-filter-panel fab operation to increase capacity to 4000 sheets of glass per month. When complete, the fab will have two photo towers and be capable of processing glass sizes ranging from 300 × 300 mm up to 450 × 500 mm. The Optical Materials Division began producing patterned color-filter glass commercially for LC and EL displays in 1993. Brewer Science will be displaying 355 × 405-mm color-filter sheets with a 9-up panel design. These 125 × 125-mm panels will feature 100-μm red, green, and blue stripe patterns.
Circle no. 5

BRITEVIEW TECHNOLOGIES, INC.
Holland, OH 419/868-7290
Booth 645

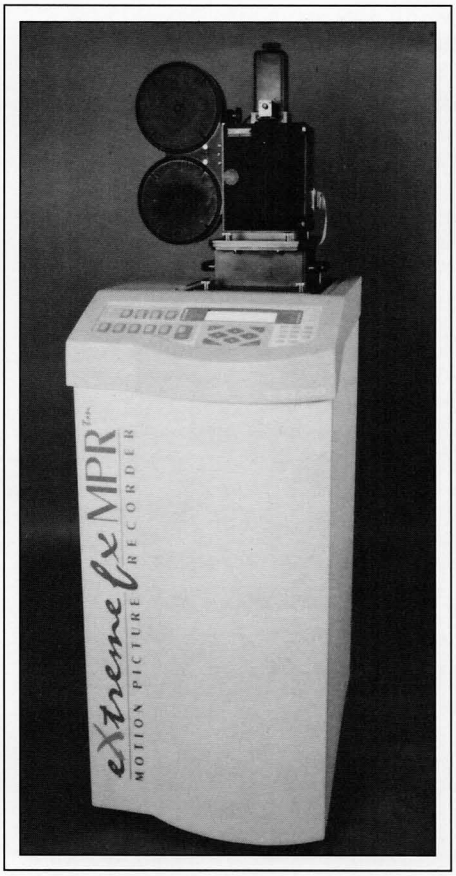
Flat-panel illumination system

BriteView Technologies will feature a thin, flexible, and energy-efficient flat-panel illumination system. This novel lighting system can be made transparent so that it is suitable for frontlighting reflective-type LCDs. When used as a transparent backlighting system, an LCD module can use ambient light for enhanced illumination and become suitable for outdoor, all-weather applications. It can also make an LCD-module system suitable for direct view as well as projector applications.
Circle no. 6

CELCO
Upland, CA 714/985-9868
Booths 331/333

Digital color film recorder

CELCO will display the *eXtreme fx* MPR digital color film recorder, which features fast recording speed, ultra-high resolution, and wide dynamic exposure range, providing the required performance for state-of-the-art special effects sequences and computer-animated motion pictures. The *eXtreme fx8* and *eXtreme fx16* models address the requirements of the professional photo lab. Interfaced with most popular computers/workstations, including SGI, SUN, MAC, and PCs, the CELCO digital color film recorders will image onto any format from 16 mm up to 8 × 10 in.



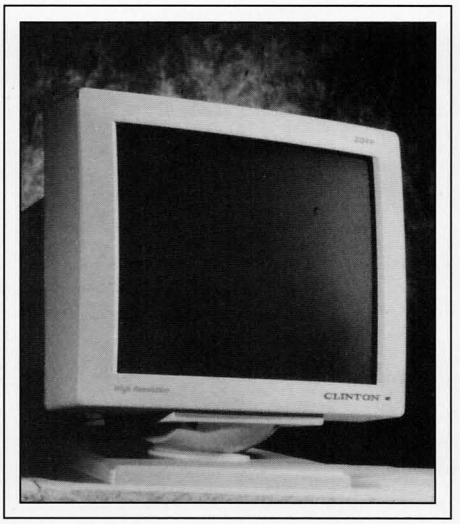
Circle no. 7

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

CLINTON ELECTRONICS CORP.
Rockford, IL 815/633-1444
Booths 113/212

Monochrome monitors and CRTs

Clinton Electronics will feature second-generation microprocessor-controlled monochrome displays with new on-screen user controls and MS-Windows-based user controls for complete integration into an OEM's video graphics driver. Clinton's family of high-resolution multi-frequency displays cover pixel formats from 768 to 1600 lines with either analog or 4-bit ECL input formats. New features include "NUTEK" compliance for energy conservation which makes these units even more green than "Energy Star." CRTs, part of Clinton's full line, will be on display, with new coatings and added value capabilities for integrated tube and yoke, plus contract assembly of display products.



Circle no. 8

CTX OPTO-ELECTRONICS CORP.
Hsinchu, Taiwan 886-35-772000
Booth 206

New-generation LCDs

CTX Opto-Electronics will display their Panoview series of LCDs combining state-of-the-art technology with advanced ergonomics. These LCDs feature sharp images in brilliant color from screens that are easy on the eyes and offer reduced glare, reduced reflection, and negligible radiation. Sleek, slim, and one-tenth the size and weight of conventional CRT monitors, these LCDs adapt easily to any environment – desk mount or industrial FPD use – and offer direct RGB input, low power consumption, touch-screen interface, and nine different designs to choose from.

Circle no. 9

DIMENSION TECHNOLOGIES, INC.
Rochester, NY 716/436-3530
Booth 605

Full-color autostereoscopic display

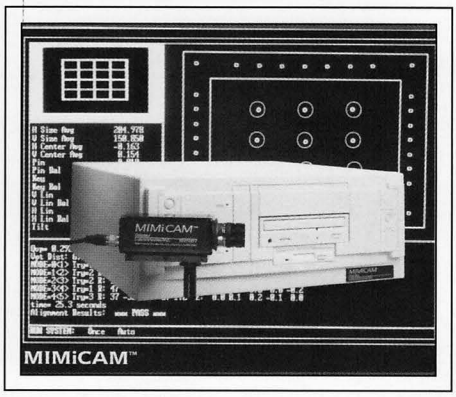
Dimension Technologies (DTI) will feature the 1100C Virtual Windows™, a portable, full-color, autostereoscopic display which produces computer-generated or video images with depth. Since the images are viewed without 3-D glasses, the user can move about freely. An integrated head tracker allows image rendering and/or camera movements to be coupled to the user's head movements. A wide range of computers and video cameras can be used for input. This display is ideal for many applications, including teleoperations, inspection, and endoscopy.

Circle no. 10

DISPLAY LABORATORIES, INC.
Boulder, CO 303/938-9099
Booth 114

Automatic alignment and inspection

Display Laboratories, Inc., will feature the MIMiCAM™, a single-camera vision system that performs automatic alignment and inspection of CRT monitors *without* operator intervention. The MIMiCAM system measures the geometry of images displayed on a monitor and aligns it to factory specifications. It features a simple menu-driven multi-window interface providing the alignment process with graphical, text, and video feedback. By referencing the known dimensions of a 3-D model of the monitor, the video image is converted to a set of flat-plane measurements by software exclusive to MIMiCAM. This patented software produces the highest level of accuracy in a "hands-free" production environment.

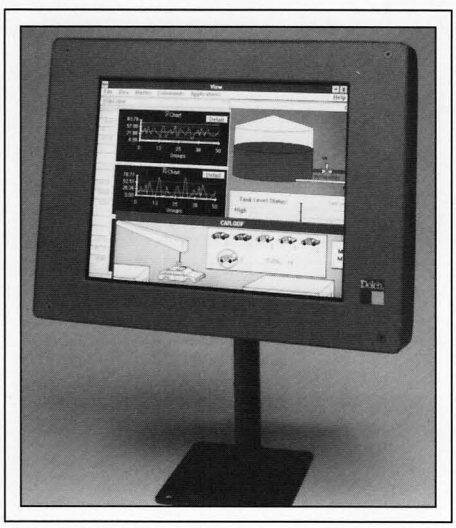


Circle no. 11

DOLCH COMPUTER SYSTEMS
Milpitas, CA 408/957-6575
Booth 312

Stand-alone flat-panel displays

Dolch Computer Systems will feature DataView™ flat panels designed to display data in cramped or rugged conditions where displays can be kept out of the way while displaying sharp, brilliant, active-matrix colors. They are well-suited to serious scientific, medical, industrial, and military uses, where instrument process control requires visual precision and high resolution. With nothing added, the display can be used as a normal analog VGA CRT monitor. With the use of Dolch's proprietary plug-and-play flat-panel video controllers, the DataView™ can be remotely tethered to an industrial computer, and with Dolch's line drivers, can be remoted up to 150 ft. It is compliant with the most widely used PC/AT hardware, operating systems, and applications software. Options for touch-screen program control, NTSC input, and VCR/TV enhance the display for custom applications. Sizes range from 8 to 14 in.



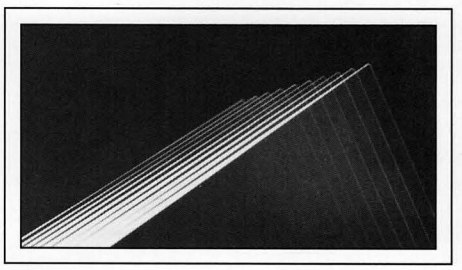
Circle no. 12

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

DONNELLY APPLIED FILMS CORP.
Boulder, CO 303/530-1411
Booth 632

Transparent conductive coatings

In addition to an extensive line of display-quality indium tin oxide (ITO) coatings for the LCD industry, Donnelly Applied Films Corp. will introduce an improved line of substrates suitable for color STN, color EL, AMLCD, and FED product manufacturing. A wide range of transparent conductive thin-film characteristics are available in a variety of substrate sizes and thicknesses. Color front-plate black-matrix thin-film-coated substrates will also be featured. These metal oxide/metal coatings are durable, optically opaque thin films that can easily be patterned to produce an attractive color LCD.

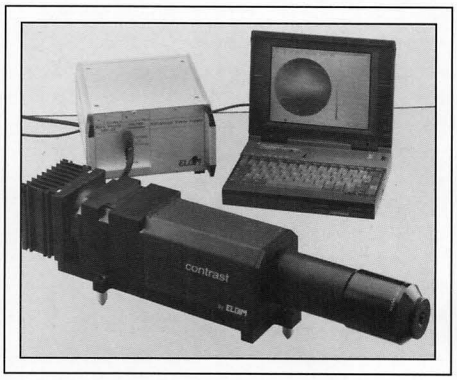


Circle no. 13

ELDIM
Caen, France 33-31-94-76-00
Booth 305

LCD spatial colorimeter

ELDIM will introduce the EZColor colorimeter, a fast and accurate system for colorimetric and photometric *vs.* viewing-angle characterization. The system allows testing in near real time in the lab or in production, which is currently difficult with conventional mechanical instruments. Measurements are realized from ±60° incident angle with 0–360° azimuth in less than 20 s due to a unique conoscopic technology (3 s for luminance). A cooled dedicated CCD, coupled with three stable color glass filters, allows high accuracy and repeatability. Results are displayed in color plots, and in CIE numerical mod, both for subjective and objective evaluation. EZColor software provides the ability to develop custom applications for raw data treatment and remote control. Customer sample testing will be available at SID '95.

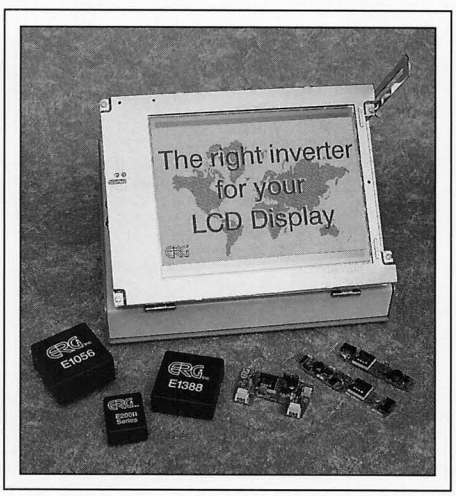


Circle no. 14

ENDICOTT RESEARCH GROUP, INC.
Endicott, NY 607/754-9187
Booth 224

dc-ac inverters

Endicott Research Group (ERG) will be exhibiting advanced dc-ac inverters for powering cold-cathode fluorescent tubes (CCFTs) used in flat-panel LCD assemblies. Designed to be the most efficient and best-matched inverters available, ERG's E200II and 8m class inverters are tailored to the specifications of individual flat-panel LCD assemblies to ensure complete system compatibility. ERG will also be displaying its extensive capabilities for custom-designed power supplies that meet specific requirements for electrical specifications, packaging, and other parameters. Other products on display will include inverters for EL displays and converters for gas plasma and vacuum fluorescent displays.

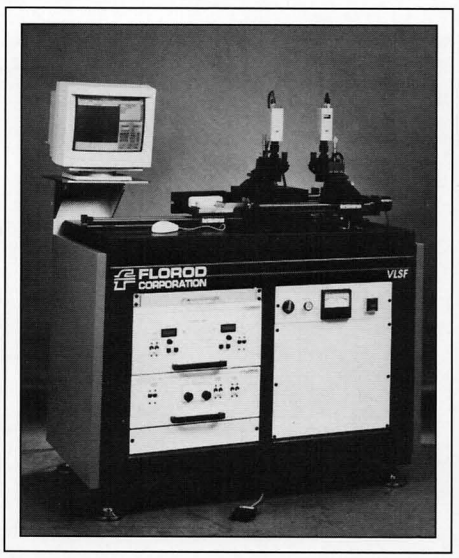


Circle no. 15

FLOROD
Gardena, CA 310/532-2700
Booth 230

Laser frit sealer

Florod will feature the Model LFS laser frit sealer that provides a vacuum seal of FPD glass panels, either at a selected spot or around the periphery of the panel. This computer-controlled system includes the laser, vacuum/nitrogen oven, laser stage, and Windows-based PC. The oven heats and cools the substrates/frit material at a programmable rate. The oven can be controlled within ±3°C. A manual stage system transports the panels from the manual load station. The stage transfers the panel to a holder inside the oven. The panel remains motionless while the laser fiber-optic beam maneuvers around the outside to track the frit-deposited positions, completing the seal.



Circle no. 16

FUJITSU MICROELECTRONICS
San Jose, CA 408/922-9000
Booth 309

21-in. full-color plasma display

Fujitsu Microelectronics will be exhibiting the FPF21C8060UA-02, a 21-in. ac-memory plasma display that provides over 260,000 colors with 64 levels of gray scale and a resolution of 640 × 480. With an interface board, the display is capable of accepting either digital RGB for VGA video or NTSC video signals for standard TV transmissions. The display features a viewing angle of more than 140° for off-axis viewing without distortion. With an average brightness of 180 cd/m^2 and a contrast ratio of 60:1, the display provides a clear image under a variety of indoor ambient lighting conditions. External dimensions are 18.90 (H) × 15.75 (W) × 1.26 (D) in. thick.

Circle no. 17

GRASEBY OPTRONICS
Orlando, FL 407/282-1408
Booth 218

Hand-held CRT colorimeter

Graseby Optronics will introduce the next generation in CRT colorimeters. The SLS 9400 is the first hand-held colorimeter to provide lab-grade accuracy and precision at an affordable price. Simple to use and portable, its unique proprietary sensor design closely mirrors the CIE tri-stimulus curves, resulting in highly accurate color measurements. Ergonomically designed to rest comfortably in one hand, it operates from simple menu-driven commands. Measurements can be displayed in either RGB bar-graph mode or CIE numerical mode on the large backlit graphics display. Simple, precise, portable, and affordable, the SLS 9400 puts laboratory quality in the palm of your hand.

Circle no. 18

HOLTRONIC TECHNOLOGIES, LTD.
London, England 41-38-33-68-00
Booth 340

Holographic mask aligner

Holtronic Technologies will feature the HMA400 high-resolution exposure tool, which permits 0.5-µm features to be printed over very large exposure fields (up to 9 × 11 in.) without any stepping of the substrate or mask. This capability is especially attractive for manufacturing active-matrix LCDs and field-emission FPDs because it avoids the undesirable effects of field stitching associated with conventional lithographic systems. An interchangeable chuck permits substrate sizes up to 370 × 470 mm (suitable for printing four 10.4-in. displays per substrate), and an alignment system provides ±0.5-µm overlay.

Circle no. 19

HOSIDEN AMERICA CORPORATION
Schaumburg, IL 708/885-8870
Booth 706

Color active-matrix and DSTN displays

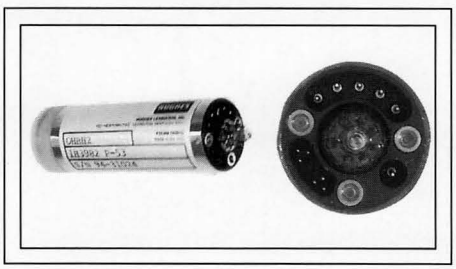
Hosiden will be exhibiting high-resolution, wide-viewing-angle, and low-power-consumption color active-matrix and DSTN displays for the computer and entertainment markets.

Circle no. 20

HUGHES LEXINGTON, INC.
Lexington, KY 606/243-5500
Booths 328/330

Helmet-mounted CRT

Hughes Lexington will be displaying a new state-of-the-art helmet-mounted CRT. Its 18-mm screen with a 22-mm O.D. has better performance than many larger CRT versions, and it is significantly lower in weight and volume (the overall length is 86 mm and the weight is <55 g). The assembly incorporates a new Reynolds adapter with an EEPROM chip to characterize the CRT for optimum performance. Two new deflection coils were developed by Syntronic Instruments to specifically match the CRT to the driving circuits. Combined performance has shown a center line width of <25 µm (50% peak) with 10,000 fL for symbology written at (15,000 in./s)/(38,100 cm/s) and 240 Hz. The adapter, combined with a newly designed miniature H.V. boot and EEPROM, not only allows for rapid change of assemblies and fast optimum performance but also improves reliability.



Circle no. 21

IMAGE PROCESSING SYSTEMS, INC.
Scarborough, Ontario, Canada
416/492-4000
Booths 517/519

Test and alignment system

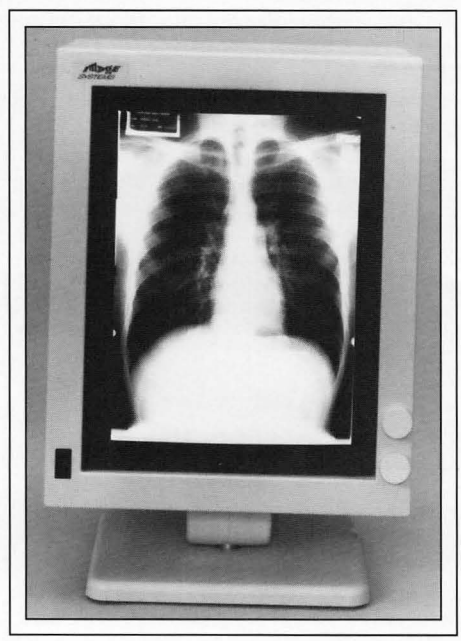
Image Processing Systems (IPS) will feature ADIS 7200 computer-vision-based test and alignment systems that employ state-of-the-art computer-vision technology to allow computer-monitor manufacturers to dramatically improve alignment specifications and increase throughput while reducing labor costs. A wide variety of models are available for engineering, quality control, and production-line use, supporting both semi- and fully automatic adjustments. ADIS systems offer a comprehensive series of monitor test and alignment functions, including color measurements such as purity, convergence, and white balance, as well as geometry measurements, including picture size, centering, and edge geometry. Loaded with features such as digital color cameras with auto-focus, high-performance scalable processing, and servo-based sensor positioning for automatic changeovers, ADIS systems offer a combination of accuracy, speed, and reliability to make monitor alignment fast, accurate, and flawlessly consistent.

Circle no. 22

IMAGE SYSTEMS CORP.
Hopkins, MN 612/935-1171
Booth 427

High-performance monitors

Image Systems will feature the MAX series of high-brightness high-pixel-count high-contrast monitors. High-resolution multi-sweep (HRMS™) circuitry dynamically adjusts to horizontal scan rates of 15.75–170 kHz, displaying up to 5 million pixels. Also featured will be the new 2048 × 2560 gray-scale high-brightness portrait and landscape displays with a brightness capacity of up to 150 fL. Image Systems' displays are used in a range of applications including scientific, medical imaging, air-traffic control, and transportation. Image Systems designs, develops, manufactures, and markets high-resolution color and gray-scale monitors, including custom monitors designed to meet OEM specifications.

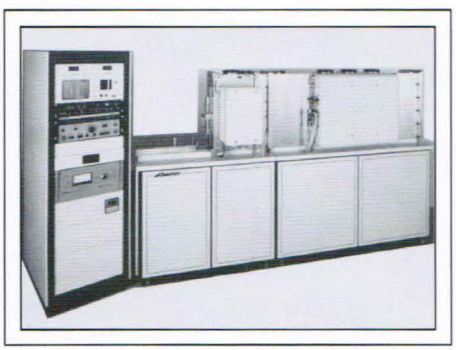


Circle no. 23

INNOTEC GROUP, INC.
Simi Valley, CA 805/522-9040
Booth 509

In-line sputtering system

Innotec will introduce the ILS-28C, a new vertical in-line sputtering system primarily designed for the manufacture of flat-panel displays. It can process substrate areas up to 28 × 28 in. and includes features such as cassette-to-cassette robotic substrate load and unload, dual substrate pallets with a centrally located substrate heater for dual-sided depostion, buffer chambers to maximize substrate throughput and target utilization, and a pallet return system which allows through-the-wall installation. Process chambers can be installed with options such as rf and dc cathodes, rf etching, rf and dc bias, and ion-beam cleaning.



Circle no. 24

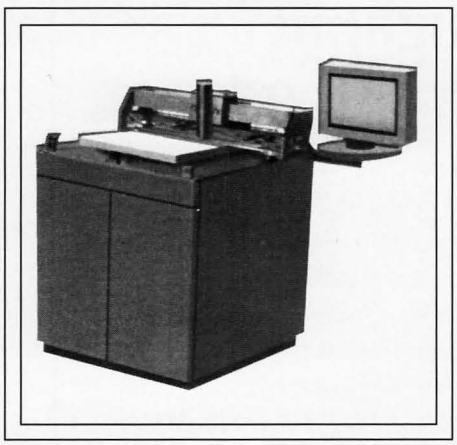
Please send new contributions or noteworthy news items to Aris Silzars, Contributing Editor, Information Display, c/o Palisades Institute for Research Services, Inc., 201 Varick Street, New York, NY 10014.

INTERSERV CORP.
Bloomington, MN 612/888-9767
Booth 611

Glue-dispensing system

Interserv will introduce the latest addition to its FPD manufacturing-equipment product line. The GDX500 glue-dispensing system accurately dispenses continuous beads of adhesive in any pattern over substrates up to 500 × 500 mm. Glue-bead dimensions range from cross sections as small as 6000 μm^2 to 100,000 μm^2 or greater. Full-time active Z-axis control and X-Y stages running in constant velocity ensure bead consistency. Stages float on frictionless air bearings driven by a non-contact linear motor/encoder system and controlled by a DSP-based eight-axis motion controller. The system provides automatic pattern placement.

trade show review

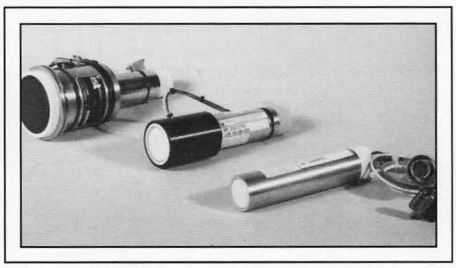


Circle no. 25

IST (IMAGING & SENSING TECHNOLOGY)
Horseheads, NY 607/796-4350
Booth 420

Miniature ruggedized CRTs

Imaging & Sensing Technology (IST) will feature a line of miniature ruggedized CRT assemblies for application in military armored-vehicle displays. These devices are specially designed to withstand harsh environments and offer superior resolution, brightness, and contrast. The CRT assemblies are available in 1-, 1.3-, and 2-in. diameters and include deflection yokes and integral magnetic shields. They can be furnished with various phosphors and lead/connector configurations.

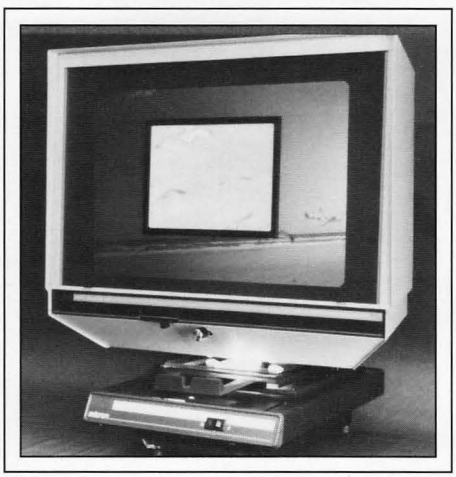


Circle no. 26

KAISER OPTICAL SYSTEMS, INC.
Ann Arbor, MI 313/665-8083
Booth 712

Holographic diffusers

Kaiser Optical Systems will feature HoloBrite™, a new line of surface-relief holographic diffusers, replicated in a variety of low-cost polymer-film materials. The diffusers have high achromatic transmission and can provide a variety of circular or elliptical angular scattering responses up to 120° wide. In LCD backlighting, HoloBrite™ smoothes the spatial structure of the light source and provides gain by concentrating Lambertian light input into a narrower-angle non-Lambertian output. Other applications include high-gain high-resolution HoloScreen™ projection screens, automotive lighting, and machine-vision illumination. Standard products up to 7 × 9 in. are available, and custom designs or larger sizes by special order.



Circle no. 27

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

KENT DISPLAY SYSTEMS
Farmington Hills, MI 810/476-4555
Booth 620

Electronic promotion display

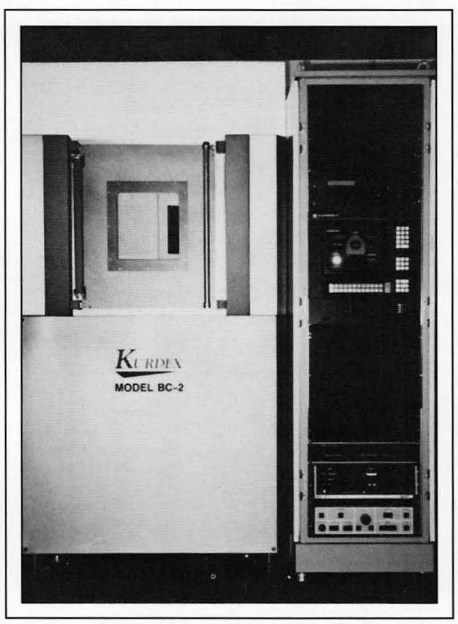
Kent Display Systems (KDS) will feature an electronic promotion display (EPD) connected with an IR transmission system. These visually effective displays are targeted at the retail industry. As a result of the IR transmission capabilities, the EPD's advertising/promotional messages can be changed instantaneously throughout the store. KDS's advanced reflective polymer stabilized cholesteric texture (PSCT) LCDs are the only commercially available displays that offer all of the following features: low power (no backlighting), memory, high resolution/contrast, wide angle of view, excellent sunlight readability, solid-state reliability, and choice of colors.

Circle no. 28

KURDEX CORP.
Sunnyvale, CA 408/734-8181
Booth 708

Box coater

Kurdex's BC-2 box coater is a batch sputtering system for coating large-area substrates for FPD applications. The system is fully automatic, reliable, precisely controlled, and user-friendly. BC-2 systems can be configured to have two or four sputtering guns and can be used as a large-area batch evaporation system.

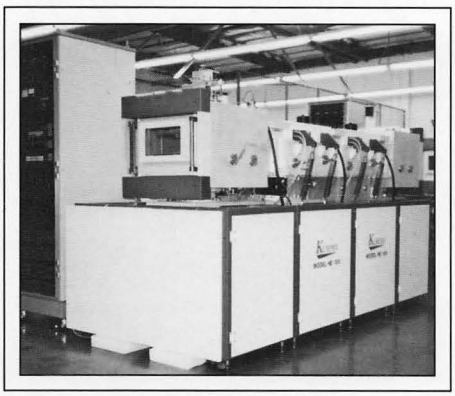


Circle no. 29

KURDEX/CPA THINFILM PRODUCTS
Sunnyvale, CA 408/734-8181
Booth 708

In-line evaporation system

Kurdex's HE-100 is an in-line evaporation system designed to address large-area FPD technologies that require deposition by evaporation. The HE-100 can be configured to have multiple evaporation modules to create sequential films in fully isolated modules, as well as programmable angle deposition. It has provision for internal mask aligners with e-beam or thermal single- or multi-source for sequential or co-deposition. The HE-100 is suitable for EL and FED applications.



Circle no. 30

MICROVISION
Los Gatos, CA 408/374-3158
Booths 202/204

CRT display analysis system

Microvision will demonstrate the fully automatic ISO test capability with the SS200 CRT display analysis system, which includes a programmable frame-rate area array CCD camera, integrated programmable pattern generator, four-axis positioner, custom-designed application software, and a graphic user interface under mouse control. This fast, accurate system will perform tests in a fraction of the time it now takes.
Circle no. 31

MTL SYSTEMS, INC.
Dayton, OH 513/426-3111
Booth 200

Display-evaluation system

MTL Systems will demonstrate its patented comprehensive display-evaluation system (CODES).

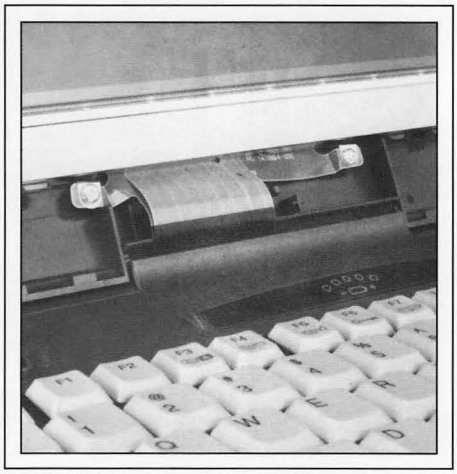
CODES is unique in that the display-testing technique defies traditional automatic testing techniques – *the source of the test patterns is* ***not*** *physically connected to the device used to test the display.* CODES technology provides a means to quickly (in less than 60 s) evaluate any light-emitting display while it is in its operational environment. The fundamental problem with displays is *"graceful degradation."* CODES allows the operator to detect degradation of the display from an established performance specification. It tests the display's *brightness, contrast, resolution, gamma, and chromaticity.*

Circle no. 32

NATIONAL SEMICONDUCTOR
Santa Clara, CA 408/721-6424
Booths 213/215

CRT driver/LCD interface components

National Semiconductor will feature the LM2406, the industry's first monolithic triple-channel CRT driver for computer-monitor applications. It is a 9-ns RGB driver for pixel clock frequencies to 80 MHz. When combined with the LM1203 or LM1205 preamplifier, it provides a complete video channel solution for SVGA (800 × 600) and XGA (1024 × 768) applications. Also featured will be National's host-LCD panel interface components (photo) that make it easier to connect LCD panels to powerful graphics accelerators. By using LVDS and PLL technology, they significantly reduce EMI and reduce the number of signals necessary to drive flat panels. Six-bit gray-scale (DS90C561/2) and 8-bit gray-scale (DS90C581/2) samples will be available by the end of May.



Circle no. 33

NEC CORP.
Tokyo, Japan 81-3798-9575
Booths 316/318

TFT-AMLCD

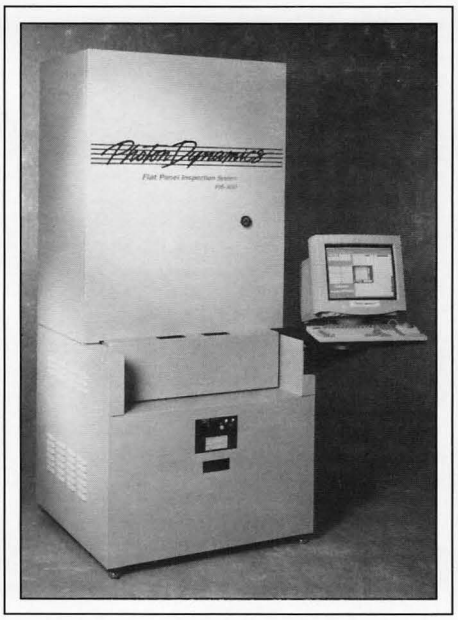
NEC will feature the NL10276AC24-01, a 12.1-in. color thin-film-transistor active-matrix liquid-crystal display (TFT-AMLCD) with a 31-cm screen diagonal and a total display area of 245.76 × 184.32 mm. The NL10276AC24-01 TFT-AMLCD is capable of displaying 4096 colors and is ideal for use in engineering workstations.

Circle no. 34

PHOTON DYNAMICS
Milpitas, CA 408/433-3922
Booths 526/528/530

Flat-panel inspection system

Photon Dynamics will display the FIS-300, the latest product in its family of flat-panel inspection systems. A 4.2-pixel cooled CCD camera, patented N-Aliasing™ technology, data-export capability, optional full-contact probing capability, and 4-in. line cassette-to-cassette operation make it the most sensitive and highest throughput solution for production testing of next-generation XGA cells and modules. Its graphical user interface, touch-screen monitor, and defect classification, reporting, and binning make it the easiest inspection system to program, edit, and use for both novice and expert operators. Currently, over 220,000 10-in.-equivalent TFT panels per month worldwide are tested on FIS systems.

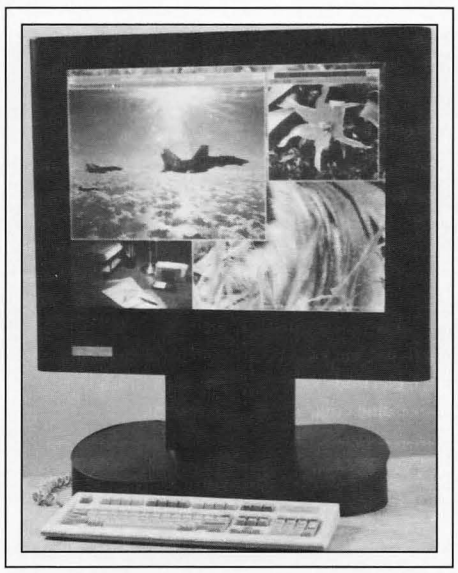


Circle no. 35

PHOTONICS SYSTEMS
Northwood, OH 419/666-6325
Booth 101

AC-PDP monitor

Photonics will feature their 30-in. pre-production-model AC-PDP monitor with 1024 × 768 full-color pixels on a display area of 24 × 18 in. This FPD has the largest number of full-color pixels of any emissive FPD made to date. The average area luminance is more than 30 fL, with a palette of 16 million colors per pixel. The unit employs new driver ICs in a chip-on-flex arrangement to allow more compact packaging, and is the first in a new line of 8-bit full-color AC-PDPs that include a 21-in. 1280 × 1024 engineering workstation video monitor to be introduced in the second half of 1995.



Circle no. 36

PHYSICAL OPTICS CORP.
Torrance, CA 310/320-3088
Booth 233

Light-shaping diffusers

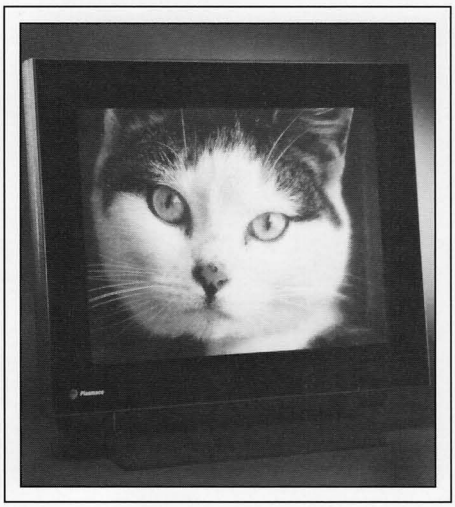
Physical Optics Corp. (POC) manufactures surface-relief holographic light-shaping diffusers (LSDs) for both edge-illuminated and serpentine fluorescent as well as LED and LCD backlights. POC also manufactures high-resolution high-gain transmission and reflection screens for projection TV and LCD systems. POC designs and customizes LSD elements for line homogenization in barcode readers and machine-vision, projector-beam homogenization, and round-to-rectangular beam-shape converters. LSDs are inexpensively mass-produced in a variety of thermoplastics, including acrylic and polycarbonate, in both rigid and flexible film formats.

Circle no. 37

PLASMACO, INC.
Highland, NY 914/883-6800
Booth 107

Full-color ac plasma display

Plasmaco will present its 21-in.-diagonal full-color plasma display, which provides a clear, bright image and a full range of 16.7 million colors (256 gray shades per primary color). The VGA display has a 640 × 480 resolution with a 0.66-mm dot pitch. Incorporating state-of-the-art color ac plasma technology, the display provides a flicker-free image with a 160° viewing angle – the widest of any FPD technology – which means no loss of color or image quality regardless of the viewer's position. Full-motion full-screen video applications are ideal for this display due to its high resolution, wide color range, and rapid update speed. Incorporating a viewing area equivalent to that of a 23-in. CRT into a package less than 2 in. thick, the display will enable users to recover several square feet of valuable desk space. It is also suitable for wall mounting and overhead displays.



Circle no. 38

PRI AUTOMATION, INC.
Billerica, MA 508/670-4270
Booths 604/606

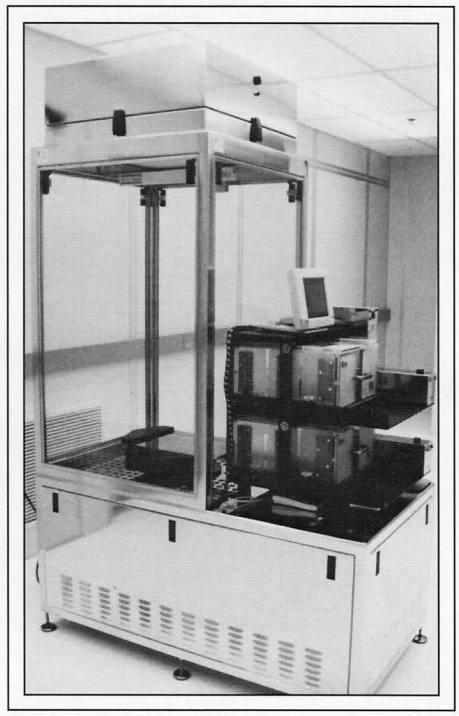
FPD substrate loading system

PRI will introduce its new FPD substrate loading system that is capable of handling 550 × 650-mm substrates in a horizontal or vertical orientation with 360° of rotation. The heart of the system is PRI's Class-1-rated 360° machine loading robot (MLR), which can support loads up to 25 lb. The 360 MLR has a 48-in.-diameter reach with 20 in. of Z travel. The 360 MLR is enclosed in a Class 1 mini-environment with an integrated HEPA filter air supply. The system can be interfaced to process tools, cassettes, and pod mini-environments.
Circle no. 39

PROGRESSIVE SYSTEM TECHNOLOGIES
Austin, TX 512/385-8191
Booths 137/236

Material handler

Progressive System Technologies will display their material handling solution system that provides integral cassette/particle-free pods (KPod™), automated docking units (ADUs™), Class 1 mini-environments (Fed. Std. 209E), programmable automated substrate sorters (PASS), and WIP carts for inter/intra-bay transport systems. This solution provides cost-effective, clean, safe, and reliable handling of large-area substrates.



Circle no. 40

SANRITZ CORP.
San Jose, CA 408/257-6686
Booth 108

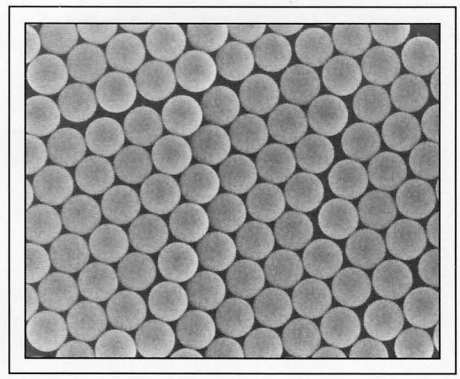
Polarizers

Sanritz will display their full line of high-quality linear, colored, infrared, and circular polarizers. Their high-durability polarizer features high optical performance.
Circle no. 41

SEKISUI CHEMICAL CO.
San Jose, CA 408/257-6686
Booth 106

Micropearls

Sekisui Chemical will feature uniform ball-shaped fine particles, referred to as micropearls, which are universally used in the production of LCDs. These uniform spheres, also available dyed black, are precise in size and have excellent heat/cold resistance, chemical resistance, and electrical insulation. When coated with gold or silver, they have excellent conductivity, and their elasticity is well-suited to fine-pitch electrode coupling in products such as cog, anisotropic conductive film, and ink.



Circle no. 42

SEMITOOL
Kalispell, MT 406/752-2107
Booths 425/524

FPD processing system

Semitool will introduce Centurium, their latest FPD processing system, which provides fully automated plate transfer and handling, including interface capability with MGV, AGV, and conveyer handling systems. Centurium's modular design allows for the integration of acid, caustic, and solvent processes in a single automated platform, thus optimizing throughput, process cleanliness, space efficiency, and capital productivity. Single- and multiple-chamber versions are available to support prototype and/or production applications.
Circle no. 43

STANFORD RESOURCES, INC.
San Jose, CA 408/448-4440
Booth 601

Electronic display reports and studies

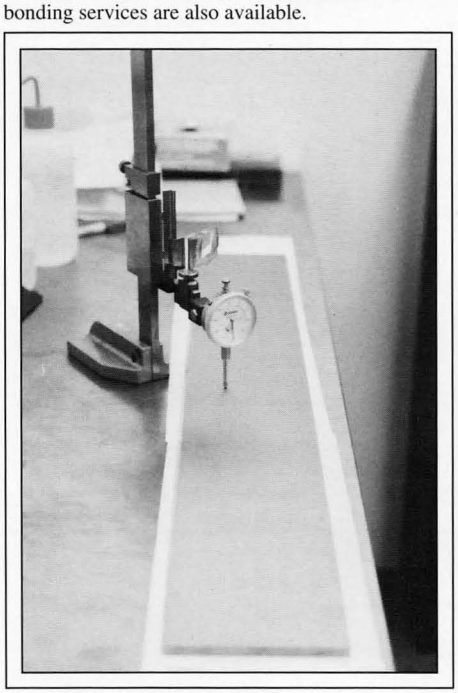
Stanford Resources produces custom and multi-client studies that address electronic display tech-

nologies and markets, with strong specialization in CRT display monitors and flat information displays. The firm will be offering its monthly periodical, *Electronic Display World*, and the quarterly *Monitrak®, Workstation Monitrak®, Display Price Trends*, and *Comtrak™* reports, which analyze the U.S. market for display monitors and portable computers. In addition, Stanford Resources will have available its multi-client reports, including *Enhanced Liquid Crystal Displays, Flat Information Displays, Flat Panel Display Manufacturing Costs, LCD Manufacturing, Materials, and Equipment, Monitor Market Trends,* and *Projection Displays.*
Circle no. 44

TARGET MATERIALS, INC.
Columbus, OH 800-292-8639
Booth 626

Sputtering targets/evaporation sources

Target Materials will display their new high-density high-purity zinc oxide w/alumina sputtering targets and evaporation sources. This material is fabricated using a new proprietary process which ensures overall homogeneity, high density, and uniform oxygen content throughout the thickness of the target. Targets are currently available as assemblies with a maximum tile size of 5×8 in. Standard sizes for finished assemblies include 5×15, 5×25, and 5×52 in. The new zinc oxide w/alumina targets joins their growing family of display materials, which includes indium tin oxide, zinc oxide, niobium, tantalum, and others. Backing plates and bonding services are also available.

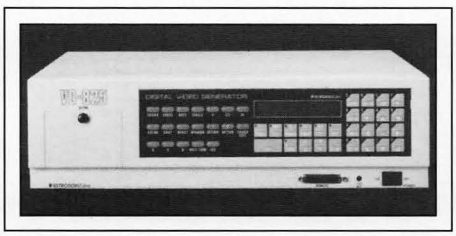


Circle no. 45

TEAM SYSTEMS, INC.
Santa Clara, CA 408/720-8877
Booths 633/635

Digital video generator

TEAM Systems will exhibit its all-new digital video generator, Model ASTRO VG-825, a unit specifically designed for engineering, evaluation, incoming inspection, testing, and marketing in the flat-panel arena. With pixel frequencies of 120 MHz maximum and digital outputs which offer up to 8 bits/pixel for R, G, and B, the ASTRO VG-825 provides optimum performance in very diversified flat-panel applications. And programmable delays between clock and data add to the flexibility. The output can be programmed to present scrolling test patterns, flickering window patterns, and all the patterns available on the other ASTRO VG-800 Series products.

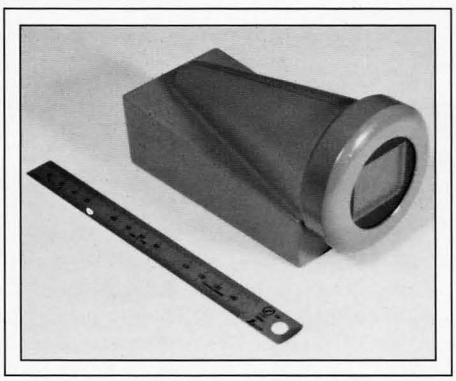


Circle no. 46

THOMAS ELECTRONICS
Wayne, NJ 201/696-5200
Booths 516/518

Miniature color monitor

Thomas Electronics will be demonstrating a new 1.5-in. color monitor. Color is generated by a field-sequential liquid-crystal shutter manufactured by Nu-Vision. The monitor provides 500-TV-lines horizontal resolution and 350-TV-lines vertical resolution. Luminance is measured at 70 cd/m^2 (through LCCS). The power consumption is 6.6 W with a power supply of 12.0 Vdc. The monitor is available with RGB input. Major applications would include virtual reality, HMDs, simulations, and compact projectors.

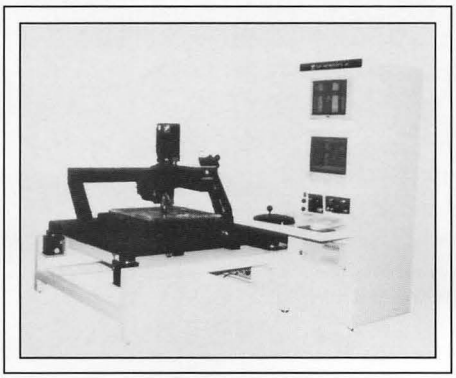


Circle no. 47

TNP INSTRUMENTS, INC.
Torrance, CA 310/787-4620
Booth 144

Laser repair system

TNP Instruments will feature Model 2424-L, a laser repair system for FPDs, large photomasks, and color filters. It comes with single, dual, or triple wavelength to achieve optimum results in the removal of aluminum, chromium, ITO, and polyimide. It can be fully controlled and operated under MS Windows™ away from the microscope for a completely automated repair station. This new model also features their newly designed 18-in. extended microscope, developed to eliminate vibration.



Circle no. 48

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

VIRATEC THIN FILMS
Faribault, MN
Booths 136/138

New anti-reflection coating

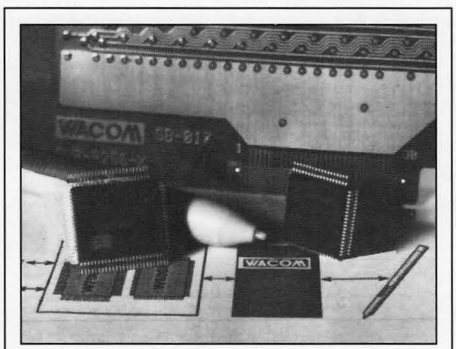
Viratec Thin Films will feature CDAR™, a high-performance clear display anti-reflection coating. By applying CDAR to the glass panels in an LCD projection device, the light transmission of the glass is increased, resulting in a 15% increase in brightness in the overall LCD projection. This new technology offers the OEM manufacturer superior optical performance and enhanced readability. Computer-generated presentations utilizing LCD projection panels can now be delivered in an improved ergonomical environment.

Circle no. 49

WACOM TECHNOLOGY CORP.
Santa Clara, CA 408/982-2727
Booth 603

3.3-V digital and analog chip sets

WACOM will feature new 3.3-V digital and analog chip sets supporting WACOM's batteryless pen technology for OEMs. These products are based on WACOM's patented electromagnetic resonance (EMR) technology currently used by IBM, Toshiba, Fujitsu, Sharp, Matsushita, and other builders of pen-enhanced computer systems. WACOM's W7003F analog and W6004F digital chip sets result in a reduction of 30–40% of the pen input subsystem's power consumption over previous-generation 5-V chips. The chip sets have the capability to support up to 10.4-in.-diagonal color TFT-LCDs.

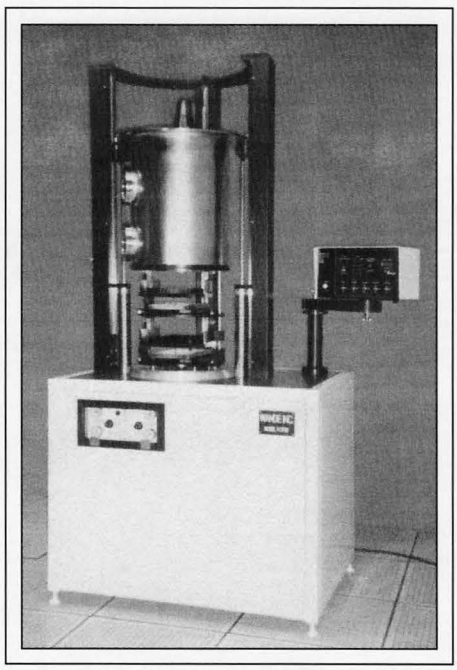


Circle no. 50

WANDE, INC.
Dallas, TX 214/701-8886
Booth 146

Liquid-crystal filling machine

Wande will display the EM-17 liquid-crystal filling machine that features a 17-in.-diameter × 38-in.-high stainless-steel lighted vacuum chamber with two 6-in. viewing windows and two 10-in. view ports on top; an oil-less vacuum pump capable of reaching 10 mtorr in 30 minutes; a digital-readout vacuum gauge with two set points; automatic control of liquid-crystal filling, including multiple vacuuming and purging; automatic or manual operation; and programmability for both time and pressure. There are also options in chamber size, pump-down-cycle time, and top or bottom filling fixtures (or both). The EM-17 can be customized to meet the customer's requirements.

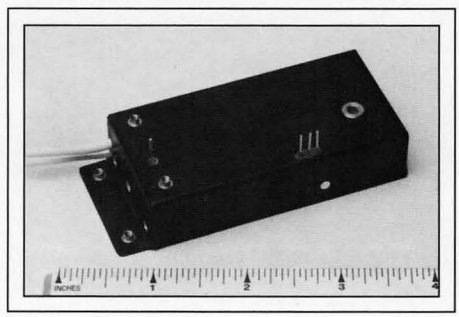


Circle no. 51

WINTRON, INC.
Bellefonte, PA 814/355-1521
Booths 125/127

HUD power supply

Wintron will feature their new mini regulated high-voltage power supply for miniature head-up and helmet-mounted displays. This small 3 × 0.7 × 1.5-in. unit weighs less than 100 grams. The anode voltage can be as high as 8.5 kV; the cathode output can be as high as 750 µA with an adjustable G2 (150–550); and the focus outputs can be as high as 1500 V. The power supply operates with a +12 Vdc (±2 V) input with a low ripple on all outputs. The anode is 0.025%. Custom variations with a wide range of electrical parameters can be manufactured for similar or other applications.

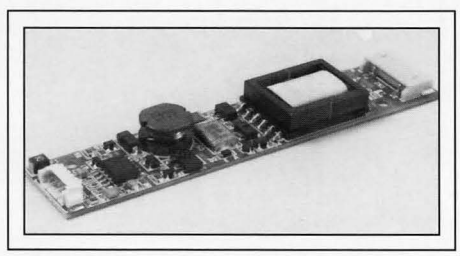


Circle no. 52

XENTEK, INC.
San Marcos, CA 619/471-4001
Booth 239

dc-to-ac inverters

Xentek will introduce the LS440, its latest model in the LS Series of dc-to-ac inverters, which provide a highly reliable low-profile power source for the cold-cathode fluorescent tubes (CCFT) used for backlighting flat-panel displays. Smaller and narrower than competitive models, the LS440 nevertheless provides a wider dc input range and higher efficiency. The inverter employs a proprietary current feedback control method which enables users to optimally configure the inverter for use with a wide variety of popular CCFTs currently available.



Circle no. 53

XEROX CORP.
Palo Alto, CA 415/812-4684
Booths 301/303

Ultra-high-resolution AMLCDs

Xerox Corp. will demonstrate its latest ultra-high-resolution color and monochrome displays. Devel-

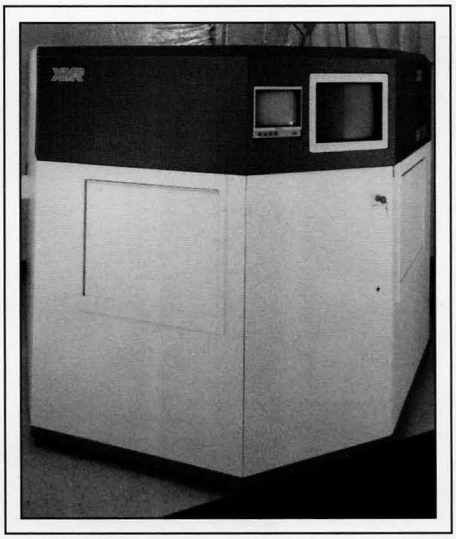
oped at the Xerox Palo Alto Research Center, these direct-view active-matrix liquid-crystal displays feature resolutions of nearly 300 dpi (150 dpi for color) and sport a new, compact design with advanced TAB packaging. Additionally, Xerox recently announced an alliance with Planar Advance, Inc., a wholly owned subsidiary of Planar Systems, Inc., to co-develop, manufacture, and market AMLCDs for use in defense applications. On display will be a 10.4-in.-diagonal color VGA prototype developed by Planar Advance and Xerox.

Circle no. 54

XMR, INC.
Santa Clara, CA 408/988-2426
Booth 120

Excimer-laser annealer

XMR will exhibit the ELA 9100, an excimer-laser-based annealing system designed to process active-matrix liquid-crystal displays (AMLCDs), changing the already deposited amorphous-silicon to polysilicon as a step in the manufacture of polysilicon thin-film transistors. The annealing system consists of a xenon chloride (308 nm) excimer laser with a beam homogenizer creating a spatially uniform rectangular beam which then selectively anneals the silicon already deposited on a glass substrate. The processing subsystem consists of the process chamber with beam delivery, substrate handling, and control systems. The entire system can process up to 20 substrates per hour.



Circle no. 55 ■

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

letters

To the Editor:

In Ken Werner's otherwise excellent report [*ID*, January 1995, p. 16 – Editor] on the Monterey IDRC, the following sentence occurs: "The first TFT-LCDs were made with cadmium selenide (CdSe), which has long been out of favor *because of long-term instability and difficulty in maintaining the proper balance of cadmium and selenium during film deposition* (my italics). In 'Fabrication of CdSe TFTs and Implementation of Integrated Drivers with Polycrystalline TFTs,' Professor Ernst Lueder reported that his group at the University of Stuttgart has solved these problems, . . .".

I strongly object to the above statement, since it implies that these problems were present in the displays we made at Westinghouse in the 70s, the displays we made at Panelvision in the early 80s, and also in the displays made by Litton Systems which are today flying in many U.S. commercial and military aircraft!

This is totally untrue and ridiculous. For example, an AM-EL TV display we fabricated at Westinghouse in 1977, containing 40,000 high-voltage TFTs, is still fully operational today, as are the many displays we sold from Panelvision, not to speak of the militarized Litton displays.

Ken Werner claims that he has simply reported what Prof. Lueder has said, but in my correspondence with Prof. Lueder, he emphatically denies this interpretation. In his published IDRC paper, he said: "... the objections mentioned above (*i.e.*, long-term instability and nonstoichiometry) are no longer a problem." He does not claim that he has just recently solved these problems – a crucial difference in meaning. In his fax to me he says: "The situation is as you have stated. Many research groups which I have listed in my publications have contributed to make CdSe a mature technology."

In view of the continuously recurring misrepresentations of CdSe technology – the one white hope that remains for the beleaguered U.S. display industry – I feel it necessary to once again make my input. NO, CdSe TFTs are not unstable – they are actually more stable than a-Si TFTs, and NO, there is no problem with Cd/Se stoichiometry, as the balance of Cd and Se during evaporation is automatically maintained because of the near-equality of the vapor pressures of these two elements. Only those who have no experience with this excellent semiconductor material repeat the tired old untruths, probably as an excuse for not even trying.

– *Peter Brody*
Active Matrix Associates
Pittsburgh, Pennsylvania

erratum

erratum

In three places in our March editorial, "CD–ROM" was inadvertently changed to "CD–R." The central part of the editorial should have read as follows.

There have been reports from different manufacturers of work on **recordable CD–ROM (CD–R)** drives that will sell for $1000 or less. In the December 1994 issue of *CD–ROM Today*, Tom Halfhill reported on the widespread rumors that Sony will introduce a CD–R drive in the first half of 1995 at a street price of less than $600. Halfhill says the technology is there, but that Sony has no reason to establish an aggressively low price. A CD–R at that price, says Halfhill, could threaten the market for other mass–storage devices, including Sony's own MD–DATA device, and would allow inexpensive copying of conventional **CD–ROMs**. The device could also copy audio CDs, but with blank CD–R disks costing $20, that is not an immediate threat. However, Sony, which owns CBS records, could be worried if it thinks that the blanks could get much less expensive. Of course, NEC and Matsushita may not have the same qualms.

CD–ROMs are becoming an all–but–essential peripheral, at least in PCs purchased for the home. Richard Wallace, *EE Times* Editor– in–Chief, reports that at Comdex some people were projecting that more than 90% of all PCs shipped to the home would contain **CD–ROM** drives. ■

16 95

OCTOBER

Asia Display '95 – International Display Research Conference

ACT CITY, HAMAMATSU, JAPAN
OCTOBER 16 –18, 1995

• An international conference on display research and development aspects of:
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continued from page 6

communications? Recently, I saw a product from a company called **Black Box** that allows businesses to fax product information to customers on request – automatically and around the clock. Callers are electronically guided through the request process and, after they hang up, the "FAX on Command" product sends them the requested information. This product has combined useful features from voice mail, disk storage, and fax.

For the next few minutes, try to imagine (imagining and dreaming – what people did before virtual reality) that you and I are partners in a business producing stand-alone fax machines. What should we do to counter the threat of computer fax boards and e-mail? Aha! we conclude, the stand-alone fax machine still has one very important advantage over the computer fax board – it can send *anything* that can be put on a piece of paper, from handwritten scribbles to schematics to recipes. Let's see you get those into and out of your computer! If you use a scanner, aren't you just duplicating the function of a fax machine in a clumsier way? Also, fax machines are so convenient because they are always there and waiting to receive or send. You don't have to leave your computer ON just in case someone might be trying to send you something. With these benefits, our business appears secure. No one can declare the stand-alone fax machine a museum piece – at least not for the foreseeable future. Right? So, should we invest in that new factory that will double our capacity?

Disconcertingly, from our viewpoint as a stand-alone fax-machine maker, there has been a troubling trend, first noted a few months ago, hinting at a new merging of functions. There seem to be more and more printers and copiers appearing that have built-in fax capability. It seems that this all got started because no one much liked the curly thermal fax paper we were selling for use with our machines. The plain-paper fax was the obvious answer, and we reluctantly made the changeover, even though it eliminated our nicely profitable fax-paper business. However, now it seems that the next step is to provide a fax board and a telephone jack in virtually every office and home printer and/or copier. The first wave of these products has recently been announced by major players such as Okidata, H-P, Panasonic, and QMS. That means that many more will follow.

Perhaps our plans for building the next stand-alone fax-product factory need some rethinking. In fact, it appears that we may have an even more serious problem on our hands. It could happen that there will be a nearly complete merging of faxes, printers, and copiers. In other words, in 2–3 years a stand-alone copier, printer, or fax machine may be a rarity found only as a low-end prod-

uct or a high-volume production machine. Looks like we'd better be thinking about a fax machine that will sell for well under $200 – and be marketed more like the ubiquitous telephone answering machine. Too bad we didn't see these changes sooner and develop our business from a broader perspective, we think to ourselves. Perhaps then we could have repositioned our products in time to take advantage of these market trends.

So, how will the desktop and laptop computers interface with this new environment? With e-mail well-established, the fax technology will need to blend with and support that capability. The need, stated in its most generic form, is to be able to access information in any form, analyze and modify it in some fashion, and then pass it on to someone while retaining a copy for future use.

Acquiring and sending information to and from desktop computers will be more attractive, I believe, when manufacturers start providing a stand-by (sleep) mode that activates, like a telephone, when someone wants to send information or if the user has programmed it to send information to someone else during off-hours. A remote retrieve mode, that produces a document in the same format and with the same fonts (with proper access protection, of course), should also become a standard feature. *I want my computer to go "bump in the night" but not to wear itself out having to be ON when it's not doing something useful.*

A complementary step in this evolutionary process will be an office copier that not only makes copies on paper but can produce a floppy disk of a document compatible with at least two or three of the most commonly used word-processor and spread-sheet formats (e.g., Word, WordPerfect, Excel). How far behind can a home-office copier be that does the same thing, perhaps slower and with less versatility, but for a suitably lower price?

The stand-alone fax machine will be with us in its present form for only a few more years. Fax boards for computers and e-mail will grow much faster than traditional fax machines. However, the amount of information being communicated is increasing at such a high rate, and the need to have it arrive in a conveniently usable format is so great, that the merging of faxes, printers, and copiers, followed by copiers with computers, is inevitable. I believe we will end up with two classes of machines, both with built-in communications capabilities. One will be the combination of a desktop or laptop computer with an electronic communicator for e-mail, CD-ROM, and floppy creation; the other, a combination of paper printer/copier/scanner, fax and floppy-disk, and CD-ROM reader/writer. The result will be the ability to handle information with equal ease on disk or on paper and to translate between the two either

locally or to and from a remote site. Since there is no fundamentally new technology needed, we could begin to see early versions of these products soon – within weeks or months. Some may already exist in first-generation forms. Let me know if you have already bumped into one or more of them in your wanderings through the "information forest."

In the industry-news segment this month, we have an abundance of items, partly because of the longer time period covered by this two-month issue, but also because of all the interesting happenings in our dynamic and growing display industry.

The second international **Display Manufacturing Technology Conference**, which took place January 31–February 2 in Santa Clara, California, was an unequivocal success. Fully paid attendance approached 500, compared to 380 last year, and with the 62 exhibit booths, total attendance was well over 850. This first year of exhibits attracted a nice cross section of companies providing services and equipment to the display-manufacturing industry. Next year, this event will take on an even broader scope. It will be re-named **Display Works 96** and be sponsored jointly by SID, SEMI, and USDC. SID will continue to organize the technical conference, with SEMI working to expand the exhibits and USDC providing a forum for the discussion of business and investment issues. With the combined efforts of the three organizations, this event is expected to become *the* forum for exchange of information on all aspects of display manufacturing.

MRS Technology, Inc., of Chelmsford, Massachusetts, has announced the appointment – and return – of **James D. McKibben** as Vice President of Marketing and Sales for the large-area FPD lithography equipment maker. In this position, he will work closely with MRS Technology's worldwide customers as he returns to MRS after a two-and-a-half-year absence. Mr. McKibben has been an outspoken advocate of the importance of FPD manufacturing to U.S. high-technology leadership for many years. Prior to rejoining MRS, Mr. McKibben directed a worldwide sales, marketing, and business-development campaign for Semiconductor Systems, Inc., a manufacturer of customized high-performance processing equipment, based in Fremont, California. His extensive experience also includes positions at Kulicke & Soffa, Leitz/Leica, GCA Corporation, and JT Baker Chemical Company.

Lou Falce has been appointed to the new position of Executive Vice President, Cathodes, by **Ceradyne, Inc.**, of Costa Mesa, California. Ceradyne's Chairman and CEO, **Joel P. Moskowitz**, stated that the recent success of its subsidiary, **Semicon Associates** of Lexington, Kentucky, coupled with Mr. Falce's

recognition as an international cathode expert, resulted in a renewed marketing focus to be chaired by Mr. Falce in his new office. Mr. Falce will relocate to Southern California to be closer to the customer base, as well as to Asian markets. Mr. Falce's career spans years of dispenser-cathode development and manufacture. He joined Ceradyne in 1985 and spearheaded the development of the company's inexpensive CRT dispenser-cathode for television and other CRT applications, including HDTV. In related developments, Ceradyne also announced the creation of two additional corporate Vice President positions to be held by Semicon's **David Bowling** and **Jim Cuppy**. Mr. Bowling will also serve as President of the Semicon Associates subsidiary.

Jim Costigan has been named national sales manager of **Extron Electronics**, a manufacturer of computer-video interfaces, switchers, distribution amplifiers, and scan converters. Mr. Costigan will report to Vice President of Sales, Gary Kayye, and will manage all domestic sales operations. He joins Extron after 8 years in the audio-visual industry, most recently with AVW Audio Visual of Dallas, Texas. Extron Electronics is based in Santa Fe Springs, California.

ULVAC Technologies, Inc., of Andover, Massachusetts, has appointed **Robert Gardner** as General Manager, Western Region. In this position, Mr. Gardner will be responsible for the day-to-day operation of all Western Region sales, service, and engineering activities, as well as the continuation of his duties in sales and marketing for all ULVAC disk manufacturing and industrial systems product lines. Mr. Gardner has been with ULVAC for the past 8 years in a variety of sales and marketing positions.

Gerald V. Butler has joined **Brite Voice Systems, Inc.**, of Wichita, Kansas, as Senior Vice President. He will be responsible for the company's computer telephone integration (CTI) and interactive voice response (CTI/IVR) business activities and setting direction for technology platform and applications development strategies. He will be located at the company's Canton, Massachusetts facility, home of Brite's Perception Technology Division. His prior positions include Vice President of Computer Special Systems for Digital Equipment Corporation, President and CEO of Culler Scientific, and President of the Systems Integration Business Unit of Prime/Computervision. Brite Voice Systems was founded in 1984 and provides voice processing systems for making telephone communications more powerful and efficient.

SI Diamond Technology, Inc., of Houston, Texas, will acquire some of the Microelectronics and Computer Technology Corporation's (MCC) semiconductor packaging and

interconnect laboratory and fabrication facility, as well as a license to approximately 125 packaging and interconnect related patents. This transfer of operations will give SIDT complete control of both the facility it has been leasing from MCC as well as MCC's work force. This move will facilitate development of SIDT's diamond field-emission displays and the packaging and commercialization of those products. SIDT has agreed to pay MCC $1 million in cash and an equal amount in lab and fab services over the next 2 years. In addition, SIDT will pay a 3% royalty over the next 6 years from commercial sales of products or services based on MCC technology.

In another FED-related announcement, **Mitsubishi Corp**. of Osaka, Japan, states that by treating silicon emitter tips in field-emitter arrays with an etching solution, they are able to achieve a factor-of-ten improvement in performance. The chemical-etch step apparently creates nanometer-sized rods at the tips where electrons are emitted, resulting in the increased emission.

The Mayo Clinic in Jacksonville, Florida, has selected **Siemens Medical Systems, Inc.**, to install an extensive Electronic Medical Imaging (EMI) system. The installation will help Mayo Clinic Jacksonville to meet its operational objective of being filmless by 1996. Siemens products will interface with an electronic medical-record system from **Cerner Corp.** and a Radiology Information System (RIS) from **ADAC/SD&G Corp**. Together, these products will form a network for an integrated electronic radiology practice, which is believed to be the first of its kind. The picture archiving and communications system is based on high-resolution Sun SPARC workstations and digital archives that allow medical centers to acquire, process, store, and distribute medical images, such as x-rays, computer tomography images, and magnetic resonance images – without hard-copy film – to diagnostic and viewing locations. **Dr. Thomas H. Berquist** is the chair of the Department of Diagnostic Radiology and responsible for managing the conversion to this new system for providing increased diagnostic capability.

Mike McClure of **Virtual Vision, Inc.,** Redmond, Washington, has provided information on an interesting application for virtual-vision head-mounted displays. Called "Virtual Vision Rx," the Virtual Vision eyewear is a monocular viewing system specifically adapted for use by patients while receiving treatment from their dentists. The combination of visual and audio stimulation is intended to provide an environment that is more pleasant to the patient than listening to the sound of the dentist's drill and/or watching the dentist work. Virtual Vision has also developed another product intended for outdoor use that combines the benefits of sunglasses and the ability to simultaneously view a video image. According to Mike McClure, his submission to *Information Display* was stimulated by the December column that suggested the many possibilities for head-mounted displays. These two interesting examples from Virtual Vision hint at the many, many opportunities yet to be uncovered.

I appreciate getting your feedback and your comments. These interactions are always stimulating and enjoyable and provide ideas which can perhaps be used in future columns. I can be reached by e-mail at aris_silzars@maca.sarnoff.com, by telephone at 609/734-2949, by FAX at 609/734-2127, or by obsolete technology (the Post Office) c/o Jay Morreale at Palisades Institute for Research Services, 201 Varick Street, Suite 1006, New York, NY 10014. ■

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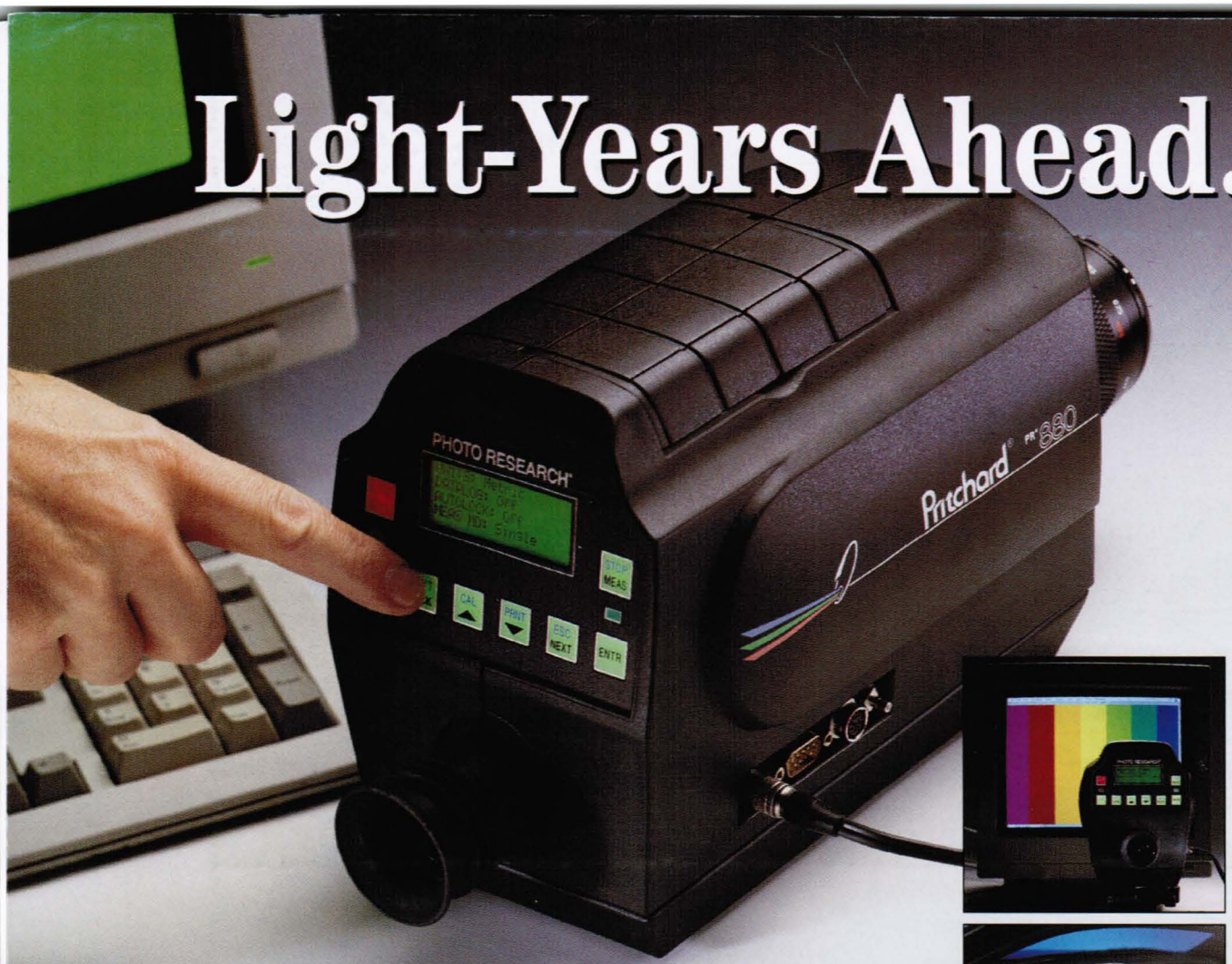

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