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INFORMATION DISPLAY

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DISPLAY OF THE YEAR / TECHNOLOGY ROUNDUP

Display of the Year
Display Technology

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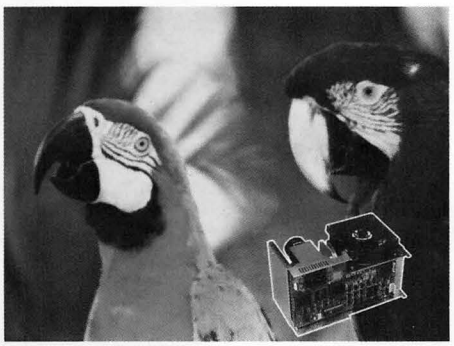
COVER: The winner of Information Display*'s first annual Display of the Year Award is Texas Instruments' Digital Light Processing™ (DLP™) engine. The engine is shown in front of a DLP-projected image. DLP technology is based on TI's Digital Micromirror Device™ (DMD™), a chip integrating tiltable mirrors and CMOS drivers. For more on the Display of the Year Awards and the Display Product of the Year Awards, see page 10.*



Credit: Texas Instruments

Next Month in Information Display

Monitor Issue
- Self-Calibrating Monitors
- Microprocessor-Controlled Monitors
- Display Color Specifications
- Japan Marathon

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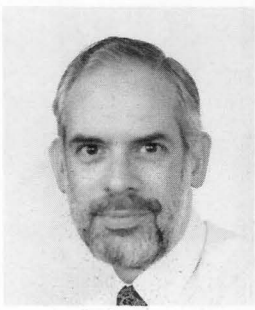


Display of the Year

Our traditional end-of-the-year Technology Roundup Issue is now also our Display-of-the-Year Issue. In our cover story, we announce the first winners of this new annual award – the display community's own "Oscar." We have two categories of awards this year. The first is for the best display itself; the second is for the best use of a display in a product or system.

We are very excited about these new awards and the increased attention they will bring to display technology and display products. But even more exciting than the concept of the awards – at least to those of us involved – was the process by which the winners were selected. Under the chairmanship of Shunsuke Kobayashi, and with staff work skillfully coordinated by *Information Display*'s Dian Mecca, we assembled a committee of eminent members of the display community and distinguished technical journalists who cover the displays world. From West to East – looked at from my Connecticut-centric point of view – the Committee members hailed from Korea, China, Taiwan, Japan, the United States, the United Kingdom, and France. (Our French member is currently located in Everett, Washington, but few people who know Jean-Noel Perbet would accuse him of being anything but French.)

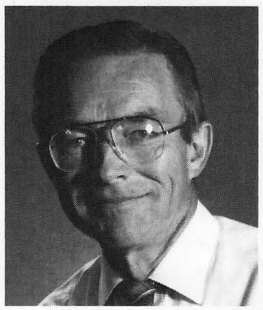
The Committee's cross-cultural deliberations were enjoyable and enlightening, and presented the Committee with a broad range of candidates for the awards as well as a broader perspective on what might be important. Some members, including me, were initially inclined to be narrowly technological or commercial in our choices, but Chairman Kobayashi made a strong case that the Committee should weigh the likely long-term social benefits of the candidate technologies and products when we made our choices.

Our deliberations were educational in another way as well. The Committee members took advantage of their attendance at the SID International Symposium, Seminar & Exhibition – the great annual gathering of the international display community – to meet together. But that was the Committee's only physical meeting. With introductions made and relationships established, we were able to conduct the remainder of our business by a mixture of facsimile, e-mail, and an occasional phone call.

For the most part, this combination of telecommunications technologies allowed us to conduct our deliberations quickly and easily. It soon became clear, though, that fax is the universal medium, especially when ideas must be sent across many time zones. E-mail may be cheaper – once you have the equipment and are linked to a service provider – and take less time, but outside of North America and perhaps the U.K., e-mail is not yet widespread even within the technical community. In the technologically sophisticated countries of Asia and Europe, though, this situation is changing rapidly. (I should add that I also maintain an active e-mail correspondence with friends and colleagues in Brazil.)

What's next for the Display of the Year Awards Committee? We will formally present the 1995 awards to the winners at SID '96 in San Diego in May. And we will all sit down together once again, this time to begin our deliberations for the Second Annual Display of the Year Awards.

– Ken Werner



A Different Kind of Reward ...

by Aris Silzars

On the wall of my office hangs a framed print of an oil painting depicting a kindly older gentleman with his arms outstretched in greeting. Behind his neatly trimmed white beard shines a smile as bright as any you have ever seen. It's one of those ear-to-ear kind that make you want to respond no matter how grumpy you may be feeling. His bright yellow shirt and straw hat seem a most appropriate complement to the cheerful glow of his dark skin. He is standing by the side of the road near a traffic circle with red and pink flowers in the center. A large bag with an umbrella sticking out sits on the grass nearby, suggesting that he may be a man-on-the-move prepared for whatever nature might offer up on any given day.

Anyone entering my office cannot help but see this picture hanging near my desk. Most take a quick glance and say nothing. But, once in a while, someone will sit down and, mostly to make polite conversation, ask, "Who's the guy in the picture?" "Why, that's Johnny Barnes," I tell them. "Johnny Barnes lives in Bermuda, and this is the traffic circle near downtown Hamilton. Johnny Barnes stands on the side of the circle for four hours every morning, rain or shine, and greets every motorist coming into town. He waves to them, shakes their hand if they extend theirs, and most important, he tells every one of them 'You know I love you,' or simply, 'I love you.' And he absolutely, positively sounds like he means it. The energy he radiates is enough to light up the whole island. And he does this because he wants to. No one pays him to do this. But, if he misses a morning, people call the local paper asking if Johnny Barnes is OK."

My typical visitor responds to this explanation by saying something like, "... Yeah ... r i g h t ... so what's the catch?" "There is no catch," I tell them. "He does this to make people feel good, and in turn it must make him feel pretty great too." At this point, we're usually into major emotional-discomfort territory, and the discussion either abruptly changes to the real reason why they came to see me in the first place or we spend more time discussing why anyone in his or her right mind would do something that requires this much effort and doesn't provide any tangible or financial return. It just can't be possible that this makes Johnny Barnes happier than anything else he could do for those four hours each day, can it? Could it be possible that he knows that by this simple act he is making a difference in the lives of thousands of people? Nah, probably not! There's got to be a catch! Isn't there always a catch?

Now, before you decide that I too have finally gone off the deep end – which is, of course, a distinct possibility – consider the following two questions. Do you work only for money and/or tangible rewards, or do you work primarily because you enjoy what you do? Do you feel that you are adequately rewarded for your creativity, talent, and the contribution you are making to the success of your company? Aha! I thought I would get your attention with that one!

In the October column, we briefly met Dr. Peter Piper, a very talented engineer who regularly comes up with great new innovative products that make major contributions to his company's success. Yet, he isn't compensated much differently from any other engineer in his company, or in any other company for that matter.

continued on page 38

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First Annual Display of the Year Awards

Information Display *assembles a distinguished international committee to select the best.*

by Ken Werner

It's a fair question: what is the "best" display of the year? Even though any answer to the question can be argued about at length – and was – asking the question is important because:

- It helps guide observers of the display circus through the bewildering profusion of new products and competing technologies, and
- It forces those of us who see lots of displays to ask ourselves what really matters.

In addition to recognizing the Display of the Year, we also established a second award for the Display Product of the Year – the product that best used display technology to add value to the product itself. For both awards, the members of the Display of the Year Awards Committee were instructed to consider an extensive list of factors, including innovation, commercial significance, and likely social impact.

All displays and products considered for the awards were nominated by the members of the committee, and the winners were selected from the nominees in two rounds of voting. To be eligible for this year's awards, products had to become commercially available – either to OEMs or end users – between July 1, 1994, and June 30, 1995.

Ken Werner is the Editor of Information Display. *The opinions expressed in this article are not necessarily those of the Publisher of* Information Display Magazine *or of the Society for Information Display.*

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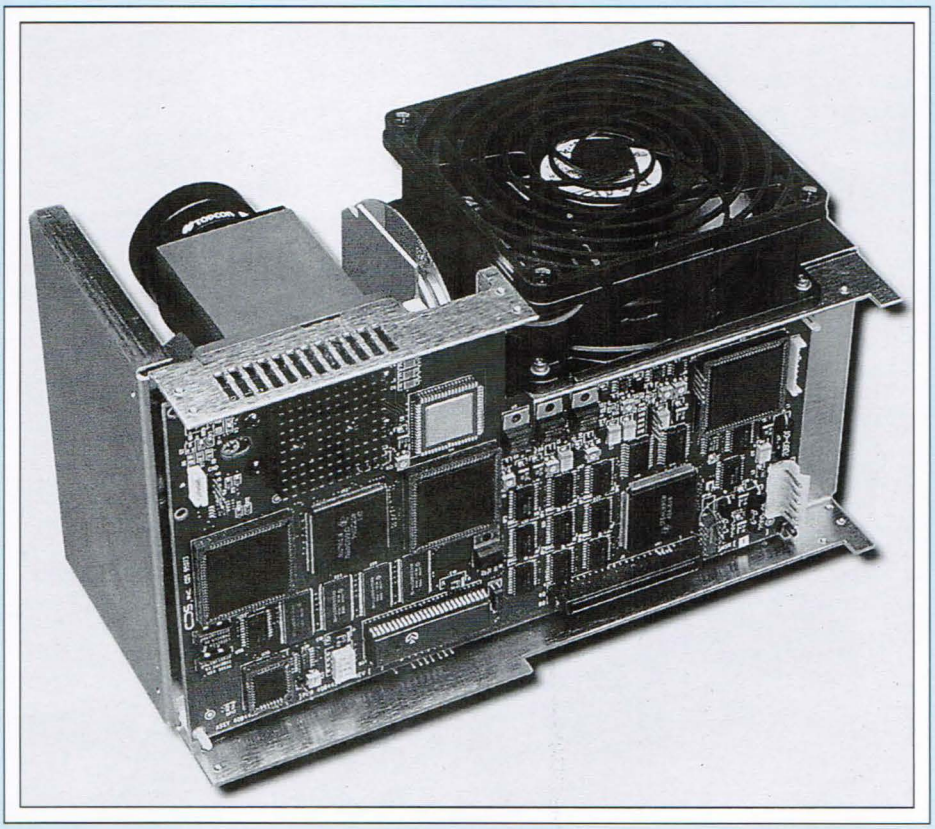
DISPLAY OF THE YEAR AWARD

Texas Instruments' Digital Light Processing™ (DLP™) Engine

The 1995 Display of the Year Award goes to Texas Instruments' Digital Light Processing™ (DLP™) engine incorporating the Digital Micromirror Device™ (DMD™). Uniquely among projection-display technologies, this approach uses individual hinged micromirrors fabricated on a MOS IC that contains the drivers for the mirrors. Each mirror represents a pixel, which is turned on and off depending upon whether the mirror is tilted so that the light it reflects is directed through a lens onto a screen or out of the lens's range. TI's unique approach to the challenges of projection-display technology has been marked by technical innovation, a long-term commitment to working out the engineering details, and a clear and consistent business model. That model is based on Canon's success in building laser-printer engines that OEMs incorporate in end-user printer products. TI is building DLP™ engines for OEMs to incorporate into end-user projection products. The first of these products should reach market shortly.



The first product on the market to use the DLP engine is nView Corporation's Diamond D-400 DLP projector. Scheduled for release in September 1995, the D-400 projects 350 ANSI lm using a 270-W metal-halide bulb. The pixel format is 640 × 480, with a typical contrast ratio of 125:1.

DISPLAY OF THE YEAR AWARD

Honorable Mention: Fujitsu's 21-in. Color Plasma Display

Fujitsu is the first company to bring a "full-color" plasma display panel (PDP) to market, and the company's model FPF21C8060UA remains the only commercial "full-color" PDP. (Full color is in quotes because some people reserve the term for displays with 8-bit color – 16.7 million colors – rather than the 6 bits or 262,000 colors presented by Fujitsu's panel, but this did not affect the committee's appreciation of Fujitsu's achievement.)

The 21-in. model is clearly the first of many commercial large-screen color PDPs – from Fujitsu as well as other manufacturers – that will dramatically alter the face of entertainment, computation, presentation, industrial-control, and communications products by making direct-view large-screen color displays practical. Fujitsu has started us down an exciting road, along which increasing screen sizes and falling prices will make color PDPs available to a growing number of applications.

DISPLAY PRODUCT OF THE YEAR AWARD

Casio's QV-10 LCD Digital Camera

Casio's QV-10 is the first digital still-image camera to be enhanced with a liquid-crystal display (LCD). Weighing just 6.7 ounces – not counting the 4 AA penlight batteries, which last about 2 hours in continuous use – the camera stores up to 96 JPEG-compressed images in its 2 megabytes of built-in flash memory. The 1.8-in.-diagonal TFT active-matrix liquid-crystal display (AMLCD) is used both as a viewfinder and playback monitor. When in record mode, you can look at your image on the LCD viewfinder and adjust the exposure interactively.

The camera can send its images in NTSC video format directly to a video tape deck, a standard television set equipped with a video-input jack, a picture phone, or a video printer. With an optional personal-computer adapter kit, the images can be uploaded to a Windows-based PC or Macintosh computer for storage, manipulation, and/or printing. The edited images can then be transmitted by modem or downloaded back to the camera if desired.

In play mode, you have the option of putting 4 or 9 images on a single screen or enlarging a selected portion of a given image.

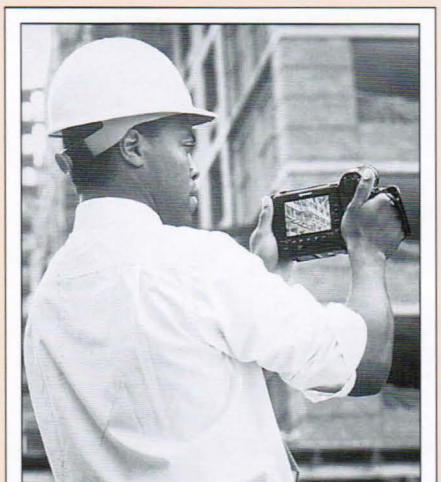
By incorporating a color display, Casio has transformed the general-purpose digital still camera into a tool of vastly expanded uses. By pricing the product at less than $1000, they have made it possible for many consumers to explore those uses.

DISPLAY PRODUCT OF THE YEAR AWARD

Honorable Mention: Sharp's Professional Hi8 Viewcams

Following its own innovative lead in creating compact consumer camcorders using a relatively large color LCD as a combination viewfinder and playback monitor, Sharp has now created the VL-H420UP viewcam for professional applications.

The unit uses a 4-in.-diagonal LCD with enhanced resolution and a reflectivity of only 1% for better contrast and viewability in brightly lit conditions. The viewcam offers a 16:9 widescreen mode, digital image stabilization, fade-in/fade-out capability, a high-speed motorized zoom that goes from full wide angle to full telephoto in 2 s, and an instantaneous 20× digital zoom.



ORIGIN OF THE DISPLAY OF THE YEAR AWARDS

The idea of awards for the best displays of the year was first suggested by Professor Shunsuke Kobayashi to *Information Display* editor Ken Werner in Monterey, California, in October 1994. Following discussions with Aris Silzars, Kathy Middo, and members of the Board of Directors of the Society for Information Display, the Display of the Year Awards Committee was formally constituted in January 1995 in Santa Clara, California, with Professor Kobayashi as Chair. To ensure a broad perspective as well as in-depth technical understanding, it was agreed that the committee should include technical journalists as well as distinguished display professionals. A full meeting of the committee was held on May 24, 1995, at La Sila Restaurant in Orlando, Florida. Electronics has made subsequent telecommunication convenient.

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Liquid-Crystal Displays

Adequate supplies lowered prices, active research produced new technologies, and the promise of new markets raised spirits.

by John L. West

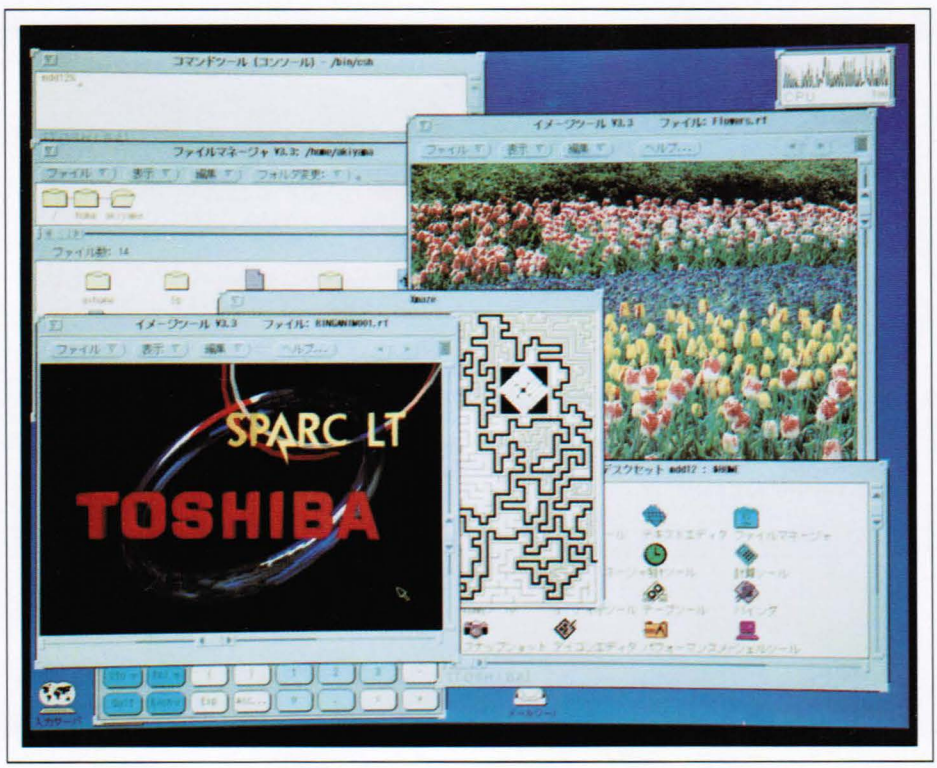
THE MARKET FOR LIQUID-CRYSTAL DISPLAYS (LCDs) diversified rapidly in 1995. Active- and passive-matrix screens for laptop computers still dominate the market, but other applications – such as projection systems and very-low-power electronic communications devices – are growing rapidly. Researchers are developing LCDs to meet the unique specifications required by the new applications.

An Active Market

Any doubts about the success of active-matrix liquid-crystal displays (AMLCDs) for the laptop-computer market evaporated in 1995. Many consumers demonstrated their desire for improved performance by paying the substantial premium required to incorporate an active-matrix screen in a laptop computer. Active-matrix screens were included in about half the laptop computers sold in the last year.

With market acceptance demonstrated, manufacturers rushed to add production capacity. As the end of 1995 approached, supply and demand came into balance, leading to the first substantial price reductions in active-matrix screens. The price for a 10.4-in.-diagonal screen dropped well below $1000 and the $500 mark is now in sight. Market forecasters now predict supply to exceed demand, and the first volleys of a price war have been fired. Laptop-computer manufacturers, who until recently worried about obtaining a reliable supply of active-matrix screens, can now shop among a half-dozen producers. Consumers will soon see these price reductions reflected in the retail price of laptops.

As the price differential between active- and passive-matrix screens shrank, so did the performance differential. Dual-scan and active-addressing (AA) schemes increased the speed of supertwisted-nematic (STN)



Toshiba

Fig. 1: *Toshiba's 13.8-in. 1152 × 900-pixel display uses light-shielded, fully self-aligned TFTs. Toshiba's engineers believe the technology can be scaled up to produce a 30-in.-diagonal screen with 2 million pixels.*

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(a) Sony

(b) Sony

Fig. 2: (a) Sony's Plasmatron is a 21-in.-diagonal plasma-addressed LCD. (b) A composite photo indicates what a large, hang-on-the-wall Plasmatron might look like.

displays, and improved retardation films enhanced color performance. While video and multimedia applications require active-matrix screens for optimum performance, the passive displays are more than adequate for word processing, spreadsheets, and number crunching. Combined with a still-significant price differential, this accounts for the continuing strength in the passive-matrix segment.

Passive- and active-matrix displays will continue to split the laptop market in the near future. Research continues to improve the performance of LCDs for laptop computers, with many of the innovations being made in the supporting hardware. Higher-efficiency backlights and new light-diffusion plates have the potential to produce brighter displays using less power.

A Broader View

Researchers from AlliedSignal reported on an enhanced-viewing-angle backlighting system utilizing a fluorescent edge-lit light-pipe design. Using an array of micro-optical elements, the light pipe illuminates the LCD with collimated light with an efficiency of 35–45%, depending on the exact design. The system employs a second film, positioned on the viewing side of the LCD, which utilizes an array of 3-D microstructures to diffuse the transmitted collimated light. The diffusion is accomplished via total internal reflection, thus avoiding scattering losses. This backlight system can be used with both active-matrix thin-film-transistor LCDs (TFT-LCDs) and passive-matrix STN-LCDs to greatly increase their viewing angles.

But active-matrix and STN displays developed for laptop computers cannot meet many

Hitachi

Fig. 3: The Raychem/Hitachi reflective NCAP light valve produced a 334-lm output with a 150-W lamp for an impressive 2.2 lm/W.

of the specifications required by a wide variety of new applications in the rapidly diversifying flat-panel display (FPD) market. Much of the research reported over the last year dealt with addressing the requirements of these new markets.

Bigger Is Better

The size of AMLCD screens continues to increase, with the short-term goal of replacing the CRT for desktop-computer monitors and the longer-term goal of eventually achieving the long-sought-after thin TV that hangs on the wall. These markets, however, are also coveted by the makers of virtually every type of FPD, and the CRT's big lead in desktop monitors will not easily be displaced. The next few years will be interesting as the market unfolds.

The largest prototype of an active-matrix screen remains the Sharp 21-in.-diagonal TFT display, announced in 1994. Toshiba has demonstrated a 13.8-in.-diagonal 1152 × 900-pixel color display using light-shielded, fully self-aligned TFTs (Fig. 1). Toshiba's engineers believe this technology can be scaled up to produce a 30-in.-diagonal screen with 2 million pixels.

In an effort to avoid the technological hurdles of fabricating TFTs over a large area, Sony has demonstrated a 21-in. plasma-addressed screen based on technology developed by scientists at Tektronix (Fig. 2). The Sony Plasmatron uses a gas plasma as the nonlinear addressing medium, which could greatly simplify the manufacture of large-area displays.

Kent State University

Fig. 4: This full-page-size 1152 × 896-pixel bistable reflective cholesteric display has a contrast ratio of 20:1 and wide viewing angles.

Current Projections

Front-projection systems utilizing liquid-crystal light valves continued their strong growth in 1995. Liquid-crystal panels and projectors dominate the educational and promotional markets. As in the laptop-computer market, active-matrix screens are capturing an increasing share of this field. (A review of liquid-crystal projectors by W. L. Coggshall appeared in the July/August 1995 issue of this magazine.)

Front-projection systems have not captured the lucrative entertainment market because of low luminous efficiencies and limited light-bulb life. Consumers like to view videos in well-lit rooms, so projected images must be bright. Consumers are also resistant to changing light bulbs every 2000 hours when a traditional CRT generally lasts for 10 carefree years.

The liquid-crystal projection market promises to explode if higher luminous efficiencies can be achieved. Researchers are turning to polymer-dispersed liquid crystals (PDLCs) to increase light throughput. PDLC light valves do not require polarizers, and eliminating the polarizers results in a doubling of the luminous efficiency. Researchers from Raychem and Hitachi demonstrated a reflective nematic curvilinear aligned-phase (NCAP) light valve with 640 × 480 pixels addressed by metal-oxide-semiconductor (MOS) transistors (Fig. 3). They achieved a 334-lm output using a 150-W lamp for a very impressive 2.2 lm/W. Asahi Glass also reported a high-efficiency reflective projection system utilizing PDLCs, this one achieving a contrast ratio of 100:1, with a driving voltage of 6 V and a collection angle of 10°.

Increasing the performance of the projection lamp is also crucial if consumers are to accept liquid-crystal projectors for entertainment. Philips reported a short-arc lamp producing 6000 lm at 100 W with a reported life of greater than 4000 hours, and the company is aiming for 8000 hours. The small arc gap

Nippondenso

Fig. 5: *The wide viewing angle and lack of color inversion in this anti-ferroelectric LCD, which Nippondenso demonstrated at SID '95, resulted in a very attractive display.*

of 1.4 mm translates into greater transmission efficiency throughout the projection system. The short arc is particularly useful with the Schlieren optics used with PDLC light valves, and it potentially offers overall efficiencies of 10% or more.

Small Is Beautiful

Researchers are also working on new LCDs capable of meeting the unique requirements of the burgeoning portable-communications industry. This market encompasses a broad array of applications ranging from relatively low-resolution displays for pagers, through higher-resolution displays used in maps for portable global positioning systems (GPS), to very-high-resolution displays for electronic manuals, books, and newspapers. The market now tolerates traditional TN and STN displays out of necessity but desperately seeks displays with improved performance.

The low power requirements of the portable-communications industry preclude the use of backlights to produce a bright display. Researchers are therefore developing bright, reflective LCDs and are, in the process, exploring electro-optic effects that do not require polarizers. Along the way, they are reinvigorating research into the guest-host effect and exploiting the reflective properties of cholesteric liquid crystals.

The brightness of reflective LCDs is being improved significantly with brightness-enhancement films such as those available from 3M. Researchers from Clio Technologies, Holland, Ohio, reported a novel transparent front-lighting system that could potentially be incorporated with most reflective LCDs, in addition to being used for backlighting.

NEC reported a bright, reflective guest-host TFT-LCD that used a rough polyimide surface coated with an aluminum reflector over the addressing TFT. The topography of the reflector was designed to maximize diffuse reflectance. Using a guest-host liquid-crystal mixture, the 23-cm-diagonal monochrome display achieved a contrast ratio of 5.2:1 with a reflection efficiency of 56% – approaching the quality of newsprint.

Researchers at Kent State University, working in collaboration with the University of Stuttgart and Kent Display Systems, reported a full-page-size reflective cholesteric display with 1152 × 896 pixels. This high pixel content is possible with only simple passive-matrix addressing techniques because of the cholesteric material's bistable switching. The Kent State researchers report contrast ratios of 20:1 and wide viewing angles (Fig 4). The high resolution and brightness of the display make it particularly useful for applications such as electronic manuals and books.

What's Hot in R&D

Multidomain TN effects and photo-alignment were the hot research topics in '95. Even though research into multidomain effects is only a few years old, an entire session was devoted to it at the SID meeting in Orlando this year, and rightly so. The multidomain approach offers the potential of greatly increasing the viewing angle of TN displays. Researchers are settling on a four-domain pixel but are using a number of techniques to achieve this effect. This topic promises to remain hot and, with any luck, one of these approaches will find its way into a product over the next few years.

In 1995, we also saw a proliferation of papers on photo-alignment. Photo-patterned alignment promises to eliminate the troublesome rubbing process for orienting liquid-crystal material at the panel substrates, so many researchers are now exploring photo-alignment techniques. Researchers reported on photo-alignment using polyimides and demonstrated the use of photo-alignment to produce multidomain LCDs. Keep an eye on this topic. It promises to proliferate rapidly in the near future.

Anyone who saw the Nippondenso demonstration of a full-color anti-ferroelectric LCD at SID '95 had to be impressed. While the measured contrast of the demonstrated display is less than that of the typical TFT-LCD, the greater viewing angle and lack of color inversion produced a very attractive display (Fig. 5). Expect to see more research into this promising topic.

The coming year promises continued improvements in LCDs for laptop computers and significantly lower prices for active-matrix screens. Projection systems will also continue to improve, with PDLCs waiting in the wings. The big growth area for LCDs promises to be in portable communications – an applications area with the potential to dominate the LCD industry in the near future. ■

Cathode-Ray Tubes

High-volume CRTs are selling in record numbers, but custom manufacturers are under pressure.

by Joe Hallett

As we wrap up 1995, the perennial question "Did the CRT die yet?" has to be answered, once again, in the negative. Despite major advances in non-CRT display technologies, the bread-and-butter markets for CRTs – TV sets and computer monitors – continued to be strong. But decreasing military requirements and increasing downward pressure on costs have forced some manufacturers to leave the custom-CRT business, while others are looking for ways to broaden their markets.

The consumer television industry, as always, has been looking for incremental ways to make its products more attractive while staying within the capabilities of their manufacturing operations. Much of the industry's recent history has involved changes in glass, which allows larger tubes to be fabricated with flatter and square-cornered screens. And the prospect of wide-screen displays (16 × 9 aspect ratio) – expected when/if high-definition services become generally available – continues to lurk just around the corner. Large, wide-screen tubes are already being produced in Japan and Europe in grades that are suitable for television and data display applications. Consumer applications continue to control the big bucks in CRTs. Agreements were reached in 1995 to standardize on a U.S. high-definition transmission standard, raising expectations that we should see the introduction of consumer high-definition receivers within 2 years. But high definition and wide-screen mean "large screen" to many observers, and CRTs that are large enough are also big enough and heavy enough to stimulate interest in other display technologies.

Clinton Electronics

Fig. 1: *Clinton Electronics Corp. exhibited a 7-in. projection CRT at SID '95. Ken Compton, General Manager of the Monitor Division, said increasing demand made re-entering the projection market attractive.*

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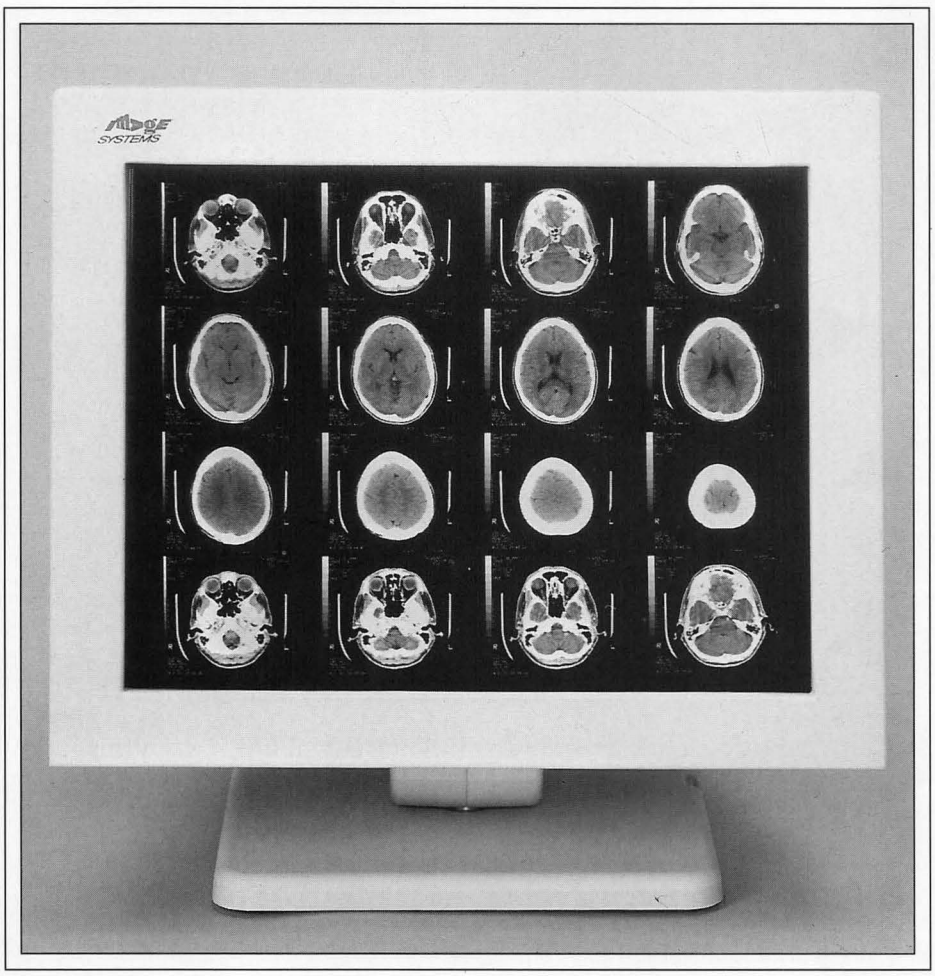


Image Systems

Fig. 2: *The most demanding requirements for medical monitors are set by radiological diagnosis, but there are a variety of less-demanding medical applications. The Image Systems M21LMEDMAX, scheduled to be exhibited at the huge Radiological Society of North America (RSNA) show in November, is designed as a patient-contact monitor in, for example, operating rooms and cath labs. The monitor is therefore designed to be splashproof and to have low leakage current.*

Projection Is Big

Projection CRTs are back "in" in a big way as a proven technology for displaying large 16 × 9 TV images. According to Zenith's Bill Rowe, his firm plans a rapid expansion of 55–65-in. displays for HDTV starting this year. "More projection-CRT capacity is needed in the U.S.," he said. Given rapid advancements in competing non-CRT projection technologies, such as Texas Instruments' Digital Micromirror Device (DMD), the projection-CRT industry should be exciting to watch for the next few years. This is particularly true because the projection industry will be dealing with some of the same challenges that were faced by direct-view CRT manufacturers during the evolution of competing flat-panel displays (FPDs).

Standing at the "high end" of CRT projection, Orlando-based Trident quietly announced plans to introduce unique electron-beam-addressed liquid-crystal light-valve technology – licensed from Tektronix – for a new line of projectors. "We are first going after the simulation market and then a broader industrial marketplace," said CEO Herbert J. Kindl. Trident expects its Vulcan 2000 projection system to fill a void left by the departure of GE's Talaria light-valve projectors by providing very high (1600–2000 lm) light output and 1600-line RGB resolution.

Clinton Electronics conveyed a subliminal message at SID '95 by showing a projection CRT with little fanfare, but clearly testing the waters for OEM interest (Fig. 1).

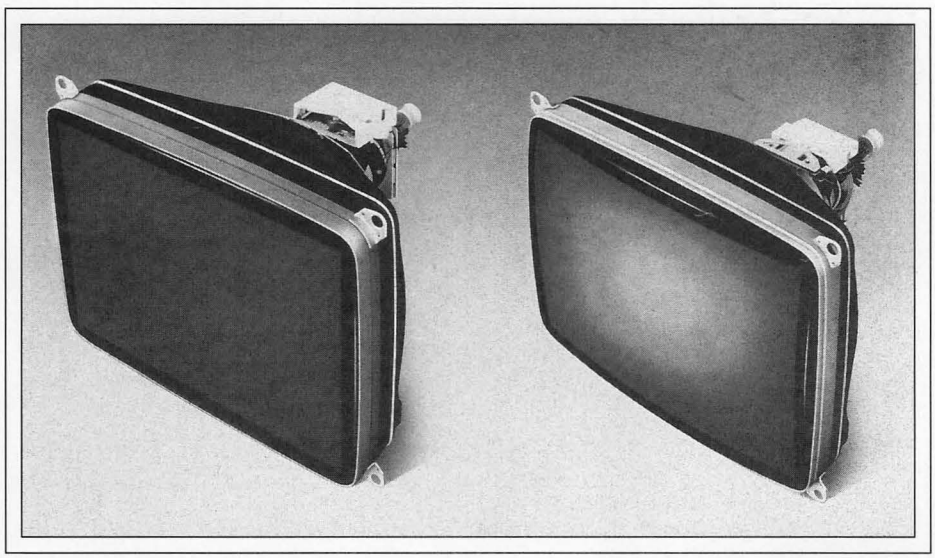
Big, Small, Flat, and Pixelated

Meanwhile, back at the computer, monitors seem to be following in the footsteps of TV as small screens gradually make way for larger ones and as users develop a greater awareness of image quality by working with more diverse software involving images, presentations, multimedia, and higher resolution and addressability.

Data-display CRT manufacturers are moving quickly to the 17-in. size and are supporting higher resolution for personal-computer users. Sony, Toshiba, and Philips showed 17-in. color products at SID '95, and Sony indicated it would respond to increased demand for computer monitors by moving some CRT production to San Diego, according to Senior Vice-President Tei Iki.

On the direct-view portion of its stand, Clinton showed several Clinton-labeled monochrome monitors – using Clinton CRTs – featuring 1600 × 1280 addressability and microprocessor control. "Our new U.S. manufacturing facility for CRT monitors is open for OEM business," said General Manager Ken Compton. "We are making several monochrome units now and are prepared to do custom assembly of color monitors as well," he said. Although the monitor business leverages Clinton's own monochrome CRTs and custom application-specific ICs (ASICs), outside sources of color CRTs are used. "We aren't ready to make our own color tubes ... yet," said Compton.

The CRT industry supports a lot of infrastructure, ranging from suppliers of parts and materials to makers of display assemblies and monitors, special test equipment, power supplies, and yokes. Exhibitors of CRTs and related products at SID '95 – one-third of all the exhibitors at the show – spoke of the downward pressure on costs for military displays, the trend toward higher performance, and the greater emphasis on small CRTs for instrumentation, head-mounted, and virtual-reality systems. They also noted trends toward increased automation in testing and the



Matsushita Electronics Corp.

Fig. 3: *Filling the gap left by Zenith's discontinuance of its flat-tension-mask (FTM) CRT, Panasonic began to promote its "perfectly flat" (PF) CRT to OEMs. (The PF tube is on the left; a conventional Panasonic tube is on the right.)*

standardization of display-circuit functions in easily replaced modules.

The presence at SID '95 of very-high-resolution monochrome products from Data Ray Corp., Image Systems, Orwin Associates, Siemens, and Thomson Tubes & Displays may indicate an increasing readiness among radiologists to accept electronic displays (Fig. 2). But all of the manufacturers of "diagnostic-quality" (or near-diagnostic-quality) medical monitors interviewed by *Information Display*'s editors reported severe difficulties in obtaining CRTs that consistently met their high performance requirements. Radiological diagnosis is an application that is pushing the limits of CRT manufacturing technology. The custom-tube maker that gets it right first will dominate a growing high-margin business.

Zenith, adjusting to the apparently friendly takeover by its Korean customer LG Electronics (formerly Gold Star), has stopped flat-tension-mask (FTM) operations and shifted capacity to TV-CRT types, while Tektronix's avionic-CRT business (also based upon a flat taut-mask technology) was sold to Planar Systems. Meanwhile, Panasonic, in keeping with the display industry's longstanding tendency to never let a good thing die, has been quietly promoting its own version of FTM – the "perfectly flat" (PF) CRT – to OEMs (Fig. 3).

It's hard to be neutral about CRTs. If you are a manufacturer, there's all that expensive manufacturing equipment that needs to be kept busy. If you are a tube designer, there's the queasy feeling that you may be an endangered species. And if you are an OEM, there's the obvious growth of competing technologies that offer lower power, lighter weight, and nicer packaging. Yet the underlying truth is that the CRT is a very elegant solution to a very difficult problem.

It is fun to speculate whether the CRT would be a strong challenger if flat panels had come on the scene first. As is true for most technologies that are pushed beyond their natural envelopes, the effort to scale CRTs up into large-screen behemoths has invited competition – as have the efforts to decrease shadow-mask dots to microscopic proportions and to increase light output to arc-lamp levels. But in the middle ground – where resolution, viewing distance, and packaging requirements converge in a constellation that the CRT can handle comfortably, and where low cost prevails – the CRT should be around for quite some time. ■

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Manufacturing Flat-Panel Displays

It will take a major technological leap for the U.S. or Europe to make a substantial dent in Asian manufacturing dominance.

by William C. O'Mara

THE WORLD HAS DEVELOPED an insatiable demand for personal computers, and many of them are portable. This year, well over 50 million personal computers will be sold. About 12 million units will be portable, and virtually all of these will have liquid-crystal flat-panel displays (FPDs).

Only a few years ago, a liquid-crystal display (LCD) meant low contrast, monochrome, and dull. "Color" displays were either blue and white or yellow and black because of the wavelength-dependent retardation of the supertwisted-nematic (STN) material upon which these displays depended. Today, however, full-color displays account for most of the display production of portable computers.

Both STN passive-matrix and thin-film-transistor (TFT) active-matrix color displays are available, and manufacturing costs of both types are coming down. TFT display manufacturing has received quite a bit of attention in the last few years as companies installed manufacturing capacity and then struggled for yield improvement. Many people thought that most full-color displays would be of the TFT type because of that technology's high contrast and video-rate response. But continued improvements in passive-matrix STN displays have improved the contrast, and the dual-scan method of addressing has permitted adequate response for VGA displays.

In dual-scan addressing, the screen is divided in half and each half is addressed separately. This eases the problem of multiplexing the nearly one million pixels of a color

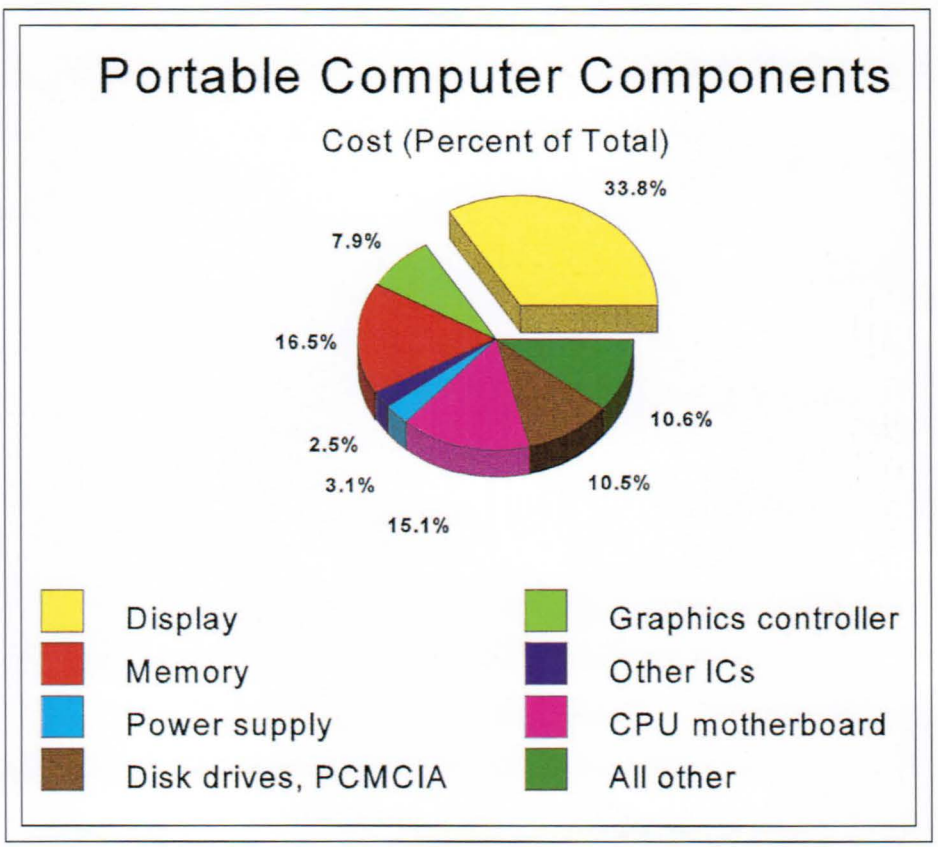

Fig. 1: *The display is the most expensive part of a portable computer – one-third the total component cost for a 486DX4/75 computer with 10.4-in. VGA-compatible color STN display. (Data from Table 1, courtesy of T. Taminato, K&T Institute, Japan.)*

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Table 1: Color portable-computer cost components

Component	Cost (¥)	Percent of Total
CPU motherboard	17,900	15.1
Graphics controller	9,400	7.9
Memory	19,500	16.5
Other ICs	2,900	2.5
Power supply	3,700	3.1
Display (color, STN)	40,000	33.8
Disk drives, PCMCIA	12,400	10.5
All other	12,500	10.6
Total	118,300	100.0

Source: K&T Institute, Tokyo, Japan.

VGA display. Further improvements in STN performance can be anticipated with other drive schemes, such as active addressing. The performance enhancements in STN displays have allowed the technology's lower manufacturing cost to become a key element when product planners choose a display for portable applications.

The Priciest Part of the Product

The display is the most expensive part of a portable computer. In the first quarter of 1995, a portable computer incorporating a 486DX4/75 microprocessor and a 10.4-in. VGA STN display cost about $1200 to manufacture. The display accounted for $400 – or one-third – of this cost. Table 1 shows the cost breakdown in a color STN portable computer. It was prepared by Mr. T. Taminato of K&T Institute in Japan, a specialist in LCD market information.

If the STN display in this computer is replaced with a TFT display, the overall cost climbs close to $2000, with the cost of the display representing almost half the total. Since the display cost is so great a fraction of the computer's total cost, both manufacturers and end users have shown a predilection for the STN display of late. The surge in color STN display production will actually overtake TFT displays this year. Next year, however, further price attrition in active-matrix displays will return them to dominance. Overall, the market for notebook-computer displays will approach $4 billion this year and will probably reach $6 billion in 1996.

Severe price attrition for both types of display seems assured for the next few years as the industry continues to add capacity. The $400 STN display of 1995 will become the $300 display of 1996 and the $260 display of 1997. The corresponding prices for TFT displays are about $750, $640, and $550 for 10.4-in. VGA displays in 1995, 1996, and 1997. This price attrition puts extreme pressure on the display supplier to cut costs, and the pressure is transferred downward to materials and component suppliers. The most expensive components of a display module are the driver integrated circuits and the color-filter panel. While the semicustom nature of the drivers has made cost reduction difficult, the somewhat generic nature of the color filter and the many suppliers of this component in Japan have allowed the cost to decrease even in the face of limited production capacity in 1995. (The color filter is the front glass panel containing the pattern of red, green, and blue rectangles that produce color images.)

It is interesting that the parsimonious nature of the industry has not produced a preference for smaller, less expensive displays. On the contrary, 8.4- and 9.4-in.-diagonal displays have virtually disappeared.

Substantial capacity for color-filter manufacturing was added in Japan in 1995 to support increased display production. Established suppliers, such as Toppan Printing and Dainippon Printing, have been joined by newcomers STI Technology (a joint venture of Sumitomo Chemical, Toyo Shijo, and C. Itoh), Toray, and many others. Except for Toppan Printing, which makes color filters using two different manufacturing processes, other suppliers are specialists and use only one method. Toppan has color-filter lines that employ the dye and pigment dispersion methods. Most other suppliers produce color filters using pigment dispersion. This method starts with a photoresist or other organic vehicle in which are suspended submicron-sized particles of colored pigment. A thin film of this material is applied to the substrate and patterned using photolithography, with one coating for each primary color. With a black matrix around the colored rectangles, a total of four layers is required. Materials are applied by spin-, roll-, or slot-coating techniques. Other color-filter manufacturing methods include dyeing (Tottori Sanyo) and electrodeposition (Toyo Shijo).

Color-filter manufacturers are planning major expansions in installed capacity over the next 2 years. Table 2 shows the announced capacity of 11 suppliers, amounting to 1,810,000 10.4-in. color filters a month in 1995. The actual capacity is less than this because production yields are not factored in. Industry yields are believed to be about 60% right now. Expansion at the rate shown in the table will cause color-filter manufacturing capacity to outstrip the requirements of display manufacturing. (Other firms, not shown in the table, will add even more capacity.) Conservative forecasts put the color portable-computer market at 15–18 million units in 1997, which would absorb only half the color-filter manufacturing capability projected for 1997.

According to K&T Institute, if captive suppliers are included, the total number of color-filter suppliers numbers more than 30 – a number that may decrease in light of the projected overcapacity. Some analysts speculate that only a handful of color-filter suppliers can survive.

Table 2: Color-filter manufacturing capacity (thousands of filters per month, 10-in. equivalents)

Firm	1995	1996	1997
Toppan	400	650	750
Dainippon Printing	250	400	400
Toray	250	500	500
STI Technology	200	200	200
Kyodo Printing	80	100	100
Tottori Sanyo	60	60	60
Kyocera	---	40	40
Toyo Paper	420	420	420
Mitsubishi Chemical	---	50	400
Nippon CMK	100	100	100
IBM Japan	50	180	180
Total	1810	2700	3150

Adapted from Nikkei Microdevices, p. 78 (August, 1995).

Japanese companies have a history of building manufacturing capacity, and overcapacity is the result of individual firms attempting to obtain a market share that will enable them to prosper. The situation resembles a high-stakes poker game in which all the players know that not everyone will walk away a winner, but the pot is big enough to attract lots of players. Japanese suppliers of electronic components have succeeded in markets where products are standardized – floppy disks and dynamic-memory chips, for example – and the standards change slowly over time. The "standard" hard disk drive, on the other hand, changes almost monthly as new technology allows increased capacity with smaller physical size. The classic Japanese approach of building massive production capacity is a disadvantage when technology is changing rapidly, and Japanese suppliers are not competitive in hard drives. Japanese color-filter suppliers are hoping that their product will be more like DRAMs than hard drives. Even so, there's going to be a shake-out.

The rest of the display world is playing catch-up with Japan. Korea is mounting a frontal attack, following the same strategy that has allowed Korean manufacturers to capture a significant fraction of the dynamic-memory IC market. That strategy has also seen them become the price leaders in memory chips.

Samsung has put up a factory that can start 80,000 displays per month, and the other Korean electronics conglomerates are coming along as well. This is causing concern among Japanese display manufacturers, who now see the Korean conglomerates breathing down their necks in displays as well as in ICs.

A significant difference between ICs and LCDs is that the Koreans are almost completely dependent on the Japanese for display-manufacturing equipment and technology right now. On the other hand, Korean companies can obtain both IC equipment and know-how from either the U.S. or Japan.

Taiwan is coming along as well. STN displays are manufactured by Nan Ya Plastics and Chunghwa Picture Tubes, as well as by Taiwan-based Japanese-subsidiary companies. Small-size active-matrix displays are now made by Unipac and Primeview Computer, with 10-in. displays expected from these two companies next year. Nan Ya and Chunghwa may enter the AMLCD arena as well.

In Europe, the FPD Corp., led by Philips, manufactures diode-array AMLCDs. In the U.S., the most significant FPD manufacturing line is the one that was shut down by Motif – the Motorola/In Focus joint venture established to develop and manufacture circuits for active addressing of STN displays. Active addressing achieves video speeds in the older STN-LCD technology, allowing it to largely keep up with the performance of active-matrix displays.

Motif's original strategy included a pilot-scale STN manufacturing line to make displays to embody the technology. The line was abruptly shut down last fall. This allowed less than a year for installation and operation of the equipment – hardly a fair trial for such an operation. Very little manufacturing experience exists in the U.S. for liquid-crystal FPD assembly operations, and STN display assembly requires exacting control of tolerances in cell gap and other parameters. The closing of the Motif line prevents the extension of STN know-how in the U.S. and raises the bar much higher for any new, privately funded liquid-crystal FPD startups.

In terms of manufacturing volume and business level, the leader of the U.S. FPD industry is Planar Systems, a manufacturer of electroluminescent (EL) displays whose sales for 1995 are expected to approach $80 million. EL displays are accepted in some medical, industrial, and military applications, and constitute a profitable niche market for Planar Systems. Sharp supplies some EL displays as well.

The U.S. Government continues to fund FPD initiatives in AMLCDs at OIS Optical Imaging Systems, and at Xerox, AT&T, and Standish Industries, who are working cooperatively. OIS is scheduled to begin pilot-level production early in 1996, while the Xerox group will start later in the year. Efforts in private-sector AMLCD manufacturing include Image Quest, Fremont, California, which is funded primarily by Hyundai, and Sharp Electronics, Camus, Washington, which is building an active-matrix pilot capability there. Sharp already has display-module assembly facilities in Camus. Industry speculation has it that Sharp will undertake an AMLCD manufacturing project in Camus when their third-generation factory in Mie is completed in 1996. So, the first high-volume AMLCD manufacturing line in the U.S. may well turn out to be Japanese.

In addition, the U.S. Government, using funding from the Technology Reinvestment Program (TRP), has provided incentives to several developers of field-emission devices (FEDs), a flat and thin replacement for CRTs that is very early in its development cycle. Other government-supported programs include the U.S. Display Consortium (USDC), which funds equipment and materials projects intended to develop a display-manufacturing infrastructure in the U.S. Funding for the USDC is provided by the Department of Defense's Advanced Research Projects Agency (ARPA) as a part of its High Definition Systems development program, with industry matching funds that currently exceed ARPA's contribution.

Right now, Japanese companies account for 95% or more of large-area FPD manufacturing volume. Over the next few years, Korean and Taiwanese manufacturers may capture 15–20% of the market, putting them at about the market share they currently hold for smaller LCDs. But unless some very dramatic technological changes occur that render the current installed manufacturing base obsolete, the U.S. and Europe will continue to lag far behind their Asian competitors. ■

Emissive Displays

Emissive flat panels are a very small fraction of the flat-panel market, but that portion is vibrant and the future is bright.

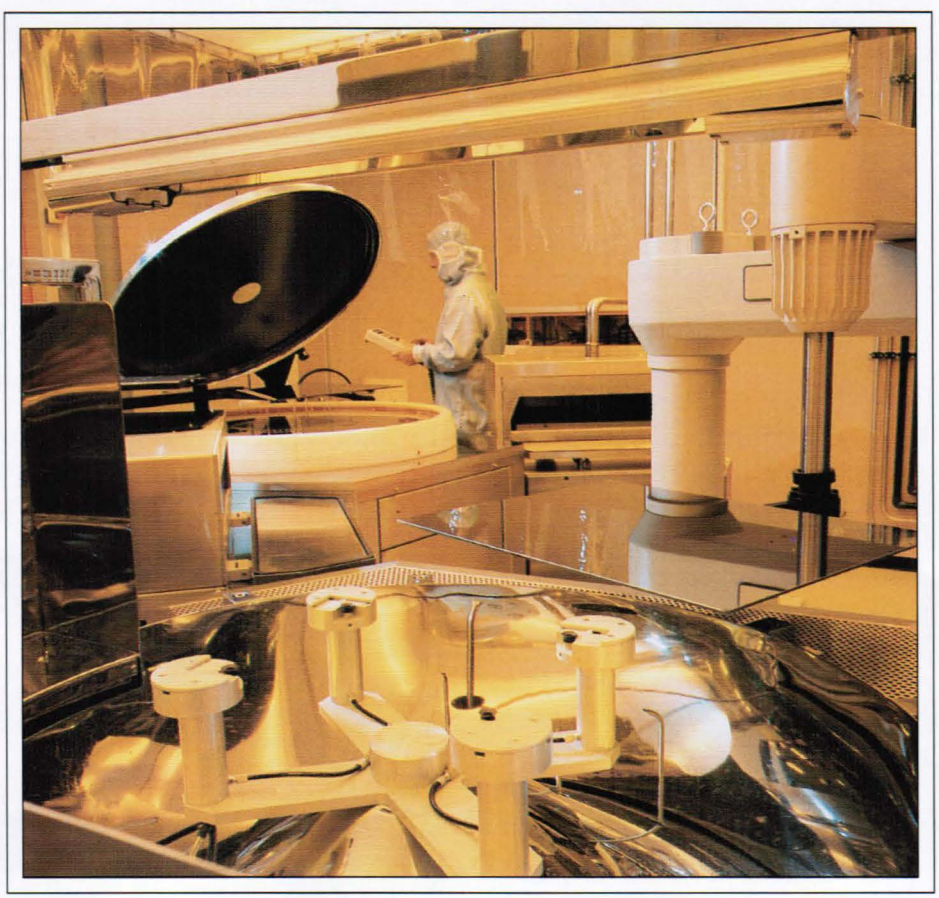
by Ken Werner and Dian Mecca

HIGH-INFORMATION-CONTENT (HIC) emissive displays account for 4% of the large-area flat-panel-display (FPD) market – and a lot of optimism. The category comprises three technologies: plasma display panels (PDPs), electroluminescent (EL) displays, and field-emitter displays (FEDs).

Plasma Display Panels

PDPs are widely held to be the only direct-view flat-panel technology that can produce full-color, video-rate, large-screen commercial displays in the foreseeable future. They are therefore generating a great deal of excitement among the military, as well as other users who require large situation-room and presentation displays, and among manufacturers of home-entertainment products, who see this technology as the likely candidate for the coming generation of large-screen hang-on-the-wall TVs.

The first full-color (6 bits per primary) commercial PDPs are Fujitsu's 21-in. displays, over 1000 of which have been installed at the New York Stock Exchange. Fujitsu is making 2000 of the 21-in. displays each month, and the price is falling. In late September, distributor pricing was being quoted as $5150 in quantity. Fujitsu announced its next generation – a 42-in. 16:9 display with 8-bit color and a luminance of 300 cd/m^2 – in August and was planning to demonstrate it at Comdex in November, according to Brian Shannon, Marketing Analyst for FPDs at Fujitsu. That would make it the largest full-color PDP ever to be publicly demonstrated. The initial sample price will also be "large" – ¥1 million. The company is investing ¥20 billion in a production line for PDP products at an existing plant in Miyazaki. Initial volume production, scheduled to begin in October, 1996, is to be 10,000 units per



Thomson Electron Tubes

Fig. 1: *Thomson's new PDP factory in Moirans, France, has 10,000 square feet of cleanroom space and an initial capacity of 10,000 units per year.*

Ken Werner *and* ***Dian Mecca*** *are the Editor and Assistant Editor of* Information Display.

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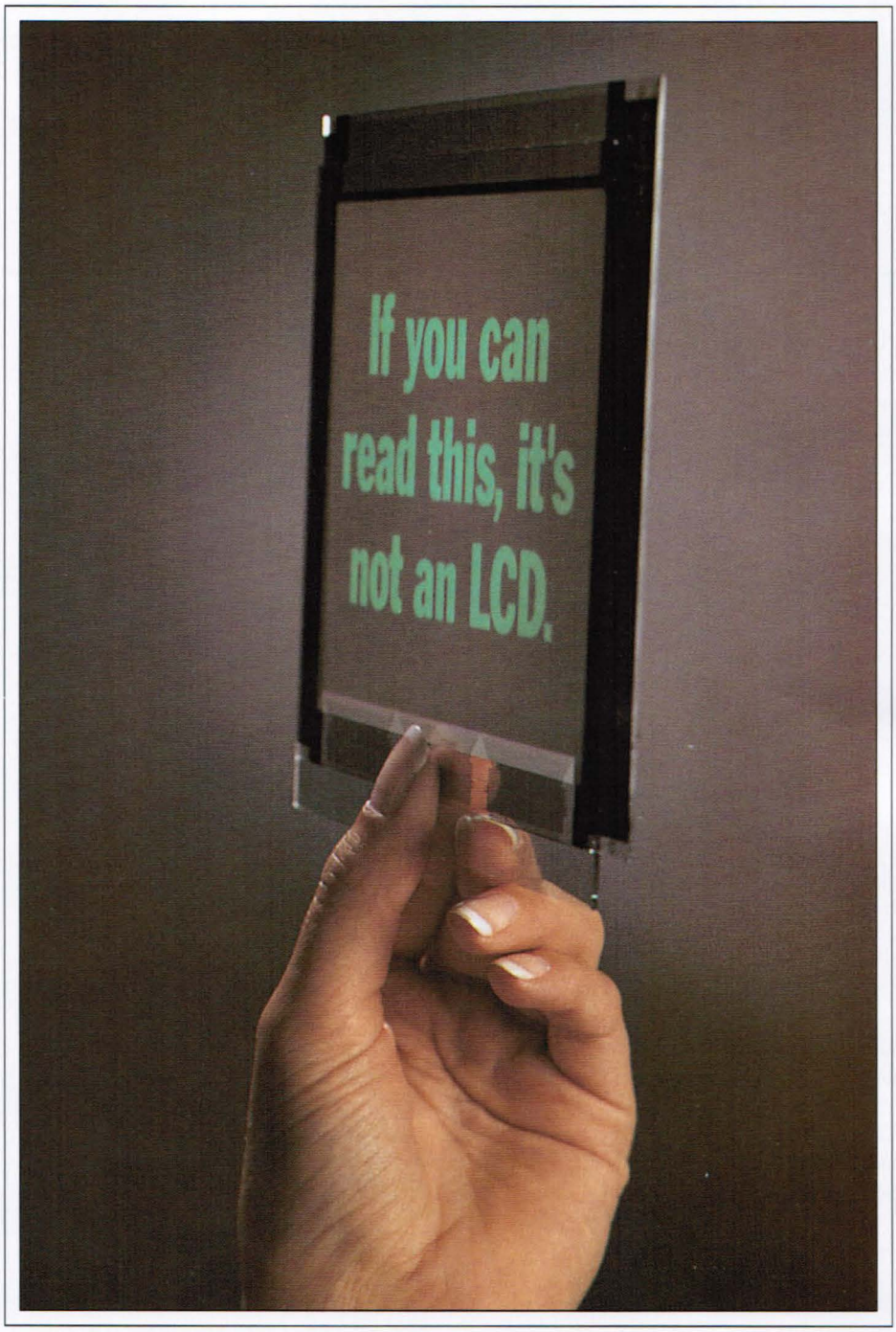
month. Fujitsu estimates that the unit price will then be ¥500,000.

Plasmaco is moving forward from prototype stage to production and is on schedule to deliver the first of their 21-in. high-luminance color PDPs this month. Production will be revved up throughout 1996, says Plasmaco's Jane Birk. The price has not yet been determined but will be "competitive."

Photonics Imaging succeeded in making a 21-in. 1280 × 1024 full-color (8 bits per primary) video-rate wide-screen PDP, and delivered a unit to the U.S. Department of Defense. The full-color pixel pitch of 0.33 mm is the best yet for PDPs. Photonics is now taking orders for delivery of this panel in the first half of 1996.

Except for Fujitsu and the long-term R&D effort at NHK (the Japan Broadcasting Corp.), Japanese companies have been keeping a generally low profile in regard to color PDPs. But that changed dramatically in 1995. In late August, Matsushita announced the development of the first 26- and 40-in. color PDPs designed for use in TV monitors and receivers. The panels, which use dc pulse-memory drive, were developed under the direction of NHK and in collaboration with DuPont and Texas Instruments Japan. (NHK proposed the basic technology, DuPont developed the high-precision thick-film microelectronic technology, and TI developed the fast pulse-driving LSIs.) Samples of the 26-in. panel, intended for use in conventional TVs, were scheduled to be available in October. Samples of the 40-in. panel, designed for HDTV, are scheduled for June 1996 availability. Matsushita is planning to incorporate the 26-in. panel into consumer products in fiscal 1996. The company is a member of the NHK-led Hi-Vision Plasma Display Panel Consortium, which was founded in October of 1994 to develop a practical 40-in. hang-on-the-wall HDTV receiver in time for the 1998 Nagano Olympic Games.

In June, NEC announced the creation of the Color Plasma Display Panel Business Promotions Division "as part of an aggressive strategy to take the lead in this important new market." The company is investing ¥5 billion in a production line to be built at its Tamagawa plant and intends to produce 1000 units/month beginning in 1996. Not a company to be accused of timidity, NEC says that by the year 2000 it expects to be manufacturing 150,000 units/month, with sales of color PDPs exceeding ¥100 billion. NEC projects the market for 20-in. color PDPs to be ¥110 billion in 1998, ¥260 billion in 2000, and ¥760 billion in 2002.



PixTech

Fig. 2: *The first standard FED product is arguably PixTech's 5.2-in.-diagonal quarter-VGA green FED, which is being included in development kits.*

Mitsubishi has a prototype 20-in. color PDP and is planning a prototype of a 40-in. PDP TV by March 1996 "at the latest." The company plans to have a 40-in. display commercially available in 18–24 months. Three deci-

Table 1: Thomson PDP Product Plans

Product	Prototype	Production
13 in., 640 × 480, 512 colors	Q4 '95	Q1 '96
19 in., 1024 × 768, 512 colors	Q1 '96	Q3 '96
24 in., 1280 × 1024, 512 colors	Q4 '96	Q2 '97
19 in., 1280 × 1024, 512 colors	Q1 '97	Q3 '97

sions Mitsubishi has yet to make are whether that display will be for TV or monitor applications, whether it will have a 4:3 or 16:9 aspect ratio, and whether it will be a captive or OEM product.

For years, Thomson Electron Tube Division has been producing data-grade multicolor PDPs in relatively low volume. After 18 months of construction, the division has now completed a new facility for the production of ac color plasma displays, said Jeff Ohstrom, Sales Manager, Optoelectronic Products. The facility – in Moirans, France – has 10,000 square feet of cleanroom space and new processing equipment, which is now being debugged (Fig. 1). The factory has an initial capacity of 10,000 units/year. Thomson has plans for four new PDP products over the next 2 years (Table 1). The 19-in. 1024 × 768 display will be exhibited at SID '96 in San Diego, Ohstrom said.

Electroluminescent Displays

The world market for EL displays is divided between Planar (about 55%) and Sharp (about 45%). Planar introduced a new line of small-to-medium-sized custom, monochrome, graphic EL displays to compete with LCDs. The company has energetically developed a full-color EL display over the last several years and has exhibited it widely. The display now looks like it could be a commercial product, but Planar did not announce any plans for commercialization at SID '95 last May.

Sharp introduced the LJ64H051, a 9.4-in. monochrome VGA EL display with a new black-layer technology that improves contrast and eliminates the need for a filter, said David Blass, EL Product Marketing Manager for Sharp in Camas, Washington. Samples were scheduled to be available from Sharp and its distributors starting December 1 at a price about 20% less than the company's 10.4-in. EL panel. Sharp increased its standard specification for shock from 100 to 150 g and widened the standard operating-temperature range to –20°C to +65°C.

Sharp's EL sales are flat, said Blass. "We're finding a smaller, more niche-oriented account base for EL. The difference in price between EL and active-matrix color is now only about 20%. So unless the application demands the ruggedness of EL, customers are starting to move to active-matrix color." Sharp's laid-back approach to EL has led some industry watchers to question the company's commitment to the technology, but Blass's comments refute this speculation. "Sharp continues to make improvements to EL that will ensure it has a place in the market," he said.

Field-Emitter Displays

FEDs were hot in 1995, even though nobody really sold any until the very end of the year. In mid-year, the French company PixTech (formerly PIXEL) showed very impressive 6-in.-square monochrome and color prototypes at SID '95 in Orlando. The company then formed a U.S. operation in Mountain View, California, and installed Tom Holzel – formerly Marketing Manager for Display Devices at Raytheon – as Vice-President, Marketing and Sales. In September, Holzel told *ID* that PixTech was producing its first standard product on its pilot line in Montpellier, France. The product – a 5.2-in. quarter-VGA green monochrome display with luminance continually variable up to 70 fL – was being incorporated in development kits for sale to selected integrators and OEMs (Fig. 2). "PixTech is on schedule with other FED sizes, including a 6-in. square panel and a 10.4-in. full-color VGA display scheduled for demonstration in Q4 of 1995," Holzel said.

Micron Display Technology actively pursued customers for its 0.7-in. color FED, which is suitable for camcorder viewfinders, helmet-mounted displays, and VR goggles, according to Jim Cathey, Vice-President of Sales and Marketing. Cathey would not divulge production plans or the names of potential customers, but sounded genuinely confident when he said the company could well be making a major announcement before the end of the year.

Silicon Video continued to assemble its own consortium of well-healed corporate supporters and quietly showed small prototypes to VIPs. The company is not predicting commercial product for 18–24 months.

FED Corporation is leading the "Smart Displays" consortium, which has received a $15 million ATP award to develop the core technologies to put FEDs in helmet-mounted displays and other avionic systems. Prototypes are envisioned in 2 years. In addition, the company says it is shipping custom product to undisclosed customers.

SI Diamond is always visible, but the company had not shown an anticipated new prototype through October. Texas Instruments and Raytheon are two of the members of PixTech's FED alliance. TI has been remarkably quiet about FEDs after a major PR initiative at SID '94. Raytheon reportedly showed a 2500-fL monochrome FED to potential customers. ■

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Edited by JOAN GORMAN

Gray-scale medical monitor

Image Systems Corp., Hopkins, Minnesota, has announced the M21LMEDMAX, a 21-in. landscape high-resolution, high-brightness (65 fL nominal), and high-contrast monochrome/gray-scale monitor. The autosynchronous monitor, with Hi-Res Multi-Sweep (HRMS™) circuitry, adjusts dynamically to horizontal scan frequencies from 15 to 80 kHz or from 30 to 90 kHz and vertical frame rates from NTSC to 90 Hz. The monitor conforms to Class 1 equipment and type-B protection standards meeting UL2601 (formerly UL544). The enclosure is designed to prevent ingress of fluids. The M21LMEDMAX is compatible with many input devices and workstations with resolutions ranging from NTSC to 1600 × 1280. Suggested list price for the M21LMEDMAX is $2915.

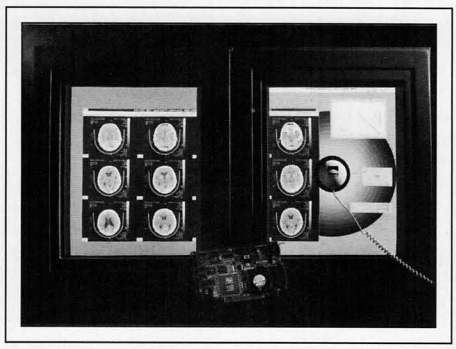
Information: Image Systems Corp., K-Tel Drive, Hopkins, MN 55343. 612/935-1171, fax 612/935-1386.

Circle no. 1

Medical-imaging displays

DOME Imaging Systems, Inc., Waltham, Massachusetts, has introduced Md4/PCI, a 1728 × 2304-pixel ultra-high-resolution display board for PCI-based imaging systems. Designed specifically for gray-scale medical-imaging applications, such as teleradiology and picture archiving and communications systems (PACS), the Md4/PCI is equipped with a set of features that address high resolution, image quality and consistency concerns, and requirements for fast image downloading and display. The display board can support spatial resolutions up to 1728 × 2304 pixels for either landscape- or portrait-mode monitors and can drive two high-resolution monitors with one slot. It also features a 10-bit DAC to drive the monitor's electron beam and an optimized PCI bus interface. The 1024 gray-scale levels that display 8-bit images allow smooth windowing and leveling adjustments and finer gradations of image detail. The 10-bit DAC on the Md4/PCI is connected to an on-board luminance-calibrator port, which enables automatic calibration and standardization of image display parameters. Delivery is 30 days ARO.

Information: Karen D. Miller, DOME Imaging Systems, 400 Fifth Ave., Waltham, MA 02154. 617/895-1155, fax 617/895-1133.



Circle no. 2

Channel-surfing with a trackball

Zenith Electronics Corp., Glenview, Illinois, a leader in TV remote-control technology, which it introduced to the industry 40 years ago, has announced Z-Trak™, the first handheld remote control that uses trackball technology. The Z-Trak's thumb-operated trackball mimics a computer mouse's "moving cursor and click" concept to allow channel surfers smooth, instant, and direct access to selected TV-set functions and features. Available in Zenith's newest line of eight StarSight™-equipped home-theater TV models, ranging from 27- to 60-in. screen sizes, Z-Trak controls both the TV and VCR. Simplified design not only reduces the number of buttons but eliminates the need for the viewer to look at the remote at all, making it convenient to view and control TVs and VCRs in a dark room. Setting the Z-Trak cursor to a preferred speed, the user can access four invisible function "hot spots" at different locations on the screen. When the cursor enters these areas, individual function commands appear, allowing the viewer to either glide through the selections in series or jump directly to the desired function, click on the on-screen display, and immediately activate it.

Information: John Taylor, Zenith Electronics Corp., 1000 Milwaukee Ave., Glenview, IL 60025. 708/391-8181.

Circle no. 3

Wide-range multimode monitors

Imaging Technologies, a division of Nortech Systems, Inc., has introduced the VCX series, the widest-range multimode gray-scale monitors available. Offered in landscape or portrait screen sizes of 17–23 in., the VCX monitors have instantaneous resolution switching to virtually any three frequencies from 15 to 148 kHz (525–2048 lines) with a video bandwidth up to 350 MHz. The monitor's independent distortion-control circuitry provides excellent linearity, page size, centering, and geometric distortion control in all resolution modes, eliminating the need to readjust the monitor each time frequencies are switched. High contrast and brightness levels of up to 100 fL make the VCX multimode monitors suitable for medical and document imaging applications.

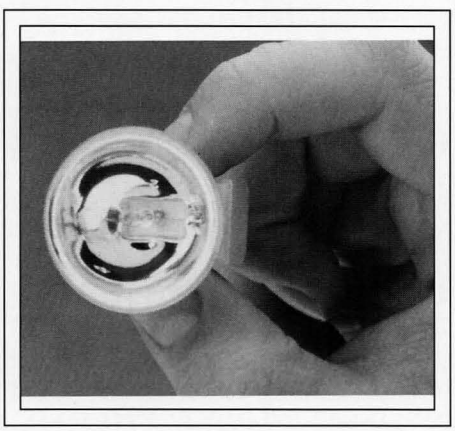
Information: Joe Lloyd, Nortech Systems/Imaging Technologies, 2500 Niagara Lane North, Plymouth, MN 55447. 612/404-0226, fax 612/404-0227.

Circle no. 4

Narrow-beam arc lamp

Welch Allyn, Skaneateles Falls, New York, has introduced the HI•Lux™, a metal-halide arc lamp with a parabolic reflector that efficiently collimates the light output into a narrow beam. Offered in 18-, 21-, and 24-W models, the lamp operates at a cool 5500K color temperature to deliver whiter, brighter light. It produces a light output of 60 lm/W, suitable for LCD projection TV and miniature-spotlight applications, which is up to three times more light than a halogen lamp running on the same amount of power. HI•Lux maintains its spectral output over the life of the lamp, withstands repeated vibration and movement, and is safer than xenon lamps due to lower gas-pressure volume. The lamp and parabolic reflector can be customized to meet the needs of specific applications.

Information: Welch Allyn Lighting Products Division, 4619 Jordan Road, P.O. Box 187, Skaneateles Falls, NY 13153-0187. 315/685-4347, fax 315/685-2854.



Circle no. 5

Thin, low-power LCDs

Hitachi America, Ltd., has announced that its Electron Tube Division has introduced a new family of 10.4-in. color TFT-LCDs and color STN modules with VGA/SVGA compatibility. Designed for use as a display for notebook computers and other portable information devices, the modules are thin (8 mm), light in weight (360 grams), and available in two basic configurations: VGA (640 × 480 pixels), consuming 1.5 W (including backlight), and SVGA (800 × 600 pixels), consuming 2 W. The color TFT modules can display 260,000 colors, making them suitable for portable multimedia devices, which require both video and graphics capabilities. Color STN models are specified at 270-ms response time and are suitable for most graphics-oriented uses. The color TFT and color STN modules are 100% mechanically compatible.

Information: Hitachi America, Ltd., Corporate Communications Dept., 50 Prospect Ave., Tarrytown, NY 10591-4698. 914/332-5800, fax 914/332-8158.

Circle no. 6

First DLP™ projector prototype

nVIEW Corp., Newport News, Virginia, demonstrated its projector prototype utilizing Texas Instruments' Digital Light Processing™ (DLP™) technology at PC Expo held recently at McCormick Place in Chicago. DLP™ technology will give PC users the ability to project exceptionally bright high-resolution computer data and full-motion video images for group viewing, even in well-lit rooms. DLP™ achieves the industry's highest refresh rates due to its use of the Texas Instruments Digital Micromirror Device™ (DMD™), a semiconductor light switch designed to turn incident light on and off. DMDs function as pixels, reflecting and focusing light in microseconds as opposed to the slower milliseconds rate of other projection technologies. *nVIEW* expects these technologies to revolutionize the electronic presentations industry. Its DLP-based self-contained projectors will incorporate proprietary electronics to recognize and adjust to almost any PC-based computer system. There will be no viewing-angle problems. Images will be uniformly bright and consistent from the center to the sides and offer higher perceived clarity and apparent resolution. Applications include sales and marketing presentations, vocational training, and internal meetings. Product availability is scheduled for the fourth quarter of 1995.

Information: *nVIEW* Corp., 860 Omni Blvd., Newport News, VA 23606-4238. 1-800-736-8439 or 1-804/873-1354.

Circle no. 7

LCD viewfinder

Matsushita Consumer Electronics Co., Secaucus, New Jersey, has introduced the Panasonic PV-LCD35 DisplayMate™, an accessory color LCD viewfinder that easily mounts to the back of a camcorder. Compatible with all 1993–95 Panasonic and Quasar Palmcorder IQ and XL models, the DisplayMate swivels up to 180° on both its vertical and horizontal axes for easy viewing from almost any angle and folds against the body of the palmcorder when not in use. The 3.2-in.-diagonal screen incorporates 105,000 pixels, 40% more than most other consumer LCD camcorder monitors. The mosaic pixel pattern all but eliminates color distortion on the edges. Users can monitor the audio through a built-in speaker or headphones, and the speaker/headphone jack can also be used during playback. Volume, brightness, tint, and color are adjustable. The DisplayMate is available at a suggested retail price of $349.95.

Information: Matsushita Consumer Electronics Co., One Panasonic Way, Secaucus, NJ 07094.

Circle no. 8

new products

Off-the-shelf touch monitor

MicroTouch Systems, Inc., Methuen, Massachusetts, has introduced the SpaceSaver VM-10, the first standard 10-in. CRT-based touch monitor targeted at point-of-sale, financial, or any application where limited space and budgets demand smaller and less expensive displays. The VM-10 has a footprint of less than 1 ft. in each dimension and weighs under 16 lbs. The 10-in. monitor features an ultra-fine 0.26-mm dot pitch and a resolution ranging from 640 × 480 to 1024 × 768. The list price for the SpaceSaver VM-10 with a VersaTouch resistive touch screen is $1280 and $1395 for the ClearTek analog capacitive version. Volume and dealer discounts are available.

Information: Annette Burak, MicroTouch Systems, Inc., 300 Griffin Brook Park Drive, Methuen, MA 01844. 508/659-9000, fax 508/659-9100.

Circle no. 9

Fine-line etching

Feldman Technology Corp., Watsonville, California, has announced the availability of its proprietary fine-line etching process for licensing to users of transparent conductors. The process is applicable to indium tin oxide (ITO) and especially to tin oxide (TO). High-resolution patterns on TO have not previously been available, and TO on barrier-protected soda-lime glass is much less expensive than ITO. Etching of 3500-Å films are accomplished in 30 s at room temperature. The wet-etch process is self-terminating, so the minimal undercut is not time-dependent. Standard photoresist processes are suitable, and the process does not require a cleanroom environment. Samples are available demonstrating the quality of the etching process for a 400-lines/in. (15.7 lines/mm) pattern on commercial 2800-Å TO film.

Information: Feldman Technology Corp., 5 Hangar Way, Watsonville, CA 95076. 408/724-3000, fax 408/768-8326.

Circle no. 10 ■

continued from page 4

So, why does he do it? Why do you do it? Why do I do it? Maybe we engineers are more like Johnny Barnes than we realize and/or are willing to admit. Most of us like doing what we do. We give the best of ourselves, we find satisfaction in creating new technology and/or new products, but oh so seldom are we adequately compensated for our efforts. Oh sure, there are always a few exceptions, especially in Redmond, Washington, these days. But they are more like evolutionary accidents – anomalies and mutations of the neat and tidy corporate-compensation world.

One can easily argue that the high-tech business world is even more competitive than professional sports. In fact, the financial risks are greater. Instead of compiling seasonal win-loss records, companies are subject to continual comparisons of how they are doing against their competitors and against industry averages. The contributions of key engineers are every bit as important to the winning products and winning strategies for these companies as are those of sports stars to winning teams. But why is it obvious in sports that the key players must be richly rewarded and yet the key contributors in business are so little appreciated? Is it because engineers do their work while hidden from view and the cheering crowds? Is it, therefore, the higher visibility that justifies the ridiculous compensation packages of certain corporate CEOs? Or are they just more clever in extracting what they believe to be their unfair share?

Let's try another comparison. How about the performing arts? Perhaps engineers are more like playwrights and composers than performing artists. That may not be such a bad analogy. The few playwrights and composers who achieve the higher levels of fame and reward may not be all that different from the new high-tech millionaires running around Redmond and the traditional and, by now, hallowed ground of Silicon Valley.

But, what about the rest of us? I'm afraid the prognosis is not promising. Most of us are doomed – doomed for the rest of our careers to suffer the ignominies and vagaries of the ANNUAL PERFORMANCE REVIEW. In a few companies, we may even be ranked against our peers and perhaps told that we don't quite measure up. The highest-ranked performers will receive five-percent raises, while those not doing so well will get three.

And we will grumble ... and complain to our colleagues ... and then we will go right back to doing the fun, creative stuff that really makes work worth getting up for in the morning and worth staying late for, until hunger and phone calls from the family drive us home.

So now what do you think about Johnny Barnes, if he's doing what he enjoys and

you're doing what you enjoy and neither of you is getting much of a financial reward?

It might be fun to try the following experiment this Holiday Season. I challenge you to **Do something unexpectedly and significantly nice for someone *without* the expectation of reciprocity or reward.** This experiment is going to result in one or more of the following:

- It will make you feel unexpectedly good.
- You will end up with a smile because, if nothing else, you will probably startle the other party into a state of total confusion.
- You just might be like the pebble in the pond that causes ripples to spread over the entire surface.

And then you may want to do it again and again. Scary thought? And now let's get on to the industry news.

The **United States Display Consortium (USDC)**, an industry-backed public/private partnership chartered by the U.S. Government to enhance the competitiveness of the domestic flat-panel display (FPD) industry, has appointed **Larry Graves** to the newly created position of director of roadmaps and standards. Reporting to USDC's Chief Executive Officer Michael Ciesinski, Graves will facilitate the organization of working groups comprising FPD manufacturers and their suppliers. These groups will define the technical and business roadmaps required to meet the future needs of the display user community. Graves will concurrently work with Semiconductor Equipment and Materials International (SEMI) to identify technical areas with a critical need for the development of FPD industry standards. Graves comes to USDC as a one-year industry assignee from Watkins-Johnson Corp., Scotts Valley, California.

David Staebler has joined the **David Sarnoff Research Center**, Princeton, New Jersey, as director of the Display and Imaging Systems Laboratory, within the Electronic Systems Research Division. He will be responsible for research in CRT and other display and imaging systems. Before joining Sarnoff, he was manager of the Materials Science Branch, National Renewable Energy Laboratory (NREL), Golden, Colorado. At NREL, he headed materials research in support of photovoltaics and hydrogen storage programs. This is something of a homecoming for David, since he started his career in Princeton at the RCA Labs until he left to join Thomson in France.

Robert Miller has also recently joined the **David Sarnoff Research Center** as the director of business development for displays. Prior to joining Sarnoff, he spent six years with Sharp Electronics as senior midwest sales manager and, most recently, as a consultant to Davis Technologies doing market development of LCD products in the U.S.

Active Matrix Associates, Pittsburgh, Pennsylvania, has been formed as a consulting group of several of the active-matrix pioneers from Westinghouse Labs. **Peter Brody**, well known to many in the display community, is the senior member of this group and is currently working to develop a lower-cost color-filter process – which he claims will produce a ten-dollar VGA filter – and a process for printing resists instead of using photolithography, photoresists, and steppers. Peter received the Karl Ferdinand Braun Prize of the SID in 1987 and the Eduard Rhein Prize for his path-breaking work on active-matrix technology.

Displaytech, Inc., Boulder, Colorado, a manufacturer of miniature displays and opto-electronic components, has announced that **Carl Higgins** has joined the company as sales manager. Mr. Higgins will be responsible for expanding the sales function at Displaytech and transitioning the company from the R&D stage to the commercial application of its products. He comes to Displaytech from Newport Corporation, a company that specializes in precision lab products for the laser and electro-optics markets. All of Displaytech's products employ the fast-switching surface-stabilized ferroelectric liquid-crystal (SSFLC) technology co-developed by two University of Colorado physics professors, Noel Clark and David Walba.

MRS Technology, Inc., Chelmsford, Massachusetts, has promoted **Mark Lucas** to vice president of product marketing. He will be responsible for strategic product planning, marketing materials, and new-product marketing development. Mr. Lucas began his career with MRS in 1987 as a control systems manager and in 1992 was promoted to his most recent position as engineering program manager. Founded in 1986, MRS supplies advanced equipment for the production of flat-panel active-matrix and field-emission displays and other large-area lithography-based electronic products.

SI Diamond Technology, Inc., Houston, Texas, reports that **Lawrence King** has resigned as chief financial officer and as a director of the company. The company expects to name a new CFO in the near future and to fill the vacancy on the board left by King's resignation, but not necessarily with the same person.

Preparing for a major long-term expansion, **XMR, Inc.**, Santa Clara, California, has announced the hiring of a new director of sales and marketing. **Leonard Goldfine**, former president of Claremont Associates and former director of marketing and sales for Lexel Laser, Inc., has been named to this position. Goldfine will join the company's management team, which includes Michael Simile, president and CEO, and Sheau Chen, who is chairman and now takes on the added title

of chief technical officer. Founded in 1979, XMR sells a variety of products, including an AMLCD annealing system, and materials-processing systems that ablate, etch, drill, and repair wafers, dies, MCMs, and substrates.

MEGA Systems and Chemicals, Inc., Chandler, Arizona, has appointed **Jack McCann** as vice president of field operations. He will be responsible for the management of MEGA's key customer accounts, project management, and MEGA's growing field-service operations. Prior to joining MEGA, Mr. McCann was Motorola operations manager in the chemical management division at FSI International in Chaska, Minnesota. MEGA Systems provides high-technology industries with specialized solutions to their ultra-high-purity chemical-handling needs.

The **Taipei Chapter of the Society for Information Display** has recently elected new chapter officers, representing several important educational, government, and business institutions. The SID Chapter director is **Dr. Wenbis Hsu**, who is the Deputy General Director of the Electronics Research and Service Organization, Industrial Technology Research Institute. Chapter chairman is **Dr. Han-Ping D. Shieh**, a professor at the Institute of Electro-Optic Engineering, National Chiao Tung University. Vice-chairman is **Dr. Chi-Fang Huang**, who is a research scientist at Chunghwa Picture Tubes, Ltd. Treasurer is **Dr. Cyril C. K. Chian**g, manager of the Applied Solid State Chem. Lab., Materials Research Laboratories of the Industrial Technology Research Institute. And the secretary is **Dr. Jammy C. Huang**, manager of vacuum microelectronics at the Electronics Research and Service Organization of the Industrial Technology Research Institute.

I continue to be accessible through multiple modes of communications, and I very much appreciate what many of you have to say. You can reach me by e-mail at asilzars @sarnoff.com, by fax at 609/734-2127, by telephone at 609/734-2949, or by a more circuitous route through Jay Morreale at Palisades Institute for Research Services, Inc., 201 Varick Street, Suite 1006, New York, NY 10014. ■

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.

* * * Obituary * * *

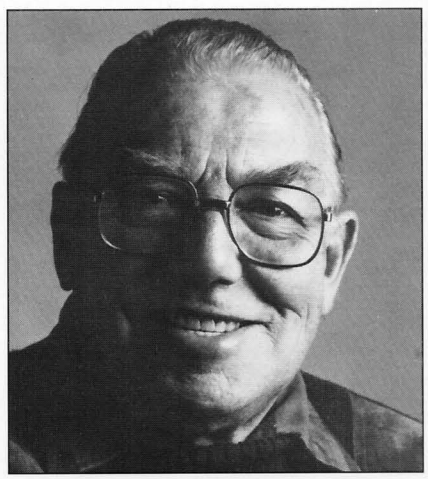
Alfred W. Woodhead (1925–1995)

With the death of Alfred Walters Woodhead on 10 August 1995, the UK and Ireland Chapter of SID has lost the man who was the guiding light in setting up the Chapter in 1984. He was also instrumental in establishing it as a very successful and active Chapter in the 10 years since the SID Board of Directors approved the petition to set up a UK and Ireland Chapter on 7 January 1985. He will be sorely missed by all those who were privileged to work with him as a member of the Chapter organizing committee.

At his funeral on 18 August, it was clear that the sense of loss was one shared not only by his widow Betty and their family, but also by many ex-colleagues from the display community in the UK, and particularly from Philips for whom he worked from 1948 until his early retirement in 1986. The sight of the funeral chapel full to overflowing with people will be cherished by all those who went to pay their last respects to a well-respected friend and colleague.

The service was simple and moving, with an opportunity for remembering and taking stock. His nephew gave a simple address recollecting Alfred's life as a kind, caring, and very well-loved family man. The music was chosen by Alfred during the last days of his illness, the Adagio from Bruch's Violin Concerto No. 1 and the Largo from Dvorak's Symphony No. 9. At Alfred's request there were only family flowers; donations were requested for the Harestone Marie Curie Centre, where Alfred was cared for during the critical stages of his illness.

The extent of Alfred's work for SID over the last 11 years has been known in full only to members of the Chapter's organizing committee. His commitment to the Chapter continued after his early retirement from Philips in 1986, and SID's UK members benefited enormously from the increased time that Alfred was prepared to devote to the day-to-day administration of the one-day technical meetings run by the Chapter. In recent years he has been joined in this by Daphne Lamport, to whom Alfred's death will be a particular loss as a friend and co-worker on SID (UK), as well as a mentor and valued ex-colleague from Philips Research Labs. To UK members and non-members who attended



Alfred W. Woodhead

meetings, Alfred was the man who accepted reservations for meetings and the man at the registration desk. His friendly face and willingness to help will be missed by all.

In spite of his illness, Alfred missed very few meetings. SID celebrated its 10th Anniversary on 7 July 1995 at Emmanuel College in Cambridge with a one-day technical meeting and an evening dinner. Alfred was the driving force behind organizing the celebration, an event for which planning started over a year before. For Alfred this was the culmination of 10 years of hard work in setting up and running a very successful chapter. Despite his worsening illness, Alfred continued to lead the organization of this meeting as well as the usual one-day technical meetings run by the Chapter.

For a period before the meeting, there was some concern felt by the committee that Alfred would not be well enough to attend. The committee need not have feared. Alfred was a fighter and, despite a serious setback in his illness, was determined that he was going to make it. He was not well enough to attend the technical meeting but came to the evening reception and dinner in a wheelchair. At the dinner, Alfred was presented with a crystal decanter and goblets as a token of appreciation for the services he put into the Chapter, a fitting tribute for services beyond the call of duty. Daphne Lamport was presented with a crystal bowl at the same time.

Alfred was born on 29 January 1925 and grew up in Hull. He gained his degree at

sid news

Sheffield University and then served an apprenticeship at Metropolitan Vickers in Manchester, close to where Betty, his future wife, lived. In 1948 he joined Mullard Research Labs (later renamed Philips Research Labs), married Betty, and moved to the South of England. He worked on a range of vacuum devices and in the 1950s became head of a group which developed high-speed shutter tubes, infrared image converters, and then passive night-viewing devices of both cascade and channel-multiplier type. His group was at the forefront of developing technologies associated with all aspects of night viewing, such as electron-optic and system modeling, channel multipliers, optical design, etc. There was also pioneering work on x-ray image intensifiers for medical applications.

Much of the work in his group led to development and production in various Philips factories, and Alfred had close contact with people in these areas, as well as colleagues in other Philips research labs in Holland, France, Germany, and the USA. In the 1970s he instigated work on the metal dynode channel electron multiplier, which led to the demonstration in the 1980s of a cathode-ray tube with a total thickness of 2 in. and a screen size of 12 in. This work was first presented at the 1982 SID Symposium, and then a group of papers published in the February 1984 IEEE Proceedings were awarded the Institution Premium, the top award of the IEEE.

In 1984 the possibility of setting up SID chapters in Europe was being considered, and Alfred, who had been a member of SID for several years, instigated proceedings to set up a UK Chapter in May 1984. He sent out a questionnaire to 54 UK members of SID and had 27 replies from people in favor of starting a UK Chapter. I was one of the ten willing to serve on the committee and have worked with Alfred on that committee from that time until now (with a break when I was working in Holland). A foundation meeting of a temporary committee was held at Mullard House in London on 25 October 1984. On 7 January 1985, the SID Board approved the petition of the UK and Ireland to form the second non-U.S. chapter. (The first was Japan.) The Chapter Bylaws drawn up by Alfred in 1984 were used as a model when the French and Mid-European chapters were formed. He also served on the committee from that time on. Alfred will always be remembered by those who worked with him as the "father" of the UK and Ireland Chapter of SID.

Alfred was a great family man and a proud father. He and Betty had three children, all of whom are now married, and three dearly loved grandchildren. Alfred was always an active sportsman, in early days with boxing. More recently, his main loves were cricket and rugby. When he could no longer play rugby, he took up squash and tennis, which he enjoyed for several years, even after his heart attacks. About 2 years ago, tennis gave way to bowls, which he was enjoying until early this year. He has always been a fighter, the classic determined Yorkshireman. He had his first heart attack in 1976 and had several setbacks since then, but had always fought back until the latest fight against cancer proved too much. Even then he fought back to recover enough to make it to the 10th Anniversary meeting and to manage a final week's holiday in Devon with Betty, his son, and family.

Our sympathy is extended to Betty, their three children, partners and grandchildren, and to all his friends. Alfred will be missed and remembered with respect and affection by all of us who were privileged to have worked with him.

– Barbara Needham
Business Development Manager
CRL, UK
Vice Chairman, SID
(UK and Ireland Chapter)

On behalf of the SID (UK) Committee:
The Funeral Directors address for any donations (cheques payable to the Harestone Marie Curie Centre) is:
Stoneman Funeral Services
Doran Court, Reigate Road
Redhill Surrey, RH1 6AZ UK ■

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 your article entitled "Overview: The Magic Kingdom" in the September issue you state, "In the introductory seminar, Larry Tannas (Tannas Electronics) presented a slide from Joel Pollack (Sharp Electronics) that projected the market for flat-panel displays to be about $20 billion in the year 2000. This is somewhat more than Stanford Resources' estimates but is consistent with the market projections presented by Fujitsu at its press conference."

You seem to imply that there is a "correct" level which is validated by having a number of sources which are similarly sized. Stanford Resources makes an annual, detailed forecast based on consumption, production, application market trends and economic factors to account for nearly every unit display produced. We assign a market price to the displays to arrive at the overall market value. The capacities are then checked to make sure that the ability to manufacture the displays exists.

The recent significant price erosion, particularly in the AMLCD market, has affected our new forecast materially. Suppliers will need to sell about 40% more large display units in the year 2000 than were originally forecast – just to meet the $20 billion figure, and this is unlikely.

– David E. Mentley
Stanford Resources
San Jose, California

Circle no. 34

Circle no. 35

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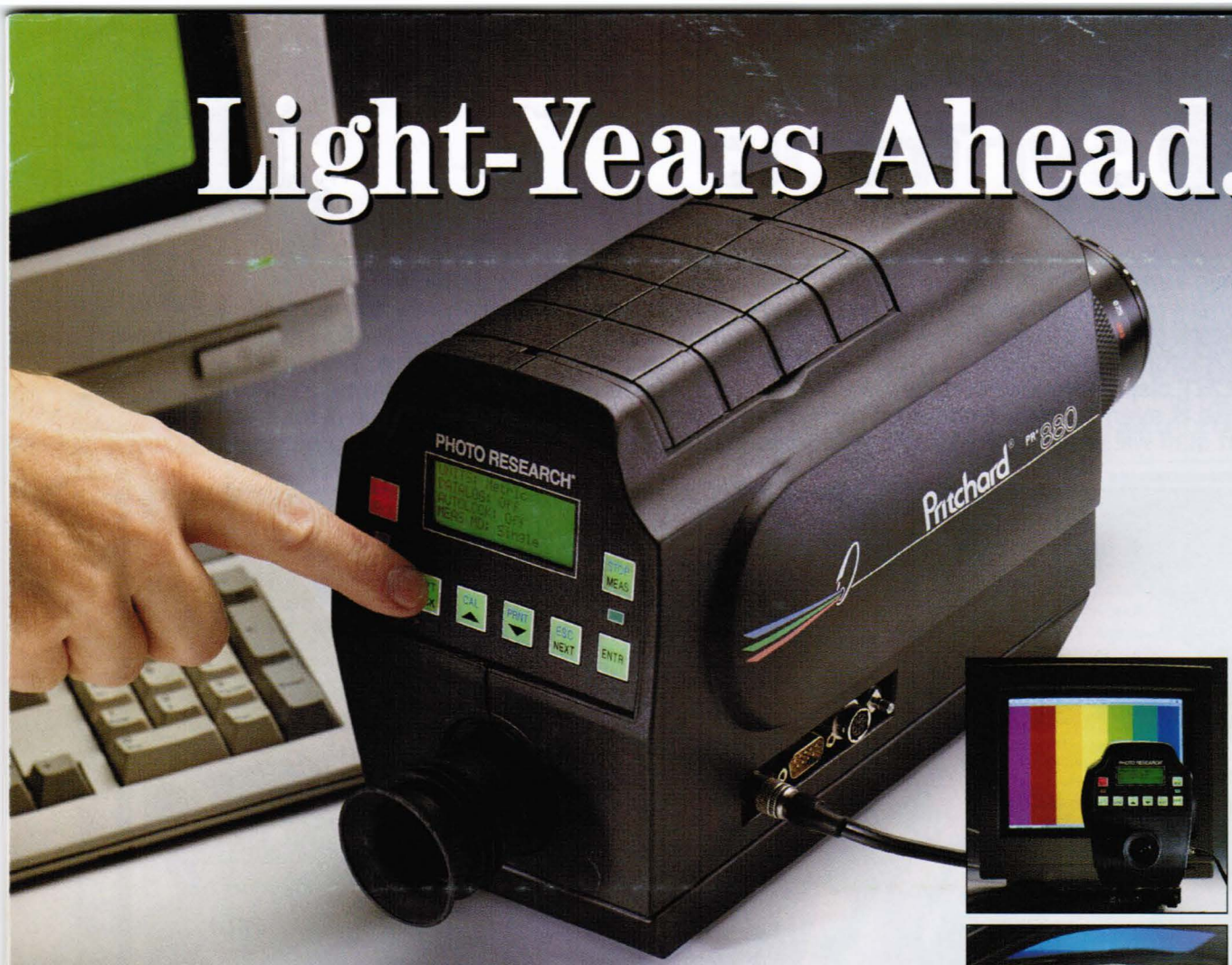

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