SID '99 PREVIEW ISSUE

Information DISPLAY

SID

MARCH 1999
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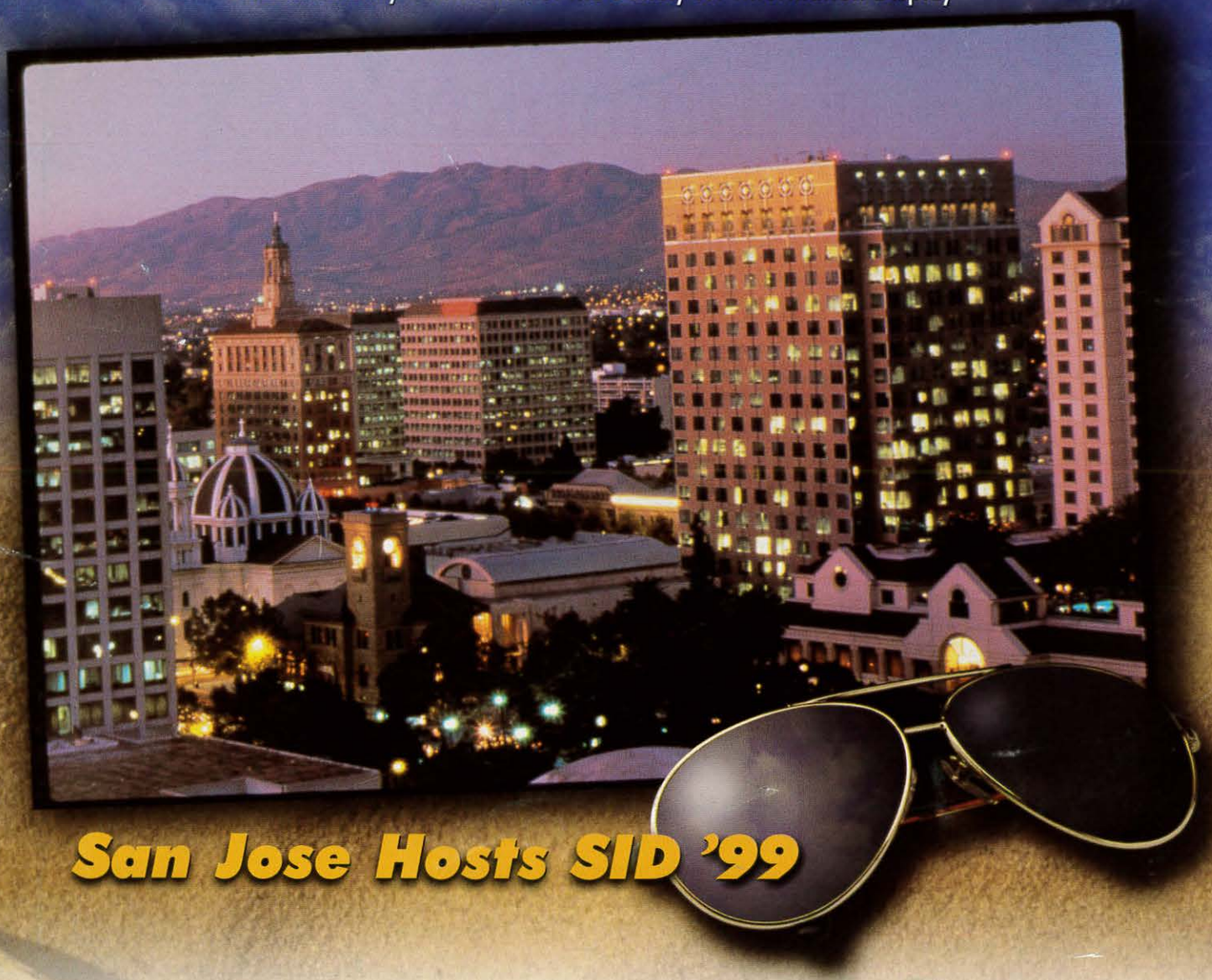

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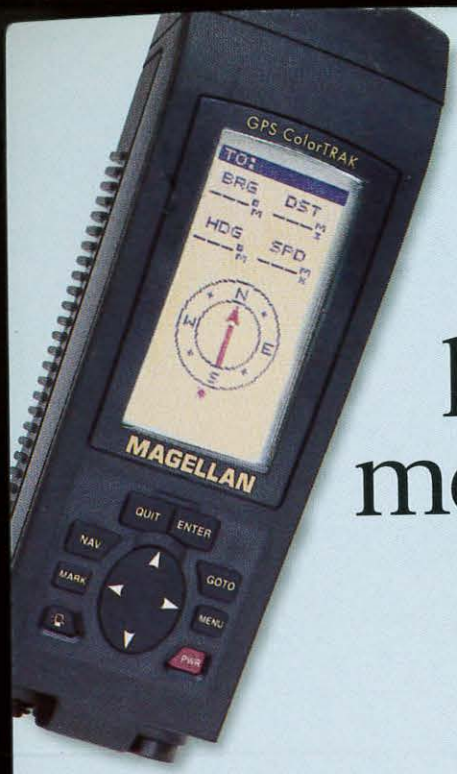
- Self-Scanned a-Si AMLCDs
- LCD-Monitor Market
- Will CRTs Survive?
- SID '99 Preview
- SMAU '98 Review



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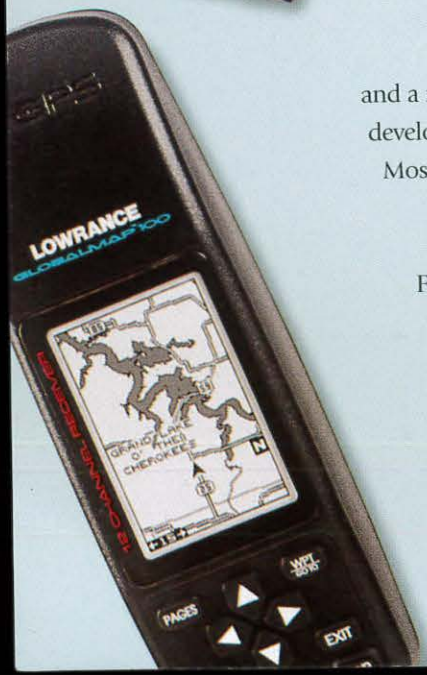

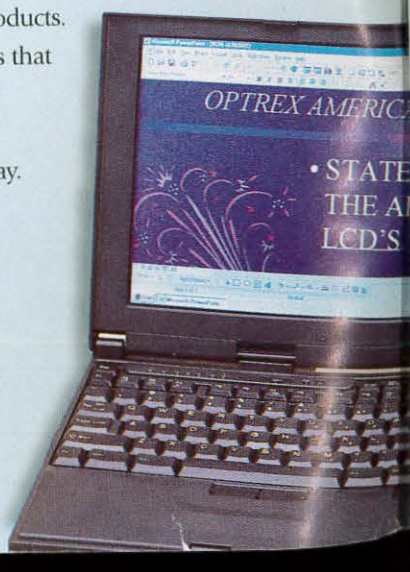

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Circle no. 1

BPA INTERNATIONAL

Information DISPLAY

MARCH 1999
VOL. 15, NO. 3

COVER: From May 16 to 21, San Jose, the capital of Silicon Valley and home of SID's International Headquarters, will welcome the largest SID Symposium and Exhibition ever held.

Credit: San Jose Convention and Cultural Facilities

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

Next Month in *Information Display*

SID '99 Show Issue
- Thin-Film Micromirror Array
- High-Quality Optics for Microdisplays
- LCoS Displays
- Company Profile: Varitronix
- Color Conference Review

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editorial

Witchcraft and the Rise of H1-B Visas

Since you, Dear Reader, are probably an engineer, technical manager, or high-tech marketer, it may have escaped your attention that there is a boom going on in the U.S. and Europe – a boom in witchcraft.

Now, I'm not saying that you are about to fall foolishly and inexplicably in love, grow warts, or develop an embarrassing facial tick. Of course, you may develop any or all of these symptoms but, if you do, they will probably not be from a witch's spell. (Shakespeare had it right: "The fault ... is not in our stars, but in ourselves that we are underlings." – *Julius Caesar,* Act I, Scene II)

The fact is you don't have to believe that spells and potions are effective to acknowledge the growth in the number of people who follow the Wiccan religion and practice the witch's craft. And the evidence of that growth is striking. In an October 26th article in the *New York Times,* Carol Publishing Group reported that while sales of books on Wiccan topics averaged between three and four thousand copies a year each in the late 1980s, the more popular titles now sell 40,000 copies.

The surge of interest has been reflected in movies and a new TV series, and major book publishers are now exploiting the market developed by specialized publishers like Carol. New "Wiccan titles," as they are being called in the book trade, are available from St. Martin's Press, Harper San Francisco, and Bantam Books. There are also Web sites. Fritz Jung, webmaster of the Witches' Voice, says his site gets nearly 17,000 hits a day, and he estimates there are a total of 2000 sites that relate to witchcraft.

Most witches, who tend to be college-educated women, make a point of explaining that Wicca is a peaceful, nature-oriented religion. So why should we care?

The potions and incantations of witchcraft constitute a technology for manipulating the physical (as well as biological, psychological, and emotional) world, but it is a non-scientific technology. Through what physical mechanism would a spell based on tin foil, cinnamon, salt, sugar, bread, and pennies help the spellmaker find an apartment (as specified in *The Supermarket Sorceress' Enchanted Evenings* by Lexa Rosean, St. Martin's Press)? None, of course, but people who believe they can manipulate the world through witchcraft are people who tend not to study the manipulation of the world through science and engineering.

How many circuit designers do we lose to Wicca in this way? How many display system engineers do we lose to voodoo? (New York City is home to about 500,000 people of Haitian extraction. Members of the New York Haitian community estimate there are thousands of voodoo altars scattered through the communities of Brooklyn and Queens, where most New York Haitians live.)

Assuming that we can take the claims of engineering shortages made by many U.S. high-technology companies at face value, would the number of lost engineers and technicians be enough to cover the alleged shortfall in technical talent? Last October, the U.S. Congress passed the American Competitiveness and Workforce Improvement Act that increased the number of H-1B visas – visas that allow non-U.S. technology workers to work in the United States – from 65,000 to 115,000 in each of the next two years in response to appeals from those companies, who said they could not otherwise obtain enough skilled employees.

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Information DISPLAY

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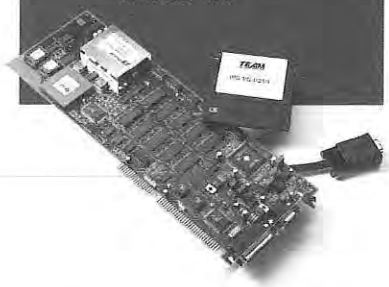

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Circle no. 2

the display continuum

There Comes a Time ...

by Aris Silzars

When it's already 2:00 a.m. on Saturday in the city that you left seven hours ago and your airplane has yet to start its descent for landing at your home airport, there comes a time ...

When you've watched the sun, apparently permanently affixed fifteen degrees above the horizon, for hours on end as you fly the polar route to the Far East, there comes a time ...

When you know that if you reply to just one more e-mail your brain is going to go into dysfunctional rebellion, there comes a time....

When for the last three days you've spent all day and all evening working on that final report and it's still not done, then also there comes a time ...

There comes the time when our brains simply will not accept one more assignment or one more significant thought. The mind rebels. It's time to take a break. Sleep? Yes, that sometimes works. Other times, such as during those long airplane flights, sleep may not be the most tolerable option. Just because the brain is fried doesn't mean that the body is similarly exhausted. In fact, sitting on an airplane with nothing to do but eat every few hours is perhaps not very healthy, but physically, it's really not all that exhausting. And sleeping in the typical airplane position is hardly the relaxing activity one desires.

We are not all made alike in our abilities to sustain challenging activities, be they physical or mental. I suspect there is a Gaussian curve that could be used to characterize the general population, from serious "couch potatoes" on one side to those who seem never to get tired of work-related activities on the other end of the distribution. We should be able to quantify some of these behaviors in terms of the well-known "sigma-variance" terminology used for measuring the quality of manufactured products.

Can you imagine a six-sigma couch potato? This person would most likely be able to sustain just a few minutes of meaningful activity each day. The rest of the time would have to be spent in non-interactive entertainment, such as watching movies, soap operas, or game shows. Perhaps even game shows would be too demanding for such an individual.

What would we find at the opposite six-sigma extreme? I suspect that I have had the dubious pleasure of working with one or two individuals in my career who exhibit this behavior. These are the types who think nothing of giving you a call at 1:00 a.m. to discuss a technical or management problem, who take it as a personal affront that you don't want to put in another seven-day week after having already done that without a break for the last four months, and who can't understand why you want a day off to go to your daughter's wedding - or your own.

Fortunately, most of us find ourselves closer to the mean, although I am indubitably correct in asserting that the average *ID* reader has a significantly more active and energetic brain than the general population. And thus, while the typical couch potato may need an hour of phase-out time for every hour of thinking activity, our ratio may be more like 5:1 or maybe even as high as 8:1 - counting only our waking hours, of course. Thus, I'm sure we compare favorably with the business types I encounter on airplanes who spend a good part of each flight engrossed in their laptop computers.

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Circle no. 3

Introducing the world's most advanced FED technology in a high-volume cluster tool.

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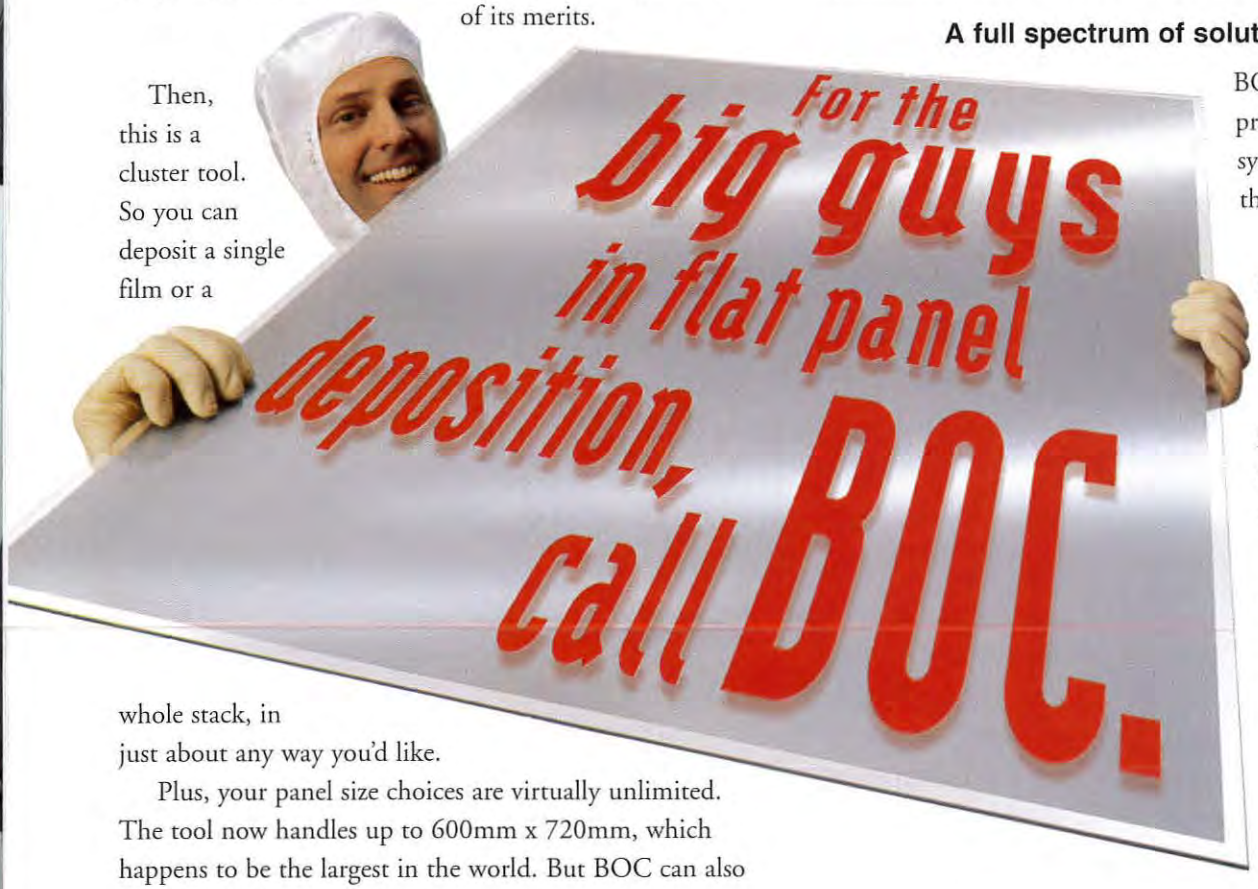
Then, this is a cluster tool. So you can deposit a single film or a whole stack, in just about any way you'd like.

Plus, your panel size choices are virtually unlimited. The tool now handles up to 600mm x 720mm, which happens to be the largest in the world. But BOC can also configure it for even larger sizes upon request.



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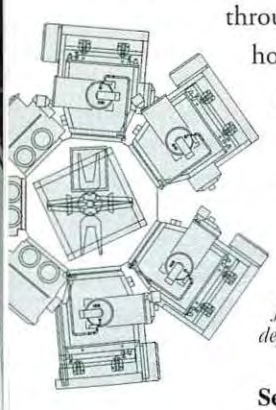
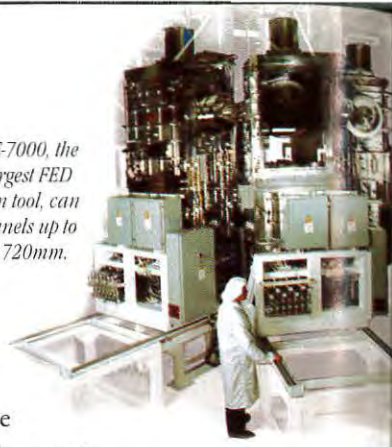
The FCE-7000 is a proven production tool that generates throughput speeds of from 10 to 60 panels per hour – and even up to 70 and 75 on certain processes. And when you combine that kind of throughput with high production quality levels, you get a very attractive return on your investment.



Designed for production, BOC's flexible cluster configuration lets you deposit a single film or an entire stack.



BOC's FCE-7000, the world's largest FED production tool, can process panels up to 600mm x 720mm.

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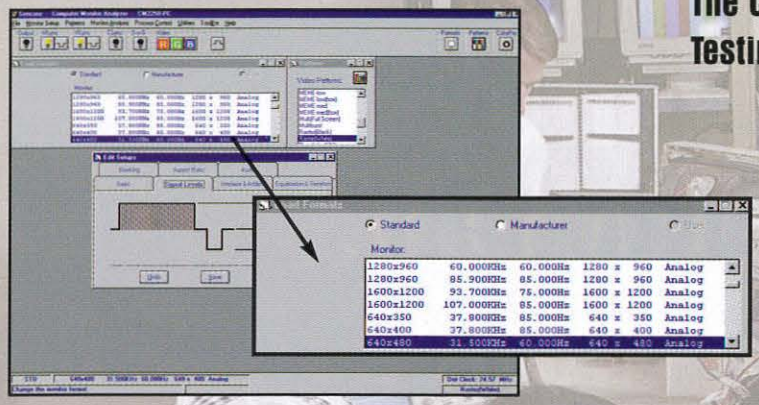
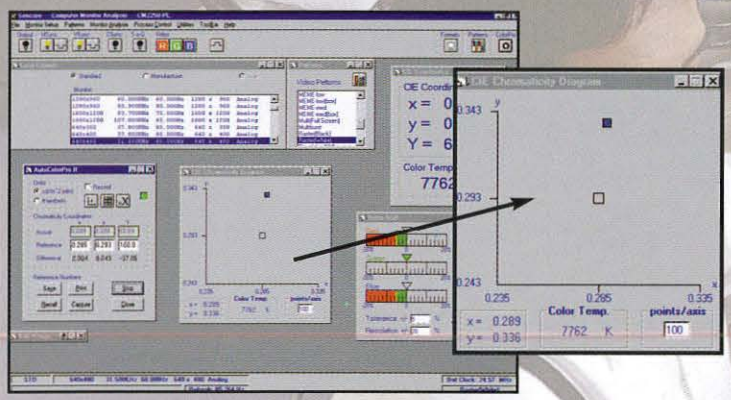


The CM2250 is fully programmable to match the requirements of the monitor under test. The CM2250 stores formats by manufacturer and model number for efficient testing of multi-format monitors.



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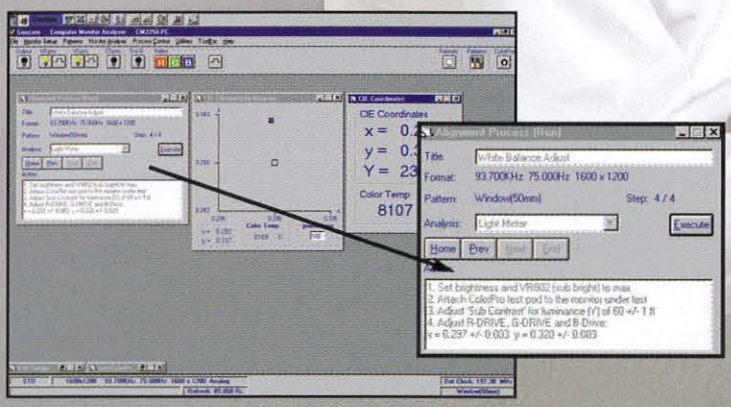

The CM2250's 'Service Process Generator' simplifies the creation of effective testing and alignment procedures and simplifies the use of these procedures.

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Circle no. 7

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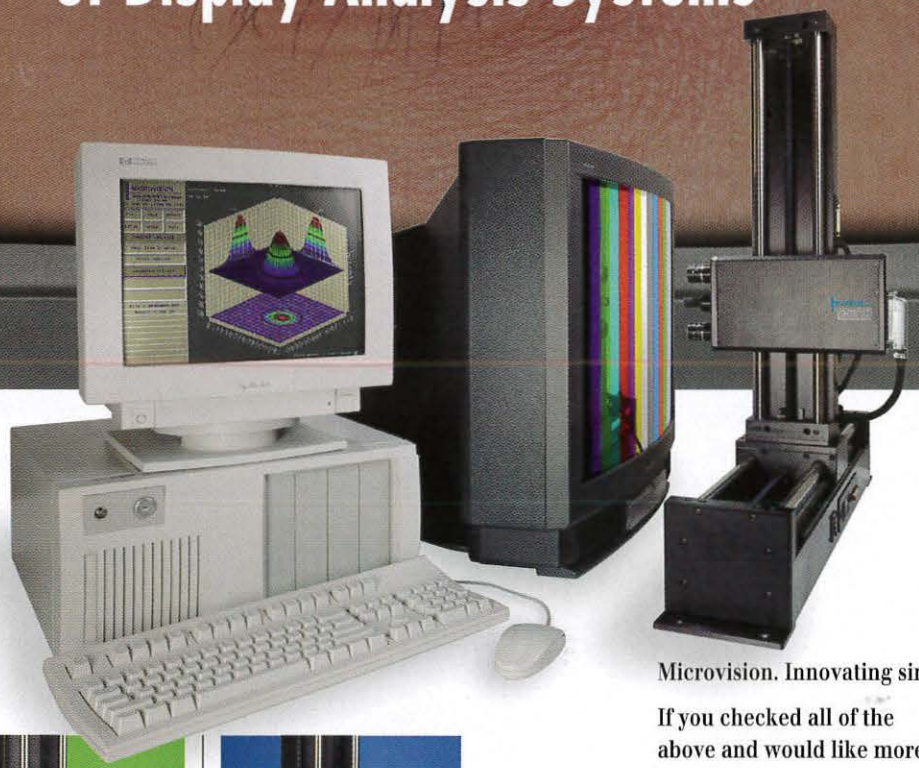

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Self-Scanned Amorphous-Silicon AMLCDs

Self-scanned amorphous-silicon integrated displays (SASIDs) combine the benefits of integrated drivers with the economy and familiarity of amorphous-silicon processing.

by Roger G. Stewart

INTEGRATING THE NECESSARY scanning electronics into the perimeter of displays has always been an advantage for active-matrix LCDs (AMLCDs) made with polysilicon (poly-Si) or bulk-silicon thin-film transistors (TFTs). These "self-scanned" displays are more compact, more reliable, and cost less than their hybrid-scanned counterparts. Unfortunately, poly-Si and bulk-silicon TFTs are much more expensive to manufacture than standard amorphous-silicon (a-Si) TFTs. Now, however, self-scanned AMLCDs have been fabricated with low-cost a-Si processing.

Why AMLCDs?

AMLCDs improve the performance of liquid-crystal light shutters by driving them with a matrix of TFTs. (Diodes and MIMs are used in some applications, but TFTs are, by far, the dominant active element.) For high-resolution displays, the active matrix increases the black-to-white voltage-control range from a typical 0.2 to 4 V or more.

By providing precise control of the pixels through their full 0-6-V range of operation, the AMLCD delivers the excellent image quality possible with LCDs. With contrast ratios of 400:1, wide viewing angles, excellent uniformity, vivid colors, low power dissipation, and video-rate response times, AMLCDs are the first flat-panel technology to exceed the excellent image quality of the proven but bulky cathode-ray tubes (CRTs).

After waiting 50 years, the world has now embraced these new high-quality flat-panel displays (FPDs) with enthusiasm. The AMLCD market has grown explosively to over $8 billion in less than 10 years (Fig. 1), and is now larger than that for all other FPDs combined, continuing to grow at roughly 20% annually!

Why Self-Scanned AMLCDs?

Promising as this new AMLCD market is, the AMLCD business has been plagued by cycles of oversupply, with resulting price instabilities. Market concentration in a few products such as laptop computers has aggravated these instabilities. Price instabilities have hindered growth and caused the pricing structure to collapse drastically in 1995 and 1998. To create a healthy business, we need to diversify the AMLCD product base.

Integrating the scanning and other display electronics into the display itself to create a self-scanned AMLCD is helping to expand and diversify the AMLCD product base in three ways:

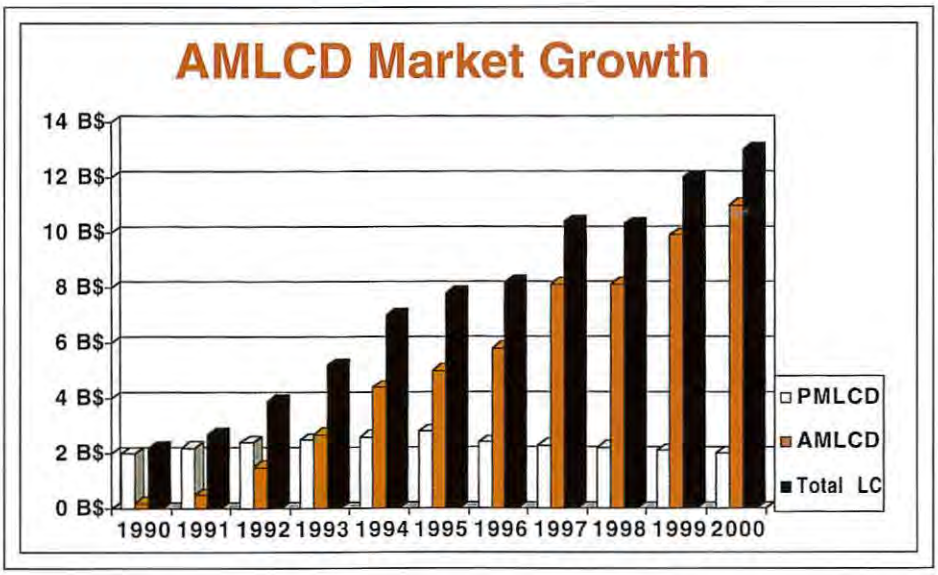

Fig. 1: The AMLCD market has grown explosively to over $8 billion in less than 10 years, and continues to grow at roughly 20% per year. (Data courtesy of Stanford Resources, Rambus, and DisplaySearch.)

***Roger G. Stewart** is Head, Solid State Display Group, Sarnoff Corp., CN 5300, Princeton, NJ 08543-5300; telephone 609/734-3128, fax 609/734-2873, e-mail: rstewart@sarnoff.com.*
The author would like to acknowledge the contributions of many people at Thomson-LCD and Sarnoff to the success of this work.

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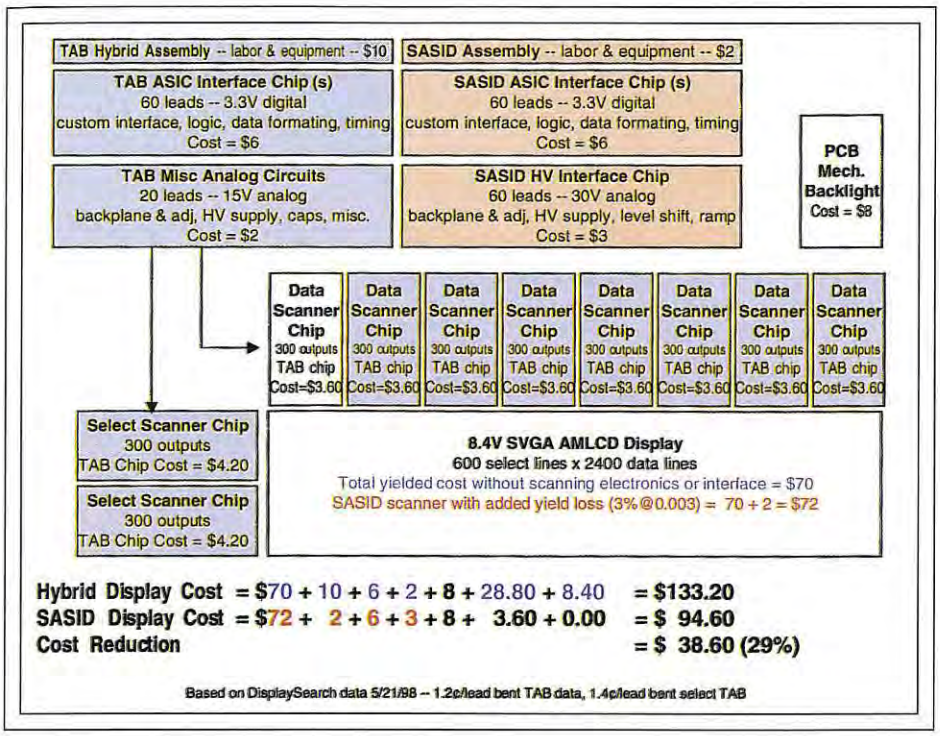


Fig. 2: A cost analysis for a representative 8.4-in. display demonstrates the cost advantages of a self-scanned a-Si SVGA AMLCD with integrated scanners over a hybrid-scanned SVGA AMLCD.

- ***Compactness.*** The integrated circuits (ICs) on self-scanned AMLCDs usually occupy less space than the tape-automated-bonding (TAB) or chip-on-glass (COG) circuitry used to drive hybrid-scanned AMLCDs. Self-scanned AMLCDs are therefore ideally suited for emerging markets like projection light valves, PDAs, and video watches, where compactness is especially important.
- ***Reliability.*** A typical hybrid-scanned display requires 3000–5000 wiring connections to connect the display to the hybrid scanners arranged around it on two, three, or four sides. The failure of even one of these connections manifests itself as a "line fault" in the display image, which demands that the display be either repaired or replaced. The reliability of hybrid-scanned AMLCDs is limited by these randomly occurring failures. Increased integration and reduced lead count improves the reliability of AMLCDs – just as it does for ICs – by dramatically lowering the rate of randomly occurring failures without degrading lifetime. The improved ruggedness and reliability provided by self-scanned AMLCDs is particularly important in opening up new markets in automotive displays, military and medical systems, and portable devices, where reliability and ruggedness are critical.
- ***Cost.*** A cost analysis for a representative 8.4-in. display demonstrates the cost advantages of a self-scanned a-Si SVGA AMLCD with integrated scanners over a hybrid-scanned SVGA AMLCD (Fig. 2). The total electronics cost for the hybrid-scanned display is about $55, and a net cost reduction of $38.60 can be achieved with integrated scanners even after allowing for slightly lower yields and a high-voltage interface chip. In this case, eliminating most of the TAB hybrid chips has reduced the product cost by 29%. The cost savings provided by the integrated scanners depends on the size and resolution of the display. It ranges from 10% for large low-resolution displays to more than 50% for smaller high-resolution displays.

Why a-Si Self-Scanned AMLCDs?

While the benefits of self-scanned AMLCDs are well established, the TFT technologies currently used to fabricate them are expensive (Fig. 3). The advantages of integrated scanners for small high-resolution displays are so overwhelming that even the 10-times-higher cost of CMOS high-temperature TFT processing is justified. Consequently, most viewfinders and projection light valves are currently built with a high-temperature poly-Si TFT process.

But for larger displays, the more modest integrated-scanner cost advantage of 10–35% is not enough to offset the higher poly-Si processing costs of 30–1000%. Consequently, most AMLCDs larger than 2 in. are built without integrated scanners, using a lower-cost a-Si process.

Clearly, the ideal solution would be to somehow fabricate self-scanned displays using a standard low-cost a-Si TFT process. But previous attempts to integrate scanning circuitry onto the perimeter of a-Si AMLCDs have been blocked by the low carrier mobility

Table 1: Specifications for an 8.4-in. Sub-Notebook SASID

General	
Display	SVGA direct view
Color	RGB (color filter)
Diagonal	8.4 in.
Aspect Ratio	4:3
Addressing Mode	Row inversion
Storage Capacitor	Previous row
Frame Frequency	75 Hz
Pin Reduction	202 from 3000
Data Scanner	
Scanner Type	Chopped ramp
Sampling Frequency	1.2 MHz
Video Inputs	120
Demux Ratio	20:1
Output Hold Time	10 µsec
Output Amplitude	5 V
RMS Accuracy	< 7.5 mV
Scanner Width	3.75 mm
Select Scanner	
Output Amplitude	25 V
Line Frequency	45 kHz
Uniformity	< 7.5 mV
Scanner Width	1.9 mm

– less than 1 cm^2/V-sec – of a-Si TFTs, the high parasitic capacitance of the non-self-aligned a-Si TFT structure, the absence of a PMOS TFT or other load device, and the threshold instability of a-Si transistors. However, this situation began to change 3 years ago with the announcement of the first self-scanned a-Si AMLCD at the annual SID Symposium in Orlando in 1995.

Recent Progress

Since 1995, circuit innovations have been developed to compensate for the limitations of a-Si TFTs and permit a standard a-Si TFT process to be used in the fabrication of self-scanned displays in sizes ranging from 1.4 to 8.4 in. on the diagonal and with screen resolutions up to SXGA (Fig. 4, Table 1). The SVGA display requires only 202 connections, compared with 3000 connections for existing hybrid-scanned AMLCDs.

Although some early SASIDs had limited lifetimes, the most recent devices have been improved to the point where their overall reliability is better than current hybrid-scanned displays.

The overall reliability of an AMLCD is limited both by randomly occurring failures and by limited lifetime. Randomly occurring LCD-screen failures account for the highest percentage of problems in portable computers sent back for repair. The average failure rate for AMLCD laptop computers is approximately 10% per year, including "trauma," TAB hybrid assembly failures, and other causes. Excluding trauma – such as dropping a notebook computer onto a hard floor or attempting to close its lid on a pen – the overall design-related failure rate for laptop AMLCDs is currently about 5% per year. TAB and COG hybrid assembly failures are the dominant non-trauma failure mechanism for AMLCDs and the cause of roughly 45% of all field failures. [See "FPD Field Failure Modes and Repair Techniques" by L. M. Bejtlich, *Display Manufacturing Technology Conference Digest of Technical Papers*, 27-28 (1998).] The average failure rate of the TAB and COG hybrid assemblies used in current laptop computers is therefore about 2% per year.

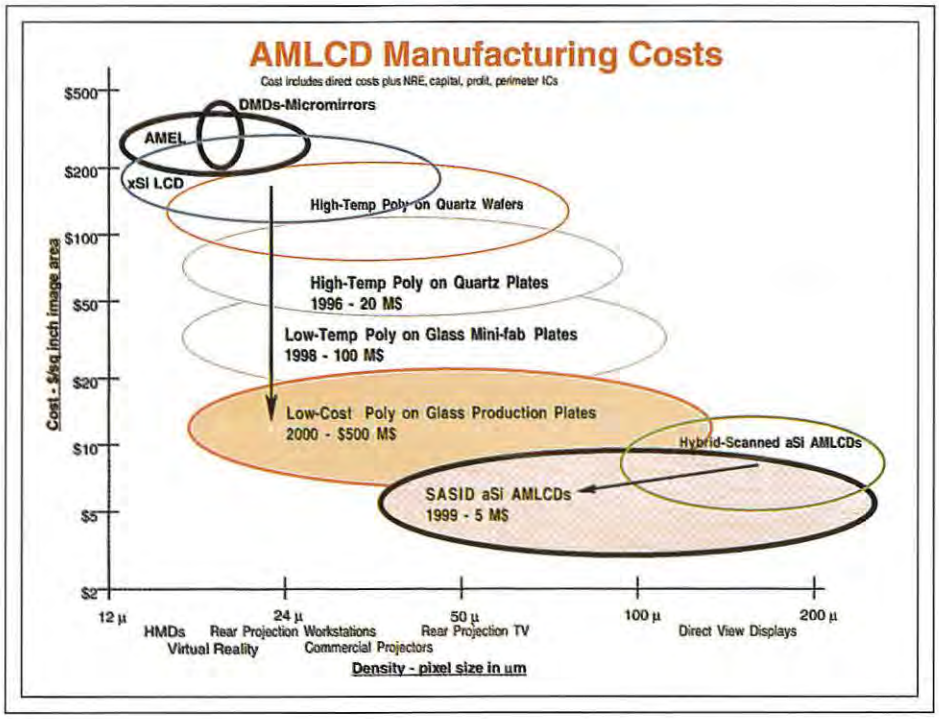


Fig. 3: On a cost-per-square-inch basis, bulk silicon is the most expensive TFT technology for self-scanned AMLCDs, while a-Si is the least expensive. The advantages of integrated scanners for small high-resolution displays are so overwhelming that CMOS high-temperature TFT processing is sometimes justified, despite its expense.

Although the failure rates for different TAB and COG assemblies vary significantly, the failure rates for TAB hybrid assemblies are roughly proportional to the number of external leads. Assuming that the lead dimensions are similar between the internally scanned and externally scanned displays, it is possible to compare the failure rates of TAB hybrid displays and SASIDs with integrated drivers (Fig. 5).

The figure shows that the reduction in lead count from integrated scanners improves upon the TAB failure rates by a factor of 15. The overall failure rate has been improved by roughly a factor of 2. In addition, because the use of integrated scanners eliminates the requirement for tight pitch, the external leads used in a SASID design are typically larger than the external leads used for existing TAB hybrid displays. The larger size of these external leads means that failure-rate

Table 2: AMLCD Lifetime Requirements by Application

Application	Expected Lifetime	Accelerated Qual Test
Laptop Computers	10,000–50,000 hours (10–40°C/typical intermittent use)	1000 hours (50°C, continuous)
TVs, PDAs, Cameras, Telephones, CE Products	10,000–50,000 hours (0–40°C/typical intermittent use)	1000 hours (50°C, continuous)
Projection Light Valves	10,000 hours (0–50°C/typical intermittent use)	1000 hours (70°C, continuous)
Automotive	5000 hours (–20–70°C/typical intermittent use)	1000 hours (85°C, continuous)
Avionics	10,000 hours (–20–70°C/typical intermittent use)	1000 hours (85°C, continuous)

Sarnoff Corp.

Fig. 4: This 8.4-in. SXGA SASID requires only 202 connections, compared with 3000 connections for comparable hybrid-scanned AMLCDs.

improvements are even greater than shown in (Fig. 5).

Lifetime of SASIDs

Despite their advantages in compactness, reduced failure rates, and cost, self-scanned AMLCDs must also meet the lifetime requirement for each application (Table 2). The table includes the accelerated qualification tests that are typically used to qualify lot samples to ensure that the product meets or exceeds the expected lifetime for that application.

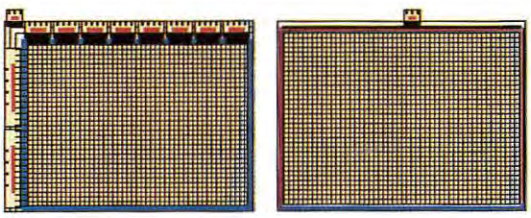
Some applications are far more demanding than others because display lifetime is strongly dependent on operating temperature, operating voltage, and duty cycle. Avionics and automotive display applications are the most demanding because they combine long periods of continuous operation with high temperature. Laptop computers and most consumer-electronics products have less demanding lifetime requirements since they typically operate for limited periods of time at lower temperatures. Qualification testing is typically accelerated by subjecting the displays to uninterrupted operation at temperatures higher than their normal maximum operating temperature. Most accelerated qualification testing is done with a 1000-hour test, which can be completed in about 2 months.

Evaluation of SASIDs has included both the normal 1000-hour accelerated qualification test plus extended accelerated life testing out to 10,000 hours of real time. During the useful display lifetime, a-Si TFT threshold voltages shift at roughly a constant rate over time, but they increase more than linearly with duty cycle. The threshold-voltage drift rate increases proportionally to the square of the voltage stress and increases exponentially with increasing temperature.

A TFT used as the pixel switch in an active-matrix array will be used only one time per frame, which is equivalent to a duty cycle of less than 0.2%. The TFTs used in the SASID select and data scanners, on the other hand, could be exposed to much higher frequencies and higher duty cycles, ranging from 0.4 to 30%. Unless the circuit design is modified to minimize transistor duty cycles and compensate for transistor threshold-voltage drift, the lifetime of SASIDs would be shorter than for TAB hybrid displays.

Consequently, new circuit solutions have been developed to extend the lifetime of SASID select and data scanners to the point where lifetime of the SASIDs meets all of the lifetime requirements listed in Table 2. These SASID devices include the following improvements: constant gate-overdrive operation, dynamic circuitry with minimum duty cycles, and closed-loop compensation.

Constant Gate Overdrive. SASID circuits working in the constant gate-overdrive mode continually self-adjust the local applied gate voltage so that key transistors operate at either a constant current or constant impedance level instead of the constant-voltage mode typical



SVGA Color Laptop Display SVGA color laptop display – 600x800x3	TAB/Hybrid	SASID/Integrated
Number of External Leads	3000	202
Estimated Random Failure Rate	2 %/year	0.13 %/year
Overall Failure Rate	5 %/year	2.9 %/year

Fig. 5: Other factors being equal, the random failure rate of an internally scanned display is much less than that of an externally scanned display, contributing to an overall failure rate that is about half that of the externally scanned display.

of conventional circuits. Key voltages within SASID scanners are shifted in response to temperature and time, and transistor threshold shifts of up to 8 V can be accommodated without significant degradation of display performance.

Dynamic Circuitry with Minimum Duty Cycles. For high-speed demux sampling on the input side of the data driver, a big current surge and fast switching are required to support demux ratios of 20:1 or more. Here, SASIDs use the conventional constant-voltage drive mode, but the duty cycle is minimized to maximize lifetime. Accurate modeling of the TFT voltage drift has been used to further extend lifetime.

Closed-Loop Compensation. In addition to using negative-feedback circuitry to compensate locally for threshold-voltage changes, some SASID designs also employ negative feedback globally by using closed-loop compensation at the system level. Global closed-loop compensation minimizes performance variations caused by both short-term temperature changes and long-term threshold-voltage effects.

Electro-optical measurements were used to measure the operating margin of a 1.4-V SASID data scanner over time. This SASID data scanner had operated continuously for 10,000 hours (1.3 years) at 50°C without exhausting its operating margin or affecting its dynamic operating characteristics. Its extrapolated lifetime is over 100,000 hours, even when operating continuously at elevated temperature.

Another, similar, SASID data scanner has been operated continuously for 5000 hours at 70°C without failure. Its extrapolated lifetime is 15,000 hours of continuous operation at 70°C. The operating margin for both devices is decreasing at a rate of about 2 V/decade. Based on a measured temperature-acceleration factor of 2 times for each 10°C temperature rise, these SASID data scanners can be expected to provide at least 5000 hours of continuous operation at 85°C with minimal adjustment in the initial operating voltages.

The SASID select scanners have also been life-tested out to 10,000 hours, with a select-scanner lifetime even longer than that of the data scanner. All of the displays maintain an operating design margin of more than 6 V even after 10,000 hours of continuous operation at 50°C or 3000 hours at 70°C. The extrapolated lifetime is 40,000 hours at 70°C and over 100,000 hours at 50°C.

A comparison of these results with the accelerated qualification test requirements for various display applications shown in Table 2 shows that these SASIDs now meet the lifetime requirements for laptop computers, TVs, PDAs, cameras, telephones, other consumer-electronics products, and projection light-valve applications. The most recent SASID designs can now meet the lifetime and reliability requirements of the more demanding automotive and avionics applications as well. ■

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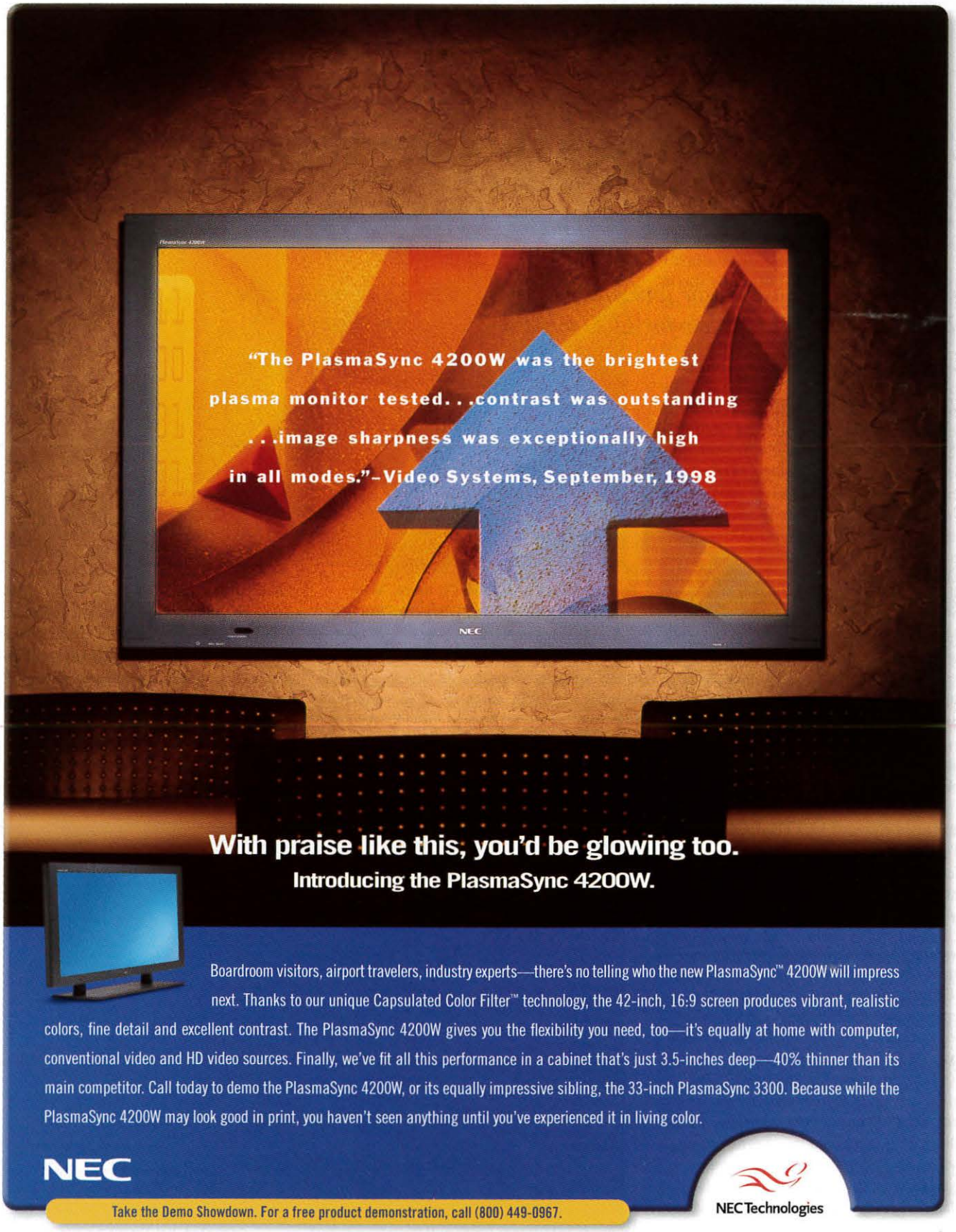

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LCD-Monitor Market Share Rises on Falling Prices

A respected Japanese editor looks at the increases in LCD production and predicts the price levels for LCD monitors in the year 2000.

by Kenichi Ohta

In June 1998, a TFT-LCD monitor (LCM) went on sale for less than ¥100,000 (about US$870) for the first time in Japan. TFT-LCMs have been attracting attention in Japan, which is partly due to their frequent appearances in TV commercials. LCD manufacturers are now devoting their full attention to preparing LCM-product line-ups in anticipation of this long-awaited major market – one the industry has badly needed to supplement notebook computers.

The Rapid Spread of TFT-LCMs

TFT-LCMs have only recently become a hot topic in the marketplace, even though 8–10-in. LCMs have been around for a while. But their prices were prohibitive – well above that of the PC itself – and were therefore well beyond the reach of most PC users. Why have TFT-LCMs suddenly begun to catch on?

The first reason is the appearance of large high-resolution LCDs on the market at relatively inexpensive prices. In targeting a CRT-monitor market in which 15–17-in. screens are the rule and resolutions are at XGA level or above, an LCD offering similar or superior quality would have to be at least a 13-in. model at XGA or higher resolution. As the sizes of notebook-PC screens expand, LCD manufacturers have invested in production lines capable of efficient production of large-sized LCDs, and all of these production lines have gone into operation nearly simultaneously. As a result, large-sized LCDs – 14 in. and larger – can now easily be mass-produced for use in monitors.

The second reason is the falling prices of TFT-LCMs. The preparation of lines for large-sized LCD production by the different

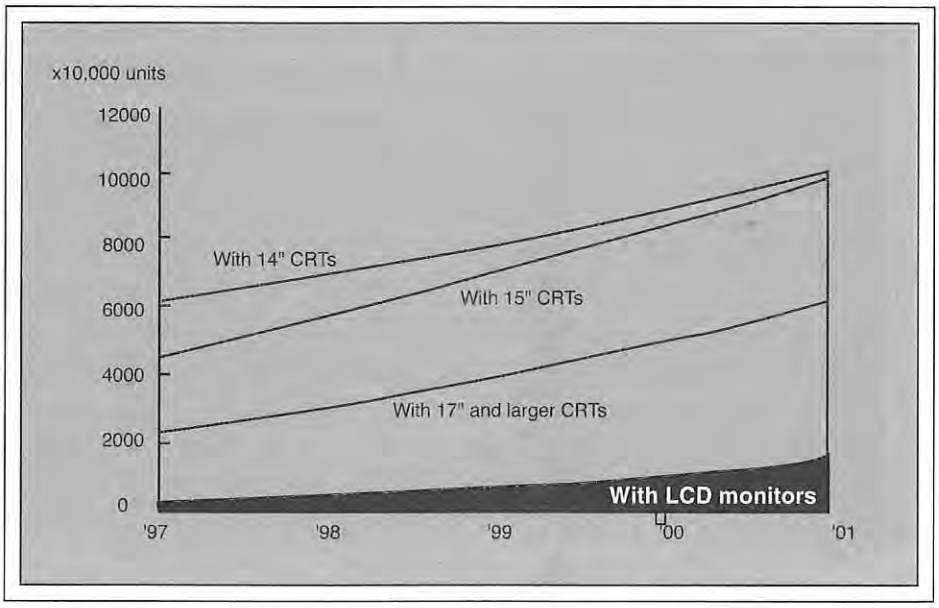

Fig. 1: *TFT-LCD models accounted for less than 3% of all PC monitors 17 in. and greater in size in fiscal 1997, but LCMs should reach 20% of the total monitor market in the year 2000.*

Kenichi Ohta, *now retired, was a member of the Editorial Department of the respected Japanese magazine* FPD Intelligence, *which is based in Tokyo; 2-4-5 Iidabashi Chiyoda-Ku, Tokyo 102-0072, Japan; telephone +81-(03)-3230-3249, fax +81-(03)-3230-4906.* *The original version of this article appeared in the September 1998 issue of the magazine.* FPD Intelligence *is translated into English by InterLingua, Redondo Beach, California (japanese2@worldnet.att.net), which also publishes the English-language edition in electronic form as part of its "Display Technology Library." This article was adapted and updated from the InterLingua translation by permission of the publisher.*

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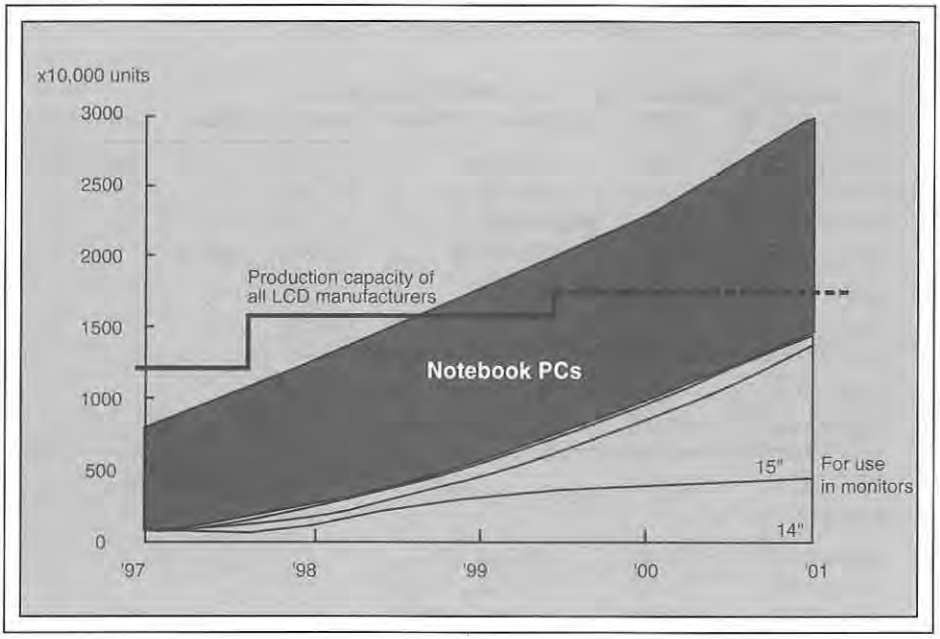

Fig. 2: The forecasted demand for TFT-LCDs cannot be satisfied by the current full capacity of all LCD manufacturers – including production lines now in the planning stage.

LCD manufacturers has not only made possible a supply of large-screen products, it has also enabled cuts in LCD prices. The recent rapid advances in the phase-locked loop (PLL) and other peripheral devices used in TFT-LCMs, including more sophisticated functions and lower costs, have also contributed greatly to pulling down LCM prices.

The third reason is the intensifying demand for greater energy efficiency and smaller footprints; users are willing to pay a premium price for these advantages. There is no doubt that the mounting global emphasis on ecology – as seen in the focus on carbon-dioxide emissions during the Kyoto conference on global warming held in December 1997 – will further accelerate the widespread adoption of TFT-LCMs, which require only about one-third the space and power of their CRT counterparts.

In addition to the above factors, it should also be noted that the slump in TFT-LCDs for notebook computers beginning in the summer of 1997 spurred LCD manufacturers to develop LCDs for use in monitors, which promise to be the next major LCD market.

14-in. Monitors Priced for Growth

Until 1997, TFT-LCMs had very limited sales. It has long been held that widespread adoption of TFT-LCMs will hinge on price, and, now that 14-in. monitors have appeared at street prices under ¥100,000, sales are beginning to show signs of explosive growth. Opinion is divided on the specific breakthrough price for TFT-LCMs – whether it is twice that of CRT products, or 1.5 times, or some other level. But more important than price ratios, an absolute price of less than ¥100,000 seems to have given the market the impression that lower prices have arrived, leading to a rapid rise in demand.

A look at the prices of monitors offered by different manufacturers reveals considerable disparity (Table 1). Many products have "open" prices, with no standard or list price. This fact in itself indicates that TFT-LCMs have recently seen sharp price cuts, and that market prices are in a chaotic state. Once a manufacturer sets a list price, others immediately release still cheaper products, and list prices lose all practical significance.

Yet, this price competition cannot continue much longer. The ability of LCD manufacturers to compete on the price front is approaching its limits; additional large drops in LCD prices cannot be expected. Right now, a 14-in.-monitor price of ¥100,000 does not represent a comfortable profit margin for monitor manufacturers. Although further gradual declines in price can be expected, there will no longer be dramatic drops in TFT-LCM prices. Having reached the "breakthrough" price range, 14-in.-monitor prices will see more short-term confusion, but will likely remain in the range just under ¥100,000.

14- and 15-in. High-Resolution Products

Nearly all the TFT-LCMs now on the market are in the 13–15-in. range, and 14- and 15-in. monitors – equivalent to 17-in. CRT monitors – are now the mainstream. It is debatable whether 14- or 15-in. monitors will dominate in the future, but, for the time being, 14-in. monitors have the early advantage based on price, with some gradual shifting to 15-in. monitors.

In terms of resolution, monitors up to 15 in. will be XGA, and everything above will tend to be SXGA. Some 18-in. SXGA monitors are being sold already, and the move from XGA to SXGA will gain momentum in the future. Considering the large number of consumers using 17-in. CRT displays in SXGA mode, 15-in. LCMs capable of SXGA look promising also.

Twenty-inch monitors have been the focus of considerable attention because they offer enough screen space to display two A4-sized pages side by side, but some analysts think that such monitors are too large for ordinary desk work. Therefore, as 18-in. LCMs proliferate, they are expected to find success in relatively limited applications, such as being paired with engineering workstations. In light of this, there will probably be interest in 20-in. monitors with still higher (UXGA) resolution.

As sizes grow beyond 15 in., parallax issues produce a need for displays with fairly wide viewing angles, even for single-user applications. For this reason, manufacturers recently have moved to LCDs with an optical-compensation film, or LCDs with in-plane switching (IPS), multi-domain vertical alignment (MVA), or some other new driving method, among various measures to improve the viewing-angle range. These improvements have not only enhanced the display quality of TFT-LCMs, they have effectively shut DSTN-LCMs out of the market.

Future trends will likely include adding features – beyond display quality – to LCMs to increase their value and appeal. For example, TFT-LCMs with USB jacks are now being marketed, which allows these monitors to be used with USB hubs and peripherals. Competition among manufacturers to offer additional

Table 1: Street Prices for Major LCM Models (Akihabara, Tokyo)

Manufacturer	Model	Size	LCD Type	Input	List Price (Yen) (98/97)	Street Price (Yen) Store A	Store B	Store C	Notes
NEC-HE	LCD400V	14.1	TFT	Analog RGB	218,000	122,000			
	LCD1510V	15.0	TN+RF	Analog RGB	248,000	186,000		178,000	
	LCD1510	15.0	SFT	Analog RGB	328,000	258,000			
	LCD2010	20.1	SFT	Analog RGB	980,000	852,000		784,000	SXGA
EIZO (Nanao)	FlexScanE151L	15.0	SuperV	Analog RGB	398,000	198,000		198,000	
	FlexScanE141L	13.8	TFT	Analog RGB	OPEN	138,000	137,999	138,000	
	FlexScanL66	18.1	TFT	Analog RGB	OPEN		457,999	458,000	
Iiyama	TXA3601GT	14.1	TFT	Analog RGB	98,000		97,999	98,000	
	TXA3602GT	14.1	SFT	Analog RGB	148,000		147,999		
	TXA3811HT	15.0	TFT	Analog RGB	148,000		147,999		
	TXA382HT	15.0	TFT	Analog RGB	158,000		157,999		With speakers
	TXA3801GT	15.0	TFT	Analog RGB				95,800	
MELCO	FTD-XT15-A	15.0	TFT	Analog RGB	228,000	176,000			
	FTD-XT14-A	14.1	TFT	Analog RGB	198,000	123,000	121,999		
	FTD-XT14S-A	14.0	TFT	Analog RGB	99,000	99,800	99,799		
	FTD-XT13-PL	13.3	S-TFT	TMDS	198,000		158,400		Including interface board
	FTD-ST12P	12.1	TFT	Digital	138,000			99,800	SVGA
Sharp	LL-T152A	15.0	SuperV	Analog RGB	OPEN	165,000	167,999	165,000	
	LL-T150A	15.0	SuperV	Analog RGB	OPEN	148,000		148,000	
	LL-T140A	13.8	TFT	Analog RGB	OPEN	127,800		127,800	
	CE-LT14M	13.8	TFT	Analog RGB	OPEN		137,999	178,000	
Mitsubishi Electric	RDT151	15.0	SuperV	Analog RGB	398,000	148,000	147,999	188,000	
	RDT151R	15.0	TFT	Analog RGB	OPEN	168,000			
	RDT141	14.0	TFT	Analog RGB	398,000	108,000	107,999	148,000	
	RDT141R	14.0	TFT	Analog RGB	OPEN	138,000			
Matsushita Electric Industrial	CF-L15TMJM2	14.5	TFT	Analog RGB	298,000			158,000	
	CF-L45TMPJ	14.5	TFT	Analog RGB	238,000	188,000			
	AL-D40TMPJ	14.0		Analog RGB	358,000		127,999		
	TX-D14L31-J	14.0	TFT	Analog RGB	348,000	139,800	139,799	139,800	
	TX-D5L31AJ	15.0	TFT	Analog RGB	248,000	168,000	167,999		
Akia	RT161SX	16.1	TFT	Analog RGB	398,000	268,000			SXGA
	RT150X	15.0	TFT	Analog RGB	164,800	139,800			
	MT145X	14.5	TFT	Digital	158,000				
	MD138X	13.8	STN	Digital	108,000	79,800			
	RT133X	13.3	TFT	Analog RGB	119,800	99,800	99,800		
	RT145WX	14.5	TFT	Analog RGB	129,800				
	RT145XR	14.5	TFT	Analog RGB	168,000		167,999		
	MT12S	12.1	TFT	Digital	148,000	89,800			SVGA

features is likely to intensify. We are likely to see the emergence of LCMs equipped with floppy-disk drives, CD-ROM drives, and other devices.

Analog RGB Still the Standard

LCMs can have either an analog RGB or a digital interface with the PC. Nearly all the LCMs now being sold rely on analog RGB connections. This is because nearly all PCs are provided with analog RGB outputs for connection with CRT monitors, but do not have digital outputs for use with LCMs – which are not yet widespread. At present, a dedicated board (or one of the few available combined analog/digital boards) must be installed in the PC to enable a digital connection with an LCM. There is also the problem of board compatibility because not all PCs will accept such boards. Consequently, LCM manufacturers cannot easily move to a digital interface if their products are to be sold as general-use monitors, and they are obliged to adopt standard analog RGB interfaces.

Table 1: Continued

Manufacturer	Model	Size	LCD Type	Input	List Price (Yen) (98/97)	Street Price (Yen) Store A	Store B	Store C	Notes
I-O Data Device	LCD-D15T	15.0	TN+RF	Digital	238,000	187,000			
	LCD-A14T	13.8	TFT	Analog RGB	218,000	118,000			
	LCD-D14T	13.8	TFT	Digital	218,000		199,999		
IBM	9514-A04	14.5	TFT	Analog RGB	438,000			158,000	
	9514	14.1		Analog RGB	OPEN				
Sony	CPD-L150	15.0	TFT	Analog RGB	OPEN	228,000	227,999	228,000	
Hitachi	PCT-DT3131	13.3	S-TFT	Analog RGB	318,000	178,000		178,000	
	PC-DT3140	14.1	S-TFT	Analog RGB	318,000				
Toshiba	PV2007JA	15.0	TFT	Digital	298,000		247,999	258,000	Bundled with PC
Magview	LS500C	15.0	STN	LVDS				198,000	
Proton	9514-A06	14.5	TFT	Analog RGB				148,000	
	9514-A04	14.5	TFT	Analog RGB				158,000	
	9516-A04	16.1	TFT					298,000	SXGA
Logitec	LCM-T133A	13.3	S-TFT	Analog RGB	218,000	154,000	137,999		
Totoku Electric	CV411T	13.8	TFT	Analog RGB	OPEN		197,999	268,000	
Apti	LM-1024A	14.5	TFT	Analog RGB	248,000		147,999		
	LM-1280	16.1	TFT	Analog RGB	OPEN		357,999		SXGA
Fujitsu	VL-1500T	15.0	MVA	Analog RGB					
	VL-1510T	15.0	MVA	Analog RGB	248,000		197,999		
	VL-1420T	14.1	TFT	Analog RGB	198,000		157,999		
	VL-2100T	21.3	MVA	Analog RGB	1,280,000			997,999	SXGA
Canon	TD13A	13.3	U-TFT	Analog RGB	278,000		197,000		
CTX	PRCM008	12.1					198,000		
TAXAN	CV650	14.5	TFT		418,000		137,999		
LG Electronics	500LC	15.1	TFT	Analog RGB	248,000		147,999		
Artwork	NLM-141A	14.1			129,800		129,799		
Sanyo Electric	LMU-TF150A1S	15.0		Analog RGB	OPEN		227,999		
Samsung	400TFT	14.0	TFT	Analog RGB	298,000		147,999		
	500TFT	15.0	TFT	Analog RGB	388,000		197,999		
Compaq Computer	170406-291	14.5	TFT	Analog RGB	248,000			220,800	

Processing within PCs is, of course, digital, and a digital interface between two all-digital devices – a PC and an LCM – would be more efficient and cost-effective. In notebook PCs, the computer and LCD can be connected internally and a digital interface is employed; but in the case of an LCM, the length of the connecting cable and the large number of connecting lines pose problems, requiring innovations to the data-transmission system. Various digital interfaces based on different transmission systems have been proposed (Table 2).

As TFT-LCMs have grown in popularity, there have been increasingly energetic movements to standardize the digital interface, but complete standardization has not yet been achieved. If we do not have further progress in standardization and in unified specifications, and if all PCs are not provided with digital outputs, there cannot be a widespread move to a digital interface. For the time being, it appears that TFT-LCMs will continue to rely mainly on an analog RGB interface.

PC-LCM Bundles?

There is another vital aspect of future marketing of TFT-LCMs: the probability that the proportion of TFT-LCMs that are sold bundled with PCs will shoot upward. Considering that more than 80% of desktop PCs sold

Table 2: Proposed Digital Interfaces for LCMs

	Data Format	Supported Signals	Interface Connectors	Notes
VESA (P&D) Standard	TMDS (PanelLink)	Digital data, analog data, DDC, USB, IEEE1384, stereo sync	Molex P&D connectors, 30 digital pins + 5 analog pins, and compatible	
DISM Standard 1	TMDS (PanelLink)	Digital data, analog data, DDC, USB, IEEE1384, stereo sync	Molex P&D connectors, 30 digital pins + 5 analog pins, and compatible	Conforms to VESA (P&D)
DISM Standard 2	TMDS (PanelLink)	Digital data, DDC, USB,	3M MDR connector, 26-pin, and compatible	
DISM Standard 3a	LVDS	Digital data, DDC, USB,	3M MDR connector, 26-pin, and compatible	
DISM Standard 3b	LDI	Digital data, DDC, USB,	3M MDR connector, 40-pin, and compatible	
DISM Standard 4	LDI	Digital data, DDC, USB,	3M MDR connector, 14-pin, and compatible	
Overseas Standard DSP	TMDS (PanelLink)	Digital data, analog data, DDC, EDID, DPMS	3M MDR connector, 20-pin, analog output DB 15-pin, video output, and compatible	Announced by ATI Technologies of Canada

today are bundled with CRT monitors, it is just a matter of time before TFT-LCMs are likewise sold in bundled packages.

Many Japanese PC manufacturers are already combining LCMs with small-footprint PCs, targeting customers intent on preserving precious desktop space. A few major U.S. PC makers are also bundling LCMs with some systems but, initially, PC-LCM bundles are likely to have more impact in Japan, where space-savings demands are more urgent. By targeting applications where space is short, such packages may erode part of the notebook-PC market, and the movements of PC manufacturers are being watched closely.

Who Drives This Market?

What will be required of the companies that finally succeed in the TFT-LCM market? Well-engineered products, of course, but the most important factor at this time is price.

The LCD panel is the most expensive component of a TFT-LCM. The proportion of the total cost represented by the panel is extremely high, so, from the perspective of a monitor manufacturer, the cost of manufacturing a TFT-LCM consists almost entirely of the cost of parts and materials. In contrast with CRT monitors, it is very hard to endow LCM products with added value. So, for monitor manufacturers, reducing the cost of the TFT-LCD itself is paramount, but a manufacturer who relies solely on cost reduction will lose his competitive edge over his rivals.

A TFT-LCM normally consists of the TFT-LCD, interface, power supply, housing, and other parts. Overhead and distribution costs are also incurred by the monitor manufacturer. Innovations among monitor manufacturers to suppress costs will be crucial to success.

The company that released the industry's first under-¥100,000 LCM was MELCO. Company president Maki relates that in addition to simply cutting manufacturing costs, margins for the manufacturer and for distribution were also shaved to reduce prices. This is a sobering observation. To state it a little differently, low-priced TFT-LCMs are only made possible by trimming overhead and squeezing distribution costs, in addition to the cost of the LCD itself.

This problem of overhead and distribution margins is especially pressing in the case of companies producing monitors on an OEM basis. In addition to the manufacturer's own margins, the overhead and distribution of the client firm must also be considered.

From this standpoint, it appears that monitor manufacturers with low overhead and the ability to market their own brands, and PC manufacturers with their own LCD production lines, will do the most to promote the widespread adoption of TFT-LCMs.

Challenges

We have made projections of the TFT-LCM market, which lead to some interesting conclusions (Figs. 1–4). As a fraction of all PC monitors 17-in. and larger in size, TFT-LCD models were under 3% of the total in fiscal 1997. However, the market is set to take off in 1999, and by 2000 should reach 20% of the

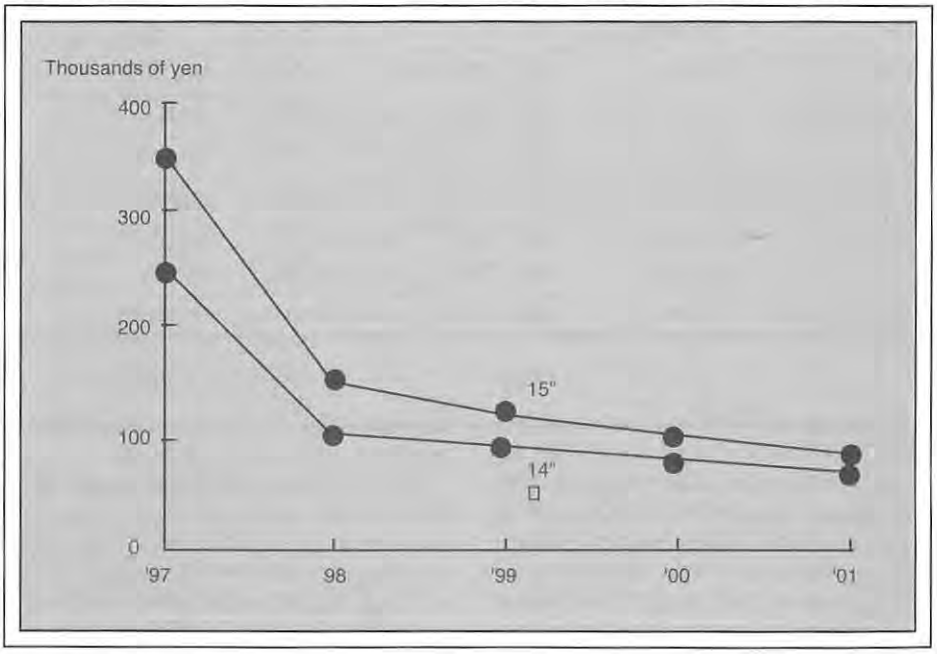

Fig. 3: The big price drop for 14- and 15-in. TFT-LCMs has already occurred.

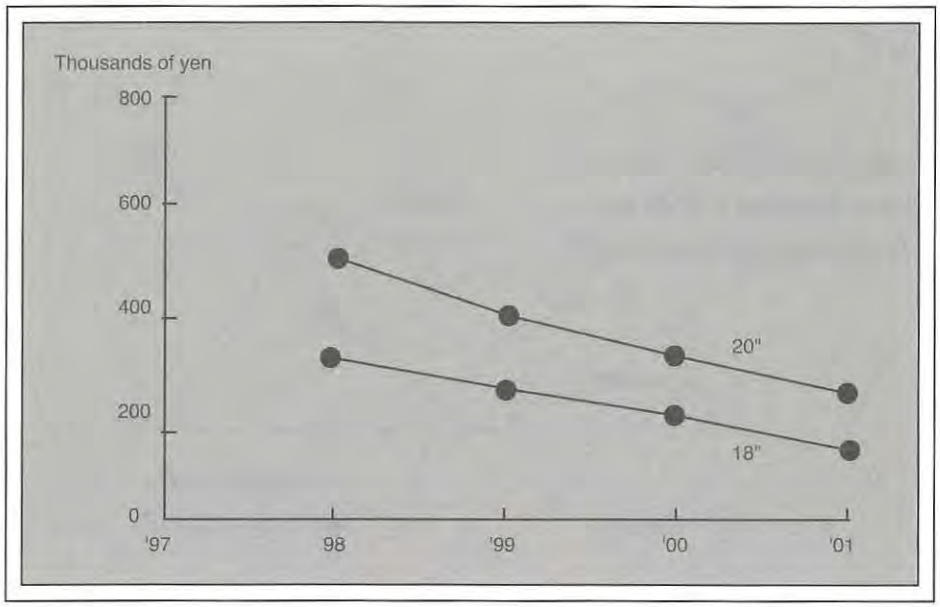

Fig. 4: Steady but appreciable price reductions are predicted for 18- and 20-in. TFT-LCMs.

total monitor market (Fig. 1). An extremely high average annual growth rate of 250% is anticipated.

But a problem arises here. The demand we've predicted cannot be satisfied even by the full capacity of all LCD manufacturers – including production lines now in the planning stage (Fig. 2). In other words, to make this kind of expansion possible, LCD manufacturers will have to make huge equipment investments. But LCD makers are just now recovering from a business slump resulting from dropping market prices, and they have no plans to augment production equipment.

So, the key to future expansion of the TFT-LCM market lies in resolving the cost problems of the LCD producers and in making large equipment investments with virtually guaranteed recovery. Although the price of 14-in. monitors, having once fallen below ¥100,000, will probably not drop much further, the prices for 15-in. monitors, now around ¥150,000 (US$1300), will likely move closer to ¥100,000 (Fig. 3). In the year 2000, it appears probable that 14-in. XGA monitors will cost around ¥80,000 (US$700), 15-in. XGA monitors will sell for ¥100,000, and 18-in. monitors will be priced at around ¥200,000 (US$1750) (Fig. 4).

So long as the TFT-LCD accounts for half the cost of an LCM, there is no doubt that the prices of TFT-LCMs will continue to hinge on the cost-cutting measures implemented by the LCD producers. But cost-cutting by the LCD producers has nearly reached its limit, so further cost reductions must await some epochal new technology. Many different plans to lower costs have been announced, such as filterless LCDs, polysilicon devices, and a smaller number of drivers. LCD manufacturers will be under intense pressure to pursue all possibilities for the further reduction of production costs. ■

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Will CRTs Survive?

The CRT's flat-panel challengers are formidable, but impressive technology advances are allowing CRTs to not only survive, but maintain their market dominance.

by Makoto Maeda

IT IS DIFFICULT to overstate the role of the cathode-ray tube (CRT) in today's display market. To characterize it as "dominant" is a bit like asserting that the oceans hold most of the world's water. Yet, new technologies – such as liquid-crystal displays (LCDs), plasma-display panels (PDPs), and field-emission displays (FEDs) – are always lining up to take their shot at the title.

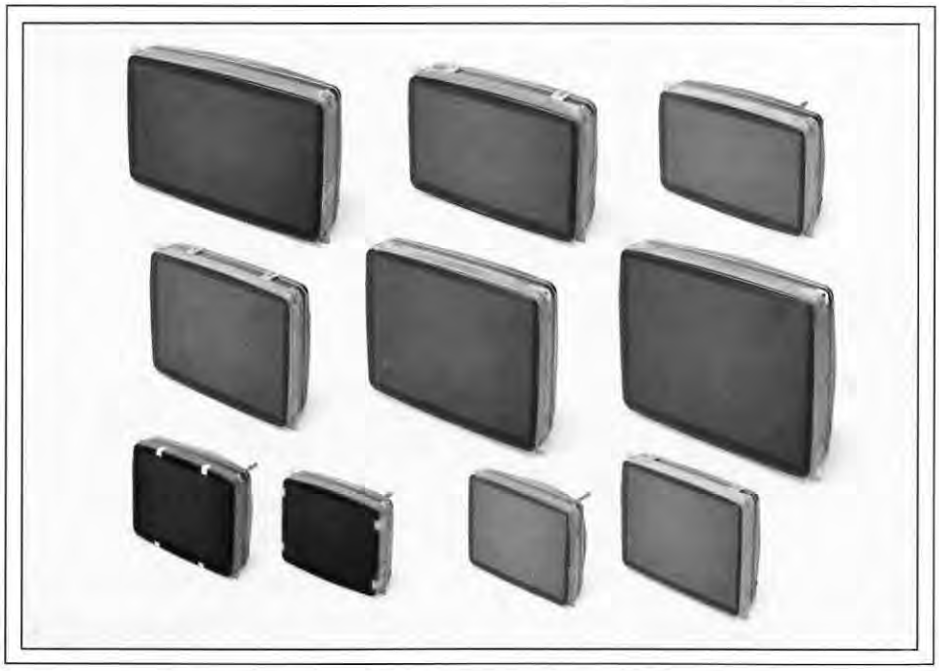
As a result of these challenges, CRT designers have constantly sought to optimize and improve their products, focusing on key attributes such as resolution, brightness, contrast, display size, depth, and weight. A brief review of some relatively recent developments indicates how far CRT technology has advanced.

Flat-Faced CRTs

A great stride in the history of CRTs was the successful invention of flat-surface displays. Eliminating the curved surface of a standard display greatly reduces reflected glare, resulting in a more pleasing image. Although there are several engineering problems involved in creating flat-faced CRTs, the flat display is likely to dominate in future CRT designs (Fig. 1).

Zenith invented the flat tension mask (FTM) and used it in their own innovative flat-display CRT, but, unfortunately, complicated manufacturing methods prevented its success. Matsushita subsequently developed the "pure flat" CRT for computer displays, which has a thin mask pulled from four directions.

Sony is well known for its Trinitron® tubes that have been flat in the vertical plane, but the company has now developed a new technology for both computer and TV displays that is flat in both directions. One of the most difficult design considerations for such a tube is the creation of a structure capable of withstanding the atmospheric forces while maintaining a reasonable weight. Sony uses prestressed tempered panel glass to prevent an increase in glass weight. Both the inside and



Sony

Fig. 1: New flat-faced Trinitron® CRTs are available in a wide range of sizes and shapes.

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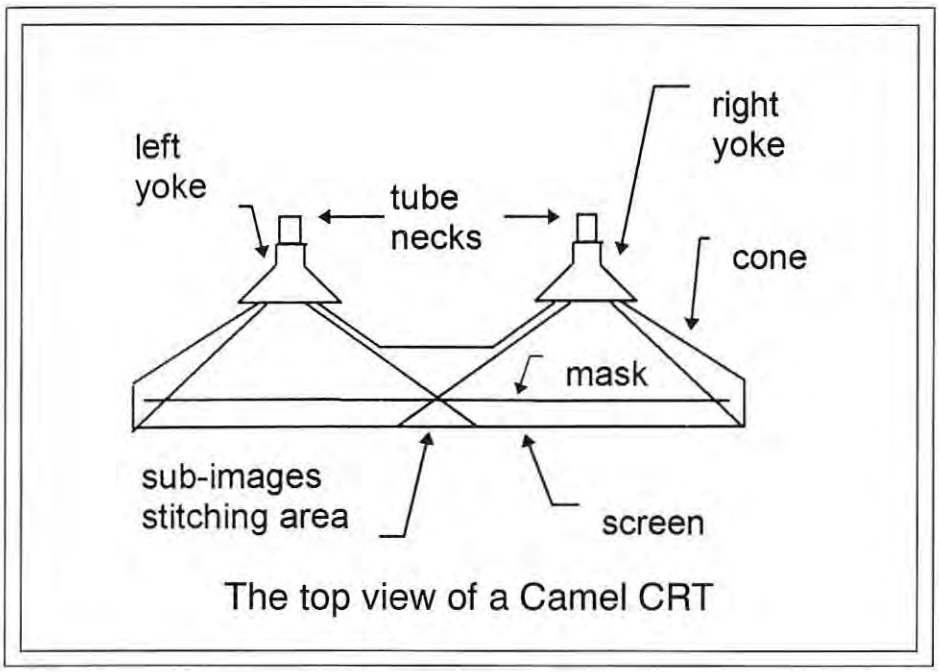

Fig. 2: The "Camel CRT" is a new short-depth design that uses a pair of yokes in a single tube to cut the CRT depth in half.

outside surface layers of the CRT glass are under compression, while the body of the glass (between the surface layers) is under tension.

Mitsubishi and Toshiba also sell flat-faced CRTs. Flat-faced-CRT designs require better deflection-yoke technology because they are more susceptible to raster distortion and convergence problems.

These designs also require more advanced masks. As the CRT face is made flatter, the mask should be flatter too. But a flat mask can be set into vibration more easily, and the doming of a flat shadow mask is greater than that of a traditional curved one. For controlling the vibration, the aperture grille in the Trinitron® type of tube must be curved uniformly so that the effect of the damping wires can be uniform. In shadow-mask tubes, the mask is made more rigid by increasing the thickness.

Shallow CRTs

One major problem with traditional CRTs is their great length (or depth). Not only does this take up more valuable space in the home or workplace, but it also results in heavier displays that cost more to manufacture and ship. Some analysts view monitor depth as the most vulnerable attribute of CRT technology, opening the door to competition from thinner and lighter flat-panel technologies.

Traditional CRT technology can offer a shallower depth if the deflection angle is made wider, but this requires more deflection power. To reduce the required deflection power, other modifications are necessary, such as making the neck diameter smaller and improving the deflection sensitivity. These modifications have been implemented in consumer-TV applications for some time, but only recently the deflection angle of 17- and 19-in. CRTs for computer use has been successfully increased from 90° to 100°.

Approaches other than simply widening the deflection angles have been tried. Aiken announced the first shallow CRT in 1951, although it was monochrome. W. W. Siekanowicz made a sample of a shallow color CRT in 1982. For these CRTs the electron beam was deflected by electrostatic deflectors. Although the depth of these displays was sharply reduced, the structures were too complicated for practical use.

Recently, A. A. S. Sluyterman proposed a new CRT that has two necks and is only half as deep as a traditional design (Fig. 2). This "Camel CRT" is essentially two conventional CRTs placed side by side in one glass envelope. It is inevitable that a CRT with two electron guns and two deflection yokes costs much more than a CRT with one electron gun and one deflection yoke. How much of a price increase will buyers accept just to have the depth made thinner?

There are flat "thin CRTs" available on the market today, but only in small monochrome designs. Even though such CRTs are still in large-scale production, they are currently limited to a screen size of 4 in.

The FED shows promise of providing us with true flat-panel CRTs. Once they become widely available in larger screen sizes, depth will no longer be a problem because their design is based on thousands of electron guns.

Improved Electron Guns

The electron gun is a key component in CRT performance, and improvements have been achieved in three critical areas: resolution, power consumption, and cost.

Resolution can be improved by maintaining a round electron-beam spot, even in the corners of the display. New electron guns that prevent beam spots from becoming oval are now appearing on the market from a growing number of sources. These guns, which include quadrupole lenses in two cases, can correct deflection defocusing properly.

Power consumption can be reduced by decreasing the neck diameter. However, this requires the use of smaller lenses, which can, in turn, result in larger spot size (which reduces display resolution). Advanced design is required to counter this problem.

These more complex electron-gun designs improve performance in significant ways, but their cost tends to be higher. Engineers are trying hard to simplify the structure and cut down on the cost while keeping the high performance of these advanced guns. Hitachi's autofocus system, which eliminates the dynamic focusing circuit, is a successful example of such efforts.

Additional challenges in electron-gun technology remain. For example, there is a need for a high-current high-resolution electron gun. At present, a 32-in. CRT cannot display bright pictures and SXGA-quality alphanumeric characters simultaneously. In this information age, people want to see characters and pictures simultaneously on their displays, but the CRT cannot do it. One proposed solution to this problem is to increase the number

of electron beams from three to six. This could result in a new CRT design that has three high-current beams for bright pictures and three high-resolution beams for displaying high-resolution information.

Reducing Power Consumption

The problem of reducing power consumption applies not just to electron guns, but to the CRT design as a whole. As many as 200 million CRTs are produced in the world every year, and each consumes about 100 W of electrical power on average (CRTs consume much more electricity than competing flat-panel technologies). In response to growing concerns in the marketplace about environmental issues and limited resources, we must come up with a CRT that consumes much less electricity.

Working against these efforts, however, is the fact that the easiest way to improve CRT performance is to raise the anode voltage to create a crisper image. At higher voltages, the image is brighter and the electron-beam diameter is smaller. For these reasons, the typical anode voltage has been getting higher for years, and is now at about 30 kV.

The deflection yoke uses 40% of the electric power consumed by the entire CRT monitor, while only 10% of the power goes to the screen. Engineers have been trying to cut down on the deflection power by making square-shaped funnel glass.

Reducing anode voltage is a challenge, but it remains the best avenue to reduced power consumption; however, this will require improvements in other areas to counter the loss of picture quality that accompanies the reduced voltage.

Computer-Aided Design

One key factor in recent CRT advances is the increasing use of computers, which are now used extensively throughout the stages of development, design, and production. In many cases, computer simulation takes the place of actually constructing a given CRT design, which dramatically shortens the design cycle and results in improved CRT performance.

The use of computers is not limited to this sort of simulation, but has been extended to provide optimum design with appropriate algorithms. It is difficult to provide a sufficiently good design just by simulating construction, especially in cases where there are lots of parameters. Optimizing lots of design parameters cannot be achieved without a computer.

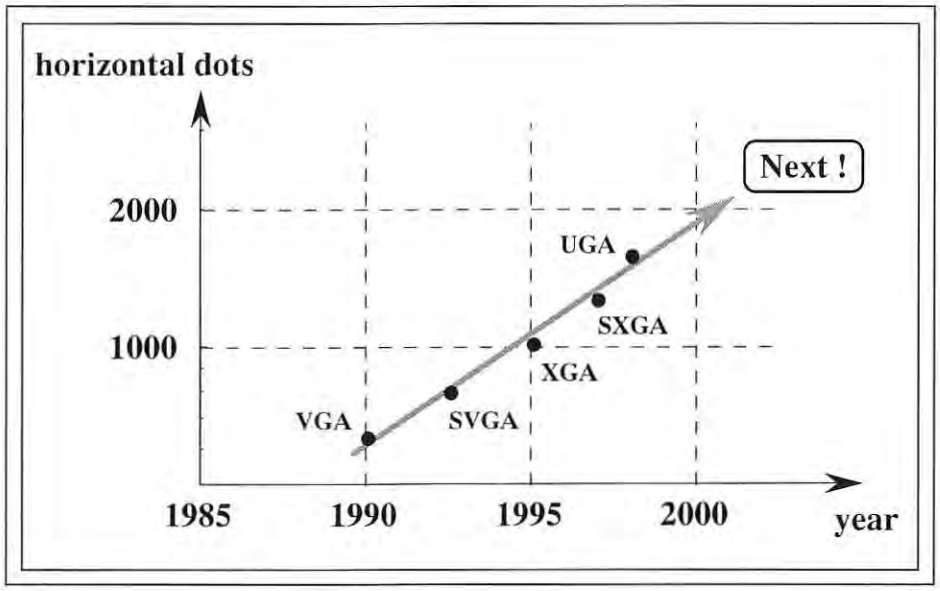

Fig. 3: The horizontal screen resolution of computer displays continues to increase at a steady rate.

Environmental Conservation

Glass represents one of the main components of a CRT, and glass remains unchanged for a very long time after it is discarded. Moreover, glass and frit contain large quantities of lead that can be harmful to the environment. Therefore, glass should be recycled after the useful life of the CRT. It is difficult to collect and disassemble used CRTs at low cost, so experimental efforts are under way to make recycling more economical.

The Future of CRTs

In spite of the recent advances, CRT technology must continue to improve if it is to maintain its dominant position in the marketplace. How must CRT technology evolve to meet the demands of the information age? There is no question that the flat-faced CRTs now being introduced will become tomorrow's standard. Just as the screen with round corners has been replaced by the screen with sharp corners, the hemispherical or cylindrical screen will be replaced by the flat-faced screen.

The screen aspect ratio of 4:3 has been a standard for CRTs thus far, but wide aspect ratios such as 16:9 and 16:10 will present another choice. In the future, the main uses for CRTs will continue to be as TV sets and computer displays.

Television CRTs of the Future

CRTs already outperform the present requirements of the NTSC and PAL standards, so performance improvements will provide little benefit there. Instead, engineers are focusing on slashing the cost of television CRTs as their top priority.

The next-generation broadcasting system can transfer a high-resolution digital signal, and this will trigger new competition to improve the CRT. And alphanumeric information will play an increasingly important role. The demand is stronger than ever for clarity in the simultaneous display of both characters and pictures on television receivers. These demands will be met through improved resolution, brightness, and contrast, and the electron gun is a key factor in achieving these improvements.

CRTs have an important advantage over most flat-panel-display (FPD) designs: they are able to generate high peak brightness on the screen. This wide dynamic range of images displayed on a CRT is well accepted, but the focus is not good enough at high beam current - especially when characters are displayed. Good focus characteristics at high beam current is a key improvement for the next-generation CRT.

Computer-Display CRTs of the Future

The more the computer improves, the more information it displays on the CRT screen, which in turn requires a finer dot pitch (Fig. 3). The CRT display is now capable of 1600 dots horizontally. But information content and density is increasing, and the CRT will soon be required to display 3200 dots, which amounts to 200 dots per inch (dpi) on a 20-in. CRT. Given that there already exist printers capable of 1000 dpi or higher, and that computers are advancing extremely quickly, the 200-dpi CRT display will be required in the next few years.

This super-fine-pitch screen will require improved masks and phosphor screens, as well as improved manufacturing methods. For example, a screen with a finer pitch cannot be made by the current UV-light exposure system because the diffraction of light prevents the fabrication of such a fine screen. A new method for fabricating a fine screen is required, such as a new light source to generate short-wave light for exposure, and a photosensitizer for short-wave light. An exposure system using an electron beam that works at these resolutions is available, but it is not yet economical.

It also becomes difficult to make a fine-pitch mask by the current etching method because it is difficult to maintain the precise hole size in the very thin iron sheet used for the mask. On the other hand, the mask cannot easily be made thinner while maintaining its required strength and structure. One solution may be to return to the Zenith FTM that uses a sheet only 25 μm thick, but the challenge of producing this mask affordably remains unsolved.

A Look to the Future

CRT technology is more than 100 years old, and there are few other technologies on the earth that have provided us with so many years of service. In spite of its highly refined level of development, we continue to improve the technology even further. As a result, we enjoy new CRTs at lower cost with improved performance.

Some people have long predicted that the CRT would be replaced by the advancing FPDs, including LCDs and PDPs. Yet the CRT has remained a stubborn and resilient competitor. While there are certain markets in which the FPDs have a commanding advantage, CRTs remain the dominant technology, and most will agree that the day when flat panels take over from CRTs is still far in the future. And if CRT technology continues to advance at its present pace, that day may never come at all. ■

The Way to San Jose

The 30th annual SID Symposium will feature the largest SID exhibition ever held, digital cinema keynotes and demos, a new display applications and electronics segment, and the Display Technology Showcase.

by Ken Werner

THE SOCIETY FOR INFORMATION DISPLAY will hold its 30th annual Symposium, Seminar & Exhibition (SID '99) at the San Jose McEnery Convention Center (SJCC) in San Jose, California - the "capital" of Silicon Valley - from May 16th to May 21st, 1999. The headquarters hotel is the elegant Fairmont, which is just two blocks from the convention center (see map).

The annual SID Symposium has become the leading international forum for electronic-display products, technology, systems, integration, applications, product engineering, manufacturing, testing, and human factors. It is covered by technical and business journalists from around the world. Because of steady growth, this year's symposium will once again feature the largest exhibition of displays, display components, display-manufacturing equipment, display test and measurement equipment, display controllers and electronics, backlights, and display products and materials, software, services, and publications ever held in North America. Over 175 exhibitors have already booked more than 300 booths. Among the exhibitors will be the world's leading display companies, major suppliers of manufacturing equipment and materials, suppliers of interfaces and components, makers of test and measurement equipment, and suppliers of services, including repair services.

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

Last year's highly successful Display Technology Showcase (DTS) will be back with more displays, more categories, and a wider variety of signal sources. As was true last year, the DTS will provide cross-technology comparisons of displays of similar sizes intended for similar applications - operating from the same signal sources. Once again, there will be sections devoted to

- Large video and graphics displays using plasma, LCD, CRT, PALC, and rear-projection technologies;
- Large- and medium-sized monitors using a variety of direct-view and rear-projection technologies for interior and exterior applications; and
- Small datagraphic displays using a variety of technologies.

Fairmont Hotel

The jets of the fountain in San Jose's Plaza de Cesar Chavez rise to their full height before the Fairmont Hotel, headquarters hotel for SID '99.

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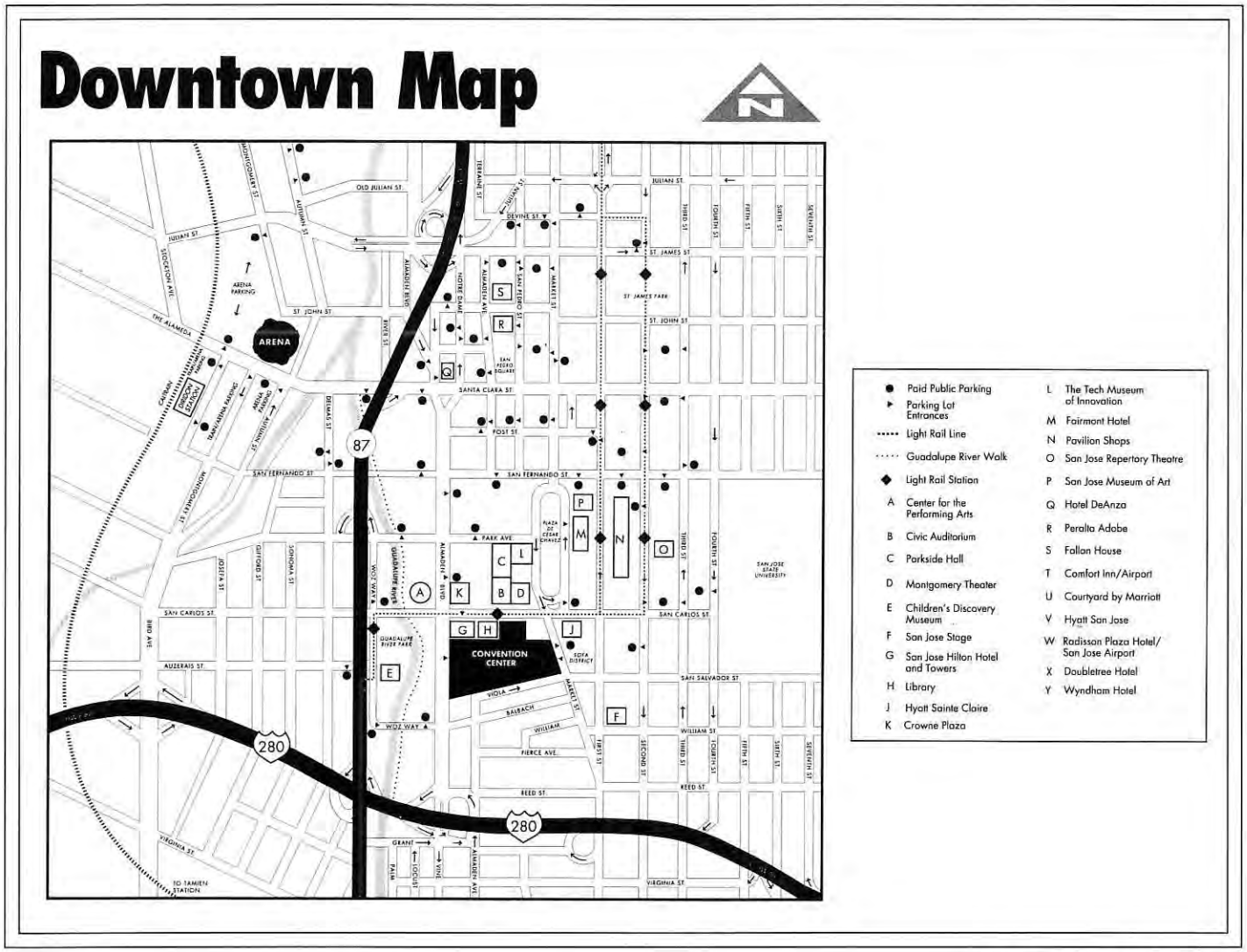
New for this year are a section devoted to HDTV displays and one devoted to comparative demonstrations of components and subsystems such as PanelLink, LVDS, and various scaling engines.

For the first time, digital signals will be available to all displays that require them, as will wide-format signals for 16:9 displays and a high-definition video feed from a camera overlooking the show floor. "We will also try to implement a system where, at the end of each day, DTS attendees will be able to have interactive control of the test suite so they can better evaluate a particular display for a particular application," said Jack Gershfeld, President of Altinex, Inc., and DTS Technical Director.

Display Week will kick off with 4-hour short courses on Sunday, May 16th, and 90-minute seminars on Monday, May 17th. There will also be 90-minute seminars on Friday, May 21st. A rich multi-track menu of technical-symposium papers, vendor exhibits, applications sessions, and applications seminars will all be held from Tuesday, May 18th, to Thursday, May 20th.

Keynotes on Digital Cinema

The Tuesday morning plenary session will feature keynote presentations on digital cinema, which is now close to pilot deployment. Larry J. Hornbeck (TI), inventor of the digital micromirror device (DMD), will discuss the creative, technical, and commercial benefits of digital cinema, and the particular benefits of coupling digital cinematic program material with a fully digital (DMD) projector. Curt Behlmer (Studio Systems, Inc.) and Bill Bleha (Hughes-JVC Technology Corp.) will discuss Cinecomm's system approach, which "seeks to replace a century-old tradition of celluloid with an end-to-end digital system" (see text box). The keynote session will include clips from feature films transferred to digital media and shown electronically.



San Jose Convention and Cultural Facilities

San Jose's compact downtown area places the Convention Center, downtown hotels, cultural and entertainment facilities, good restaurants, and interesting architecture within convenient walking distance.

Digital Cinema: Ready for Opening Night

The SID '99 keynote session will be devoted to discussions of digital cinema by people who are leading its technological and business development, as well as demos showing what makes digital cinema so exciting.

Dr. Larry J. Hornbeck, inventor of the Digital Micromirror Device™ (DMD™) for TI, will discuss the creative, technical, and commercial benefits of digital cinema. Hornbeck told *ID* that TI has had an ongoing dialogue with the Hollywood creative community, and that the community is excited about TI's third-generation theatrical projection prototypes. "DLP Cinema™ emulates the quality of film," said Hornbeck. (DLP™, or Digital Light Processing™, is TI's name for the all-digital projection approach that incorporates the DMD microchip.) "Cinematographers use different film stocks as part of their creative vocabulary. One reason for their excitement is that they can see the subtle differences these stocks produce when the final product is shown on the screen using DLP Cinema."

"What excites me as the inventor of DMD technology," said Hornbeck, "is that it could create a paradigm shift in the cinema industry. For a display technology to be great, it must change the way people do their business. If cinematic delivery and exhibition *via* film is replaced by digital delivery and exhibition *via* DLP Cinema, the DMD could join the CRT and LCD as the third great display invention of the 20th Century."

ID asked Hornbeck: "When are ordinary people likely to see a demonstration of digital cinema?" The prompt answer: "It could happen this year."

DLP™ is not the only candidate for projection of electronic cinema. The other is the Image Light Amplifier (ILA™) from Hughes-JVC Technology Corporation (HJT). HJT has joined with Qualcomm to provide technology to a new company, CineComm Digital Cinema, L.L.C. CineComm is proposing an end-to-end digital system to "replace a century-old tradition of celluloid." Qualcomm is providing signal compression and encryption technology, while HJT is providing the projection technology. (*ID* called HJT's ILA-12K the undoubted "king of the show" at last June's INFOCOMM.)

CineComm's presentation will consist of two parts. Consultant Curt Behlmer (Studio Systems, Inc.) - who was responsible for the conceptual design and implementation of a new post-production digital infrastructure at Warner Brothers Studios, and served as Governor for the Sound Branch of the Academy of Motion Picture Arts and Sciences, among many other achievements - will speak on "Electronic Cinema and Hollywood."

William J. Bleha - who is Vice President, Engineering, for JVT; winner of the 1986 Rank Prize for Opto-Electronics for his role in the invention and development of the liquid-crystal light valve; and the holder of 20 patents - will speak on "The ILA Projector for Electronic Cinema."

Bleha told *ID* that digital cinema offers inexpensive duplication of "prints," quick and economical delivery to exhibitors, and unvarying image quality that does not degrade with use as film does. "And digital cinema also eliminates environmental hazards from the disposal of film," he said.

The technical sessions will be anchored with approximately 25 invited papers, including

- Mimicking the Sense of Olfaction: A Conducting-Polymer-Based Electronic Nose (Nathan Lewis, California Institute of Technology),
- Light-Emitting Polymer Display Driven by Poly-Si TFT (Tatsuya Shimoda, Seiko-Epson Corp.),
- Solid-State Laser-Based Displays (David E. Hargis, Microlaser Technology),
- Low-Temperature Poly-Si TFT Technology (Nobuki Ibaraki, Toshiba Corp.),
- 21st Century Aerospace Defense Displays (Darrel G. Hopper, Air Force Research Laboratory),
- A New PDP Technology to Improve Display Performance (Yoshikazu Kanazawa, Fujitsu Ltd.).

Switching speed has been a historical weakness of LCD technology, but that's changing rapidly. A whole session, chaired by Phil Bos and Tatsuo Uchida, will be devoted to the subject "Fast LCDs."

New this year is a lively concentration on display electronics, including sessions on display controllers and digital interfaces. In addition, there will be an all-invited session on video processing featuring papers by two of the leaders in the field:

- Video Processing for Pixelized Displays (Yves Faroudja, Faroudja Laboratories),
- Video Format Conversion (Gerard De Haan, Philips Research Laboratories).

Also new this year is a strong group of sessions on display applications, which include eight invited papers. Among these are

- In-flight Entertainment Display Applications (David Frankenbach, Rockwell Collins),
- Information Display Considerations of Automotive Plug-and-Play Computers, (Stephen Buckley, Daimler-Chrysler),
- CRT-Based Display Systems in Radiology (Hartwig Blume, Philips Medical Systems).

Together, these new sessions are intended to provide information and perspective to system and product designers, who are finding that displays are an increasingly important part of many electronic systems and that the variety of display technologies and implementations is steadily increasing.

Special Events

The President's Reception and the Awards Banquet will be held Monday evening, May 17th. (Tickets for the Awards Banquet must be purchased in advance.) The formal opening of SID '99 will be on Tuesday morning, and the extremely popular exhibitor-sponsored reception will be held in Exhibit Halls 2 & 3 at the SJCC on Tuesday evening, followed by the evening panel sessions.

At the gala Wednesday luncheon, the Fourth Annual SID/*Information Display* Display of the Year Awards will be presented. In addition to the two categories - Display of the Year and Display Product of the Year - that have been part of the DYA since its inception - a new category has been added for this year: Display Material or Component of the Year.

The winners of this year's Gold Awards in all categories are Tohoku Pioneer's organic electroluminescent display, Hughes-JVC's

Do You Know the Way to San Jose?

San Jose is served by San Francisco International Airport (SFO) for international and North American flights and by San Jose Airport (SJC) for regional (and some North American) flights.

Depending on traffic, it takes between 45 and 90 minutes to drive from SFO to downtown San Jose, and about 10 minutes to do so from SJC. Rental cars are readily available, but perhaps the most convenient and economical means of transportation from SFO is the United Airlines South Bay Flyer shuttle bus (www.landyacht.com/sbf). Reservations are not required and pick-up is at all blue pillars on the center island outside the baggage claim area on the *lower level* at all terminals. The fare is $19.00, which must be paid in cash, travelers check, or South Bay Flyer Ticket issued by United Airlines. Departure times are approximately 10 minutes before each hour from 7:50 to 11:50 a.m. and from 5:50 to 7:50 p.m. Additional departure times are 1:50 p.m. and 3:50 p.m.

For about $26, shuttle service to downtown San Jose is available from the South & East Bay Airport Shuttle (phone 408/225-4444; fax 408/226-4444) 24 hours a day, seven days a week. The shuttle provides door-to-door service for every passenger, so you may find yourself making interesting detours into residential neighborhoods in Palo Alto and Sunnyvale. Pick-up is from the center island on the *upper level* outside the airline ticket counters at all terminals. There is no need to call the shuttle when you arrive at SFO. Just go out to the center island and tell one of the dispatchers where you want to go. Assistance is also available from the information desk on the terminal's lower level and the Traveler's Aid booth on the upper level.

South Bay Flyers leave San Jose Airport for downtown San Jose at 15 minutes before and 15 minutes after the hour for most of the day between 7:45 a.m. and 10:45 p.m., with a final departure at 11:35 p.m. The fare is $7.00 (cash, travelers check, or United-issued ticket), but a taxi costs between $10 and $12 to the downtown hotels and is therefore cheaper for two or more people.

San Jose Convention and Cultural Facilities

An antique trolley passes San Jose's McEnery Convention Center on the tracks of San Jose's modern Light Rail System.

The "Capital of Silicon Valley" Welcomes SID '99

San Jose's most famous attraction is San Francisco, the unique and marvelous city 50 miles to the north. But San Jose and the surrounding area offer remarkable riches of their own, not the least of which are the companies and people of "Silicon Valley," Northern California's remarkable engine for technical innovation and the generation of wealth.

San Jose's McEnery Convention Center (SJCC) is located in downtown San Jose within easy walking distance of the elegant Fairmont (the headquarters hotel). Just across Market Street from the SJCC is the beautiful Hyatt Sainte Claire Hotel. It has the smallish rooms typical of the 1920s, when it was built, but they have been lovingly renovated, and the St. Claire's main public room is a 1920s masterpiece.

The Crowne Plaza Hotel is across San Carlos Street from the SJCC, and the San Jose Hilton and Towers is physically connected to the convention center. There are two other downtown hotels, and half a dozen hotels clustered near the San Jose airport, which is only 3 miles away. These include the Wyndham, Airport Inn International, Radisson, Hyatt San Jose, Doubletree, and Hanford. A hotel reservation form appears elsewhere in this issue. The convention center is also just a 15-minute walk from the SID International Headquarters at 31 East Julian Street (see top of map).

Among the area's technical and non-technical attractions are the Intel Museum in the Robert Noyce Building at Intel's headquarters in neighboring Santa Clara (408/765-0503), and the new and spectacular Tech Museum of Innovation (408/294-TECH; www.thetech.org), which is about halfway between the SJCC and the Fairmont Hotel.

The San Jose Museum of Art, also just a few steps from the Fairmont, shows works from the permanent collection of New York's Whitney Museum and a wide range of changing exhibitions emphasizing 20th-century art. The Peralta Adobe, built in 1797, is San Jose's oldest building, and is open as a museum.

The Rosicrucian Egyptian Museum contains over 5000 Egyptian artifacts, including mummies and a replica rock tomb. It is the largest Egyptian collection on the West Coast. The Winchester Mystery House (408/247-2101; www.winchestermysteryhouse.com) is an elaborate 160-room Victorian house, built by an eccentric heiress to the Winchester firearms fortune, which has many irrational architectural details, such as stairs that lead nowhere and doors that open onto walls. The famous Lick Observatory (408/274-5061), 25 miles south of San Jose atop Mount Hamilton, has a 120-in. reflecting telescope and a 36-in. refractor for the use of visitors.

Japantown in San Jose is the site of a Buddhist Church, the Japanese-American Historical Museum, a Sunday morning farmer's market, and a variety of shops. San Jose and Okayama, Japan, are "sister cities," and the Japanese Friendship Gardens in Kelley Park (408/277-5254) are patterned after Okayama's Korakuen Park. The San Jose Historical Museum (408/287-2290) is also located in the Kelley Park.

One of the famous California missions, Mission Santa Clara de Asis, founded in 1777, is located on the campus of the University of Santa Clara. Its lush gardens contain some of the oldest cultivated plants in California, including an original Castillian rosebush and the oldest grapevine in Northern California. Speaking of grapevines, although the wineries of Napa and Sonoma counties north of San Francisco are generally more famous, there are some excellent wineries in the Santa Clara Valley, including Mirassou and J. Lohr. Check with the Santa Clara Valley Wine Growers Association (www.scvwga.com) for directions and visiting (and tasting) hours.

In addition to tourist attractions, various opportunities for entertainment will be available around the time of SID '99. The musical *South Pacific* will play at the American Musical Theatre of San Jose starting on May 21st (408/453-7108), and the play *Sisters Matsumoto* - about three Japanese-American sisters who return to their father's farm to rebuild their lives after years in an American internment camp during WWII - will be at the San Jose Repertory Theatre through May 23rd (408/291-2255). (Show times for *Sisters Matsumoto* are 8:00 p.m. Tuesday through Saturday, with a 3:00 p.m. matinee on Saturdays and a 2:00 p.m. matinee on Sundays. There is a 7:00 p.m. show on Sunday the 16th.) The San Jose Symphony (408/288-2828) will present concerts on May 14-15 and May 21-23.

D-ILA™ digital graphics G1000 projector, Silicon Image's PanelLink™ digital interface for flat-panel monitors, and Dai Nippon's Ultra Contrast Screen for high-resolution rear-projection with improved contrast.

Silver Awards go to Fujitsu's 15-in. multi-domain vertical alignment TFT-LCD, which simultaneously delivers wide viewing angle and very fast switching time; and Alcatel's One-Touch Com™, which uses a display-centric interface to combine the functions of a GSM digital cellular phone, a personal organizer, a wireless Internet e-mail communicator, and a PC companion in a 240-gram package. Awards for the best papers from SID '98 will also be presented.

This year's luncheon speaker will be Dr. Edwin F. Erickson of the NASA Ames Research Center, who will speak on SOFIA: The Stratospheric Observatory for Infrared Astronomy.

The special evening event - an evening at San Jose's spectacular new Tech Museum of Innovation - will be held on Wednesday evening, May 19th. The evening will include complimentary drinks and an upscale buffet dinner, which includes a carving station. The museum, called "The Tech," is midway between the SJCC and the Fairmont and an easy walk from each of them, as well as from the Hyatt Sainte Claire. It's even closer to the Crowne Plaza. The only consistent criticism of last year's Symposium was directed at the special event. Says this year's Special Events Chair Hugo Steemers: "You'll enjoy this one." ■

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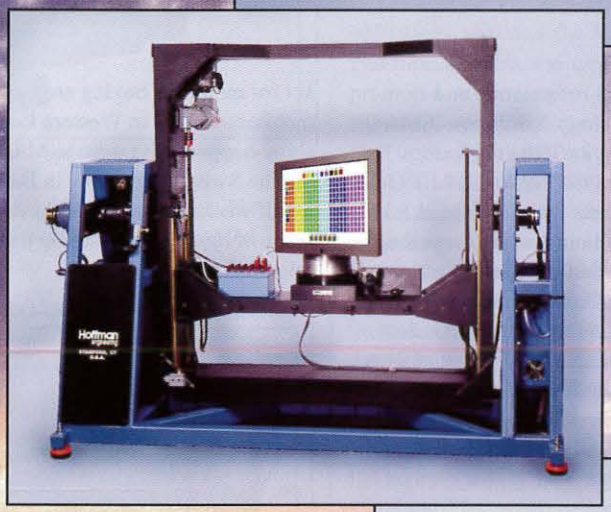

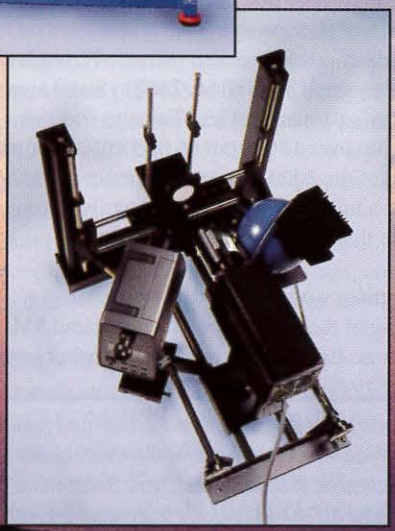

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Circle no. 14

SMAU Celebrates Its 35th Year in Style

The 35th running of the second largest IT trade fair in Europe attracted nearly half a million visitors, some of whom were there to check out the new CRT and LCD technologies on display.

by Bryan Norris

THE International Information and Communications Technology Exhibition (SMAU '98) was celebrating its 35th anniversary somewhat late, since the event was held October 22–26 – two weeks later than usual. Despite this change in its routine, or perhaps because of it, the Milan-based show attracted many more visitors than expected. Visitor numbers were up 31% to 470,000, comfortably exceeding the organizers' target of 400,000. Perhaps the fine Italian weather was helping to foster general enthusiasm.

The number of exhibitors who either had stands of their own or were represented on stands of others had also increased from last year to reach 3000 (from 2600). Stand area at Milan's permanent Fiera/Fair site was therefore up over 17% from 86,000 to 101,000 m^2. And of the 3000 companies present at SMAU, over a hundred were there primarily to promote displays.

Monitors of the Mediterranean

Many of the monitor companies attend SMAU because Italy is an extremely important market for monitors, buying around 9% of color-monitor supplies in Western Europe. Any show-hoppers who went to Milan after attending the Swiss Orbit Show in Basel three-and-a-half weeks before would have felt a distinct sense of *déjà vu* upon seeing the same "new releases" on display.

But suppliers should beware! Swiss buyers appreciate top-end high-quality high-specification products, and are therefore very receptive to the latest technologies. Italy, on the other hand, remains an extremely price-conscious market – along with its southern European counterparts, Spain, Portugal, and Greece.

Seleco

Fig. 1: *Plasma screens are now common at exhibitions, and SMAU was no exception. Many of the models were based on the Fujitsu panels, including this unit from Seleco.*

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La Cie

Fig. 2: *La Cie launched its 19-in. "electron 19 blue" at the show, which uses the new Mitsubishi Natural Flat tube. La Cie's units are high-end calibrated monitors directed at the graphic arts professions.*

Buyers may be wooed and dazzled at SMAU by the latest offerings, but their first question still remains "How much?" So, sales of 14- and 15-in. CRT models remain significant in Italy. These smaller screen sizes accounted for over 70% of color-monitor shipments in Italy during the first half of 1998, with 17- and 19-in. still only making up one-quarter of the shipments.

However, the movement away from basic low-end models in Italy is becoming more pronounced. Local PC assemblers, for example, reported that some of their corporate clients were actually specifying that bundled monitors should have features such as TCO '95! Suppliers are therefore increasing their efforts to push larger screen sizes and the latest technologies, feeling that the tide may at last be turning.

Who Needs Flat Panels Anyway?

Since most Italians are price-squeamish when it comes simply to moving from 14- or 15-in. to 17- or 19-in. CRTs, the thought of leaping to flat-panel-display (FPD) prices is much too traumatic. Luckily there are plenty of monitor suppliers who can put all nasty thoughts of FPDs to the back of a buyer's mind. The latest generation of cathode-ray tubes (CRTs) is a welcome cold shower for those temporarily consumed with FPD lust.

For a start, just look how much leaner CRTs can be nowadays. ***Panasonic*** (Matsushita) short-neck/depth (ZenTan) tubes were very much in evidence at SMAU. ***Panasonic***'s own 19-in. SL90 monitor, priced at L1400k/US$840, was displayed with the comment "a depth less than a conventional 17-in."

Naturally, the "smaller is better" theme was being put to good use elsewhere. ***ViewSonic***'s forthcoming PS790 19-in., displayed on the Hall 19 stand of distributor ***Test Firenze*** (exhibiting for the first time at SMAU), is described as providing "extra screen real estate without taking up much more than a typical 15-in. footprint."

And smaller-sized models are not simply being promoted for their space-saving advantages. ***Nokia*** was highlighting the improved health benefit for users of its new 446XS (L1550k/US$930), which incorporates ***Hitachi***'s short-length 19-in. tube. The 446XS is fitted into a unique well-designed low-profile ergonomic case. The model boasts a depth of only 424 mm and a height of only 360 mm (in mid-position) from the desk to the top of the screen, which means that a user's neck movement is reduced to a minimum. You can almost see the advertising straplines now: "A Computer That Cares!"

New CRTs: "Mean" As Well As "Lean"

The new generation of CRTs aren't being promoted for their slimline appearance alone. Let's not forget that all-important front view, where improvements have also been taking place. Take for example the recently released Diamond Pro 900U from ***Mitsubishi***, which incorporates the company's own Natural Flat Diamondtron™ 19-in. tube. The 900U has superb picture quality, accurate colors, and sharp focus across the whole screen, which has a wide viewing angle. A compact cabinet design with a depth of 456 mm ensures that this model has a smaller-than-expected footprint – and all this for a recommended end-user price of L1990k/US$1190.

The ***Iiyama*** Vision Master A901GT (Pro 450) 19-in. also uses the Mitsubishi Natural Flat tube, and this was one of two new models promoted on the stand of Iiyama's Italian distributor ***Concordia Graphics*** at the far end of Hall 20/2. This had a recommended end-user price of L2100k/US$1260.

Not to be outshone (literally!), ***Philips*** was promoting two new monitors that use a new Super High Contrast Tube and an Advanced Dynamic Focus System Design, which increase the luminance by 20%. The price of the 19-in. model, the Brilliance 109MP, was reported as L1595k/US$960.

In fact, it seems that nobody wants to be without a special claim to fame, and Hitachi has a good one. The company's CM814ET has the highest horizontal-scan frequency range to date (31–125 kHz) for a computer monitor! This is one of the CM81X series models (the CM811/2/3/4ET), which use the new 21-in. FST tube. This new tube and a space-saving 3S cabinet gives the 81 series a minimized footprint. The monitor depth, for example, has been reduced to 470 mm, compared to 520 mm for a typical 21-in. model.

What's in a Face?

Samsung was displaying its 19-in. 900IFT and 17-in. 700IFT models (scheduled for imminent release), which use the unique Samsung Infinitely Flat Tube that was shown at Asia Display in Seoul in September (see the Asia Display review in the January 1999 issue of *Information Display*). These tubes have a construction that gives a flat outer (glass) face whilst retaining the traditional curved inner face. Also on display were the 19-in. SyncMaster 900p that uses Samsung's (90°) mini-

neck tube, and the 19-in. 900SL (scheduled for release in 1999) that uses a mini-neck and short-depth 100° tube that gives the monitor a depth of only 407 mm.

Sony's 21-in. GDM-F500 was difficult to find in the crowded Sony hall, which was packed with a multitude of products. But once located it proved to have excellent focus, fitted as it was with the new Flat Display (FD) Trinitron technology with the SAGIC tube (small aperture G1 with tungsten-impregnated cathode). The ***Eizo*** 21-in. T960 displayed on the monitor wall of the ***Epson*** stand also uses this tube.

Sharing the Limelight

However dazzling the new CRT models, they couldn't take all the attention away from the FPDs. Of the LCD monitors, the ***Panasonic*** LC90 19-in. (which is due for release within the first 2 months of 1999) was the star of the show. This model has a pixel spacing of 0.27 mm, a resolution of 1280 × 1024, and features that include OSD and TCO '95 approval. The LC90 must be a serious contender for a European market that is currently the sole preserve of NEC's 20-in. models.

And talking of ***NEC***, the latest versions of its 20-in. LCD were prominently exhibited on the NEC stand along with the rest of the company's extensive range of LCD monitors. The 20-in. family now includes the LCD 2010 touch-panel and portrait industrial-frame versions. (The international PC house ***ZDS*** included the NEC range of LCD monitors in its catalogue.)

As elsewhere in Europe, there are currently only two 18.1-in. (SXGA) LCD products actually being sold in Italy at the moment, namely the Eizo L66 and the NEC LCD1810. But this state of affairs is set to change shortly because there were some "forthcoming" models in this size category on show in Milan. ***Hitachi***'s 18.0-in. (own-panel) DT18, exhibited on its small Assoprint-area booth in Hall 9, was expected to be on sale by the end of 1998. And ***Nokia*** is also aiming to bring its 18.1-in. 800Xi (with an NEC panel) to market before the end of 1998. This model was extensively publicized in the press and was heavily promoted on Nokia's own stand, as well as on those of distributor ***Discom*** and its subsidiary ***Eletec.*** At the other end of the publicity scale, ***LG***'s 18.1-in. 800LC was being quietly displayed in the back room of its large (Hall 11) stand.

Plenty of 15-in. LCDs

LG was less shy about its new 15-in. model, the 500LC, which was proudly exhibited at the front of the stand. At Milan it became obvious that in Italy, as in the rest of Western Europe, the 15-in. is becoming the prime screen size for LCD monitors. Named brands such as ***ADI, Belinea, Eizo, Hitachi, LG, Mitsubishi, NEC, Nokia, Panasonic, Samsung, Siemens, Sony,*** and ***ViewSonic*** were all being promoted. And ***IBM*** had its new 15-in. models, in both analog and digital versions, although they were a little tricky to find on such an enormous stand.

But on some stands, such as that of PC assembler ***ASEM,*** 15-in. models were intriguingly absent. Apparently, a decision had been taken not to introduce them until prices had stabilized! The extremely "competitive" price of the ***Philips*** 151AX at L1980k/US$1190 had "upset" the Italian marketplace as it had elsewhere in Europe!

European markets continue to retain some "brand" individuality, and the Italian market is no exception, with some monitor brands unique to southern Europe. Italian makers/suppliers exhibiting LCDs at SMAU included companies such as ***CA&G*** and ***McPerson.*** McPerson, exhibiting a range of models that extended from a 10.4-in. TFT to a 15.5-in. DSTN, must have been the happiest of the Italian companies at SMAU because it had just won a sizeable contract to supply the Italian Post Office.

And McPerson had other good news. The company announced it would be working with new partner ***MicroTouch*** to produce a range of touch-screen LCD monitors. Not that these are the only touch screens in town. ***Elo Touchsystems,*** with a range of touch-screen monitors based on Philips' models, was promoting its new touch-screen 15-in. LCD monitor, the Trimline 15.1.

Preparing the Way for Plasma

Plasma screens are now common at exhibitions, and SMAU was no exception. Many of the models were based on the ***Fujitsu*** panels, including those of ***Fujitsu General*** and Italian manufacturers ***Sambers*** (***Hantarex*** brand) of Milan and ***Seleco*** (Fig. 1). Fujitsu General's plasma displays were exhibited on the stand of its distributor ***Melchioni.*** The 42-in. (852 × 480 screen resolution) products were the PDS 4203E, the PDS 4204E, and the new PDS 4201E. These were priced at L20.6M/US$12,360, L25M/US$15,000, and L19M/US$11,400, respectively. The 21-in. VGA PDS 2174B was also being promoted.

Sambers forecasted it would have its Fujitsu-based 25-in. plasma display on sale in April 1999, to join its highly successful large-screen CRT line-up (28-, 29-, and 32-in.). The plasma display was being designed primarily for airport information systems. In the same way, ***Fimi,*** the Italian manufacturing arm of Philips at Saronno, has taken responsibility for both plasma units and large-screen CRT information monitors, which are primarily designed with airports in mind.

A tour of SMAU revealed a number of other plasma offerings. On the ***Epson*** stand, a prototype Eizo-branded 42-in. NEC-panel-based unit was displayed so that the level of interest could be ascertained. And ***NEC***'s 33- and 42-in. plasma displays, the PlasmaSync 3300 and 4200W, were on view in a prominent place on its stand. ***Mitsubishi***'s XP-4015C plasma monitor is a 40-in. VGA model with 4:3 aspect ratio and a luminance of over 300 cd/m^2, making it "as bright as a conventional CRT." ***Pioneer***'s plasma monitors were shown on its stands in Halls 25 and 26.

La Cie

Fig. 3: La Cie also introduced its "blue eye" calibrator, a novel hardware calibration system that operates by using a serial connection between the monitor and its host Macintosh PC.

Sharp was promoting the advantages of its prototype 42-in. plasma-addressed liquid-crystal (PALC) display, notably the high 100:1 contrast ratio.

Selling Ourselves, Not Just Our Products

As regular exhibition-goers will know, shows like SMAU do not simply provide an opportunity to say, "Look at our wonderful products." They are also the forum to push out the PR boat and say, "Look how well our company is doing."

ADI had opened an Italian office in Verona in April and was celebrating with its own stand at this year's show (in Hall 11), as well as using its traditional venue on the booth of distributor ***Digitronica.*** ***CTX*** had also just opened its Italian office (at Vimercate near Milan), and its stand always seemed to be crowded despite being located on the top floor of Hall 20, which is quite far from Hall 11.

La Cie may not have a permanent presence in Italy as yet, but seems to be present practically everywhere else. Founded in France in 1989, La Cie has since opened offices in London (1991), Brussels and Copenhagen (1992), Dusseldorf (1993), Rotterdam (1994), Madrid (1995), Stockholm and Toronto (1996), and Portland, Oregon (1997). Around 83% of the company's business is now outside France.

La Cie is steadily obtaining an excellent reputation as a supplier of high-end 19- and 21-in. CRT monitors that are specked out extremely well for graphics applications. The company launched its 19-in. "electron 19 blue" at the show, which uses the new Mitsubishi Natural Flat tube. Previously branded "d2," all La Cie-branded monitors currently use aperture-grille tubes and carry 3-year on-site warranties. On its stand at SMAU (in the "Apple" Hall 8), La Cie was displaying its hooded dark-blue-cased models, whose unique dark blue bezels, non-glare tubes, and color-enhancing hoods minimize light reflections and shadows (Fig. 2). La Cie was demonstrating its "blue eye" calibrator, which was also launched at the show (Fig. 3). This novel hardware calibration system operates by using a serial connection between the Macintosh PC and La Cie's electron 21/108 monitor. "Blue eye" has a higher specification than the much older BARCO system and sells for only two-thirds of the price.

Intercomp Computer

Fig. 4: *A recent trend among Italian distribution and assembly companies is to sell branded monitors with their PCs rather than units bearing their own name, as is the case with the MAG monitor bundled with this Intercomp computer.*

The Italian Mob

Apart from tracking down the monitor suppliers, it's useful to use national shows like SMAU to understand local distribution. However, following the progress of monitor products from supplier to end user in Italy has always been a nightmare, since it is often impossible to differentiate clearly between different channels - distributors, large dealers, and PC assemblers! Each year the route to market becomes more complex and confused.

Where, for example, should companies such as ***Computer Store*** and ***Executive*** be positioned? Computer Store has numerous outlets throughout Italy, distributes a wide range of PC peripherals (currently including the monitors of LG and Samsung), and also assembles PCs (bundled with the aforementioned branded monitors). Executive distributes a wide range of products from "Accessori" to "Videoproiettori," including the monitors of ***Daewoo*** and (exclusively) ***Sampo*** - and also acts as distributor/dealer in selling ***Acer, Philips, Sony,*** and ***Eizo*** monitors. ***Executive***'s own-brand monitor, Timeline, has been discontinued, so the company's PCs are sold with a branded monitor.

In fact, there is a trend among distribution and assembly companies to sell branded monitors with their PCs rather than units bearing their own name. Italian PC assemblers turning to branded monitors include ***D.I.I. Computer,*** which places Hyundai monitors on its PCs; ***Gruppo Elettrodata,*** with LG monitors on its Sam@ra PCs; ***Eletec,*** with Belinea and Nokia monitors on its Reckon PCs; ***Unibit*** (D-Top) with CA&G "Vidi" monitors; and ***Michieli***'s "Hidea" PCs, usually with LG monitors, although Michieli also sells monitors from Germany's ***Peacock.*** Many of the distributors/assemblers have also diversified into selling other PC peripheral products, which often include the monitor brand(s) they bundle with their PCs.

Some Italian companies did decide to buck the trend towards using well-known monitor names and introduced their own new brand names to the market. Previously unseen

show report

brands encountered at the show included ***GEO Vision*** and ***Hiva,*** for ranges of LCD monitors from ***Monolith Italia*** (which majors in notebooks) and ***Grupo Elettrodata,*** respectively. ***HOYO*** was another new brand name for a range of CRT monitors - 15-in. (70 kHz), 17-in. (70 and 95 kHz), and 19-in. (95 kHz) - from the Dutch parent company of ***Global Impact Italia.*** And Italian hardware distributor ***TVS*** (Test Video System) made an interesting choice of name for its new brand: Yusonic!

Three quality products are being made exclusively for TVS by Matsushita, a 17- and a 21-in., plus a 19-in. (the TX-D9S54) with the short-neck ZenTan tube. TVS was founded in 1993 to distribute IBM OEM products. It has expanded its portfolio to reach a turnover of US$33M, and is setting its sights on establishing "a significant market penetration in Europe (outside Italy)!" TVS also distributes ProView monitors from Taiwanese ***EMC.***

As discussed at the beginning of this article, the Italian PC assemblers were glad to report a move towards larger-sized monitors. ***Olidata,*** a major PC assembler at around 130,000 units a year, reported that 70% of the (own-brand) monitors bundled with its PCs are now 15-in. models. And ***Intercomp*** reported that around 60% of its clients now request 15-in. monitors and 35% request 17-in., with most of the rest taking 21- or 19-in. models. Intercomp had a large room in the Ambassador Hotel, as well as a stand on the third floor of Hall 17, to demonstrate its PCs for professional and industrial clients, which it builds (at its office/factory site in Verona) to ISO 9002 standards. It places ***MAG*** monitors with its PCs (Fig. 4) and also acts as MAG's Italian distributor.

On the Diagonal

So, the main message from SMAU is that Italy remains a price-conscious market, but buyers are now more amenable to displays with larger screen sizes and higher specifications. Thus, the local suppliers trust that "reduced-depth" CRTs and 15-in. LCDs will soon become firm favorites with their customers. Regardless of screen size, the suppliers are also trying to boost their market by offering even better service facilities - warranty periods of 3 years with 1-year on-site are becoming the norm.

Next year SMAU will return to its customary time slot, taking place from September 30 to October 4, 1999. ■

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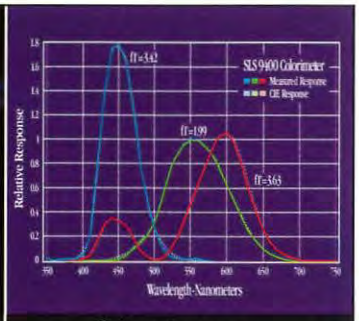

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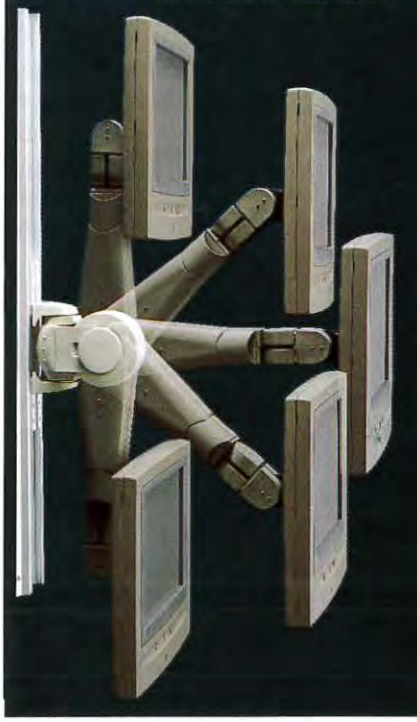

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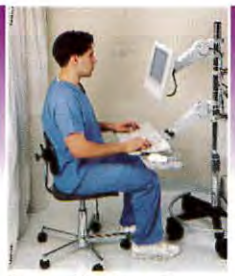

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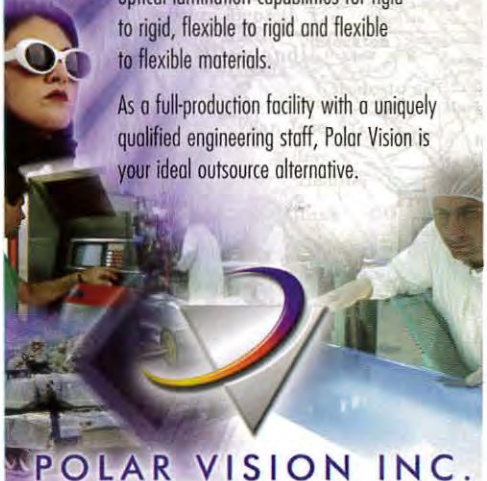

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Now that all the latest laptop computers have screens with wide viewing angles, it takes little effort to see how these machines are being used – these state-of-the-art 12.1-in. active-matrix-display 300+ MHz machines, so carefully justified to upper management as indispensable for conducting business. Well, here are the results of my survey. The early part of each trip is typically used to enter travel expenses using a highly sophisticated spreadsheet. Don't ask me why. Apparently, that's just the way it has to be done. Then, for the remainder of the trip, this highly sophisticated computer, with its great-looking display, is used to play solitaire. Such color! Such clarity! Much better and more convenient than a real deck of cards.

A 300-MHz processor used to play solitaire? Can you imaging how bored that processor must be doing that? However, while the processor is dying of boredom, or maybe of an expiring battery due to the extra juice needed to keep that wide-viewing-angle screen nice and bright, the human is functioning at the limits of his or her remaining late-day capability. Isn't there something that could be done with a laptop computer better than playing solitaire? Isn't there some other low-stimulant activity that would require no more and maybe even less from that nearly brain-dead traveler? Couldn't the computer at least play a movie or something? After all, there is that CD-ROM drive already installed just waiting for something to do.

Well, the very next day I was looking at an IBM advertisement for the ThinkPad laptop computers and what did I see? A video adapter for a mere $219 that allows the ThinkPad DVD drive to be used for movie playback. By golly, those folks at IBM do understand us business travelers. Finally, a laptop-computer application that meets the needs and abilities of the great majority of business travelers during those long hours while they are lashed into their airplane seats. But, couldn't IBM, with all its marketing cleverness, have included this adapter in a package deal so that purchasing departments everywhere wouldn't have to question the justification for this item on the requisition form? I'm very sure that this oversight will be quickly corrected by IBM and others in subsequent product offerings.

The idea of letting seat-bound airplane passengers watch something more than the standard movie offering, with the barely intelligible sound, has already been implemented in the first-class section on several airlines. Portable videotape players with LCD screens are offered, along with a selection of 20 or so movies brought around by the flight attendants. This system is a good start, but the tapes are too bulky to have a really large selection. Just think how much better this could be and will be with DVDs.

Have you been waiting and wondering when HDTV is going to happen? Eventually, it *will* happen, but not the next year, or two, or

three. However, look what's already happening instead. Movies and other video materials are now becoming available on laptop computers. New portable DVD players are appearing with increasing regularity. Television sets with true 500-line resolution at affordable prices are almost here. Home-use DVD players are already available for well under $500. And even the somewhat unusual (it will be called innovative if it succeeds) rental/purchase DVIX concept could take off if the purchase price of DVDs doesn't drop soon into the $20-and-below range.

The next generation of video is happening right now and it's not HDTV. DVD is gaining acceptance faster than VCRs did and faster than audio CD players did. Eighteen months after their introduction, roughly 400,000 VCRs and 360,000 CD players had been sold. The comparable number for DVD players is just over 1,000,000 units. And it's only been very recently that the movie industry has become serious about putting out the program titles needed to make DVD sales really take off.

The additional impetus of *portable* video entertainment, with as good a display as one can afford, combined with the factor-of-two resolution improvement over a VCR, is going to make DVD the "next big thing" in consumer electronics.

This is even good news for helping get HDTV and DTV moving. Once the consumers can see how good a 500-line picture can be for anything up to 30-in.-diagonal video displays, there will be the realization that the higher-resolution 700- and 1000-line formats are only needed for the larger wall-hanging flat panels or for sophisticated projection systems. That will drive the acceptance of the intermediate resolution and more affordable products.

Have you purchased your DVD player yet? If not, get out your credit card. Nineteen ninety-nine is going to be the year of the DVD. Your video entertainment center needs one, and most certainly your laptop computer needs one.

Isn't this display business great? There just seems to be one new opportunity after another. All these portable DVD players will need a range of displays from low-priced modest-performance ones to really high-quality high-resolution ones. Even I, a most reluctant moviegoer with maybe three movies attended in the past year, am thinking how nice it would be to have a 9:16 format 12-in.-diagonal-screen DVD player, with a good set of earphones, to carry around with me. But please, make sure you give me at least six hours of battery life. I wouldn't want to have to wait to get to my hotel to see the suspenseful ending of that Windows 98 tutorial that I will be watching on my next flight.

display continuum

Should you wish to suggest some alternate program material for me to play on my new DVD machine, you can reach me by e-mail at silzars@ibm.net, by fax at 425/557-8983, by phone at 425/557-8850, or send me your company's promotional DVD to 22513 S.E. 47th Place, Issaquah, WA 98029. ■

editorial

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The surge in interest in witchcraft is not only a redirection of talent, but also a disturbing indication that the culture of science and technology is endangered by magical and mystical thinking. (There isn't any particular hostility to science and technology. Witches make enthusiastic use of the Internet and have spells to fix recalcitrant computer mice and to "free oneself from excessive computer enchantment.")

Witches and their "New Age" cousins of various flavors are often happy to enjoy the fruits of science and technology, but they don't share the world view that makes those fruits possible. And, I'm afraid, this is true of much of the American population today, whether they count themselves witches or not.

Some analysts believe the current claims of engineering shortages to be exaggerated at best and deceitfully self-serving at worst. But if the shortage is not real today, it will surely be real tomorrow. As science and technology lose whatever glamour they still have, how are we to attract the next generation of technologists? The "Wizard of Menlo Park" will be replaced by the "witch of Mill Valley." I hope she has a spell for a good blue phosphor.

– Ken Werner

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

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6 SEPTEMBER 99

19th International Display Research Conference (Euro Display '99)

BERLIN, GERMANY
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8 NOVEMBER 99

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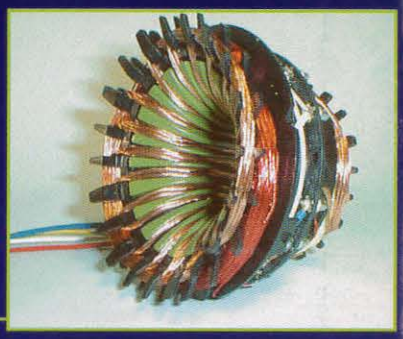

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CELCO Yoke for Naval Shipboard Display

Left: Commerical Head-Up Display Yoke

Top: Flight Mgt. Display Yoke

Bottom: F-18 Map Display Yoke

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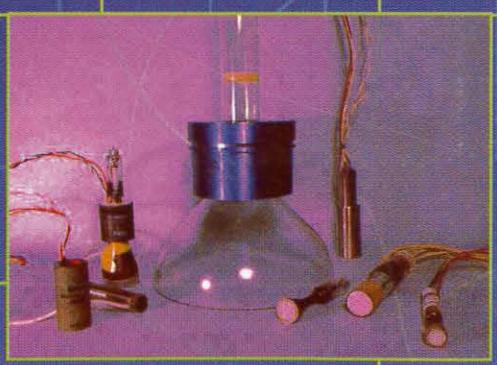

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